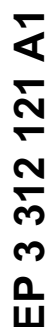


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(74) Representative: **Hoffmann Eitle**
Patent- und Rechtsanwälte PartmbB
Arabellastraße 30
81925 München (DE)

take-up apparatus 2 is configured to wind the spun-out yarn Y onto a bobbin B while traversing the yarn Y, to form a package. The yarn threading robot 3 includes a controller configured to control the suction force of the sucking retaining unit 42.



Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a yarn threading robot configured to perform yarn threading onto a spun yarn take-up apparatus.

[0002] Patent Literature 1 (Japanese Unexamined Patent Publication No. S53-106815), for example, discloses an automatic yarn threading device configured to perform yarn threading onto a spun yarn take-up apparatus configured to wind spun yarns to form packages. The automatic yarn threading device is configured to operate while sucking and retaining the yarns by a suction gun, to enable yarn threading onto elements structuring the spun yarn take-up apparatus.

SUMMARY OF THE INVENTION

[0003] Now, consideration is given to the case in which yarn threading is performed while yarns are sucked and retained by a suction gun. In this case, if the suction force of the suction gun is too small, yarn swaying or the like may occur, causing a possibility that yarn threading onto each element cannot be properly performed. Meanwhile, if the suction force of the suction gun is too large, the tension of the yarns may become too high, with the result that yarn breakage may be caused, and/or vibration of the yarns caused by the suction may be propagated excessively. That is, if the suction force of the suction gun is not properly controlled, there is a high possibility that yarn threading is failed. However, in Patent Literature 1, no mention is made of the control of the suction force of the suction gun to stably perform yarn threading.

[0004] The present invention has been made in view of the above problem. An object of the present invention is to provide a yarn threading robot capable of stably performing yarn threading.

[0005] According to an aspect of the present invention, a yarn threading robot configured to perform yarn threading onto a spun yarn take-up apparatus while sucking and retaining a yarn by a sucking retaining unit is provided, the spun yarn take-up apparatus being configured to wind the spun-out yarn onto a bobbin while traversing the yarn to form a package. The yarn threading robot includes a controller configured to control a suction force of the sucking retaining unit.

[0006] The yarn threading robot of the above aspect of the present invention includes the controller configured to control the suction force of the sucking retaining unit. Due to this, it is possible to stably perform yarn threading by increasing or decreasing the suction force as needed.

[0007] Furthermore, in the above aspect of the present invention, it is preferable that: the sucking retaining unit is configured so that compressed fluid is supplied to the sucking retaining unit and thereby a suction force corresponding to a pressure of the compressed fluid is generated; and the controller is configured to control the suc-

tion force of the sucking retaining unit by controlling the pressure of the compressed fluid supplied to the sucking retaining unit.

[0008] In the above arrangement, the suction force of the sucking retaining unit can be easily increased or decreased merely by adjusting the pressure of the compressed fluid.

[0009] Furthermore, in the above aspect of the present invention, it is preferable that: the yarn threading robot further includes a pressure adjuster configured to adjust the pressure of the compressed fluid, the pressure adjuster provided to a path through which the compressed fluid is supplied to the sucking retaining unit; and the controller is configured to control the suction force of the sucking retaining unit by controlling operation of the pressure adjuster.

[0010] Because the pressure adjuster configured to adjust the pressure of the compressed fluid is provided to the yarn threading robot, the distance between the pressure adjuster and the sucking retaining unit is short, which provides quick responsivity in the control of the suction force.

[0011] In the above aspect of the present invention, it is preferable that the pressure adjuster is an electro-pneumatic regulator.

[0012] The use of the electro-pneumatic regulator as the pressure adjuster allows the pressure of the compressed fluid to be adjusted in a substantially non-step manner, which allows minute control of the suction force of the sucking retaining unit.

[0013] In the above aspect of the present invention, it is preferable that the controller is configured to change the suction force of the sucking retaining unit in a single set of processes of yarn threading.

[0014] Even in a single set of processes of yarn threading, proper suction force can change depending on which of the processes is performed. In the above-mentioned arrangement, it is possible to deal with the case where the proper suction force changes within the single set of processes of yarn threading, thereby to enable more stable yarn threading.

[0015] Furthermore, in the above aspect of the present invention, it is preferable that the controller controls the suction force of the sucking retaining unit so that the suction force in a process of yarn threading onto the bobbin is the largest in the single set of processes of yarn threading.

[0016] Generally, in the process of yarn threading onto a bobbin, it is necessary to thread a yarn into a slit of the bobbin. Due to this, if the suction force is insufficient in the process of yarn threading onto the bobbin, the tension of the yarn may be too low, resulting in unsuccessful yarn threading into the slit. In the above-mentioned arrangement, the suction force is adjusted so that the suction force in the process of yarn threading onto the bobbin is the largest in the single set of processes of yarn threading. This makes it easier to thread the yarn into the slit, and enables reliable yarn threading onto the bobbin.

[0017] In the above aspect of the present invention, it is preferable that the controller changes the suction force of the sucking retaining unit based on a type of yarn wound by the spun yarn take-up apparatus and/or based on a production condition.

[0018] Proper tensions in the processes of yarn threading may differ depending on the type of yarn and/or production conditions. Even in such a case, each process of yarn threading is performed with a tension suitable for a subject yarn by changing the suction force depending on the type of yarn and/or production conditions, as described above.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019]

FIG. 1 is a schematic diagram of a spun yarn take-up system of an embodiment of the present invention.

FIG. 2 is a front view illustrating a spun yarn take-up apparatus and a yarn threading robot.

FIG. 3 is a side view illustrating the spun yarn take-up apparatus and the yarn threading robot.

FIG. 4 is a block diagram illustrating an electric structure of the spun yarn take-up system.

FIG. 5(a) and FIG. 5(b) are top views of fulcrum guides.

FIG. 6 is a perspective view illustrating a yarn threading unit of the yarn threading robot.

FIG. 7 is a cross-section of a suction.

FIG. 8(a) to FIG. 8(e) are side views showing the operation of the yarn threading robot at the time of yarn threading.

FIG. 9(a) to FIG. 9(c) are top views showing the operation of the yarn threading robot at the time of yarn threading.

FIG. 10 is a top view showing the operation of the yarn threading robot at the time of yarn threading.

FIG. 11 is a top view showing the operation of yarn threading from a yarn separation guide to the fulcrum guides.

FIG. 12 is a graph showing an example of control of the suction force of the suction.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0020] The following will describe a preferred embodiment of the present invention.

(Overall Structure of Spun Yarn Take-Up System)

[0021] FIG. 1 is a schematic diagram of a spun yarn take-up system of the present embodiment. The spun yarn take-up system 1 of the present embodiment includes: a plurality of spun yarn take-up apparatuses 2 lined up in one horizontal direction; yarn threading robots 3 configured to perform yarn threading onto the spun

yarn take-up apparatuses 2; a centralized controller 4 configured to control the operation of each spun yarn take-up apparatus 2 and the operation of each yarn threading robot 3; compressed air suppliers 5 configured to supply compressed air (an example of compressed fluid) to the yarn threading robots 3; and waste yarn boxes 6 configured to receive waste yarns from the yarn threading robots 3. In the present embodiment, one yarn threading robot 3, one compressed air supplier 5, and one waste yarn box 6 are provided for each of the spun yarn take-up apparatuses 2 included in the spun yarn take-up system 1. In FIG. 1, yarns are not illustrated to avoid complexity in the figure. Hereinafter, the direction in which the spun yarn take-up apparatuses 2 are lined up is referred to as a left-right direction, and the direction which is horizontal and orthogonal to the left-right direction is referred to as a front-back direction.

(Spun Yarn Take-Up Apparatus)

[0022] Now, the details of each spun yarn take-up apparatus 2 will be described. FIG. 2 is a front view showing the spun yarn take-up apparatus 2 and the yarn threading robot 3. FIG. 3 is a side view showing the spun yarn take-up apparatus 2 and the yarn threading robot 3. FIG. 4 is a block diagram showing the electric structure of the spun yarn take-up system 1.

[0023] The spun yarn take-up apparatus 2 is configured to take up yarns Y spun out from an unillustrated spinning apparatus, to wind the yarns onto bobbins B, and to form packages P. More specifically, the spun yarn take-up apparatus 2 is configured to feed the yarns Y spun out from the unillustrated spinning apparatus to a winding unit 13 by a first godet roller 11 and a second godet roller 12, and to wind the yarns Y onto the bobbins B in the winding unit 13, thereby to form packages P.

[0024] The first godet roller 11 is a roller having an axis substantially in parallel to the left-right direction and is provided above a front end portion of the winding unit 13. The first godet roller 11 is rotationally driven by a first godet motor 111 (see FIG. 4).

[0025] The second godet roller 12 is a roller having an axis substantially in parallel to the left-right direction and is provided above and backward of the first godet roller 11. The second godet roller 12 is rotationally driven by a second godet motor 112 (see FIG. 4). The second godet roller 12 is movably supported by a guide rail 14. The guide rail 14 extends obliquely with respect to an up-down direction with a positive slope in the backward direction. The second godet roller 12 is configured to be movable along the guide rail 14 by a cylinder 113 (see FIG. 4). Due to this, the second godet roller 12 is movable between a winding position (indicated by solid lines in FIG. 3) in which winding of the yarns Y is performed and a yarn threading position (indicated by dashed lines in FIG. 3) in which yarn threading is performed. The yarn threading position is closer to the first godet roller 11 than the winding position.

[0026] The spun yarn take-up apparatus 2 further includes an aspirator 15 and a yarn regulating guide 16. The aspirator 15 is configured to suck and retain the yarns Y spun out from the spinning apparatus before yarn threading is performed by the yarn threading robot 3. The aspirator 15 extends along the left-right direction. The aspirator 15 has, at its right end portion, a suction port 15a for sucking the yarns Y. The aspirator 15 is provided somewhat above the first godet roller 11 so that the suction port 15a is positioned near the yarns Y.

[0027] The yarn regulating guide 16 is provided between the first godet roller 11 and the aspirator 15 with respect to the up-down direction. The yarn regulating guide 16 is, for example, a known yarn guide with a comb teeth shape including guide grooves. The yarn regulating guide 16 functions to regulate the intervals between neighboring yarns Y threaded thereon. The yarn regulating guide 16 is arranged to be movable in the left-right direction (the axial direction of the first godet roller 11) by a cylinder 114 (see FIG. 4). Due to this arrangement, in the left-right direction, the yarn regulating guide 16 is movable between: a retracted position (indicated by solid lines in FIG. 2) where the guide 16 falls within the range of the first godet roller 11; and a protruding position (indicated by dashed lines in FIG. 2) where the guide 16 is to the right of a leading end portion of the first godet roller 11.

[0028] The winding unit 13 includes: fulcrum guides 21; traverse guides 22; a turret 23; two bobbin holders 24; and a contact roller 25.

[0029] FIG. 5(a) and FIG. 5(b) are top views of the fulcrum guides 21. The fulcrum guides 21 are provided for the yarns Y, respectively, and are lined up in the front-back direction. Each fulcrum guide 21 has a groove 21a which is open to the back side. Yarn threading onto the fulcrum guide 21 is performed by inserting the yarn Y into the groove 21a from the back side. The fulcrum guides 21 are attached to sliders 27, respectively. The sliders 27 are supported to be movable in the front-back direction along a guide rail 28. The sliders 27 are connected to a cylinder 115 (see FIG. 4). As the cylinder 115 is driven, the sliders 27 move in the front-back direction along the guide rail 28. Due to this, the fulcrum guides 21 are movable between: winding positions (positions shown in FIG. 5(a)) where the fulcrum guides 21 are separated from one another in the front-back direction and winding of the yarns Y is performed; and yarn threading positions (positions shown in FIG. 5(b)) where the fulcrum guides 21 are close to one another at a front end portion of the guide rail 28 and yarn threading is performed. The fulcrum guides 21 in their yarn threading positions are approximately straight below the first godet roller 11 and the second godet roller 12 in the yarn threading position.

[0030] The traverse guides 22 are respectively provided for the yarns Y, and are lined up in the front-back direction. The traverse guides 22 are driven by a common traverse motor 116 (see FIG. 4) 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.

[0031] The turret 23 is a disc-shaped member having an axis which is substantially in parallel to the front-back direction. The turret 23 is rotationally driven by a turret motor 117 (see FIG. 4). The two bobbin holders 24 have axes which are substantially in parallel to the front-back direction. The bobbin holders 24 are rotatably supported at an upper end portion and a lower end portion of the turret 23. Bobbins B are attached to each bobbin holder 24. The bobbins B are respectively provided for the yarns Y and lined up in the front-back direction. The two bobbin holders 24 are rotationally driven by their respective winding motors 118 (see FIG. 4).

[0032] When 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 turret 23 is rotated, to switch the positions of the two bobbin holders 24 with each other. As a result, the bobbin holder 24 having been at the lower position is moved to the upper position, which allows the yarns Y to be wound onto the bobbins B attached to the bobbin holder 24 having been moved to the upper position, to form packages P. Meanwhile, the bobbin holder 24 having been at the upper position is moved to the lower position, and the packages P are collected by a package collector which is not illustrated.

[0033] 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 is configured to contact the surfaces of the packages P supported by the upper bobbin holder 24. With this, the contact roller 25 applies a contact pressure to the surfaces of the unfinished packages P, to adjust the shape of the packages P.

(Yarn Threading Robot)

[0034] Now, the yarn threading robot 3 will be described. The yarn threading robot 3 includes a main body 31, a robotic arm 32, and a yarn threading unit 33.

[0035] The main body 31 is rectangular parallelepiped in shape, and has a robot controller 102 (see FIG. 4) and the like mounted inside thereof. The robot controller 102 is configured to control operations of the robotic arm 32, the yarn threading unit 33, an electro-pneumatic regulator 37, and the like. The main body 31 hangs down from two guide rails 35 and is movable in the left-right direction along the two guide rails 35. The two guide rails 35 are provided in front of the spun yarn take-up apparatuses 2 so as to be separate from each other in the front-back direction. Each guide rail 35 extends in the left-right direction so as to cover the plurality of spun yarn take-up apparatuses 2. That is, the yarn threading robot 3 is configured to be movable in the left-right direction in front of the spun yarn take-up apparatuses 2.

[0036] Four wheels 36 are provided at an upper end

portion of the main body 31. Two of the four wheels 36 are on the upper surface of one of the guide rails 35, and the remaining two wheels 36 are on the upper surface of the other one of the guide rails 35. The four wheels 36 are rotationally driven by a movement motor 121 (see FIG. 4). As the four wheels 36 are rotationally driven, the main body 31 moves in the left-right direction along the two guide rails 35.

[0037] The robotic arm 32 is attached to a lower surface of the main body 31. The robotic arm 32 includes arms 32a and joints 32b connecting the arms 32a with one another. Each joint 32b incorporates therein an arm motor 122 (see FIG. 4). As the arm motor 122 is driven, the arm 32a is swung about the joint 32b. This arrangement allows the robotic arm 32 to move three-dimensionally.

[0038] FIG. 6 is a perspective view showing the yarn threading unit 33 of the yarn threading robot 3. The yarn threading unit 33 is attached to a distal end portion of the robotic arm 32. The yarn threading unit 33 is long in one direction. Hereinafter, this direction is referred to as a first direction. An end portion of the yarn threading unit 33, which is on one side in the first direction, is connected to the arm 32a. Hereinafter, the one side in the first direction is referred to as a base end side in the first direction. In addition to the above, hereinafter, the side opposite to the base end side in the first direction is referred to as a leading end side.

[0039] In the present embodiment, as the robotic arm 32 is driven, the yarn threading unit 33 attached to the distal end portion of the robotic arm 32 moves three-dimensionally. In so doing, the orientation of the yarn threading unit 33 is changeable. As described later, at the time of yarn threading, the yarn threading unit 33 is mainly used in an orientation such that the up-down direction in FIG. 6 is in parallel to the vertical direction, the upper side in FIG. 6 is the upper side in the vertical direction, and the lower side in FIG. 6 is the lower side in the vertical direction. In view of the above, hereinafter, directions relative to the yarn threading unit 33 are defined as follows: the up-down direction in FIG. 6 is referred to as a second direction; the upper side in FIG. 6 is referred to as the upper side in the second direction; and the lower side in FIG. 6 is referred to as the lower side in the second direction. Furthermore, hereinafter, a direction orthogonal to both the first direction and the second direction is defined as a third direction, and one side and the other side in the third direction are defined as shown in FIG. 6.

[0040] The yarn threading unit 33 includes a frame 41, a suction 42, a yarn convergence guide 43, a cutter 44, a slidable component 45, a pressing roller 46, a yarn separation guide 47, and the like. The frame 41 is connected with the arm 32a at the base end portion in the first direction. The suction 42 is attached to a part of the frame 41, which is on the one side in the third direction. The suction 42 extends in the first direction and is able to suck and retain the yarns Y at its leading end portion. The yarn convergence guide 43 is attached to the frame

41 and is below the leading end portion of the suction 42 in the second direction. Onto the yarn convergence guide 43, the yarns Y are threaded in a converged state at the time of yarn threading. The cutter 44 is attached to the frame 41 and is below the yarn convergence guide 43 in the second direction. As described later, the cutter 44 is provided to cut the yarns Y when the yarns Y are passed from the aspirator 15 to the suction 42.

[0041] The slidable component 45 is provided on the other side in the third direction of the suction 42, the yarn convergence guide 43, and the cutter 44. The slidable component 45 is attached to the frame 41 via a cylinder 48. As the cylinder 48 is driven, the slidable component 45 moves in the first direction relative to the frame 41.

[0042] The pressing roller 46 is a free roller rotatably supported by a shaft 46a which is orthogonal to the second direction. The pressing roller 46 is provided above the slidable component 45 in the second direction so as to be movable together with the slidable component 45 in the first direction. An end portion of the shaft 46a is attached to a hollow cylindrical shaft 49. The shaft 49 extends in the second direction to penetrate the slidable component 45. A roller swinging device 50 is connected to an end portion of the shaft 49, which is on the lower side in the second direction. The pressing roller 46 is configured to swingable about the axis of the shaft 49 by the roller swinging device 50 within a plane including the first direction and the third direction. The pressing roller 46 is swingable about the axis of the shaft 49, and this allows the pressing roller 46 to selectively take one of the following postures: a retreat posture (posture shown in FIG. 6) in which the axial direction of the pressing roller 46 is substantially in parallel to the first direction, and the entirety of the pressing roller 46 is on the other side in the third direction relative to a range in which the suction 42, the yarn convergence guide 43, and the cutter 44 are provided; and a pressing posture (posture shown in FIG. 9(a)) in which the axial direction of the pressing roller 46 is substantially in parallel to the third direction, and the pressing roller 46 partially overlaps, with respect to the third direction, the range in which the suction 42, the yarn convergence guide 43, and the cutter 44 are provided.

[0043] The yarn separation guide 47 is provided above the pressing roller 46 in the second direction so as to be movable together with the slidable component 45 in the first direction. The yarn separation guide 47 has grooves 47a lined up along the length of the guide 47. Each of the grooves 47a is open at one end. The intervals between the grooves 47a increase in the direction away from the open ends. In this regard, the intervals between the grooves 47a may be constant regardless of the distance from the open ends. The yarn separation guide 47 is, at an end portion in its longitudinal direction, attached to an unillustrated shaft which extends to be in parallel to the second direction. The shaft is inserted through the hollow cylindrical shaft 49. A guide swinging device 51 is connected to a lower end portion of the shaft, which is on the lower side in the second direction. The yarn sep-

aration guide 47 is configured to be swung about the axis of the unillustrated shaft by the guide swinging device 51. This allows the yarn separation guide 47 to selectively take one of the following postures: a retreat posture (posture shown in FIG. 6) in which the longitudinal direction of the yarn separation guide 47 is substantially in parallel to the first direction, and the entirety of the yarn separation guide 47 is on the other side in the third direction relative to the range in which the suction 42, the yarn convergence guide 43, and the cutter 44 are provided; and a yarn threading posture (posture shown in FIG. 9(c)) in which the longitudinal direction of the yarn separation guide 47 is substantially parallel to the third direction, and the yarn separation guide 47 partially overlaps, with respect to the third direction, the range in which the suction 42, the yarn convergence guide 43, and the cutter 44 are provided.

[0044] FIG. 7 is a cross-section of the suction 42. The suction 42 includes a suction pipe 42a extending in the first direction, and a compressed air pipe 42b unitarily connected to an intermediate portion of the suction pipe 42a. A leading end portion of the suction pipe 42a functions as a suction port 42c through which the yarns Y are sucked. A base end portion of the suction pipe 42a is connected to a waste yarn hose 8 (see FIG. 1), which is connected to the waste yarn box 6. A leading end portion of the compressed air pipe 42b communicates with the suction pipe 42a via a communication hole 42d. A base end portion of the compressed air pipe 42b is connected to a compressed air hose 7 (see FIG. 1), which is connected to the compressed air supplier 5. The communication hole 42d is inclined with respect to the suction pipe 42a so that an end of the communication hole 42d which is close to the suction pipe 42a is on the base end side relative to its opposite end. A part of the compressed air hose 7 and a part of the waste yarn hose 8 are attached to the main body 31 or the robotic arm 32 so as not to interfere with the operation of the robotic arm 32.

[0045] In the suction 42 configured as above, compressed air having flowed from the compressed air pipe 42b into the suction pipe 42a flows from the leading end side to the base end side of the suction pipe 42a, as indicated by an arrow in FIG. 7. This airflow creates a vacuum or a negative pressure at the suction port 42c, which makes it possible to suck the yarns Y from the suction port 42c. The yarns Y sucked from the suction port 42c are discharged to the waste yarn hose 8 along with the airflow in the suction pipe 42a. The yarn threading robot 3 performs yarn threading while sucking and retaining the yarns Y using the suction 42.

[0046] As described above, the suction 42 of the present embodiment is configured so that suction force (vacuum) is created at the suction port 42c by compressed air supplied from the compressed air supplier 5. The suction force of the suction 42 is changeable by changing the pressure of compressed air supplied to the suction 42. In the present embodiment, as shown in FIG. 1, the electro-pneumatic regulator 37 is provided to a part

of the compressed air hose 7, the part being provided to the yarn threading robot 3. The electro-pneumatic regulator 37 is able to adjust the pressure of compressed air in a substantially non-step manner, i.e., substantially continuously. This arrangement makes it possible to adjust the pressure of the compressed air supplied to the suction 42, and thus it is possible to adjust the suction force of the suction 42.

10 (Electric Structure of Spun Yarn Take-Up System)

[0047] Now, the electric structure of the spun yarn take-up system 1 will be described. As shown in FIG. 1, the spun yarn take-up system 1 includes the centralized controller 4 which serves to control the entire system. The centralized controller 4 includes an operation unit 4a which allows an operator to make various settings, and a display unit 4b configured to display thereon a screen for assisting the settings and/or a screen showing the state of each component. As shown in FIG. 4, each spun yarn take-up apparatus 2 is provided with a winding controller 101. The winding controller 101 is configured to control the operation of each driving unit of the spun yarn take-up apparatus 2. In the yarn threading robot 3, a robot controller 102 is provided. The robot controller 102 is configured to control the operation of each driving unit of the yarn threading robot 3. The centralized controller 4 is communicably connected, wirelessly or by cable, with each winding controller 101 and each robot controller 102.

(Flow of processes of yarn threading)

[0048] The following describes processes of yarn threading performed by the yarn threading robot 3. FIG. 8(a) to FIG. 8(e) are side views showing the operation of the yarn threading robot 3 at the time of yarn threading. FIG. 9(a) to FIG. 9(c) and FIG. 10 are top views showing the operation of the yarn threading robot 3 at the time of yarn threading. FIG. 11 is a top view showing the operation in which the yarns Y are threaded from the yarn separation guide 47 to the fulcrum guides 21. To be more specific, FIG. 8(a) to FIG. 8(e) show the process of receiving the yarns Y spun out from the spinning apparatus and winding the yarns Y onto the first godet roller 11 and the second godet roller 12. This process is one of the processes of yarn threading. FIG. 9(a) to FIG. 9(c) and FIG. 10 show the process of threading the yarns Y onto the yarn separation guide 47 of the yarn threading robot 3. In FIG. 8(a) to FIG. 8(e), the yarn threading unit 33 is oriented such that the first direction of the yarn threading unit 33 is substantially in parallel to the front-back direction, for the sake of convenience. In practice, however, yarn threading is performed while the posture of the yarn threading unit 33 is changed.

[0049] As shown in FIG. 8(a), before yarn threading is performed by the yarn threading robot 3, the yarns Y spun out from the spinning apparatus are sucked and

retained by the aspirator 15 in advance. In addition, the second godet roller 12 of the spun yarn take-up apparatus 2 subjected to yarn threading is positioned at the yarn threading position, in advance. Furthermore, the fulcrum guides 21 are positioned at their yarn threading positions (positions shown in FIG. 5(b)), in advance. Furthermore, the pressing roller 46 and the yarn separation guide 47 of the yarn threading unit 33 are arranged to be in their respective retreat postures (postures shown in FIG. 6), in advance.

[0050] Thereafter, the yarn threading robot 3 is moved to a position in which the robot 3 overlaps the spun yarn take-up apparatus 2 subjected to yarn threading with respect to the front-back direction. Subsequently, the yarn threading robot 3 actuates the robotic arm 32, thereby to move the yarn threading unit 33 to a position somewhat above the aspirator 15, as shown in FIG. 8(b). At this time, the yarn threading unit 33 is moved so that: the leading end portion of the suction 42 is pressed onto the yarns Y sucked and retained by the aspirator 15; and the cutter 44 is at a position which enables the cutter 44 to cut the yarns Y. Subsequently, the yarns Y are cut by the cutter 44. Then, as shown in FIG. 8(c), the yarns Y are sucked and retained by the suction 42, and thus handing over of the yarns Y from the aspirator 15 to the suction 42 is completed.

[0051] After the completion of handing over of the yarns Y from the aspirator 15 to the suction 42, the yarns Y are threaded onto the yarn regulating guide 16 while the yarn threading unit 33 is moved to a position below the first godet roller 11, as shown in FIG. 8(d). To thread the yarns Y onto the yarn regulating guide 16, the yarn regulating guide 16 is moved to the protruding position (position indicated by the dashed line in FIG. 2) for a while, to avoid interference by the godet rollers 11 and 12 with the yarn threading unit 33. Then, the yarns Y are threaded onto the yarn regulating guide 16 in the protruding position. After yarn threading onto the yarn regulating guide 16, the yarn regulating guide 16 is returned to the retracted position (position indicated by the solid line in FIG. 2). Subsequently, the yarn threading unit 33 is moved appropriately to wind the yarns Y retained by the suction 42 onto the first godet roller 11 from below, and then to wind the yarns Y onto the second godet roller 12 from above, as shown in FIG. 8(e).

[0052] Now, yarn threading onto the fulcrum guides 21 will be described with reference to FIG. 9(a) to FIG. 9(c) and FIG. 10. After yarn threading onto the godet rollers 11 and 12, the yarn threading robot 3 swings the pressing roller 46, to change its posture from the retreat posture to the pressing posture, as shown in FIG. 9(a). As a result, the pressing roller 46 is pressed onto the yarns Y and rotates due to the friction force with the yarns Y. This widens the intervals of the yarns Y at the parts onto which the pressing roller 46 is pressed.

[0053] Subsequently, as shown in FIG. 9(b), the slidable component 45 is slid toward the leading end side in the first direction. As a result, the pressing roller 46

pressed onto the yarns Y slides toward the leading end side in the first direction together with the slidable component 45, so as to move away from the suction 42. With this, as compared to the state shown in FIG. 9(a), the tilting angles of the yarns Y running from the pressing roller 46 to the suction 42 decrease. The tilting angles of the yarns Y are the angles of the yarns Y inclined with respect to the first direction when viewed in the second direction. In this regard, if the above tilting angles of the yarns Y are large, variations tend to be caused in the position where the yarns Y leave the pressing roller 46 toward the suction 42, and this may disadvantageously cause yarn swaying. To minimize yarn swaying, in the present embodiment, the tilting angles of the yarns Y are decreased by moving the pressing roller 46 away from the suction 42, as described above. As a result, the intervals between the yarns Y become substantially identical with the intervals between the openings of the grooves 47a of the yarn separation guide 47, which are substantially equal to the intervals between the guide grooves of the yarn regulating guide 16.

[0054] Subsequently, as shown in FIG. 9(c), the yarn separation guide 47 is swung to change its posture from the retreat posture to the yarn threading posture. As a result, the grooves 47a of the yarn separation guide 47 are respectively opposed to the yarns Y onto which the pressing roller 46 is pressed. Subsequently, as shown in FIG. 10, the pressing roller 46 is swung to change its posture from the pressing posture to the retreat posture. As a consequence, the pressing roller 46 moves away from the yarns Y, and the yarns Y are inserted into the respective grooves 47a. In this connection, because the intervals between the grooves 47a increase in the direction away from the openings of the grooves 47a, the intervals between the yarns Y inserted into the grooves 47a further increase. Further, at this time, the yarn threading unit 33 is positioned so that linear lines each connecting one of the grooves 47a of the yarn separation guide 47 with the opening at the leading end of the groove 21a of the corresponding fulcrum guide 21 are in parallel to one another, as shown in FIG. 11.

[0055] The yarn separation guide 47 in the above state is moved as shown in FIG. 11. As a result, the yarns Y inserted into the grooves 47a are respectively threaded onto the respective fulcrum guides 21. After the completion of yarn threading onto the fulcrum guides 21, the second godet roller 12 and the fulcrum guides 21 are moved to their respective winding positions. Further, the slidable component 45 is slid toward the base end side in the first direction, and the yarn separation guide 47 is returned to the retreat posture.

(Control of Suction Force of Suction)

[0056] During the above-described series of processes of yarn threading, the yarn threading robot 3 sucks and retains the yarns Y using the suction 42. In this regard, proper suction force changes depending on the el-

ement subjected to yarn threading, and there is a possibility that yarn threading is not successfully performed if the suction force of the suction 42 is constant. To deal with this, in the present embodiment, the electro-pneumatic regulator 37 is provided to an intermediate portion of the compressed air hose 7, so that the suction force of the suction 42 is adjustable by controlling the electro-pneumatic regulator 37 by the robot controller 102, as described above. The following will describe a specific example of the control of the suction force of the suction 42.

[0057] FIG. 12 is a graph showing an example of the control of the suction force of the suction 42. In the present embodiment, as shown in FIG. 12, the robot controller 102 controls the suction force of the suction 42 based on which of the processes of yarn threading is performed. The robot controller 102 stores, in advance, control data shown in FIG. 12 (suction force as a function of the processes of yarn threading). Based on the control data, the robot controller 102 controls the electro-pneumatic regulator 37 in a series of processes of yarn threading (a single set of processes of yarn threading) from the process of handing over the yarns Y to the suction to the process of yarn threading onto the bobbins B, which will be described later.

[0058] In the first place, the robot controller 102 controls the electro-pneumatic regulator 37 so as to generate a predetermined level of suction force in the suction 42. With this suction force, the yarns Y are passed from the aspirator 15 to the suction 42 (handing over of the yarns Y). Thereafter, yarn threading onto the yarn regulating guide 16 is performed. When yarn threading is performed onto the yarn regulating guide 16, the robot controller 102 controls the electro-pneumatic regulator 37 so that the suction force of the suction 42 is larger than the above predetermined level in the process of handing over of the yarns Y. This is because, unless the tension of the yarns Y is increased to some extent in the process of yarn threading into the guide grooves of the yarn regulating guide 16, the motions of the yarns Y tend to be unstable due to the contact with the yarn regulating guide 16, which may result in unsuccessful yarn threading.

[0059] Subsequently, yarn threading onto the godet rollers 11 and 12 is performed. In this process, the robot controller 102 controls the electro-pneumatic regulator 37 so as to adjust the suction force of the suction 42 by increasing or decreasing the suction force, as needed, in accordance with the motion of the yarn threading unit 33. It should be noted that the increase or decrease of the suction force as above is not essential. Yarn threading onto the godet rollers 11 and 12 may be performed with the suction force equal to that in the process of yarn threading onto the yarn regulating guide 16.

[0060] After yarn threading onto the godet rollers 11 and 12, yarn threading onto the pressing roller 46 and the yarn separation guide 47 is performed, in this order. Before yarn threading onto the pressing roller 46, the robot controller 102 controls the electro-pneumatic reg-

ulator 37 so as to decrease the suction force of the suction 42. This is because, if the suction force of the suction 42 is too large, large vibration is imparted to the sucked yarns Y by the suction 42, causing a possibility that the propagation of the vibration cannot be suppressed by the pressing roller 46. This may increase yarn swaying, leading to unsuccessful yarn threading onto the yarn separation guide 47.

[0061] Subsequently, yarn threading onto the fulcrum guides 21 at the yarn threading positions is performed. In this process, the robot controller 102 controls the electro-pneumatic regulator 37 to adjust the suction force of the suction 42. As can be clearly seen from FIG. 11, in the process of yarn threading onto the fulcrum guides 21, it is necessary to increase the suction force of the suction 42 to minimize yarn swaying, in order to increase the success rate of yarn threading, because the yarns Y are inserted into the grooves 21 a while coming into contact with the fulcrum guides 21. In this regard, however, if the suction force of the suction 42 is increased too much to minimize yarn swaying, friction between the yarns Y and the yarn separation guide 47 becomes too high, which may cause yarn breakage. For this reason, as described above, the suction force in the process of yarn threading onto the fulcrum guides 21 is adjusted to minimize both yarn breakage and yarn swaying, taking the friction between the yarns Y and the yarn separation guide 47 into consideration. This adjustment increases the success rate of yarn threading onto the fulcrum guides 21. FIG. 12 shows the case in which the suction force of the suction 42 is slightly increased in the process of yarn threading onto the fulcrum guides 21, by way of example.

[0062] After the yarn threading onto the fulcrum guides 21, the fulcrum guides 21 are moved from the yarn threading positions to the winding positions. Regardless of whether the fulcrum guides 21 have been moved from the yarn threading positions to the winding positions, after the yarn threading onto the fulcrum guides 21, the yarn threading unit 33 is moved to the yarn threading position for yarn threading onto the bobbins B attached to the bobbin holder 24. At this position, yarn threading onto the bobbins B is performed. In the process of yarn threading onto the bobbins B, the robot controller 102 controls the electro-pneumatic regulator 37 so that the suction force of the suction 42 is the largest in a single set of processes of yarn threading. Increase in the suction force increases the tension of the yarns Y. This reduces the possibility that yarn threading onto the bobbins B is failed due to slack of the yarns Y.

[0063] Now, proper suction force of the suction 42 can change depending on the material and diameter of the yarns Y, production conditions such as the spinning-out speed of the yarns Y, and the like. Accordingly, in the present embodiment, there are plural sets of control data corresponding to various types of yarns Y and/or production conditions (an example of such a set of data is indicated by broken lines in FIG. 12). For example, when an

operator inputs the type of the yarns Y and/or production conditions through the operation unit 4a of the centralized controller 4, information regarding the yarn type and/or the production conditions is transmitted from the centralized controller 4 to each robot controller 102. Then, the robot controller 102 selects a set of control data corresponding to the type of the yarns Y and/or the production conditions, and controls the suction force of the suction 42 based on the selected control data. It should be noted that the manner of the control of the suction force of the suction 42 does not have to be changed depending on the type of the yarns Y and/or the production conditions.

(Advantageous Effects)

[0064] As described above, the yarn threading robot 3 of the present embodiment includes the robot controller 102 configured to control the suction force of the suction 42 (sucking retaining unit). Due to this, it is possible to stably perform yarn threading by increasing or decreasing the suction force as needed.

[0065] Furthermore, in the present embodiment, the suction 42 is configured so that compressed air (compressed fluid) is supplied to the suction 42 and thereby a suction force corresponding to the pressure of the compressed air is generated; and the robot controller 102 is configured to control the suction force of the suction 42 by controlling the pressure of the compressed air supplied to the suction 42. In the above arrangement, the suction force of the suction 42 can be easily increased or decreased merely by adjusting the pressure of the compressed air.

[0066] Furthermore, in the present embodiment, the yarn threading robot further includes the electro-pneumatic regulator 37 (pressure adjuster) configured to adjust the pressure of the compressed air, the regulator 37 provided to the compressed air hose 7 (path) through which the compressed air is supplied to the suction 42; and the robot controller 102 is configured to control the suction force of the suction 42 by controlling the operation of the electro-pneumatic regulator 37. Because the electro-pneumatic regulator 37 configured to adjust the pressure of the compressed air is provided to the yarn threading robot 3, the distance between the electro-pneumatic regulator 37 and the suction 42 is short, which provides quick responsivity in the control of the suction force.

[0067] Furthermore, in the present embodiment, the electro-pneumatic regulator 37 functions as the pressure adjuster, as described above. The use of the electro-pneumatic regulator 37 as the pressure adjuster allows the pressure of the compressed air to be adjusted in a substantially non-step manner, which allows minute control of the suction force of the suction 42.

[0068] Furthermore, in the present embodiment, the robot controller 102 is configured to change the suction force of the suction 42 in a single set of processes of yarn threading. Even in a single set of processes of yarn threading, proper suction force can change depending

on which of the processes is performed (for example, depending on the element onto which yarn threading is performed). In the above-mentioned arrangement, it is possible to deal with the case where the proper suction force changes within a single set of processes of yarn threading, thereby to enable more stable yarn threading.

[0069] Furthermore, in the present embodiment, the robot controller 102 is configured to control the suction force of the suction 42 so that the suction force is the largest in a process of yarn threading onto the bobbins B among the single set of processes of yarn threading. Generally, in the process of yarn threading onto the bobbins B, it is necessary to thread yarns Y into respective slits of the bobbins B. Due to this, if the suction force is insufficient in the process of yarn threading onto the bobbins B, the tension of the yarns Y may be too low, resulting in unsuccessful yarn threading into the slits. In the above-mentioned arrangement, the suction force is adjusted so that the suction force in the process of yarn threading onto the bobbins B is the largest in the single set of processes of yarn threading. This makes it easier to thread the yarns Y into the slits, and enables reliable yarn threading onto the bobbins B.

[0070] Furthermore, in the present embodiment, the robot controller 102 is configured to change the suction force of the suction 42 based on the type of the yarns Y wound by the spun yarn take-up apparatus 2 and/or based on production conditions. Proper tensions in the processes of yarn threading may differ depending on the type of the yarns Y and/or production conditions. Even in such a case, each process of yarn threading is performed with a tension suitable for subject yarns Y by changing the suction force depending on the type of the yarns Y and/or production conditions.

(Other embodiments)

[0071] Although an embodiment of the present invention has been described, the present invention is not limited to the above-mentioned embodiment and can be suitably changed within the scope of the present invention as described below.

[0072] For example, in the embodiment above, the electro-pneumatic regulator 37 functioning as the pressure adjuster is provided to the part of the compressed air hose 7, the part being provided to the yarn threading robot 3. However, the position at which the electro-pneumatic regulator 37 is provided is not limited to this. For example, the electro-pneumatic regulator 37 may be provided to a part of the compressed air hose 7, the part being not provided to the yarn threading robot 3. Furthermore, as the pressure adjuster, an electrically-controlled flow regulating valve may be provided, for example, instead of the electro-pneumatic regulator 37.

[0073] In the embodiment above, the robot controller 102 controls the suction force of the suction 42 based on which of the processes of yarn threading is performed. However, arrangements other than the above are also

possible. For example, various sensors configured to detect the position and/or posture of the robotic arm 32 may be provided, and the robot controller 102 may control the suction force of the suction 42 based on values output from these sensors.

[0074] In the embodiment above, the robot controller 102 stores in advance control data regarding the suction force of the suction 42, and controls the suction force based on the stored control data. However, it is not essential for the robot controller 102 to store such control data in advance. For example, a sensor configured to detect the tension of the yarns Y may be provided, and the robot controller 102 may control the suction force of the suction 42 based on a value output from the sensor.

[0075] In the embodiment above, the yarn threading robot 3 is arranged to hang down from the guide rails 35, however, the yarn threading robot 3 does not have to hang down. For example, the yarn threading robot 3 may be arranged to travel on the floor.

[0076] In addition to the above, the configuration of the yarn threading unit 33 is not limited to that of the above embodiment. For example, the yarn threading unit 33 may just include the suction 42, the yarn convergence guide 43, and the cutter 44, when the winding unit 13 includes the pressing roller 46, the yarn separation guide 47, and a driving source configured to thread the yarns Y, which have been threaded onto the yarn separation guide 47, onto the fulcrum guides 21.

of the compressed fluid, the pressure adjuster provided to a path through which the compressed fluid is supplied to the sucking retaining unit, wherein the controller is configured to control the suction force of the sucking retaining unit by controlling operation of the pressure adjuster.

4. The yarn threading robot according to claim 3, wherein the pressure adjuster is an electro-pneumatic regulator.

5. The yarn threading robot according to any one of claims 1 to 4, wherein the controller is configured to change the suction force of the sucking retaining unit in a single set of processes of yarn threading.

6. The yarn threading robot according to claim 5, wherein the controller controls the suction force of the sucking retaining unit so that the suction force in a process of yarn threading onto the bobbin is the largest in the single set of processes of yarn threading.

7. The yarn threading robot according to any one of claims 1 to 6, wherein the controller changes the suction force of the sucking retaining unit based on a type of yarn wound by the spun yarn take-up apparatus and/or based on a production condition.

Claims

1. A yarn threading robot configured to perform yarn threading onto a spun yarn take-up apparatus while sucking and retaining a yarn by a sucking retaining unit, the spun yarn take-up apparatus being configured to wind the spun-out yarn onto a bobbin while traversing the yarn to form a package, the yarn threading robot comprising a controller configured to control a suction force of the sucking retaining unit.

2. The yarn threading robot according to claim 1, wherein:

the sucking retaining unit is configured so that compressed fluid is supplied to the sucking retaining unit and thereby a suction force corresponding to a pressure of the compressed fluid is generated; and

the controller is configured to control the suction force of the sucking retaining unit by controlling the pressure of the compressed fluid supplied to the sucking retaining unit.

3. The yarn threading robot according to claim 2, further comprising a pressure adjuster configured to adjust the pressure

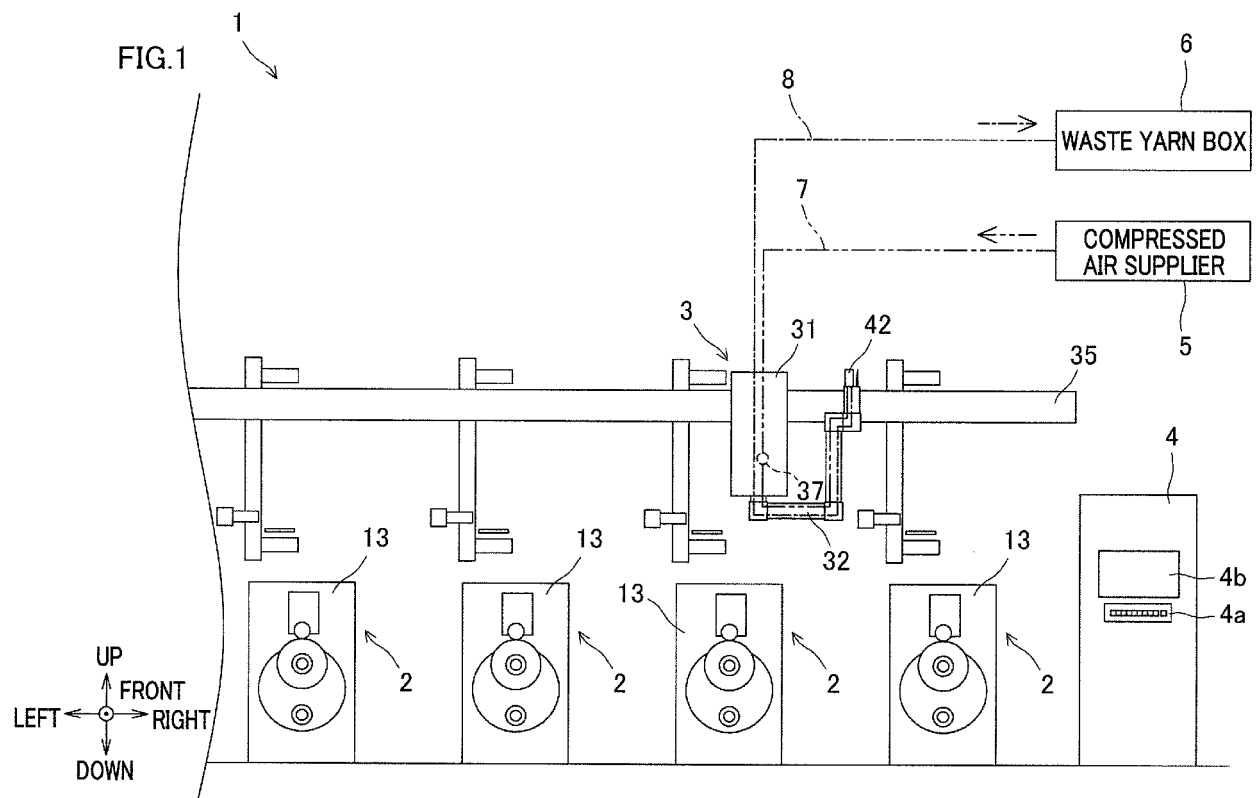


FIG.2

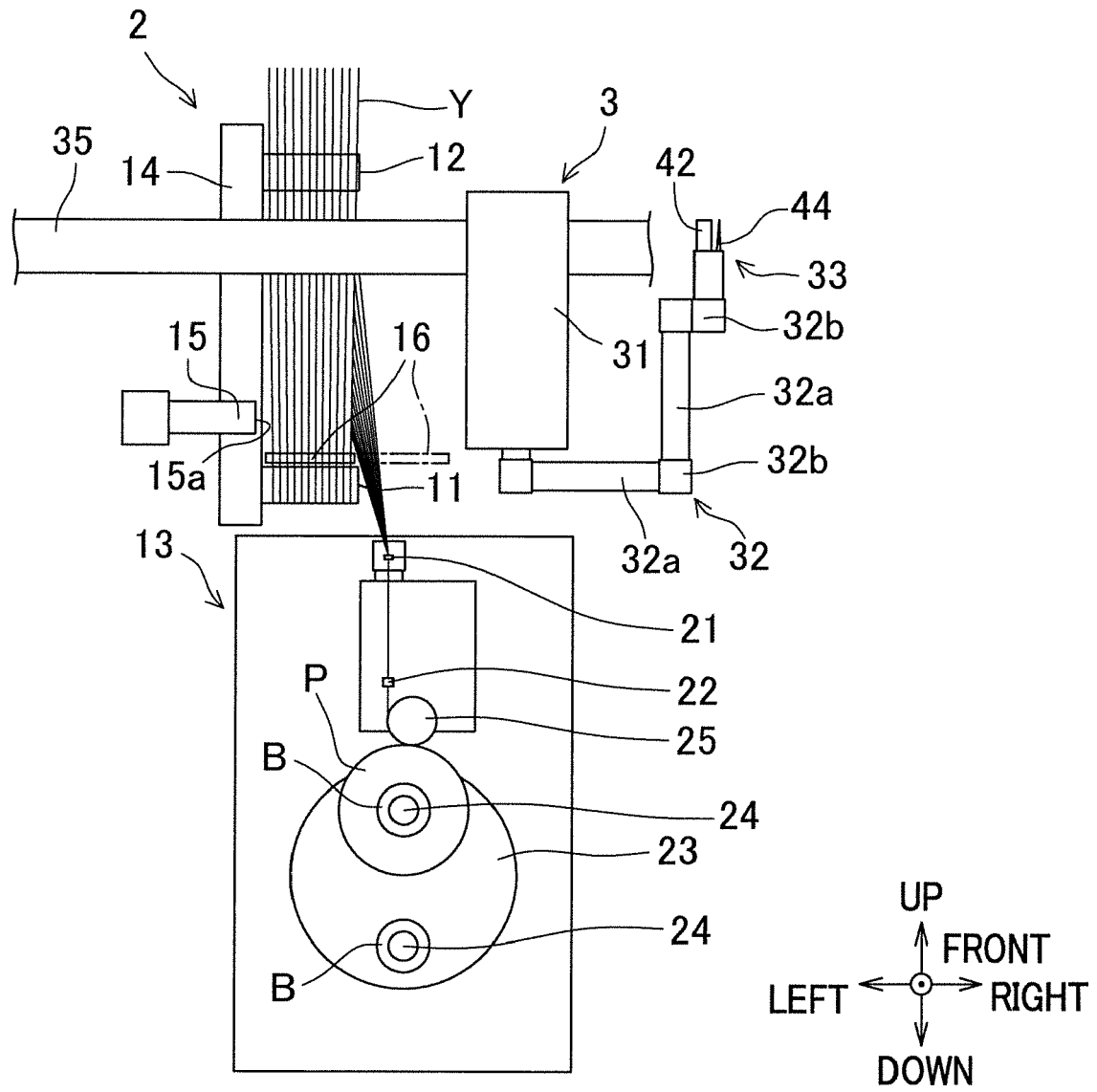


FIG.3

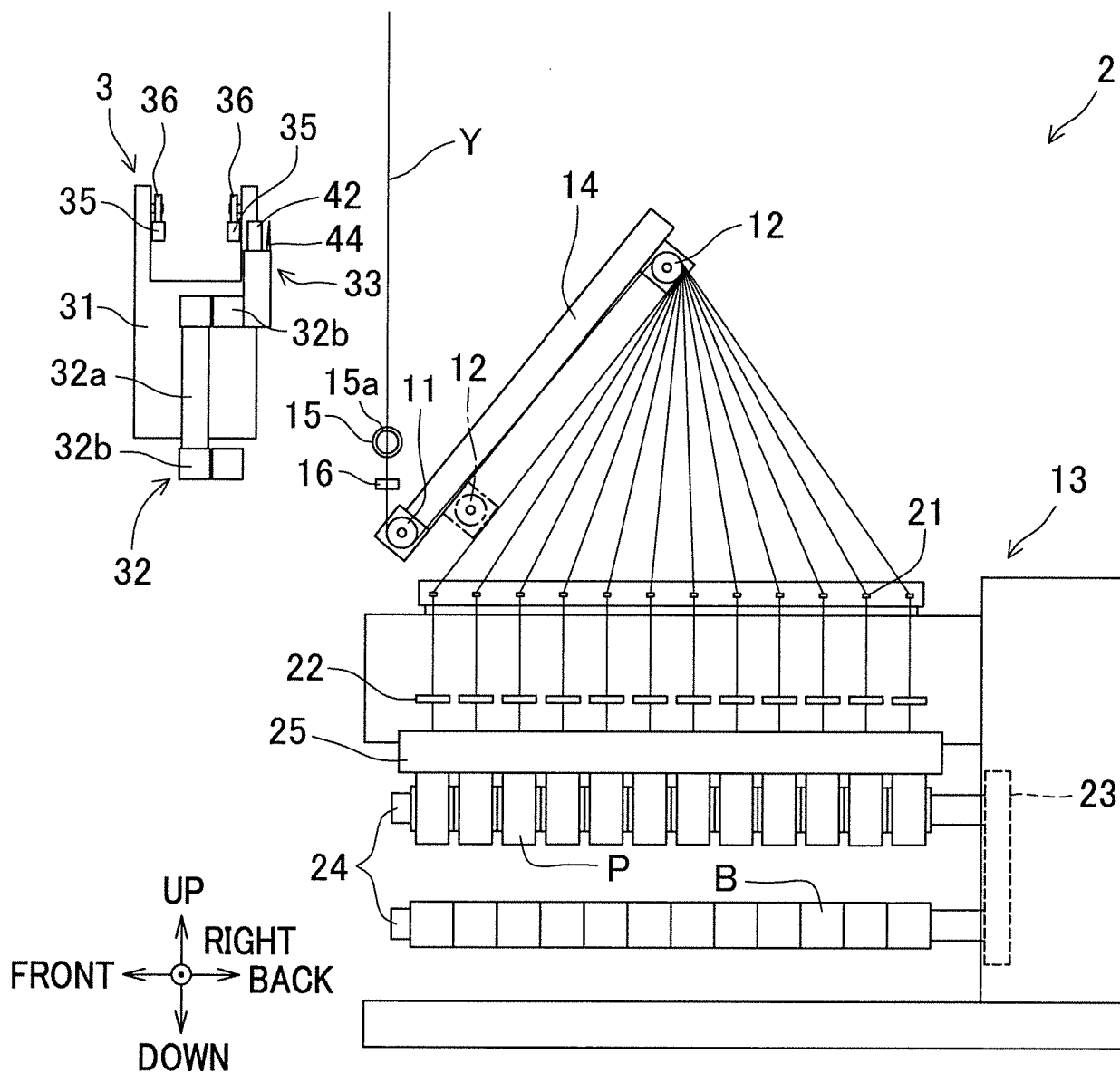


FIG.4

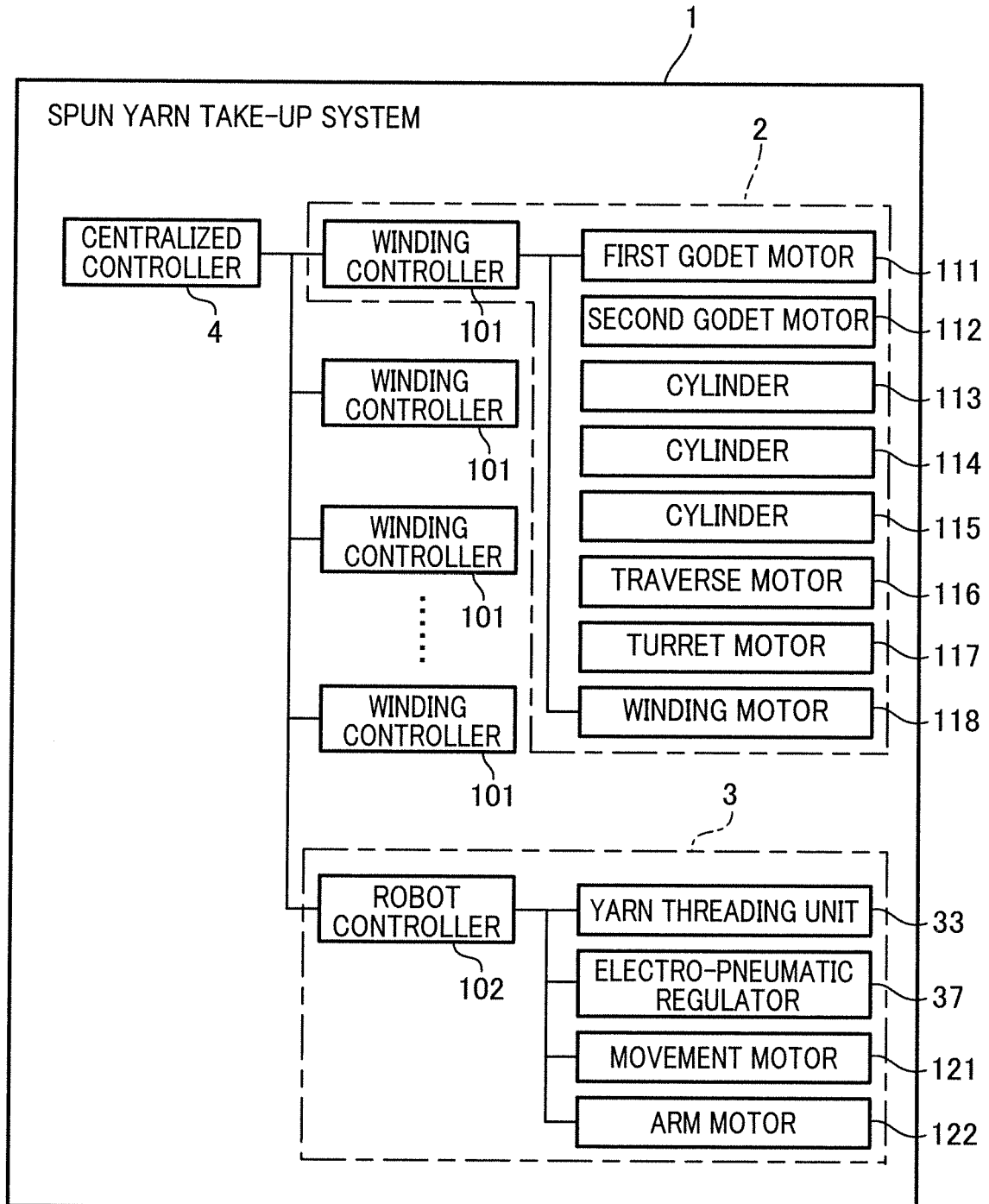


FIG.5

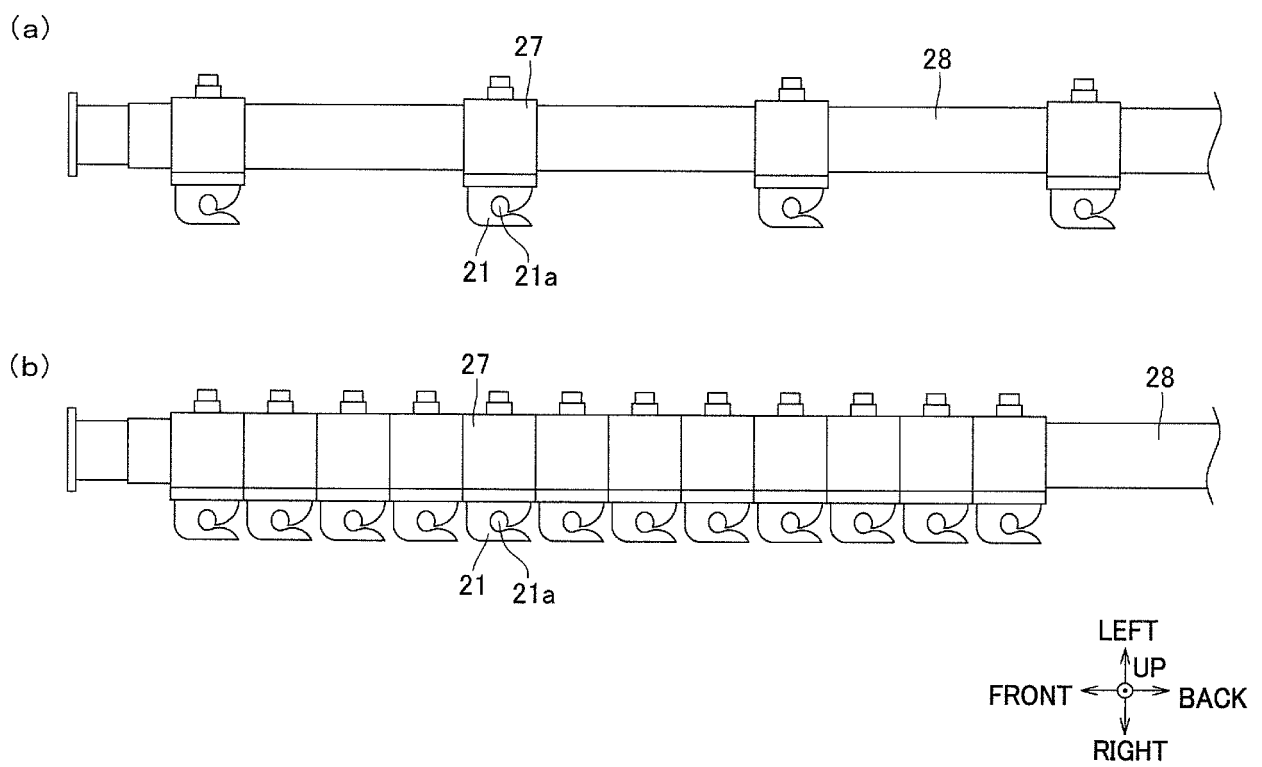


FIG.6

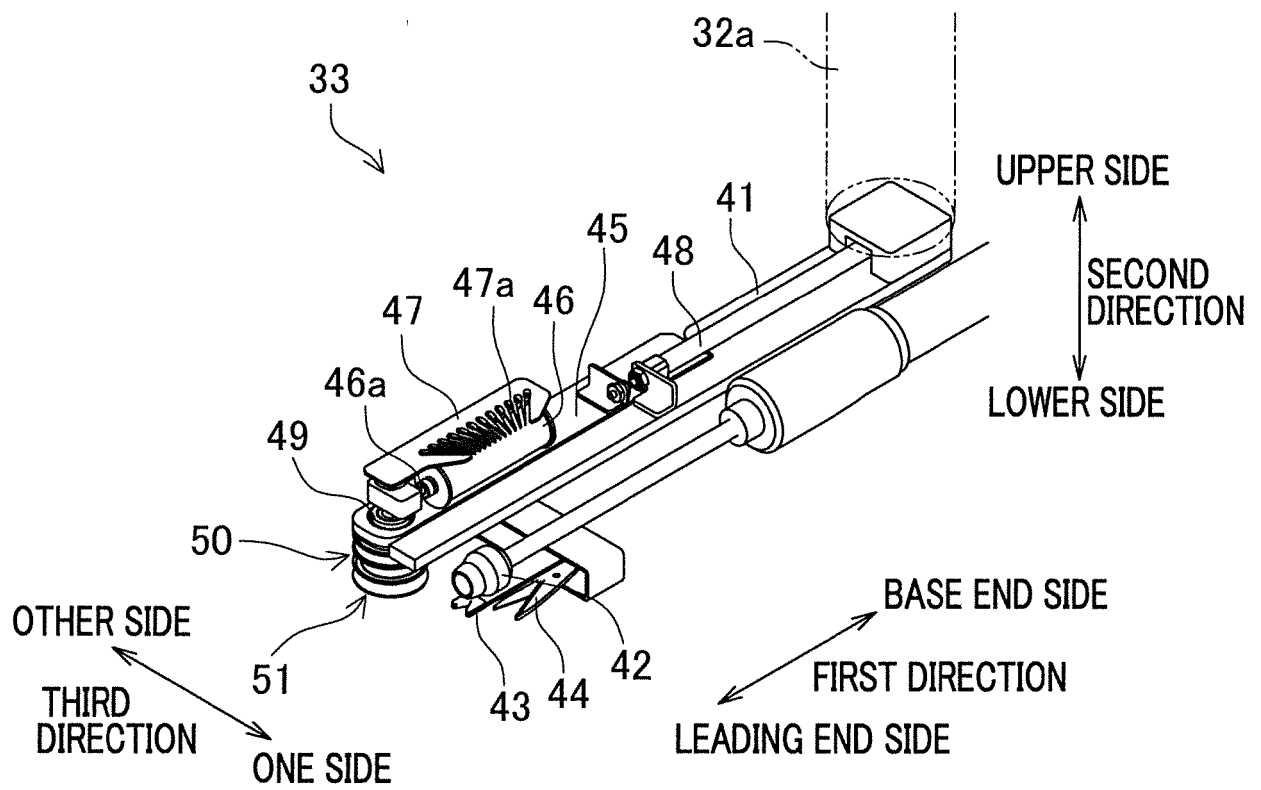


FIG.7

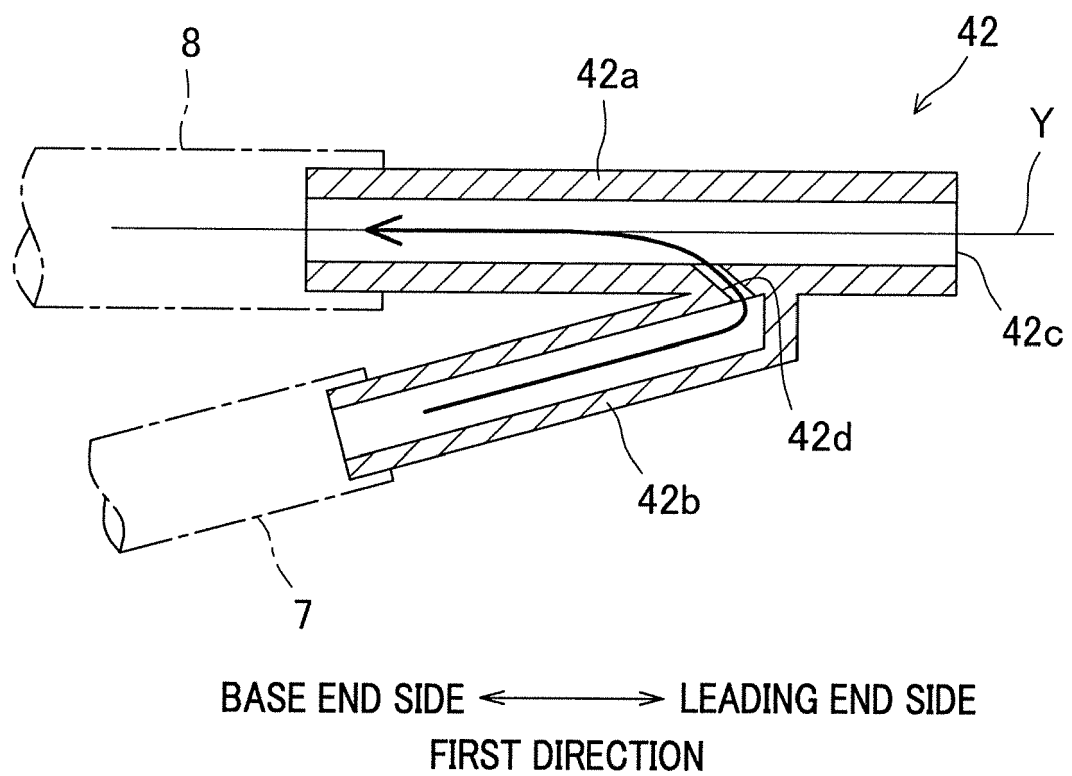


FIG.8

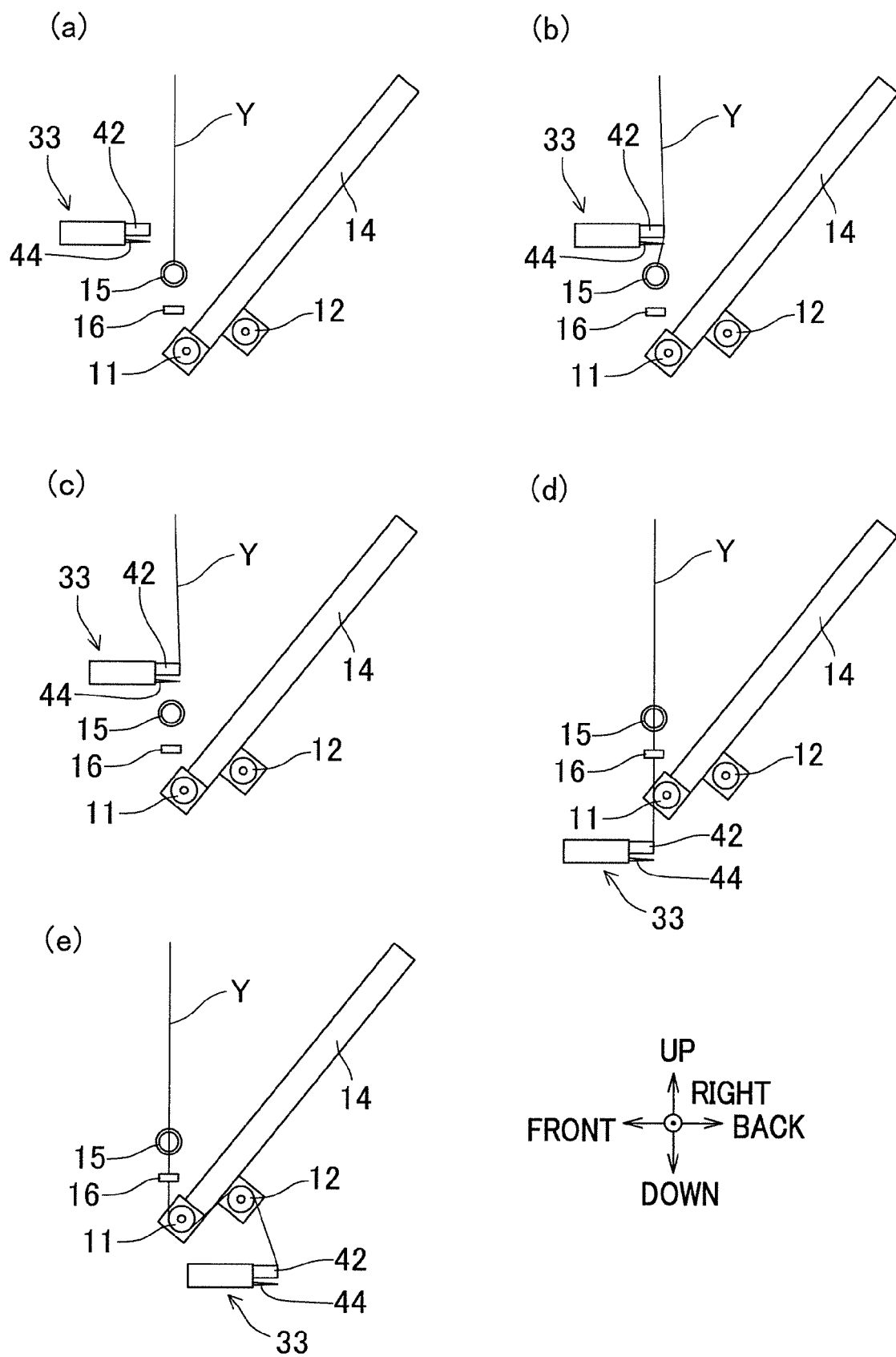


FIG.9

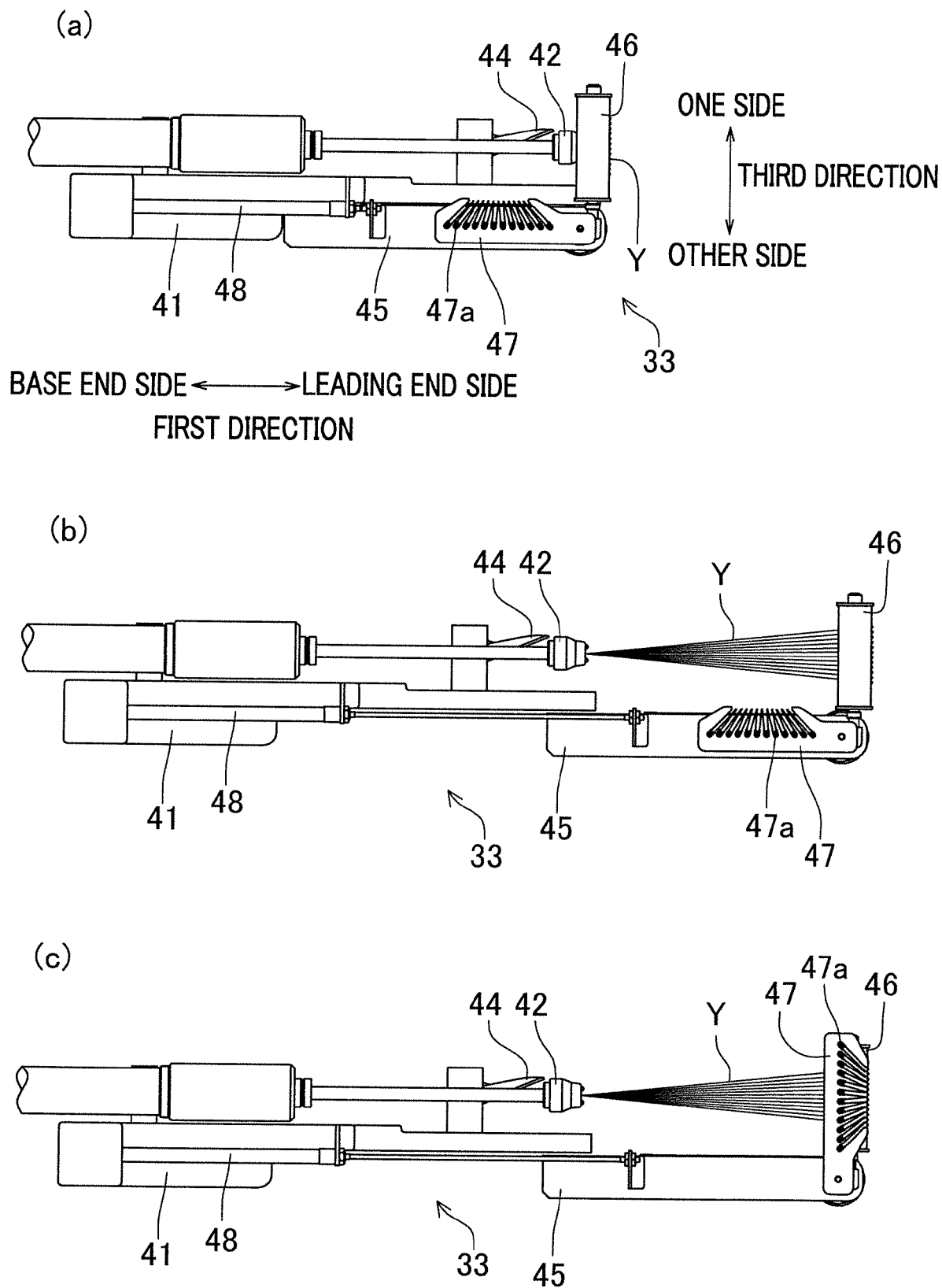


FIG.10

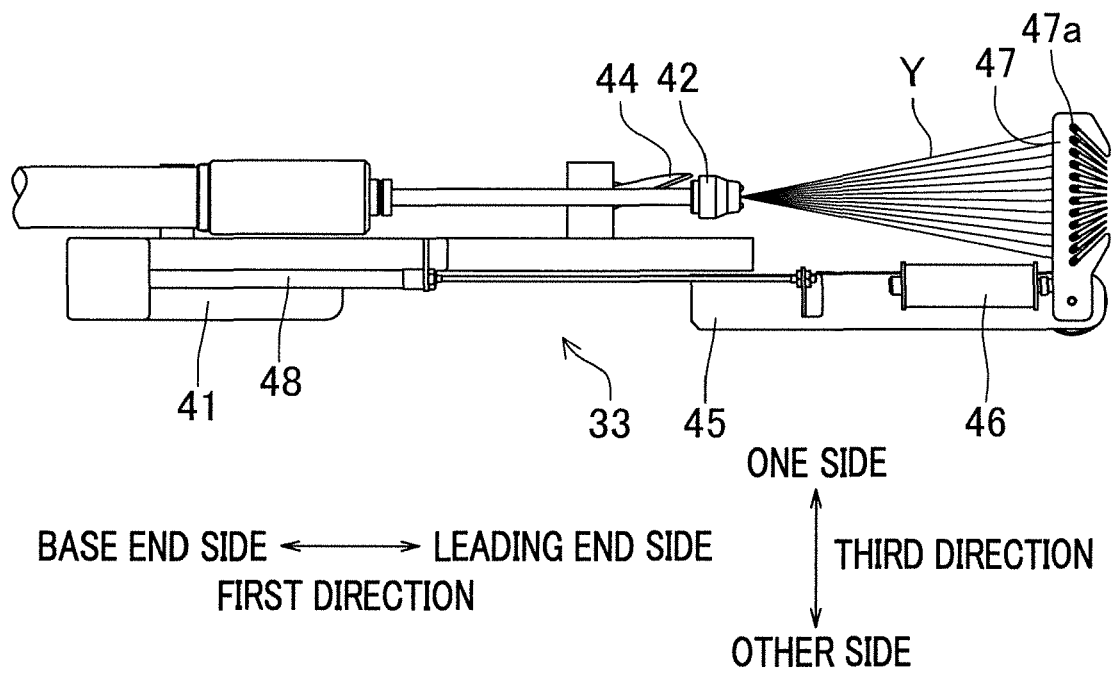
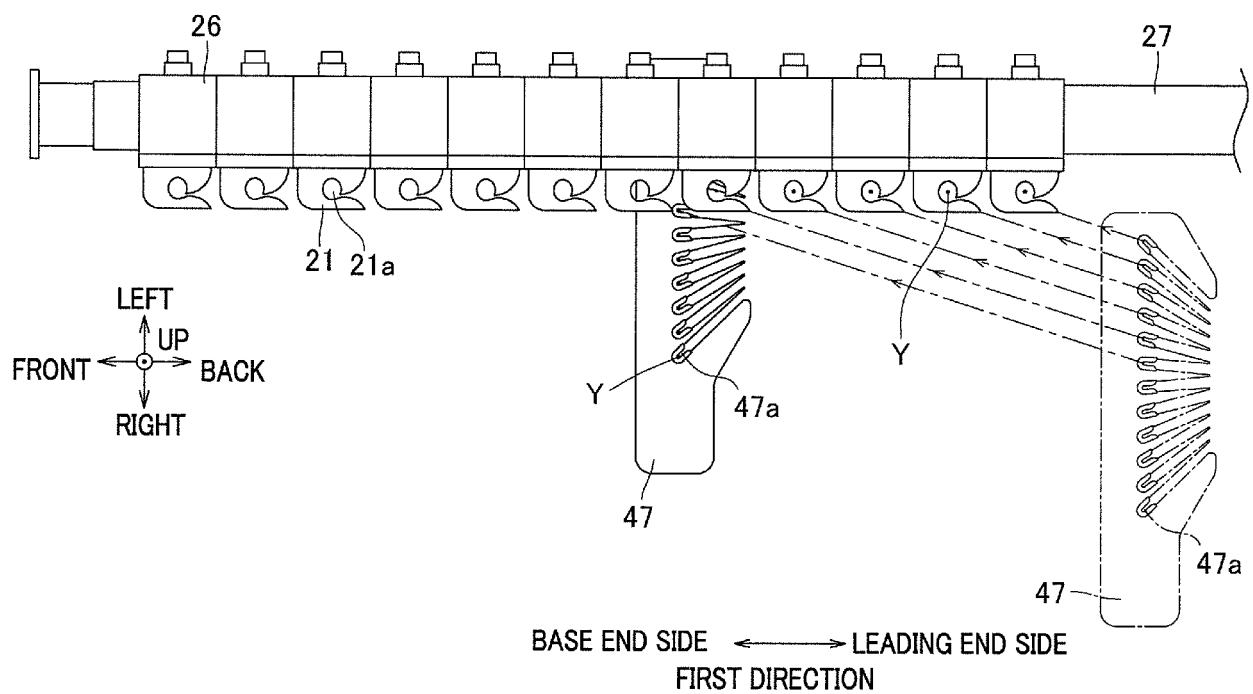
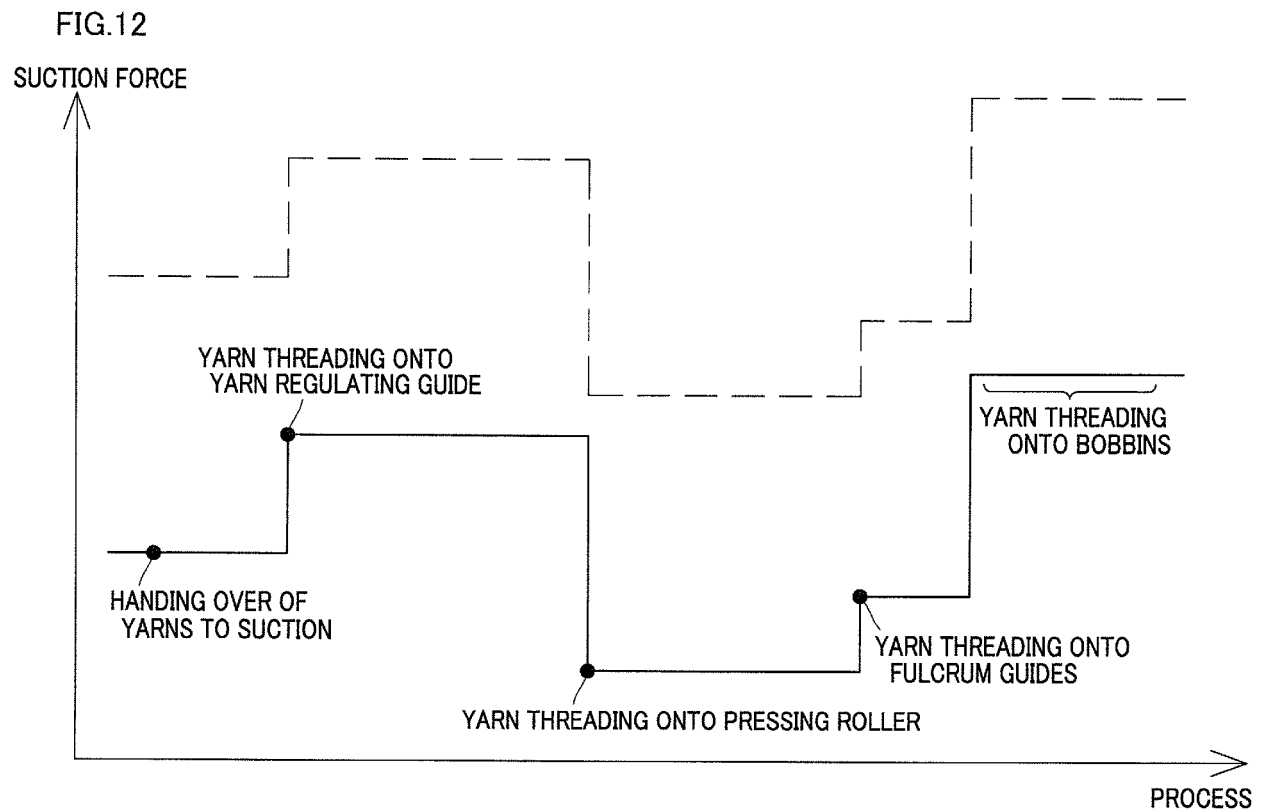


FIG.11







EUROPEAN SEARCH REPORT

Application Number
EP 17 19 6158

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Place of search The Hague		Date of completion of the search 16 February 2018	Examiner Lemmen, René
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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