



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:  
**03.05.2017 Bulletin 2017/18**

(51) Int Cl.:  
**B65H 54/88 (2006.01)** **B65H 57/00 (2006.01)**  
**B65H 67/048 (2006.01)** **D01D 13/02 (2006.01)**

(21) Application number: **16196252.7**

(22) Date of filing: **28.10.2016**

(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**  
Designated Validation States:  
**MA MD**

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(30) Priority: **30.10.2015 JP 2015213745**

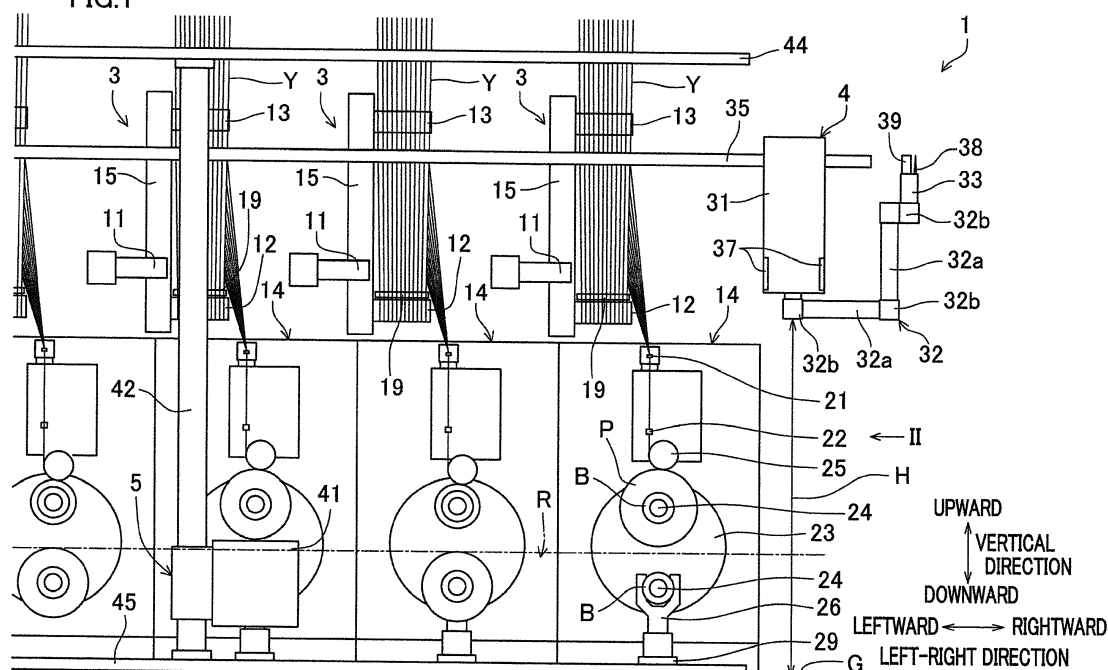
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(54) **SPUN YARN WINDING SYSTEM**

(57) In a spun yarn winding system, a yarn threading robot is less likely to interfere with an operator or an apparatus which collects packages. Take-up units 3 are lined up in the left-right direction. Each take-up unit 3 is configured to take up yarns Y spun out from a spinning apparatus and form packages by winding the yarns Y into bobbins B. A yarn threading robot 4 is provided above

a winding unit 14 of the take-up unit 3, and hangs down from a guide rail 35 extending in the left-right direction over the take-up units 3 and moves in the left-right direction along the guide rail 35. At least when moving along the guide rail 35, the yarn threading robot 4 is positioned above the upper end of a fully-wound package P attached to a bobbin holder 24.

**FIG.1**



## Description

### BACKGROUND OF THE INVENTION

**[0001]** The present invention relates to a spun yarn winding system configured to take up yarns spun out from a spinning apparatus.

**[0002]** In a spun yarn winding system recited in Patent Literature 1, yarns spun out from a spinning apparatus are wound onto first and second godet rollers. These yarns are then threaded onto fulcrum guides. Each yarn is then traversed by a traverse guide about the fulcrum guide, and is wound onto a bobbin attached to a bobbin holder. In Patent Literature 1 (Japanese Unexamined Patent Publication No. 2015-78455), furthermore, to thread the yarns spun out from the spinning apparatus onto the spun yarn winding system, to begin with, the first godet roller and the second godet roller are arranged to be close to each other as the second godet roller is moved to a yarn threading position, and the fulcrum guides are arranged to be close to one another as the fulcrum guides are moved to yarn threading positions. Subsequently, while being retained by a suction gun, the yarns spun out from the spinning apparatus are wound onto the first godet roller and the second godet roller in this order. These yarns are then threaded onto the respective fulcrum guides.

**[0003]** In Patent Literature 2 (Japanese Unexamined Patent Publication No. 11-106144), spinning apparatuses are lined up to form a single line, and a winding device (equivalent to a take-up unit of the present invention) is provided below each spinning apparatus to correspond to that spinning apparatus. In other words, the winding devices form a line in Patent Literature 2. In Patent Literature 2, furthermore, on the front side of the line of the winding devices, a vertical column is provided to movable along the line of the winding devices, and a lift table is provided on the vertical column in an elevatable manner. In the lift table, a spindle (equivalent to a shaft of the present invention) is provided to be inserted into a package. In Patent Literature 2, the lift table is moved to a winding device which has requested doffing, and the lift table receives a package from the winding device as the spindle is inserted into the package.

### SUMMARY OF THE INVENTION

**[0004]** In Patent Literature 1, an operator threads yarns onto godet rollers and fulcrum guides. To achieve automation, it is possible, for example, to provide a yarn threading robot which is common to plural winding devices, is movable across the winding devices, and automatically performs threading onto godet rollers and fulcrum guides.

**[0005]** In the meanwhile, in the spun yarn winding system of Patent Literature 1, it is necessary to collect a package from a bobbin holder. The collection of the package may be manually done by an operator or may be

done by an apparatus recited in Patent Literature 2.

**[0006]** When the above-described yarn threading robot is provided in the spun yarn winding system of Patent Literature 1, during the collection of a package from a winding device, the yarn threading robot may be moved to another winding device to thread yarns onto godet rollers and fulcrum guides. At this stage, the collection of the package may be being performed at a position between the current position of the yarn threading robot and the winding device where the yarn threading is to be performed. In such a case, to prevent the yarn threading robot from interfering with the operator or apparatus collecting the package, it is necessary to, for example, move the yarn threading robot to the target winding device after the completion of the collection of the package, and hence the completion of the yarn threading may be delayed.

**[0007]** An object of the present invention is to provide a spun yarn winding system including a yarn threading robot which is less likely to interfere with an operator or an apparatus collecting a package.

**[0008]** According to the first aspect of the invention, a spun yarn winding system includes: take-up units each of which includes a take-up member configured to take up yarns spun out from a spinning apparatus and a winding unit provided below the take-up member to wind the yarns taken up by the take-up member onto bobbins lined up in a horizontal first direction so as to form packages, the take-up units being lined up in a second direction which is horizontal and is orthogonal to the first direction; a yarn threading robot which is commonly provided for the take-up units, is provided on one side in the first direction of the winding unit, and is configured to thread the yarns onto the take-up members of the take-up units; and a controller configured to control the yarn threading robot, the yarn threading robot being movable in the second direction while hanging down from above.

**[0009]** In the present invention, because the yarn threading robot is movable in the second direction while hanging down from above, the yarn threading robot on the move is less likely to collide with an operator, another device, or the like.

**[0010]** According to the second aspect of the invention, the spun yarn winding system of the first aspect is arranged such that the yarn threading robot is movable in the second direction at a space which is on the one side in the first direction of the winding unit and is above a package ejection space to which the packages are ejected from the winding unit.

**[0011]** In the present invention, because the yarn threading robot moves above the package ejection space, the movement of the yarn threading robot and the collection of the packages in the package ejection space can be simultaneously done.

**[0012]** According to the third aspect of the invention, the spun yarn winding system of the second aspect is arranged such that the package ejection space is a space between an upper end of a fully-wound package at the

winding unit and an installation surface of the take-up units.

**[0013]** In the present invention, because the yarn threading robot moves above the fully-wound packages at the winding unit, the movement of the yarn threading robot and the collection of the packages in the package ejection space can be simultaneously done.

**[0014]** According to the fourth aspect of the invention, the spun yarn winding system of the second or third aspect is arranged such that the winding unit includes a package ejector configured to eject the packages to the package ejection space, and a package collector is provided to collect the packages ejected from the winding unit in the package ejection space.

**[0015]** In the present invention, the movement of the yarn threading robot and the collection of the packages by the package collector can be simultaneously done.

**[0016]** According to the fifth aspect of the invention, the spun yarn winding system of the fourth aspect is arranged such that the package collector is movable in the second direction on a side opposite to the take-up units in the first direction with respect to the yarn threading robot.

**[0017]** In the present invention, the package collector can be moved in the second direction even if the yarn threading robot is performing yarn threading.

**[0018]** According to the sixth aspect of the invention, the spun yarn winding system of any one of the first to fifth aspects is arranged such that the take-up member includes a godet roller on which the yarns spun out from the spinning apparatus are wound, the yarn threading robot is provided on one side in the first direction of the take-up units to thread the yarns onto the godet roller, and when the yarn threading robot threads the yarns, the godet roller is provided at an end portion on the one side in the first direction of each of the take-up units.

**[0019]** In the present invention, while the yarn threading robot hanging down from above is provided on the one side in the first direction of the take-up members, the godet roller is provided at an end portion on the one side in the first direction of the take-up unit when the yarn threading robot performs yarn threading. This allows the yarn threading robot to relatively easily perform yarn threading onto the godet roller.

**[0020]** According to the seventh aspect of the invention, the spun yarn winding system of the sixth aspect is arranged such that the winding unit includes distribution guides which are lined up in the first direction and are configured to distribute the yarns sent from the godet roller to the bobbins, the yarn threading robot threads the yarns onto the distribution guides, and when the yarn threading robot threads the yarns, the distribution guides are shifted to an end portion on the one side in the first direction of the take-up units.

**[0021]** In the present invention, while the yarn threading robot hanging down from above is provided in the one side in the first direction of the take-up members, the distribution guide are shifted to an end portion on the one

side in the first direction of the take-up unit when the yarn threading robot performs yarn threading. This allows the yarn threading robot to relatively easily perform yarn threading onto the distribution guides.

**[0022]** According to the eighth aspect of the invention, the spun yarn winding system of any one of the first to seventh aspects is arranged such that the yarn threading robot includes: a main body configured to be movable in the second direction while hanging down from above; an arm member attached to the main body; and a yarn holding member attached to a leading end portion of the arm member to retain the yarns, and the arm member in a moving posture for moving in the second direction is positioned above the arm member in a yarn threading posture for threading the yarns.

**[0023]** In the present invention, when yarn threading is performed, the yarn threading robot is allowed to perform yarn threading by lowering the arm member. In the meanwhile, when moving in the second direction, the arm member is positioned to be above the arm member in the yarn threading, so that the arm member and the yarn holding member are less likely to interfere with an operator, another device, or the like.

**[0024]** According to the ninth aspect of the invention, the spun yarn winding system of the eighth aspect is arranged such that, in the moving posture, a projected area of the yarn threading robot is minimized in the second direction.

**[0025]** In the present invention, as the yarn threading robot is arranged such that, in the moving posture, the projected area of the yarn threading robot is minimized in the second direction, the yarn threading robot moving in the second direction is least likely to collide with an operator, another device, or the like.

**[0026]** According to the tenth aspect of the invention, the spun yarn winding system of the eighth or ninth aspect is arranged such that the main body is supported at two parts distanced from each other in the first direction and hangs down.

**[0027]** In the present invention, because the main body is supported at two parts distanced from each other in the first direction and hangs down, swing of the main body in the first direction is restrained when the arm member is driven.

**[0028]** According to the eleventh aspect of the invention, the spun yarn winding system of any one of the first to tenth aspects is arranged such that the yarn threading robot is driven by motors, and the controller restricts torque of the motors when the yarn threading robot collides with an obstacle.

**[0029]** In the present invention, because the torque restriction is performed for the yarn threading robot when the yarn threading robot collides with an operator the like, the occurrence of a severe accident when the yarn threading robot collides with the operator or the like is prevented.

**[0030]** According to the twelfth aspect of the invention, the spun yarn winding system of any one of the first to

eleventh aspects further includes an obstacle sensor configured to detect an obstacle in a space which is overlapped with the yarn threading robot in the second direction, the controller stopping the movement of the yarn threading robot when the obstacle sensor detects an obstacle.

**[0031]** In the present invention, this prevents the yarn threading robot on the move from colliding with an operator or the like.

**[0032]** According to the thirteenth aspect of the invention, the spun yarn winding system of any one of the first to twelfth aspects is arranged such that the height of a lower end of the yarn threading robot moving in the second direction is 1700mm or more from the installation surface of the take-up units.

**[0033]** In the present invention, when the height of the space between the take-up unit and the yarn threading robot on the move is 1700mm or more, an operator is allowed to relatively easily perform operations such as maintenance of the winding unit and attachment of bobbins to the bobbin holder in this space, even if the yarn threading robot is moving.

**[0034]** According to the fourteenth aspect of the invention, the spun yarn winding system of any one of the first to thirteenth aspects is arranged such that the take-up member includes a first sucking retaining unit configured to suck and retain the yarns, and the yarn threading robot includes: a second sucking retaining unit configured to suck and retain the yarns; and a cutter configured to cut the yarns.

**[0035]** In the present invention, as the yarns sucked and retained by the first sucking retaining unit of the take-up member are cut by the cutter and the yarns having been cut are sucked and retained by the second sucking retaining unit, handover of the yarns to the second sucking retaining unit (yarn threading robot) is carried out.

**[0036]** According to the fifteenth aspect of the invention, the spun yarn winding system of the fourteenth aspect is arranged such that the controller causes the first sucking retaining unit to hand the yarns to the second sucking retaining unit by causing the cutter to cut the yarns retained by the first sucking retaining unit and causing the second sucking retaining unit to suck and retain the yarns having been cut.

**[0037]** In the present invention, as the cutter cuts the yarns sucked and retained by the first sucking retaining unit of the take-up member and the second sucking retaining unit sucks and retains the yarns having been cut, handover of the yarns to the yarn threading robot (second sucking retaining unit) is carried out.

**[0038]** According to the sixteenth aspect of the invention, the spun yarn winding system of the fifteenth aspect is arranged such that the take-up member further includes a godet roller which is provided below the first sucking retaining unit and on which the yarns spun out from the spinning apparatus are wound, and the controller causes the yarn threading robot to thread the yarns sucked and retained by the second sucking retaining unit

onto the godet roller.

**[0039]** In the present invention, the yarns sucked and retained by the second sucking retaining unit are threaded onto the godet roller.

**[0040]** According to the seventeenth aspect of the invention, the spun yarn winding system of the sixteenth aspect further includes a yarn regulating guide provided between the godet roller and the first sucking retaining unit to regulate an interval between neighboring yarns to be at a predetermined value, the yarn regulating guide being movable in an axial direction of the godet roller under the control of the controller, and when the yarn threading robot is caused to thread the yarns sucked and retained by the second sucking retaining unit onto the godet roller, the controller moving the yarn regulating guide to a position which protrudes as compared to a leading end portion of the godet roller, then performing yarn threading onto the yarn regulating guide by moving the second sucking retaining unit to a position below the godet roller, and then moving the yarns to a position overlapped with the godet roller by moving the second sucking retaining unit and the yarn regulating guide to the base end side in the axial direction of the godet roller.

**[0041]** When the yarns are handed from the first sucking retaining unit to the second sucking retaining unit, the second sucking retaining unit is positioned above the godet roller. To perform the yarn threading onto the godet roller, it is necessary to move the second sucking retaining unit to a position below the godet roller. Furthermore, it is necessary to perform yarn threading onto the yarn regulating guide. In the present invention, when the handover of the yarns is completed, the yarn regulating guide is moved to a position where the yarn regulating guide protrudes as compared to the leading end portion of the godet roller, and then the second sucking retaining unit is moved to a position below the godet roller, with the result that the yarn threading onto the yarn regulating guide is carried out. This prevents the interference of the yarn threading robot with the godet roller when the second sucking retaining unit is moved. Furthermore, the second sucking retaining unit is moved to a position below the godet roller and then the second sucking retaining unit and the yarn regulating guide are moved to the base end side in the axial direction of the godet roller, with the result that the yarns are moved to a position overlapped with the godet roller. In this state, yarn threading onto the godet roller becomes possible.

**[0042]** In the present invention, because the yarn threading robot is movable in the second direction while hanging down from above, the yarn threading robot on the move is less likely to collide with an operator, another device, or the like.

## BRIEF DESCRIPTION OF THE DRAWINGS

**[0043]**

FIG. 1 is a schematic diagram of a spun yarn winding

system of an embodiment of the present invention and shows that an automatic yarn threading robot is in a moving posture and an elevation unit is in a collecting posture.

FIG. 2 shows FIG. 1 in the direction of the arrow II. FIG. 3 is equivalent to FIG. 1 and shows that the automatic yarn threading robot is in a yarn threading posture and the elevation unit is in a conveyance posture.

FIG. 4 is equivalent to FIG. 2 and shows that the automatic yarn threading robot is in the yarn threading posture and the elevation unit is in the conveyance posture.

FIG. 5(a) and FIG. 5(b) shows fulcrum guides from above. FIG. 5(a) shows a state in which the fulcrum guides are at winding positions, whereas FIG. 5(b) shows a state in which the fulcrum guides are at yarn threading positions.

FIG. 6(a) is an enlarged view of the upper end portion of the automatic yarn threading robot shown in FIG. 2. FIG. 6(b) shows FIG. 6(a) in the direction of the arrow B.

FIG. 7 is a block diagram showing an electric structure of the spun yarn winding system.

FIG. 8(a) shows a state in which an aspirator of a yarn threading unit is in contact with yarns. FIG. 8(b) shows a state in which handover of the yarns to the aspirator of the yarn threading unit has been completed. FIG. 8(c) shows a state in which the yarn threading unit is moved to a position below a first godet roller. FIG. 8(d) shows FIG. 8(c) in the direction indicated by the arrow D. FIG. 8(e) shows a state in which the yarn threading unit and a regulating guide are moved so that the yarns are overlapped with the first godet roller. FIG. 8(f) shows a state in which the yarn placement onto the first godet roller and the second godet roller has been completed.

FIG. 9 shows a state in which packages ejected from a bobbin holder is retained by the elevation unit.

FIG. 10 shows a state in which the elevation unit retaining the packages is in the conveyance posture.

FIG. 11 relates to a modification and is equivalent to FIG. 7.

## DESCRIPTION OF THE PREFERRED EMBODIMENTS

**[0044]** The following will describe a preferred embodiment of the present invention.

(Overall Structure of Spun Yarn Winding System)

**[0045]** A spun yarn winding system 1 of the present embodiment is configured to take up yarns Y spun out from an unillustrated spinning apparatus and form packages P by winding the yarns Y onto bobbins B, respectively. As shown in FIG. 1 to FIG. 4, the spun yarn winding system 1 includes take-up units 3 and a single yarn threading robot 4 and a single package collector 5 which

are provided to be in common among the take-up units 3.

**[0046]** The take-up units 3 are provided to be lined up in one horizontal direction. Hereinafter, the direction in which the take-up units 3 are lined up will be referred to as a left-right direction (second direction in the present invention), the direction which is horizontal and is orthogonal to the left-right direction will be referred to as a front-back direction (first direction of the present invention), and the direction in which the gravity acts will be referred to as a vertical direction. Furthermore, hereinafter, the right side and the left side in the left-right direction as shown in FIG. 1 and the front side and the back side in the front-back direction as shown in FIG. 2 are defined and used for explanations.

(Take-Up Units)

**[0047]** Each take-up unit 3 includes an aspirator 11 (first sucking retaining unit of the present invention), a first godet roller 12, a yarn regulating guide 19, a second godet roller 13, and a winding unit 14. The aspirator 11 extends along the left-right direction. The aspirator 11 is provided to suck and retain yarns Y spun out from the spinning apparatus in advance, before yarn threading onto the godet rollers 12 and 13 and the winding unit 14.

**[0048]** The first godet roller 12 has an axis substantially in parallel to the left-right direction, and is provided below the aspirator 11 in the vertical direction. For this reason, the first godet roller 12 is at a front end portion of the take-up unit 3. The first godet roller 12 is rotationally driven by a first godet motor 111 (see FIG. 7).

**[0049]** The yarn regulating guide 19 is provided between the aspirator 11 and the first godet roller 12 in the vertical direction. The yarn regulating guide 19 is, for example, a known yarn guide with a comb teeth shape. When the yarns Y are threaded thereon, the yarn regulating guide 19 regulates the interval between neighboring yarns Y to a predetermined value (e.g., 4mm). The yarn regulating guide 19 is arranged to be movable in the left-right direction (the axial direction of the first godet roller 12) by a cylinder 119 (see FIG. 7). With this, in the left-right direction, the yarn regulating guide 19 is movable between a protruding position where the guide protrudes as compared to the leading end portion of the first godet roller 12 and a withdrawn position where the guide falls within the range of the first godet roller 12.

**[0050]** The second godet roller 13 has an axis substantially in parallel to the left-right direction, and is provided backward of the first godet roller 12. The second godet roller 13 is rotationally driven by a second godet motor 112 (see FIG. 7). The second godet roller 13 is movably supported by a guide rail 15. The guide rail 15 extends upward in the vertical direction toward the back side in the front-back direction. The second godet roller 13 is connected with a cylinder 113 (see FIG. 7). As the cylinder 113 is driven, the second godet roller 13 moves along the guide rail 15. With this, the second godet roller 13 is movable between a winding position which is indicated

by the full lines in FIG. 2 and where winding of the yarns Y is carried out and a yarn threading position which is indicated by the dashed lines in FIG. 2 and where the second godet roller 13 is close to the first godet roller 12 at a front end portion of the take-up unit 3 and yarn threading is carried out. At the yarn threading position, the second godet roller 13 is at the front end portion of the take-up unit 3.

**[0051]** The yarns Y spun out from the spinning apparatus are wound onto the rotationally-driven godet rollers 12 and 13 in order. In the present embodiment, a combination of the aspirator 11, the first godet roller 12, the yarn regulating guide 19, and the second godet roller 13 is equivalent to a take-up member of the present invention.

**[0052]** The winding unit 14 includes fulcrum guides 21 (distribution guides of the present invention), traverse guides 22, a turret 23, two bobbin holders 24, a contact roller 25, and a pusher 26. As shown in FIG. 2, FIG. 4, FIG. 5(a), and FIG. 5(b), the fulcrum guides 21 are provided for the respective yarns Y and are lined up in the front-back direction. Each fulcrum guide 21 has a groove 21a which is open to the back side. As the yarn Y is inserted into the groove 21a from the back side, yarn threading is carried out.

**[0053]** As shown in FIG. 5(a) and FIG. 5(b), the fulcrum guides 21 are attached to sliders 27. The sliders 27 are supported to be movable in the front-back direction along the guide rail 28. The sliders 27 are connected with a cylinder 114 (see FIG. 7). As the cylinder 114 is driven, the sliders 27 moves in the front-back direction along the guide rail 28. With this, the fulcrum guides 21 are movable between winding positions where the fulcrum guides 21 are separated from one another in the front-back direction and winding of the yarns Y is performed as shown in FIG. 2 and FIG. 5(a) and yarn threading positions where the fulcrum guides 21 are close to one another on the front side of the guide rail 28 and yarn threading is carried out as shown in FIG. 5(b). The fulcrum guides 21 are therefore shifted to the front end portion of the take-up unit 3 when they are at the yarn threading positions.

**[0054]** The traverse guides 22 are provided for the respective yarns Y and are lined up in the front-back direction. The traverse guides 22 are driven by a common traverse motor 115 (see FIG. 7) and reciprocate in the front-back direction. With this, the yarns Y threaded onto the traverse guides 22 are traversed about the fulcrum guides 21.

**[0055]** The turret 23 is a disc-shaped member having an axis which is in parallel to the front-back direction. The turret 23 is rotationally driven by a turret motor 116 (see FIG. 7). The two bobbin holders 24 have axes in parallel to the front-back direction and are rotatably supported at an upper end portion and a lower end portion of the turret 23. To each bobbin holder 24, bobbins B provide for the respective yarns Y are attached to be lined up in the front-back direction. Each of the two bobbin holders 24 is rotationally driven by an individual winding motor 117 (see

FIG. 7).

**[0056]** As the upper bobbin holder 24 is rotationally driven, the yarns Y traversed by the traverse guides 22 are wound onto the bobbins B, with the result that packages P are formed. After the completion of the formation of the packages P, the positions of the two bobbin holders 24 are changed upside down as the turret 23 is rotated. As a result, the bobbin holder 24 which is on the lower side moves to the upper side, and a package P can be formed by winding a yarn Y onto a bobbin B attached to this bobbin holder 24. In the meanwhile, the bobbin holder 24 on the upper side moves to the lower side, and collection of the packages P becomes possible.

**[0057]** The contact roller 25 is a roller having an axis substantially in parallel to the front-back direction and is provided immediately above the upper bobbin holder 24. The contact roller 25 makes contact with the surface of the package P formed by winding the yarn Y onto the bobbin B attached to the upper bobbin holder 24, so as to apply a contact pressure to the surface of the package P on which the yarn Y is being wound.

**[0058]** The pusher 26 is provided to be movable along the guide rail 29 extending in the front-back direction, across the entire length of the bobbin holder 24. The pusher 26 is connected with a cylinder 118 (see FIG. 7). As the cylinder 118 is driven, the pusher 26 moves forward along the guide rail 29, so as to push the fully-wound packages P retained by the lower bobbin holder 24 into a package ejection space R which is frontward of the winding unit 14. The package ejection space R is a space frontward of the winding unit 14 and is between the upper ends of the packages P retained by the lower bobbin holder 24 and an installation surface G of the take-up unit 3.

(Yarn Threading Robot)

**[0059]** Now, the yarn threading robot 4 will be described. The yarn threading robot 4 includes a main body 31, a robot arm 32, and a yarn threading unit 33 (a yarn holding member of the present invention). The main body 31 is rectangular parallelepiped in shape. Inside the main body 31, a yarn threading controller 102 (see FIG. 7) is mounted for controlling operations of the robot arm 32 and the yarn threading unit 33. On the front side of the take-up units 3, two guide rails 35 are provided at an interval in the front-back direction. Each guide rail 35 extends in the left-right direction across plural take-up units 3. The main body 31 hangs down from the two guide rails 35 and is movable in the left-right direction along the two guide rails 35.

**[0060]** To be more specific, at the upper end portion of the main body 31, as shown in FIG. 6(a) and FIG. 6(b), four wheels 36 are provided. Two of these four wheels 36 are provided on the upper surface of each guide rail 35. The main body 31 therefore hangs down from the guide rail 35 while being supported by the guide rail 35 at two parts which are distanced from each other in the

front-back direction. The two wheels 36 on the upper surface of each guide rail 35 are distanced from each other in the left-right direction. The four wheels 36 are rotationally driven by a movement motor 121 (see FIG. 7). As the four wheels 36 are rotationally driven, the main body 31 moves in the left-right direction along the two guide rails 35.

**[0061]** On the main body 31, two area sensors 37 (an obstacle sensor of the present invention) are provided. The area sensors 37 are provided at the left and right edge portions of the main body 31, respectively. Each area sensor 37 detects the presence of an obstacle such as an operator and a device in a region which is overlapped with the yarn threading robot 4 in the left-right direction.

**[0062]** The robot arm 32 is attached to the lower surface of the main body 31. The robot arm 32 includes arms 32a and joints 32b connecting the arms 32a with one another. Each joint 32b includes an arm motor 122 (see FIG. 7). As the arm motor 122 is driven, the arm 32a is swung about the joint 32b. In this way, the robot arm 32 is driven. The maximum outputs of all arm motors 122 are 80W or lower. The yarn threading unit 33 is attached to the leading end portion of the robot arm 32. At the leading end portion of the yarn threading unit 33, an aspirator 39 (a second sucking retaining unit of the present invention) for sucking and retaining the yarns Y and a cutter 38 for cutting the yarns Y are provided. In addition to the aspirator 39 and the cutter 38, the yarn threading unit 33 is provided with various devices for distributing the yarns Y to the fulcrum guides 21 and threading them onto the fulcrum guides 21 as described below, such as a comb-shaped yarn threading assisting tool shown in Japanese Unexamined Patent Publication No. 2015-164875. Explanations of structures of such devices, however, are omitted.

(Package Collector)

**[0063]** The package collector 5 includes an elevation unit 41 and a column 42. The elevation unit 41 is rectangular parallelepiped in shape and extends horizontally. Inside the elevation unit 41, a shaft 43 extending along the length of the elevation unit 41 is provided to be substantially as long as the bobbin holder 24. The shaft 43 is inserted into the packages P when the packages P are collected as described later. The column 42 is provided frontward of the yarn threading robot 4 and extends in the vertical direction. The elevation unit 41 is supported by the column 42 to be able to move up and down. The elevation unit 41 is connected with a cylinder 131 (see FIG. 7). As the cylinder 131 is driven, the elevation unit 41 moves up or down along the column 42. The column 42 is supported at respective end portions in the vertical direction by guide rails 44 and 45 each of which extends in the left-right direction, and hence the column 42 is movable in the left-right direction along the guide rails 44 and 45. The column 42 is connected with a cylinder 132 (see

FIG. 7). As the cylinder 132 is driven, the column 42 moves in the left-right direction. As the column 42 moves in the left-right direction, the elevation unit 41 attached to the column 42 moves in the left-right direction, too. The column 42 is connected with a motor 133 (see FIG. 7). As the motor 133 is driven, the column 42 rotates while the upper and lower ends thereof are positionally fixed. As the column 42 rotates, the elevation unit 41 attached to the elevation unit 41 rotates, too. With this, in the package collector 5, the elevation unit 41 is able to take a collecting posture in which the shaft 43 is substantially in parallel to the front-back direction as shown in FIG. 1 and FIG. 2 and a conveyance posture in which the shaft 43 is substantially in parallel to the left-right direction as shown in FIG. 3 and FIG. 4. In the collecting posture, the elevation unit 41 is partially in the range of the movement of the yarn threading robot 4 in the front-back direction. In the conveyance posture, the elevation unit 41 is positioned entirely frontward of the yarn threading robot 4.

(Electric Structure of Spun Yarn Winding System)

**[0064]** Now, an electric structure of the spun yarn winding system 1 will be described. In the spun yarn winding system 1, as shown in FIG. 7, a take-up unit controller 101 is provided for each take-up unit 3, and the take-up unit controller 101 controls the first godet motor 111, the second godet motor 112, the cylinders 113, 114, 118, and 119, the traverse motor 115, the turret motor 116, the winding motor 117, or the like. Although each take-up unit 3 includes two winding motors 117, FIG. 7 shows only one winding motor 117. Furthermore, FIG. 7 shows, for only one single take-up unit controller 101, the first godet motor 111, the second godet motor 112, the cylinders 113 and 114, the traverse motor 115, the turret motor 116, the winding motor 117, and the cylinder 118 which are the targets of control by that take-up unit controller 101.

**[0065]** In the spun yarn winding system 1, a yarn threading controller 102 is provided in the yarn threading robot 4. The yarn threading controller 102 controls the movement motor 121, the arm motor 122, the yarn threading unit 33, and the like. To the yarn threading controller 102, information regarding the torque of each of the motors 121 and 122 of the yarn threading robot 4, detection results by the area sensors 37, and the like are input. While the robot arm 32 includes plural joints 32b and plural arm motors 122 corresponding to the respective joints 32b, FIG. 7 shows only one arm motor 122. While on the main body 31 two area sensors 37 are provided, FIG. 7 shows only one area sensor 37.

**[0066]** In the spun yarn winding system 1, a collection controller 103 is provided in the package collector 5, and the collection controller 103 controls the cylinders 131 and 132, the motor 133, and the like.

**[0067]** In addition to the above, the spun yarn winding system 1 includes a controller 100 which serves to control

the entire apparatus. The controller 100 is connected with the take-up unit controller 101, the yarn threading controller 102, and the collection controller 103 of each of the take-up units 3. By controlling the take-up unit controllers 101, the yarn threading controller 102, and the collection controller 103, the controller 100 controls the entire spun yarn winding system 1.

#### (Method of Yarn Threading)

**[0068]** Now, the following will describe a method of causing the yarn threading robot 4 to perform yarn threading onto the godet rollers 12 and 13 and the fulcrum guides 21.

**[0069]** Before causing the yarn threading robot 4 to perform the yarn threading, the aspirator 11 is caused to suck and retain the yarns Y spun out from the spinning apparatus in advance. Furthermore, the second godet roller 13 of the take-up unit 3 performing yarn threading is positioned at the above-described yarn threading position at the front end portion of the take-up unit 3. Furthermore, the fulcrum guides 21 are positioned at the above-described yarn threading positions to be shifted to the front end portion of the take-up unit 3.

**[0070]** To perform the yarn threading onto the godet rollers 12 and 13 and the fulcrum guides 21 by the yarn threading robot 4, to begin with, the yarn threading robot 4 is moved to a position frontward of the take-up unit 3 for which the yarn threading is to be performed. At this stage, as shown in FIG. 1 and FIG. 2, the robot arm 32 is arranged to take a posture such that the arm 32a closest to the main body 31 is substantially in parallel with the left-right direction and the arm 32a on the leading end side of the arm 32a closest to the main body 31 is substantially in parallel with the vertical direction. The posture of the yarn threading robot 4 in this state is equivalent to the moving posture in the present invention.

**[0071]** When the yarn threading robot 4 is in the moving posture above, most of the robot arm 32 and the yarn threading unit 33 is overlapped with the main body 31 in the left-right direction, and the projected area of the yarn threading robot 4 in the left-right direction is minimized. Furthermore, the yarn threading robot 4 in the moving posture is positioned above the above-described package ejection space R. Furthermore, the height H of the lower end of the yarn threading robot 4 from the installation surface G of the take-up unit 3 is about 1700mm.

**[0072]** When the area sensors 37 detect an obstacle during the movement of the yarn threading robot 4 to the front of the take-up unit 3, the movement of the yarn threading robot 4 (driving of the movement motor 121) is stopped, and then the movement of the yarn threading robot 4 is resumed when the area sensors 37 no longer detect an obstacle.

**[0073]** After the yarn threading robot 4 is moved to the front of the take-up unit 3 which will perform the yarn threading, the robot arm 32 is moved to be lower than the moving posture, and the yarn threading unit 33 is

moved to a position where the leading end portion of the aspirator 39 is pressed onto the yarns Y as shown in FIG. 8(a). At this stage, the cutter 38 is below the aspirator 39 and the yarns Y passes through the cutter 38. Subsequently, the aspirator 39 is caused to perform sucking and the yarns are cut by the cutter 38. As a result, the yarns Y having been cut are sucked and retained by the aspirator 39, and handover of the yarns Y from the aspirator 11 to the aspirator 39 is carried out as shown in FIG. 8(b).

**[0074]** After the completion of the handover of the yarns Y from the aspirator 11 to the aspirator 39, as shown in FIG. 8(c) and FIG. 8(d), the yarn regulating guide 19 is moved to the protruding position and then the yarn threading unit 33 is moved to a position where in the left-right direction the yarns Y can be threaded onto the yarn regulating guide 19 and is below the first godet roller 12. In the present embodiment, when, for example, a signal for driving the cutter 38 is output, it is determined that the handover of the yarns Y from the aspirator 11 to the aspirator 39 is completed, and the operation above is carried out.

**[0075]** Subsequently, as shown in FIG. 8(e), the yarn threading unit 33 of the robot arm 32 is moved to the base end side in the axial direction of the first godet roller 12, and the yarn regulating guide 19 is moved by the cylinder 119 to the base end side in the axial direction of the godet roller 12. As such, the yarns Y are moved to a position where the yarns Y are overlapped with the outer circumferential surface of the godet roller 12. Thereafter, as the yarn threading unit 33 of the robot arm 32 is moved, the yarns Y are wound onto the godet rollers 12 and 13 as shown in FIG. 8(f).

**[0076]** Subsequently, the yarns Y are threaded onto the fulcrum guides 21 one by one. With this, the yarn threading onto the godet rollers 12 and 13 and the fulcrum guides 21 is completed. After the yarn threading is completed, the second godet roller 13 and the fulcrum guides 21 are moved to the above-described winding positions. In the present embodiment, the posture of the automatic yarn threading robot in which the robot arm 32 is lower than that in the moving posture, which posture is taken when the yarn threading onto the godet rollers 12 and 13 and the fulcrum guides 21 is carried out, is equivalent to the yarn threading posture of the present invention. In this regard, while in FIG. 3 and FIG. 4 the robot arm 32 is positioned above the package ejection space R, the robot arm 32 may temporarily enter the package ejection space R when the robot arm 32 is driven at the time of the yarn threading.

**[0077]** In addition to the above, during the above-described yarn threading by the yarn threading robot 4, if the torque of the movement motor 121 or the arm motor 122 varies for a predetermined quantity or more, it is determined that the yarn threading robot 4 collides with an operator or the like, and the torque of the movement motor 121 or the arm motor 122 is restricted.

## (Method of Collecting Packages)

**[0078]** Now, a method of collecting the packages P by using the package collector 5 will be described. To collect the packages P by the package collector 5, the elevation unit 41 is moved down to be as high as the lower bobbin holder 24 and is arranged to take the conveyance posture, and the elevation unit 41 is then moved to a position frontward of the take-up unit 3 from which the packages P are to be collected. Then the elevation unit 41 is rotated for about 90 degrees to take the collecting posture. In this state, as shown in FIG. 9, the packages P retained by the lower bobbin holder 24 are pushed out by the pusher 26. As a result, the shaft 43 is inserted into the packages P pushed out from the bobbin holder 24, and the packages P are retained by the shaft 43.

**[0079]** After the completion of the ejection of the packages P by the pusher 26, as shown in FIG. 10, the elevation unit 41 is rotated for about 90 degrees to take the conveyance posture, and is moved in the left-right direction. As such, the collected packages P are conveyed. Furthermore, as the pusher 26 is moved backward and returned to the position before the press out of the packages P. Thereafter, bobbins B are attached to the bobbin holder 24 from which the packages P have been ejected. The attachment of the bobbins B to the bobbin holder 24 is, for example, manually done by an operator. Alternatively, after the completion of the conveyance of the packages P, the package collector 5 may attach the bobbins B to the bobbin holder 24.

**[0080]** According to the embodiment described above, because the yarn threading robot 4 provided at the front of the take-up unit 3 hangs down from the guide rail 35, there is a space below the yarn threading robot 4. With this arrangement, the yarn threading robot 4 on the move is less likely to interfere with an operator, another device, or the like.

**[0081]** In the present embodiment, the first godet roller 12 is provided at the front end portion of the take-up unit 3. Furthermore, as described above, at the time of the yarn threading, the second godet roller 13 is positioned at the front end portion of the take-up unit 3 and the fulcrum guides 21 are shifted to the front end portion of the take-up unit 3. With this arrangement, the yarn threading robot 4 at the front of the take-up unit 3 is able to relatively easily perform the yarn threading onto the godet rollers 12 and 13 and the fulcrum guides 21. In regard to the yarn threading onto the fulcrum guides 21 is performed, an operation program and control of the robot are easily achieved by, for example, employing and applying a yarn threading method (using a comb-shaped yarn threading assisting tool) recited in Japanese Unexamined Patent Publication No. 2015-164875.

**[0082]** In the moving posture, the yarn threading robot 4 is able to move in the left-right direction at a position above the package ejection space R. With this arrangement, when the package collector 5 is collecting packages P from a bobbin holder 24 of a take-up unit 3, the

yarn threading robot 4 can be moved to a position at the front of another take-up unit 3 as the yarn threading robot 4 is moved in the left-right direction above the elevation unit 41. On this account, when the yarn threading robot 4 is moved to perform the yarn threading onto the godet rollers 12 and 13 and the fulcrum guides 21 of the another take-up unit 3, it is unnecessary to wait for the completion of the collection of the packages P from the bobbin holder 24. In other words, it is possible to simultaneously carry out the yarn threading by the yarn threading robot 4 and the collection of the packages P by the package collector 5. This prevents the delay of the completion of the yarn threading.

**[0083]** In addition to the above, in the conveyance posture, the elevation unit 41 of the package collector 5 is entirely at the front of the yarn threading robot 4. This prevents the yarn threading robot 4 and the elevation unit 41 from interfering with each other even if the elevation unit 41 is moved in the left-right direction while the yarn threading robot 4 is performing the yarn threading. In other words, it is possible to move the elevation unit 41 in the left-right direction while the yarn threading robot 4 is performing the yarn threading.

**[0084]** In addition to the above, in the moving posture, the projected area of the yarn threading robot 4 in the left-right direction is minimized. On this account, the possibility of interference between the yarn threading robot 4 and an operator, another device, or the like is minimized when the yarn threading robot 4 is moved in the left-right direction.

**[0085]** In addition to the above, the main body 31 of the yarn threading robot 4 is supported by and hangs down from the two guide rails 35 which are provide at an interval in the front-back direction. This restrains the swing of the yarn threading robot 4 in the front-back direction when the robot arm 32 is driven to swing the arm 32a at the time of, for example, yarn threading.

**[0086]** In addition to the above, in the present embodiment, the area sensors 37 are provided on the main body 31 of the yarn threading robot 4. When an obstacle is detected by the area sensors 37, the movement of the yarn threading robot 4 is stopped. This prevents the yarn threading robot 4 on the move from colliding with an operator or like.

**[0087]** In addition to the above, in the present embodiment, because the maximum outputs of the arm motors 122 of the yarn threading robot 4 are all equal to or lower than 80W in compliance with the international standard ISO10218, the occurrence of a severe accident when the yarn threading robot 4 collides with an operator is prevented.

**[0088]** In addition to the above, in the present embodiment, whether the yarn threading robot 4 collides with an operator or the like is determined based on a change in the torque of each of the movement motor 121 and the arm motor 122, and the torque of the movement motor 121 or the arm motor 122 is restricted when the yarn threading robot 4 collides with an operator or like. This

prevents the occurrence of a severe accident when the yarn threading robot 4 collides with an operator.

**[0089]** Furthermore, the height H of the lower end of the yarn threading robot 4 in the moving posture from the installation surface G of the take-up unit 3 is about 1700mm. With this arrangement, a space which is about 1700mm in height is formed below the yarn threading robot 4 on the move, and operations can be relatively easily done in this space.

**[0090]** In addition to the above, while the yarns Y are sucked and retained by the aspirator 11, the aspirator 39 is pressed onto the yarns Y, and the yarns Y are cut by the cutter 38 while being sucked by the aspirator 39. With this, the handover of the yarns Y from the aspirator 11 to the aspirator 39 is achieved. Furthermore, after the handover of the yarns Y from the aspirator 11 to the aspirator 39, the yarn regulating guide 19 is moved to the protruding position and then the yarn threading unit 33 is moved to a position below the first godet roller 12. As a result, the yarn threading unit 33 moves downward at a position to the right of the godet roller 12, and hence interference of the yarn threading unit 33 with the first godet roller 12 is prevented.

**[0091]** The following will describe modifications of the above-described embodiment of the present invention.

**[0092]** While in the embodiment above the height H of the lower end of the yarn threading robot 4 in the moving posture from the installation surface G of the take-up unit 3 is about 1700mm, the disclosure is not limited to this arrangement. The height H may be longer than 1700mm. Also in such a case, an operator is able to perform operations relatively easily in the space below the yarn threading robot 4. The height H may be shorter than 1700mm.

**[0093]** While in the embodiment above the projected area of the yarn threading robot 4 is minimized in the left-right direction when it is in the moving posture, the disclosure is not limited to this arrangement. The projected area in the left-right direction of the yarn threading robot 4 when it takes the moving posture may be larger than the minimum area in the embodiment above.

**[0094]** In the embodiment above, when the yarn threading robot 4 is in the moving posture, the arm 32a and the yarn threading unit 33 are positioned above those when the yarn threading robot 4 is in the yarn threading posture. The disclosure, however, is not limited to this arrangement. For example, when the lower end of the yarn threading robot 4 is always above the package ejection space R at the time of the yarn threading, the heights of the arm 32a and the yarn threading unit 33 may be unchanged between the moving posture and the yarn threading posture.

**[0095]** While in the embodiment above the area sensors 37 are provided on the main body 31 of the yarn threading robot 4, such area sensors 37 may not be provided. In such a case, however, the yarn threading robot 4 may collide with an operator when moving in the left-right direction. In this regard, for example, when the main

body 31 is moving, the torque of the movement motor 121 or the arm motor 122 may be restricted when it is determined that the yarn threading robot 4 collides with an operator or the like as in the embodiment above. This arrangement prevents the occurrence of a severe accident when the yarn threading robot 4 collides with the operator.

**[0096]** While in the embodiment above the torque of the movement motor 121 or the arm motor 122 is restricted when it is determined that the yarn threading robot 4 collides with an operator or the like, such torque restriction may not be performed. When the maximum outputs of the arm motors 122 are all 80W or lower, the occurrence of a severe accident when the yarn threading robot 4 collides with the operator is prevented at the time of the yarn threading, even if the torque restriction is not performed.

**[0097]** While in the embodiment above the maximum outputs of the arm motors 122 of the yarn threading robot 4 are all 80W or lower, the disclosure is not limited to this arrangement. The maximum output of at least one of the arm motors 122 may be higher than 80W. Also in this case, for example, the torque of the arm motor 122 may be restricted in the same manner as in the embodiment above when it is determined that the yarn threading robot 4 collides with an operator or the like. This arrangement prevents the occurrence of a severe accident when the yarn threading robot 4 collides with the operator.

**[0098]** While in the embodiment above the movement of the yarn threading robot 4 is stopped when an obstacle is detected by the area sensors 37, the disclosure is not limited to this arrangement. For example, when an obstacle is detected by the area sensors 37, the traveling speed of the yarn threading robot 4 is decreased to a safe speed as a first step and the movement of the yarn threading robot 4 may be stopped as a second step before the yarn threading robot 4 collides with the obstacle.

**[0099]** While in the embodiment above the area sensors 37 are provided as an obstacle sensors, the disclosure is not limited to this arrangement. According to a modification, as shown in FIG. 11, a contact sensor 201 may be provided in place of the area sensors 37. The contact sensor 201 is configured to detect that an obstacle such as an operator collides with the yarn threading robot 4. The contact sensor 201 may be provided at the same part as the area sensor 37 on the main body 31 (see FIG. 1). Preferably the contact sensor 201 is provided at each part of the yarn threading robot 4 where the collision with an obstacle such as an operator is likely to occur, e.g., at the leading end portion of the robot arm 32. In this case, by detecting that an obstacle collides with the yarn threading robot 4, the contact sensor 201 detects an obstacle in a region which is overlapped with the yarn threading robot 4 in the left-right direction. In this case, the movement of the yarn threading robot 4 is stopped when the yarn threading robot 4 moves in the left-right direction and collides with an operator or the like.

**[0100]** Alternatively, as obstacle sensors, an area sen-

sor 37 and a contact sensor 201 may be both provided. In this case, for example, when the yarn threading robot 4 moves in the left-right direction, the traveling speed of the yarn threading robot 4 is lowered to a safe speed when the area sensor 37 detects an obstacle. Furthermore, the movement of the yarn threading robot 4 is then stopped when the contact sensor 201 detects that the yarn threading robot 4 collides with the obstacle.

**[0101]** While in the embodiment above the main body 31 of the yarn threading robot 4 is supported by and hangs down from the two guide rails 35 provided at an interval in the front-back direction, the disclosure is not limited to this arrangement. The main body 31 may be supported by and hang down from a single guide rail 35.

**[0102]** While in the embodiment above the elevation unit 41 of the package collector 5 is at the front of the yarn threading robot 4 when the elevation unit 41 takes the conveyance posture, the disclosure is not limited to this arrangement. In the conveyance posture, the elevation unit 41 may be partially overlapped with the yarn threading robot 4 in the front-back direction. In this case, however, when the elevation unit 41 is moved in the left-right direction while the yarn threading robot 4 is performing the yarn threading, the elevation unit 41 may interfere with the yarn threading robot 4. On this account, the movement of the elevation unit 41 in the left-right direction may be stopped until the yarn threading by the yarn threading robot 4 is completed. However, because also in this case the elevation unit 41 can be positioned to be below the yarn threading robot 4 in the moving posture, the movement of the elevation unit 41 and the movement of the yarn threading robot 4 can be simultaneously done.

**[0103]** While in the embodiment above the package collector 5 controlled by the collection controller 103 collects the packages P from the bobbin holder 24, the disclosure is not limited to this arrangement. For example, a wagon having a shaft is moved by an operator to the front of a take-up unit 3 from which packages P are to be collected, and the shaft is inserted into the packages P by moving the pusher 26 frontward in this state. Alternatively, an operator may manually collect the packages P from the bobbin holder 24.

**[0104]** While in the embodiment above the yarn threading robot 4 performs the yarn threading onto the godet rollers 12 and 13 and the fulcrum guides 21, the disclosure is not limited to this arrangement. For example, the yarn threading robot 4 performs yarn threading onto the godet rollers 12 and 13, and then an operator performs yarn threading onto the fulcrum guides 21 manually or by using an automatic yarn threading device provided in the winding unit 14. Alternatively, the yarn threading robot 4 may perform yarn threading onto a yarn guide, a nozzle, or the like other than the godet rollers 12 and 13 and the fulcrum guides 21.

**[0105]** While in the embodiment above the handover of the yarns Y to the aspirator 39 is carried out in such a way that the yarns Y sucked by the aspirator 11 are cut by the cutter 38 and the yarns Y having been cut are

sucked by the aspirator 39, the disclosure is not limited to this arrangement. For example, the aspirator 11 may not be provided and the yarns Y spun out from the spinning apparatus may be directly sucked by the aspirator 39. Alternatively, no cutter 38 may be provided at the leading end portion of the yarn threading unit 33, and a cutter for cutting the yarns Y sucked by the aspirator 11 may be provided at an upper part of the aspirator 11.

**[0106]** In the embodiment above, the yarn regulating guide 19 is movable in the left-right direction, and the yarn threading onto the yarn regulating guide 19 is carried out in such a way that, after the yarn regulating guide 19 is moved to the protruding position where the yarn regulating guide 19 protrudes as compared to the leading end portion of the first godet roller 12 in the left-right direction, the yarn threading unit 33 which is sucking and retaining the yarns Y by the aspirator 39 is moved to a position below the first godet roller 12. The disclosure, however, is not limited to this arrangement. For example, the yarn regulating guide 19 may be arranged to be movable in the front-back direction. In this case, for example, yarn threading onto the yarn regulating guide 19 is carried out in such a way that, after the yarn regulating guide 19 is moved to the front of the first godet roller, the yarn threading unit 33 which is sucking and retaining the yarns Y by the aspirator 39 is moved to a position between the yarn regulating guide 19 and the first godet roller 12. Subsequently, after the yarn threading unit 33 is moved to a position below the first godet roller 12, the yarn regulating guide 19 is moved backward, so that yarn threading onto the first godet roller 12 is achieved. In this case, because the yarn threading unit 33 is moved at the front of the first godet roller 12 when the yarn threading unit 33 is moved to a position below the first godet roller 12, interference of the yarn threading unit 33 with the first godet roller 12 is prevented.

**[0107]** In addition to the above, the yarn regulating guide 19 may not be movable. For example, the yarn regulating guide 19 may be fixed at the withdrawn position. By means of the robot arm 32, the yarn threading unit 33 is freely movable not only in the vertical direction but also in the left-right direction and the front-back direction. For this reason, in this case, the yarns Y are threaded onto the yarn regulating guide 19 by, for example, moving the yarn threading unit 33 between the yarn regulating guide 19 and the first godet roller 12. Thereafter, the yarn threading unit 33 is moved to a position to the right of the first godet roller 12 and then to a position below the first godet roller 12. This prevents the interference of the yarn threading unit 33 with the first godet roller 12. In this case, however, the control of the robot arm 32 is complicated as compared to the embodiment above.

**[0108]** While in the embodiment above the second godet roller 13 is movable between the winding position and the yarn threading position, the disclosure is not limited to this arrangement. The second godet roller 13 may be fixed at the front end portion of the take-up unit 3.

[0109] While in the embodiment above each take-up unit 3 includes two godet rollers 12 and 13, the disclosure is not limited to this arrangement. Each take-up unit 3 may include three or more godet rollers.

[0110] While in the embodiment above the yarns Y spun out from the spinning apparatus are sucked and retained by the aspirator 11 in advance, the disclosure is not limited to this arrangement. For example, the yarns Y spun out from the spinning apparatus may be taken down to a position opposing the aspirator 11 by an unillustrated yarn take-down device, and the aspirator 11 may suck the yarns Y from the yarn take-down device.

[0111] While in the embodiment above the yarn threading robot 4 is movable in the left-right direction while hanging from above, the disclosure is not limited to this arrangement. For example, the yarn threading robot 4 may be movable not only in the left-right direction but also in the vertical direction. In this case, because the yarn threading robot 4 is moved above when moved in the left-right direction, the height H from the lower end of the yarn threading robot 4 in the moving posture to the installation surface G of the take-up unit 3 can be further elongated. For example, when the height H is 2000mm or more which is longer than 1700mm in the embodiment above, the workability of the operator is further improved and the safety is further improved, too. Furthermore, because the yarn threading robot 4 is movable in the vertical direction, the length of the robot arm 32 is shortened as the yarn threading robot 4 is moved downward at the time of the yarn threading. Because a short robot arm 32 is handy, position adjustment of the robot arm 32 can be easily done and positioning accuracy is improved.

[0112] While in the embodiment above the take-up member includes two godet rollers 12 and 13, the disclosure is not limited to this arrangement. The take-up member may, for example, include godet rollers (heating rollers) each including a heater therein, as disclosed in Japanese Unexamined Patent Publication No. 2014-5555. Also in such a case, the yarn threading robot is able to place yarns onto these godet rollers.

## Claims

### 1. A spun yarn winding system comprising:

take-up units each of which includes a take-up member configured to take up yarns spun out from a spinning apparatus and a winding unit provided below the take-up member to wind the yarns taken up by the take-up member onto bobbins lined up in a horizontal first direction so as to form packages, the take-up units being lined up in a second direction which is horizontal and is orthogonal to the first direction;  
a yarn threading robot which is commonly provided for the take-up units, is provided on one side in the first direction of the winding unit, and

is configured to thread the yarns onto the take-up members of the take-up units; and  
a controller configured to control the yarn threading robot,  
the yarn threading robot being movable in the second direction while hanging down from above.

2. The spun yarn winding system according to claim 1, wherein, the yarn threading robot is movable in the second direction at a space which is on the one side in the first direction of the winding unit and is above a package ejection space to which the packages are ejected from the winding unit.

3. The spun yarn winding system according to claim 2, wherein, the package ejection space is a space between an upper end of a fully-wound package at the winding unit and an installation surface of the take-up units.

4. The spun yarn winding system according to claim 2 or 3, wherein,  
the winding unit includes a package ejector configured to eject the packages to the package ejection space, and  
a package collector is provided to collect the packages ejected from the winding unit in the package ejection space.

5. The spun yarn winding system according to claim 4, wherein, the package collector is movable in the second direction on a side opposite to the take-up units in the first direction with respect to the yarn threading robot.

6. The spun yarn winding system according to any one of claims 1 to 5, wherein,  
the take-up member includes a godet roller on which the yarns spun out from the spinning apparatus are wound,  
the yarn threading robot is provided on one side in the first direction of the take-up units to thread the yarns onto the godet roller, and  
when the yarn threading robot threads the yarns, the godet roller is provided at an end portion on the one side in the first direction of each of the take-up units.

7. The spun yarn winding system according to claim 6, wherein,  
the winding unit includes distribution guides which are lined up in the first direction and are configured to distribute the yarns sent from the godet roller to the bobbins,  
the yarn threading robot threads the yarns onto the distribution guides, and  
when the yarn threading robot threads the yarns, the distribution guides are shifted to an end portion on

the one side in the first direction of the take-up units.

8. The spun yarn winding system according to any one of claims 1 to 7, wherein,  
the yarn threading robot includes:

a main body configured to be movable in the second direction while hanging down from above;  
an arm member attached to the main body; and  
a yarn holding member attached to a leading end portion of the arm member to retain the yarns, and  
the arm member in a moving posture for moving in the second direction is positioned above the arm member in a yarn threading posture for threading the yarns.

9. The spun yarn winding system according to claim 8, wherein, in the moving posture, a projected area of the yarn threading robot is minimized in the second direction.

10. The spun yarn winding system according to claim 8 or 9, wherein, the main body is supported at two parts distanced from each other in the first direction and hangs down.

11. The spun yarn winding system according to any one of claims 1 to 10, wherein,  
the yarn threading robot is driven by motors, and  
the controller  
restricts torque of the motors when the yarn threading robot collides with an obstacle.

12. The spun yarn winding system according to any one of claims 1 to 11, further comprising  
an obstacle sensor configured to detect an obstacle in a space which is overlapped with the yarn threading robot in the second direction,  
the controller  
stopping the movement of the yarn threading robot when the obstacle sensor detects an obstacle.

13. The spun yarn winding system according to any one of claims 1 to 12, wherein, the height of a lower end of the yarn threading robot moving in the second direction is 1700mm or more from the installation surface of the take-up units.

14. The spun yarn winding system according to any one of claims 1 to 13, wherein,  
the take-up member  
includes a first sucking retaining unit configured to suck and retain the yarns, and  
the yarn threading robot includes:

a second sucking retaining unit configured to

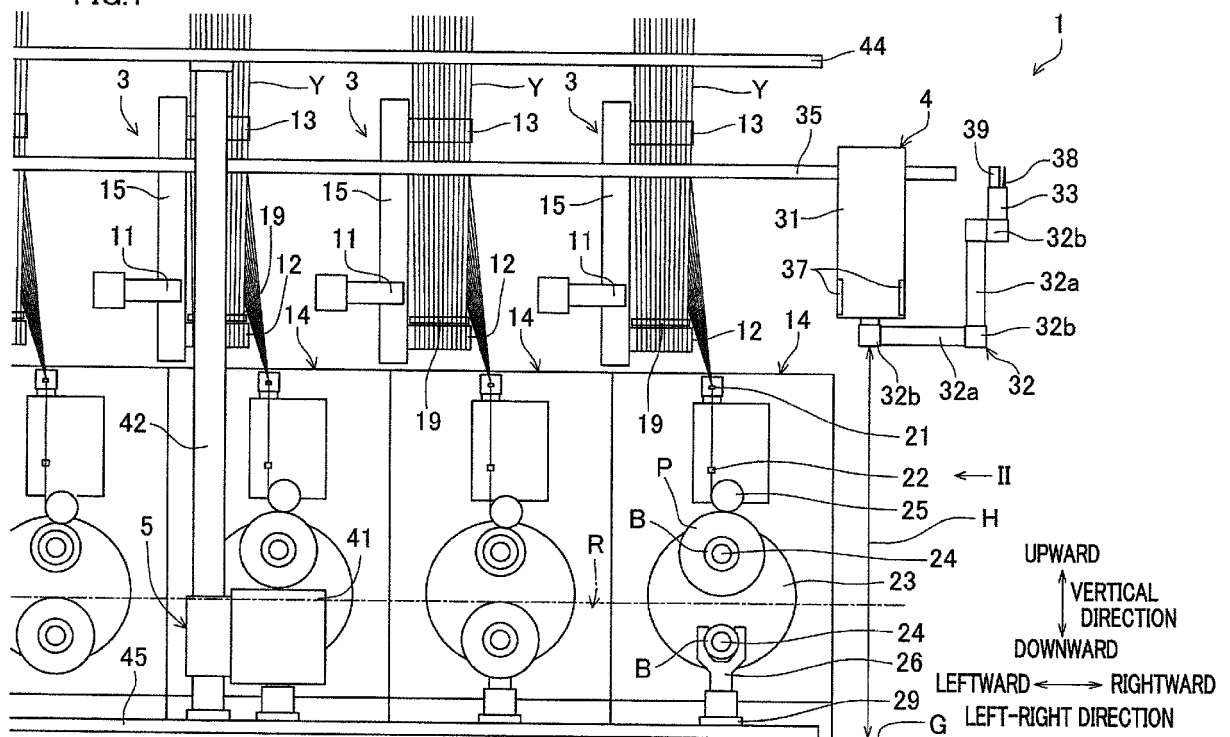
suck and retain the yarns; and  
a cutter configured to cut the yarns.

15. The spun yarn winding system according to claim 14, wherein,  
the controller  
causes the first sucking retaining unit to hand the yarns to the second sucking retaining unit by causing the cutter to cut the yarns retained by the first sucking retaining unit and causing the second sucking retaining unit to suck and retain the yarns having been cut.

16. The spun yarn winding system according to claim 15, wherein,  
the take-up member  
further includes a godet roller which is provided below the first sucking retaining unit and on which the yarns spun out from the spinning apparatus are wound, and  
the controller  
causes the yarn threading robot to thread the yarns sucked and retained by the second sucking retaining unit onto the godet roller.

17. The spun yarn winding system according to claim 16, further comprising  
a yarn regulating guide provided between the godet roller and the first sucking retaining unit to regulate an interval between neighboring yarns to be at a predetermined value,  
the yarn regulating guide being movable in an axial direction of the godet roller under the control of the controller, and  
when the yarn threading robot is caused to thread the yarns sucked and retained by the second sucking retaining unit onto the godet roller, the controller  
moving the yarn regulating guide to a position which protrudes as compared to a leading end portion of the godet roller,  
then performing yarn threading onto the yarn regulating guide by moving the second sucking retaining unit to a position below the godet roller, and  
then moving the yarns to a position overlapped with the godet roller by moving the second sucking retaining unit and the yarn regulating guide to the base end side in the axial direction of the godet roller.

FIG.1



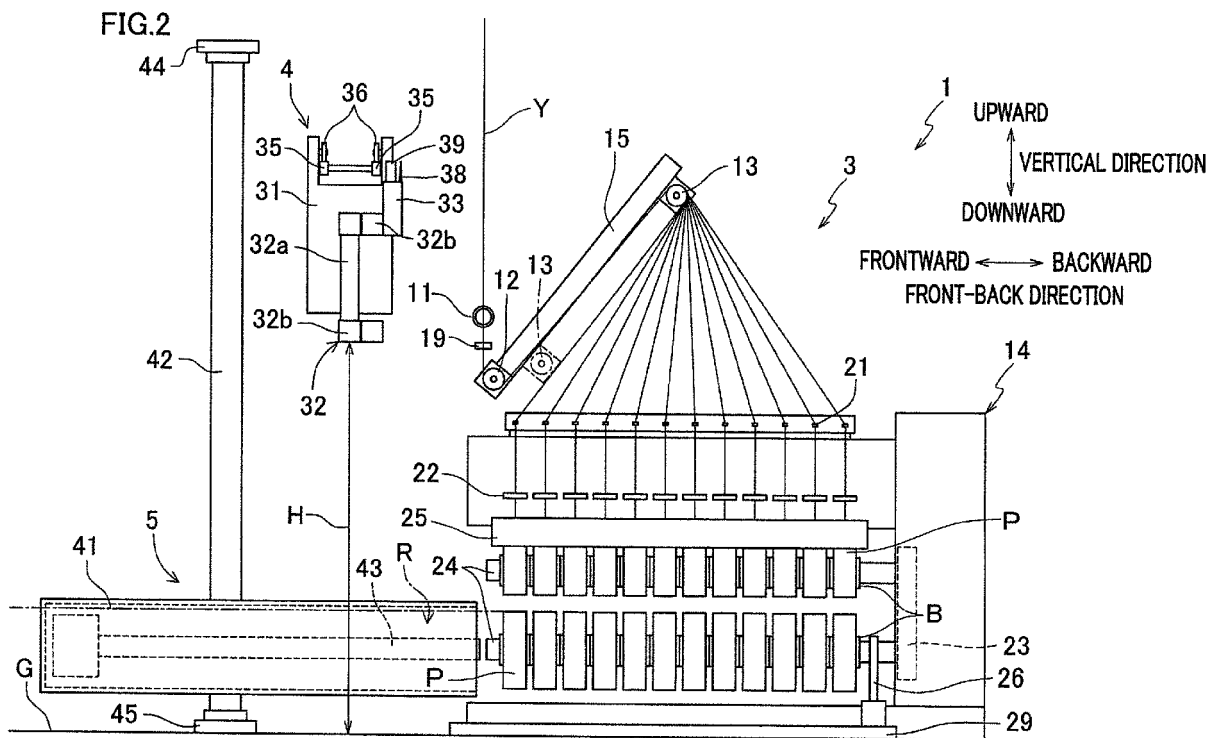


FIG.3

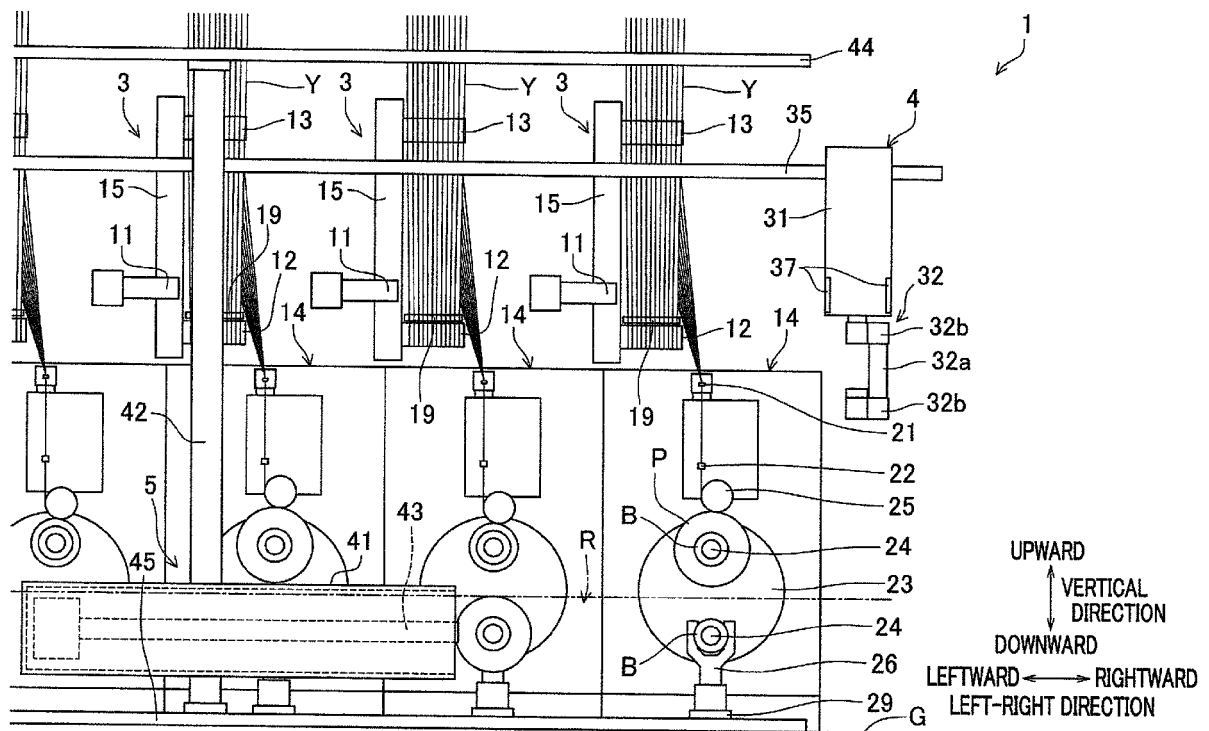
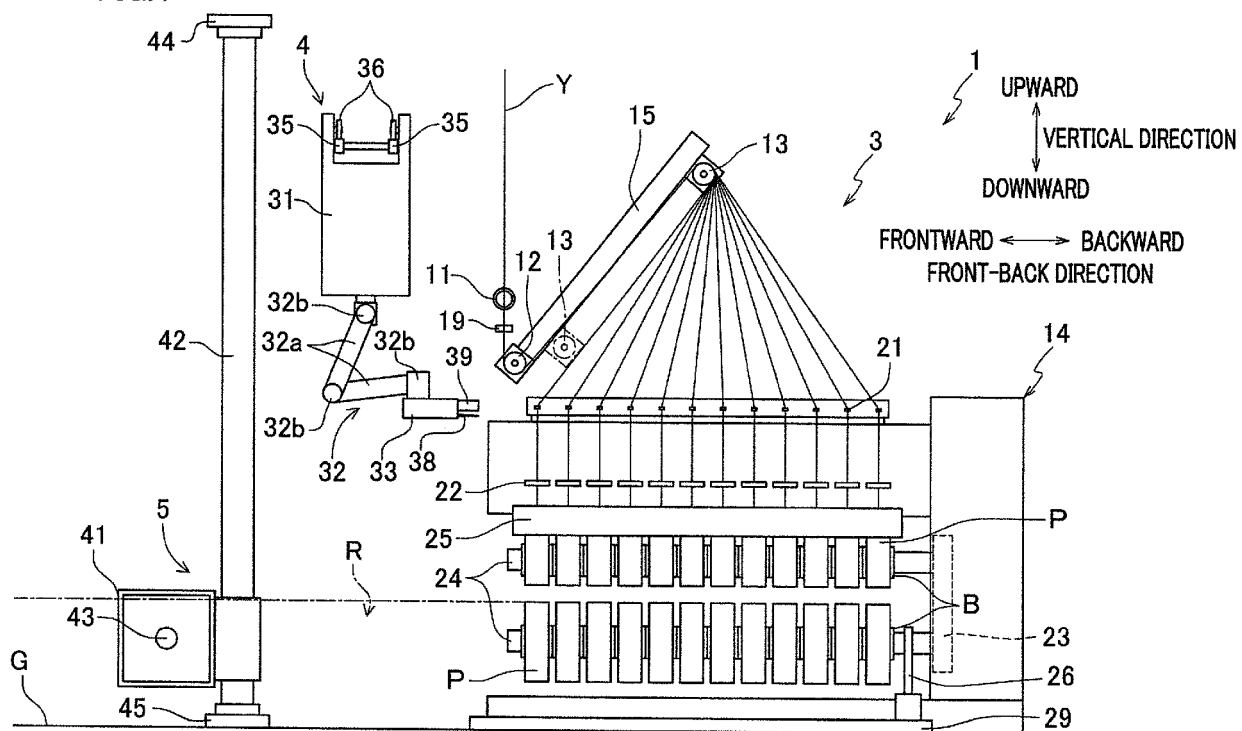


FIG.4



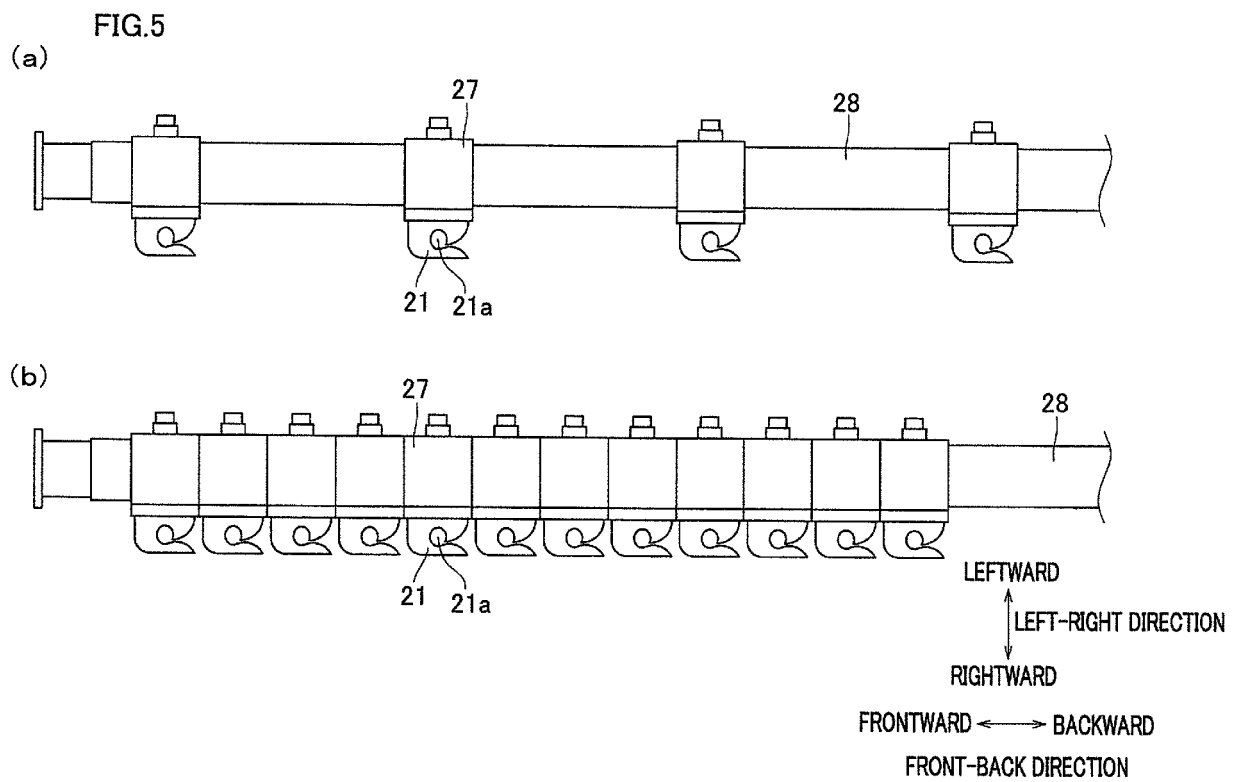
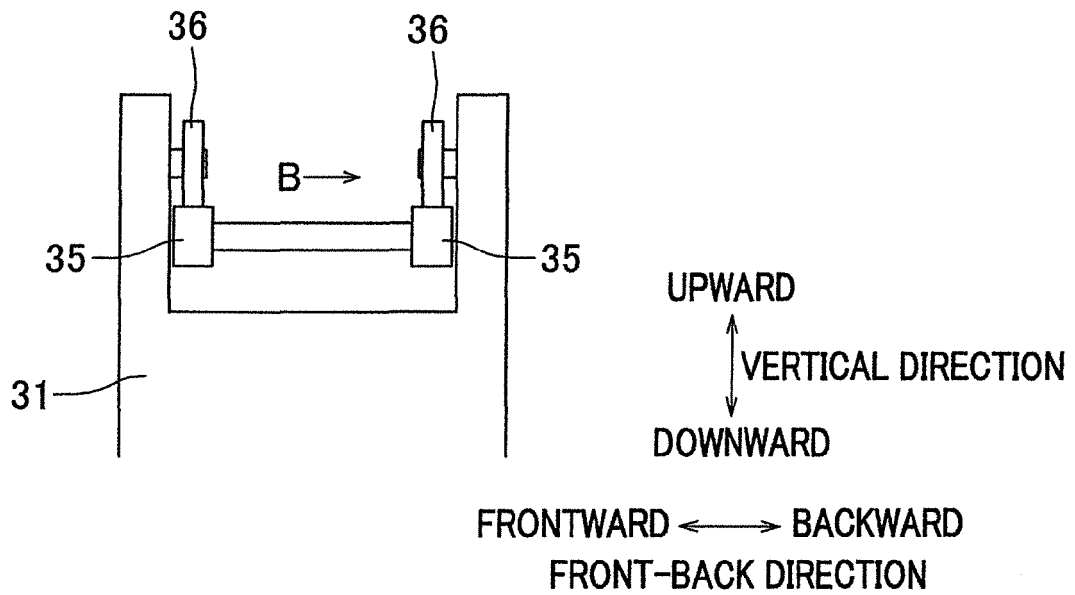


FIG.6

(a)



(b)

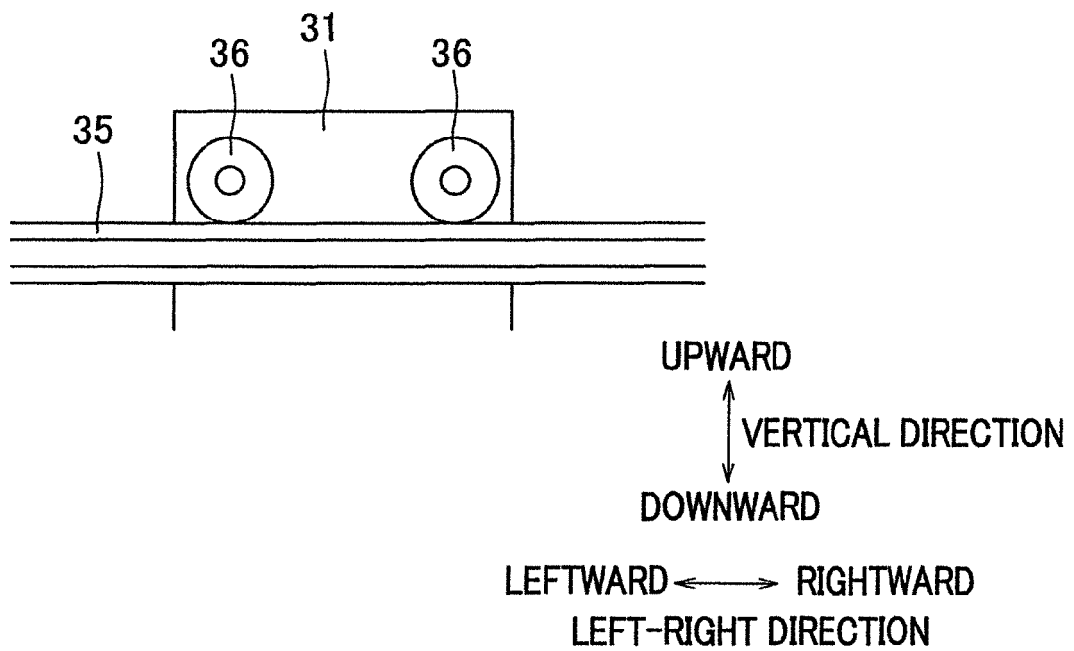


FIG. 7

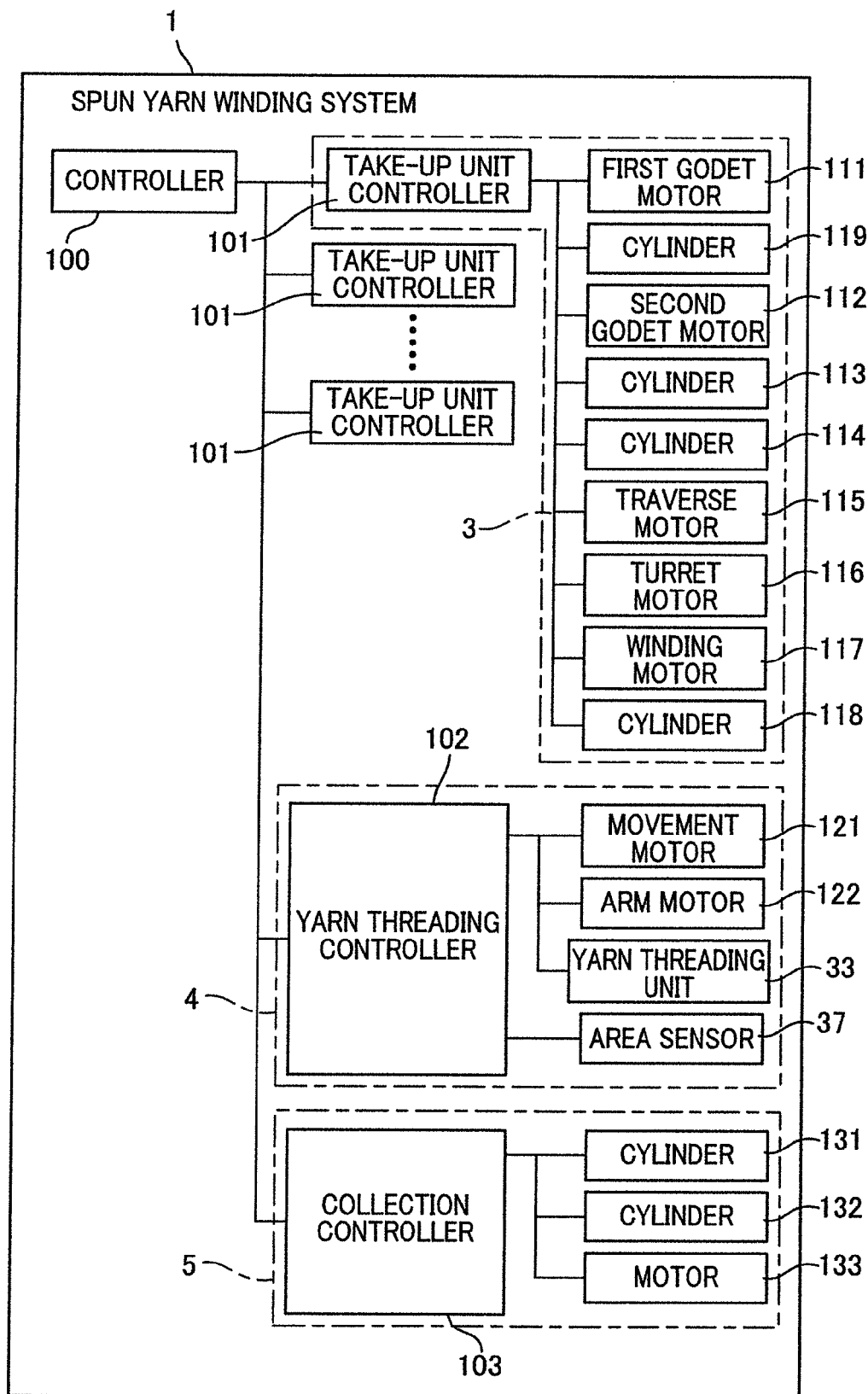
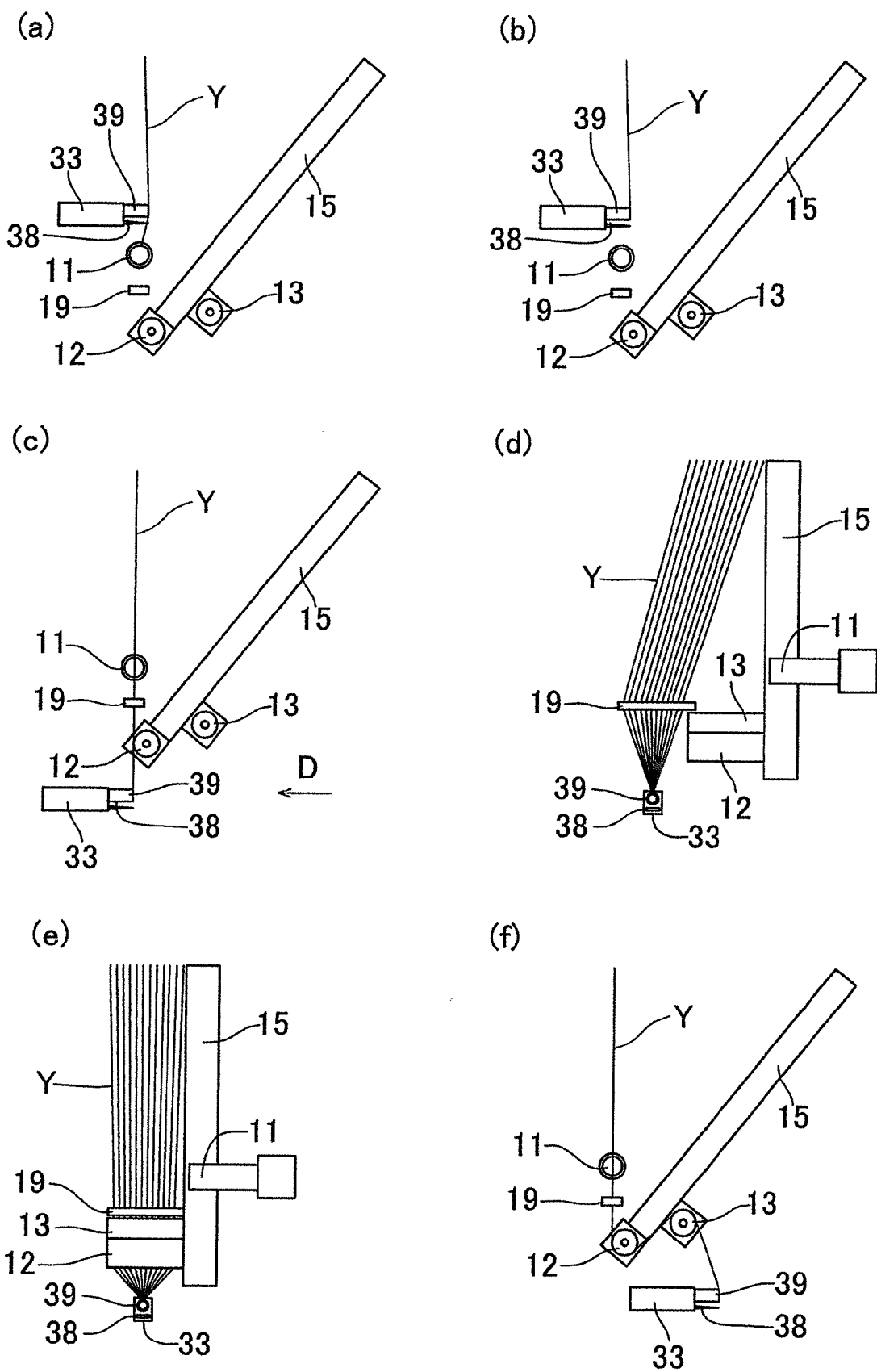
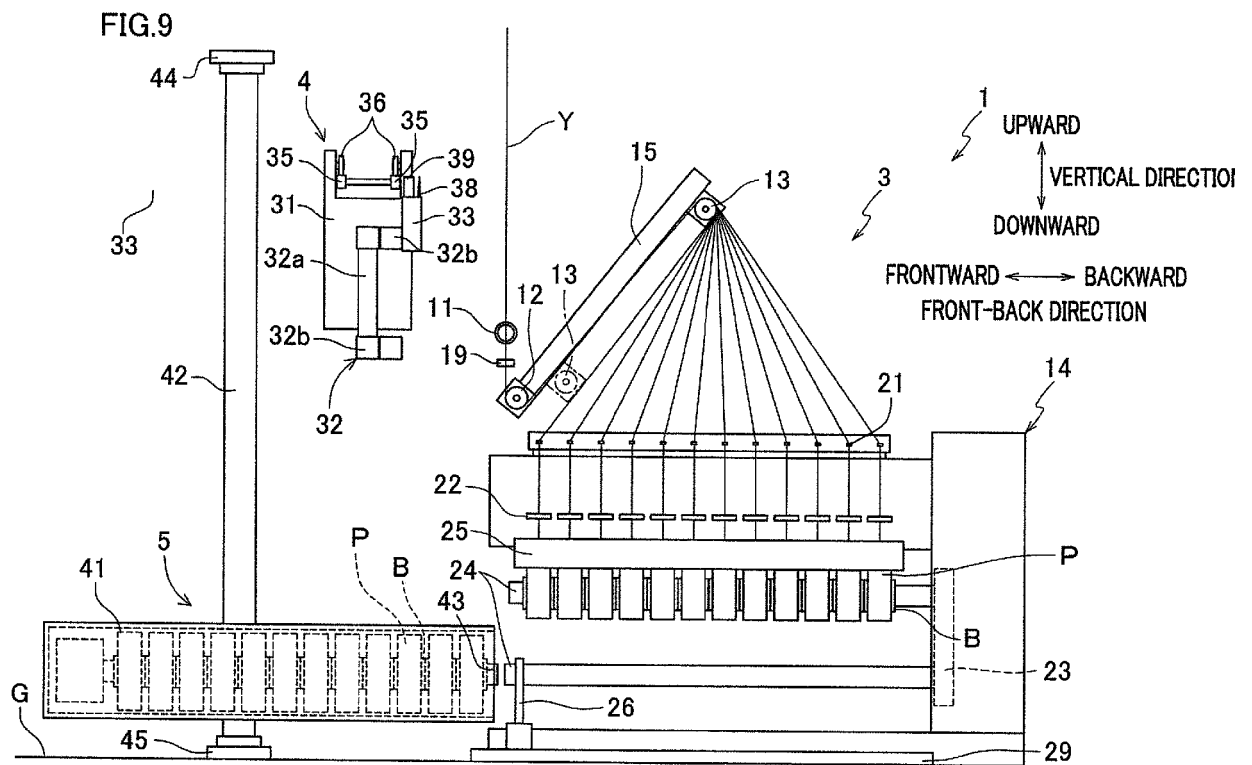


FIG.8





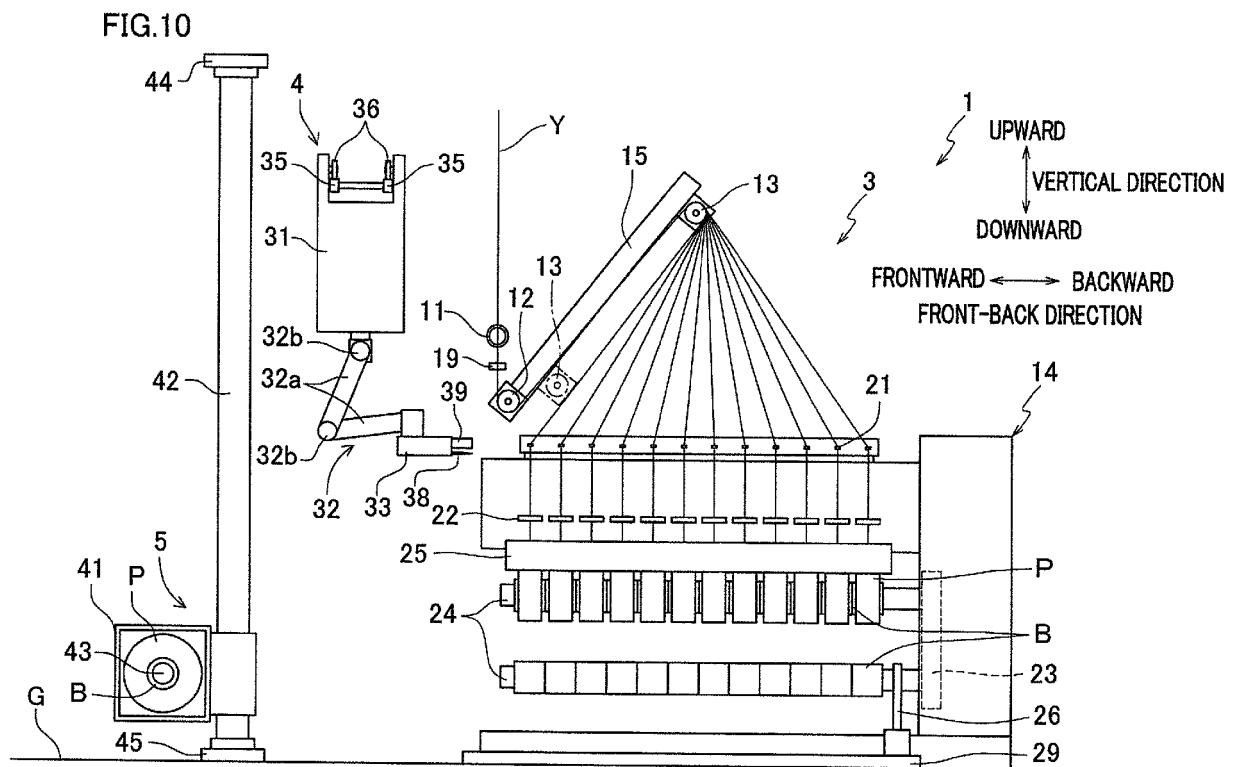
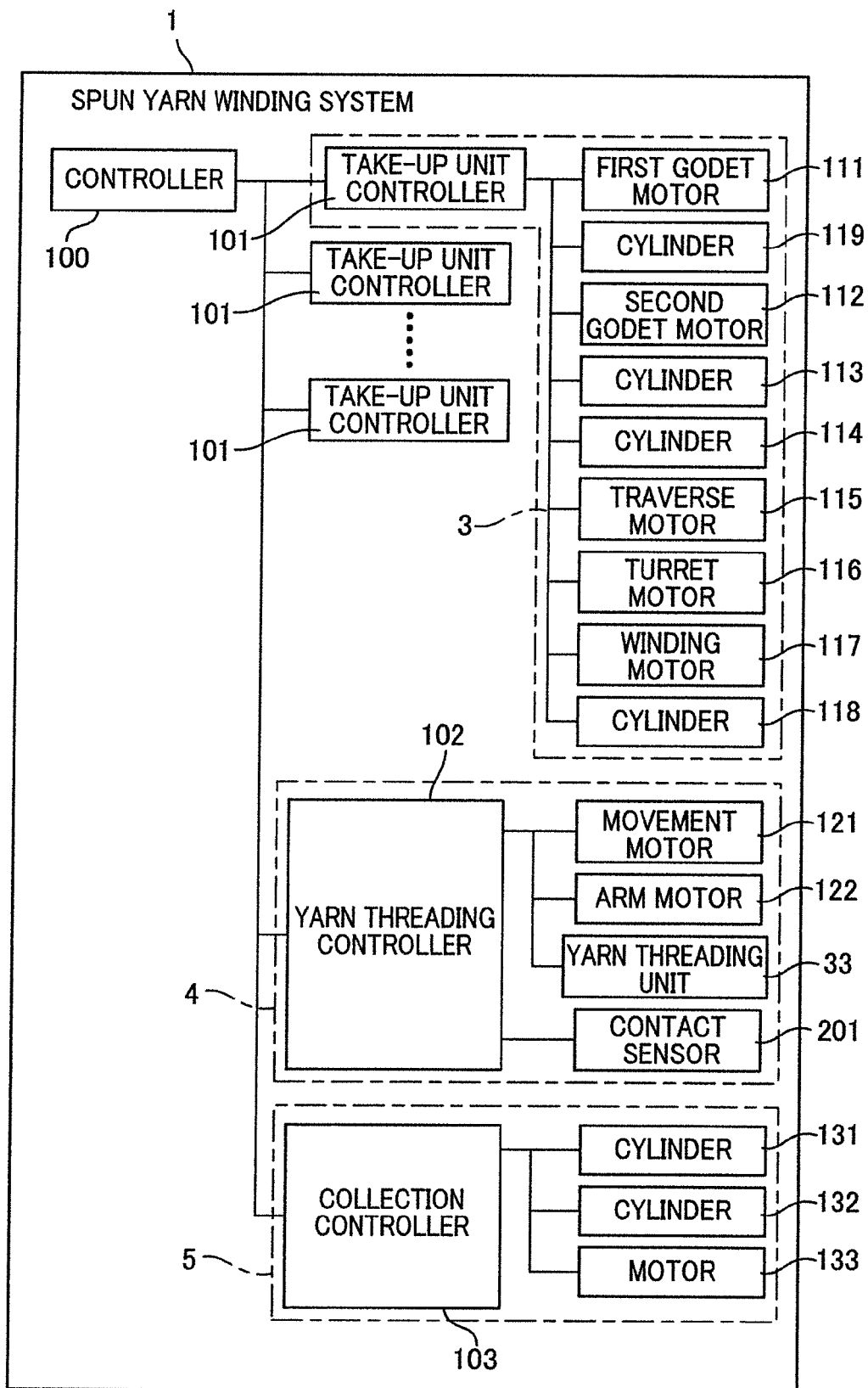


FIG.11





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