(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 4 484 347 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
01.01.2025 Bulletin 2025/01

(21) Application number: **23203737.4**

(22) Date of filing: **16.10.2023**

(51) International Patent Classification (IPC):
B65H 54/26 *(2006.01)* ***B65H 54/88*** *(2006.01)*
B65H 57/00 *(2006.01)*

(52) Cooperative Patent Classification (CPC):
B65H 57/003; B65H 54/26; B65H 54/88;
B65H 2701/3132

(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 ME MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA
Designated Validation States:
KH MA MD TN

(30) Priority: **26.06.2023 JP 2023104411**

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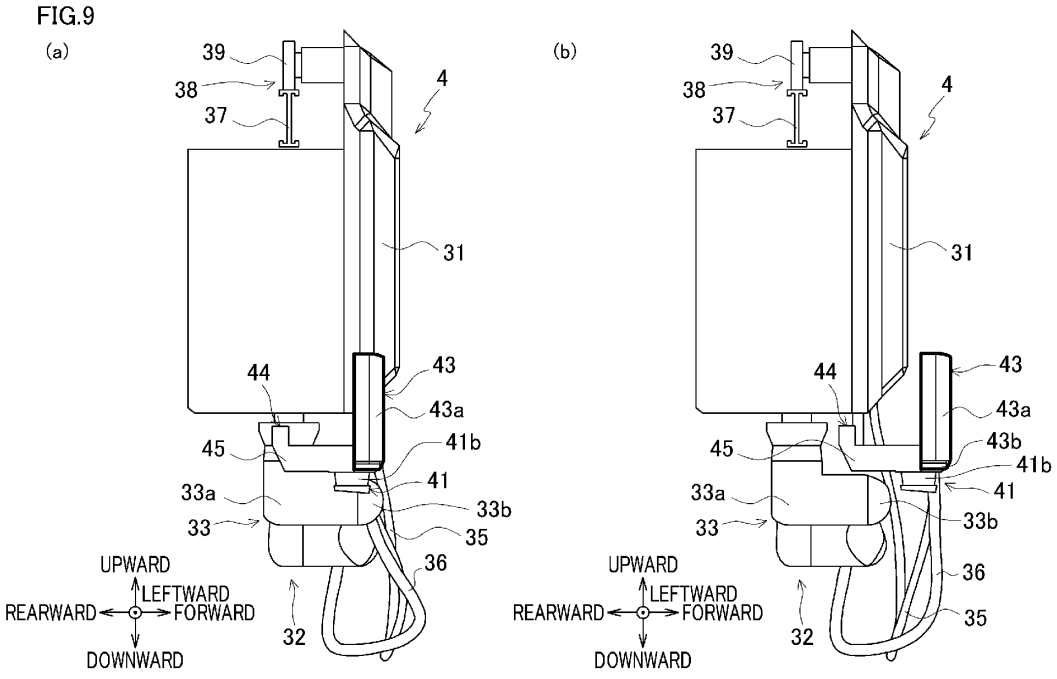
Remarks:
Amended claims in accordance with Rule 137(2) EPC.

(54) YARN THREADING ROBOT

(57) Monitoring of a wide area at the time of yarn threading by a yarn threading robot is achieved, and obstruction of other devices by a detecting portion is avoided when the yarn threading robot is running. A yarn threading robot 4 includes a robot main body 31, a movable portion 32 capable of performing yarn threading, a detecting portion 41b, and a moving unit 44. The moving unit 44 is capable of moving the first detecting portion 41b between a yarn threading position where the yarn threading is performed by the movable portion 32 and a running position which is on the rear side of the yarn threading position.

FIG.9



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Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a yarn threading robot that is able to perform yarn threading to plural yarn winders.

[0002] Patent Literature 1 (Japanese Laid-Open Patent Publication No. 2017-82381) discloses a yarn threading robot that is able to perform yarn threading to plural take-up apparatuses (yarn winders) configured to take up the respective yarns spun out from a spinning apparatus. The yarn threading robot includes a robot main body and a movable portion. The robot main body is able to run along a predetermined direction in which the take-up apparatuses are aligned. The movable portion is able to perform the yarn threading by moving relative to the robot main body.

[0003] The yarn threading robot further includes an area sensor (detecting portion) which is able to detect an obstacle. The detecting portion is attached to an end portion of the robot main body in the predetermined direction. The detecting portion is able to detect an obstacle on a running path of the robot main body. When the obstacle is detected, the running of the robot main body is stopped. As a result, the collision between the robot main body and the obstacle is avoided.

SUMMARY OF THE INVENTION

[0004] The robot main body of the yarn threading robot is controlled to stop running at the time of yarn threading. To improve safety, it is required to avoid the contact of a person or an object to the yarn threading robot at the time of the yarn threading. To be more specific, when the yarn threading is performed, a space (hereinafter, a working space) opposing the yarn winder over the yarn threading robot in a direction (hereinafter, an orthogonal direction) orthogonal to the predetermined direction should be monitored.

[0005] In recent years, yarn threading robots become increasingly compact, and the robot main body tends to become thinner in the orthogonal direction. If the attaching position of the detecting portion in the orthogonal direction is changed in accordance with the thinning of the robot main body, the detecting portion becomes far from the working space in the orthogonal direction. On the other hand, an area (movable area) in which the movable portion is movable is not largely changed. As a result, the possibility of a detection error due to overlap between the detection area of the detecting portion and the movable area of the movable portion is increased at the time of the yarn threading, and necessary monitoring may not be possible. On this account, the detecting portion is required to protrude toward the working space in the orthogonal direction to some degree. However, when the detecting portion protrudes in this way, the detecting portion may obstruct other devices when the yarn threading robot is running.

[0006] An object of the present invention is to achieve monitoring of a wide area at the time of yarn threading by a yarn threading robot, and to avoid a detecting portion from obstructing other devices when the yarn threading robot is running.

[0007] According to a first aspect of the invention, a yarn threading robot is able to perform yarn threading to yarn winders aligned in a first direction interesting with a vertical direction, the yarn threading robot comprising: a robot main body which is able to run in the first direction and which is provided on one side of the yarn winders in a second direction orthogonal to both the vertical direction and the first direction; a movable portion which is attached to the robot main body and which is able to perform the yarn threading by moving relative to the robot main body in a predetermined movable area; a first detecting portion which is attached to the robot main body and which is able to detect an object provided in a predetermined first detection area; and a moving unit which is capable of moving the first detecting portion between a yarn threading position where the yarn threading is performed by the movable portion and a running position which is on the other side of the yarn threading position in the second direction.

[0008] According to this aspect, when the yarn threading robot performs yarn threading, the first detecting portion is positioned at the yarn threading position. With this arrangement, the first detecting portion can be arranged to protrude toward one side in the second direction (i.e., away from the yarn winder) at the time of the yarn threading. On this account, overlap of the detection area of the first detecting portion and the movable area of the movable portion, which tends to occur, is suppressed, and proper monitoring of the area on one side in the second direction of the robot main body and the movable portion is facilitated. It is therefore possible to monitor a wide area at the time of the yarn threading by the yarn threading robot. Furthermore, when the first detecting portion is at the running position, protrusion of the first detecting portion toward the one side in the second direction as compared to the robot main body is suppressed. On this account, obstruction of other devices by the first detecting portion is suppressed at the time of the running of the yarn threading robot.

[0009] According to a second aspect of the invention, the yarn threading robot of the first aspect is arranged such that, when the first detecting portion is at the yarn threading position, one end of the robot main body is provided on the one side in the second direction, and at least a part of the first detecting portion protrudes to be on the one side of the one end of the robot main body in the second direction.

[0010] According to this aspect of the present invention, the first detecting portion makes it possible to detect an obstacle in a wide area without being obstructed by the robot main body and the movable portion.

[0011] According to a third aspect of the invention, the

yarn threading robot of the second aspect is arranged such that, when the first detecting portion is at the yarn threading position, the first detecting portion is distanced from the robot main body and provided on the one side of the robot main body in the second direction.

[0012] According to this aspect of the present invention, the first detecting portion makes it possible to detect an obstacle in a wide area without being obstructed by the robot main body and the movable portion.

[0013] According to a fourth aspect of the invention, the yarn threading robot of any one of the first to third aspects is arranged such that the first detection area extends from a predetermined first detection origin, and when the first detecting portion is at the yarn threading position, the first detection origin is provided on the one side of the movable area of the movable portion in the second direction.

[0014] According to this aspect of the present invention, the first detecting portion makes it possible to detect an obstacle in a wide area without being obstructed by the robot main body and the movable portion.

[0015] According to a fifth aspect of the invention, the yarn threading robot of any one of the first to fourth aspects is arranged such that the first detection area extends from a predetermined first detection origin to at least one side of both an arrangement area of the robot main body and the movable area of the movable portion in the first direction, a predetermined virtual plane which is a first virtual plane extends from the first detection origin to the one side of both the arrangement area of the robot main body and the movable area of the movable portion in the first direction without overlapping each of the arrangement area and the movable area, and the first detecting portion is provided so that the first detection area is included in the first virtual plane, and at least while the yarn threading is in execution, the first virtual plane is fan-shaped and includes: a first virtual line segment extending from the first detection origin to the one side of both the arrangement area of the robot main body and the movable area of the movable portion in the second direction without overlapping the each of the arrangement area and the movable area; and a second virtual line segment extending along the first direction from the first detection origin to the other side of both the arrangement area of the robot main body and the movable area of the movable portion in the first direction without overlapping the each of the arrangement area and the movable area.

[0016] According to this aspect of the present invention, at least when the yarn threading is being performed, the fan-shaped first virtual plane on which the first detection area is provided includes the first virtual line segment and the second virtual line segment. With this arrangement, the first detecting portion makes it possible to detect an obstacle in a wide area without being obstructed by the robot main body and the movable portion. It is therefore possible to avoid an increase in the number of detecting portions, and to detect an obstacle in a sufficiently wide area.

[0017] According to a sixth aspect of the invention, the yarn threading robot of the fifth aspect is arranged such that at least while the yarn threading is in execution, a central angle of the first virtual plane is 180° or more.

[0018] According to this aspect of the present invention, the first detecting portion makes it possible to detect an obstacle in a wide area.

[0019] According to a seventh aspect of the invention, the yarn threading robot of the fifth or sixth aspect is arranged such that at least a part of the movable area of the movable portion is provided on the other side of the robot main body in the first direction. This yarn threading robot further includes a second detecting portion which is attached to the robot main body and which is able to detect an object provided in a predetermined second detection area extending from a predetermined detection origin to at least the other side of both the arrangement area of the robot main body and the movable area of the movable portion in the first direction. In this regard, a predetermined virtual plane which is a second virtual plane extends from the second detection origin to the other side of both the arrangement area of the robot main body and the movable area of the movable portion in the first direction without overlapping the each of the arrangement area and the movable area, and the second detecting portion is provided so that the second detection area is included in the second virtual plane.

[0020] According to this aspect of the present invention, the second detecting portion is provided so that the second virtual plane extends to the other side of the movable area of the movable portion in the first direction while avoiding the movable area. A blind area may occur in the second detection area and in the vicinity of the movable area of the movable portion, depending on the positional relationship between the second detection area and the movable area of the movable portion. In this regard, at least during the execution of the yarn threading, the first detecting portion makes it possible to detect an obstacle in an area which is wide in the first direction without being obstructed by the robot main body and the movable portion. With this arrangement, at least during the execution of the yarn threading, the first detecting portion is able to monitor an area which needs to be monitored and which cannot be monitored by the second detecting portion. It is therefore possible to suppress the occurrence of a blind area.

[0021] According to an eighth aspect of the invention, the yarn threading robot of any one of the first to seventh aspects is arranged such that the first detecting portion is able to change at least one of shape and size of the first detection area by settings.

[0022] In an arrangement in which the first detecting portion is movable, in order to prevent erroneous detection of the movable portion, the first detection area needs to be different between a case where the first detecting portion is at the yarn threading position and a case where the first detecting portion is at the running position. In this regard, for example, the first detecting portion may be

arranged to be rotatable, and the first detection area may be physically changed by the rotation of the first detecting portion. However, because, for example, a driving mechanism for rotating the first detecting portion is required in this case, the structure of the yarn threading robot becomes disadvantageously complicated. Furthermore, in this arrangement, the shape and area of the first detection area are not changed. On this account, when the first detecting portion is moved to the running position, an object which is not detected in the yarn threading may be unintentionally located in the first detection area. Such an object may be erroneously detected as an obstacle.

[0023] According to the aspect of the present invention, the first detection area is changeable by the settings. Because the addition of the above-described driving mechanism is unnecessary, it is possible to suppress the yarn threading robot from being structurally complicated. Furthermore, according to the aspect of the present invention, the first detection area is changeable with a relatively high degree of freedom by the settings. It is therefore possible to easily avoid erroneous detection of an object, which is not detected at the time of the yarn threading, as an obstacle, when the first detecting portion is moved to the running position.

[0024] According to a ninth aspect of the invention, the yarn threading robot of any one of the first to eighth aspects is arranged such that the movable portion includes: a sucking unit which is able to suck and retain a running yarn; and a pipe portion which is connected to the sucking unit, which is able to supply fluid used for generating a negative pressure used for sucking and retaining the yarn to the sucking unit, and which is able to discharge the fluid from the sucking unit. In this regard, a part of the pipe portion is provided outside the robot main body, and a part of this part is fixed to the robot main body.

[0025] When the pipe portion unintentionally swings at the time of the yarn threading due to inertia, the pipe portion may unintentionally enter the detection area of the first detecting portion so as to cause a detection error. According to this aspect of the present invention, the part of the pipe portion is provided outside the robot main body, and a part of this part is fixed to the robot main body so as to be suppressed from swinging. It is therefore possible to suppress the occurrence of a detection error of the first detecting portion.

[0026] According to a tenth aspect of the invention, the yarn threading robot of any one of the first to ninth aspects is arranged such that the movable portion includes: a sucking unit which is able to suck and retain a running yarn; an arm mechanism which is configured to move the sucking unit relative to the robot main body; and a pipe portion which is connected to the sucking unit, which is able to supply fluid used for generating a negative pressure used for sucking and retaining the yarn to the sucking unit, and which is able to discharge the fluid from the sucking unit, a part of the pipe portion which is provided outside the robot main body has a portion that is fixed in position relative to the first detecting portion, and when the first detecting portion is at the yarn threading position, the portion of the pipe portion is far from the movable area of the arm mechanism in the second direction as compared to a state in which the first detecting portion is at the running position.

[0027] When the pipe portion unintentionally swings at the time of the yarn threading due to inertia, the pipe portion may unintentionally enter the first detection area so as to cause a detection error. Furthermore, when the arm mechanism moves and hits the pipe portion, the pipe portion may further swing. According to the aspect of the present invention, a part of the pipe portion moves together with the first detecting portion, and a part of the pipe portion is away from the movable area of the arm mechanism when the first detecting portion is at the yarn threading position. On this account, at the time of yarn threading, it is possible to suppress the arm mechanism from colliding with the pipe portion. Due to this, it is possible to effectively suppress the pipe portion from shaking. It is therefore possible to suppress the occurrence of a detection error of the first detecting portion.

[0028] According to an eleventh aspect of the invention, the yarn threading robot of any one of the first to tenth aspects is arranged such that the first detecting portion is provided inside the movable area of the movable portion in an up-down direction.

[0029] When the first detecting portion is provided outside the movable area of the movable portion in the up-down direction, a space available for providing a member which is not the yarn threading robot may be narrow. According to this aspect of the present invention, such narrowing of the space for providing another member by the first detecting portion is avoided.

[0030] According to a twelfth aspect of the invention, the yarn threading robot of any one of the first to eleventh aspects is arranged such that the robot main body is suspended from a rail extending in the first direction.

[0031] According to this aspect of the present invention, the robot main body is provided at a high position in the up-down direction. It is therefore possible to reduce the risk of contact of a person or an object with the yarn threading robot. It is also possible to provide a necessary apparatus and/or a member below the robot main body.

[0032] According to a thirteenth aspect of the invention, the yarn threading robot of any one of the first to twelfth aspects further comprises: a housing which is attached to the robot main body and to which the first detecting portion is fixed; and a cover provided to cover at least a part of the housing when viewed from the one side in the second direction.

[0033] When the first detecting portion and the housing protrude toward the one side in the second direction at the time of the yarn threading, the beauty of appearance of the yarn threading robot may be lost. According to this aspect of the present invention, at least the part of the housing is covered by the cover. It is therefore possible to suppress the loss of beauty of the appearance. Furthermore, the cover makes it possible to protect the housing,

etc. against dirt and an obstacle.

[0034] According to a fourteenth aspect of the invention, the yarn threading robot of any one of the first to thirteenth aspects is arranged such that the first detecting portion is included in an area sensor which is able to detect a detection medium reflected by an object provided on a predetermined virtual plane.

[0035] According to this aspect of the present invention, an obstacle is detected by the widely-available area sensor.

BRIEF DESCRIPTION OF THE DRAWINGS

[0036]

FIG. 1 is a front view of a spun yarn take-up system including a yarn threading robot of an embodiment of the present embodiment.
FIG. 2 is a profile of each spun yarn take-up machine.
FIG. 3 is a block diagram showing an electric structure of the spun yarn take-up system.
FIG. 4 is a front view of the yarn threading robot.
Each of FIGs. 5(a) and 5(b) shows a running portion.
Each of FIGs. 6(a) to 6(d) shows yarn threading to each part of the spun yarn take-up machine.
Each of FIGs. 7(a) and 7(b) shows an area sensor.
FIG. 8 shows a detailed lower end portion of a robot main body and its surroundings.
Each of FIG. 9(a) and FIG. 9(b) is a profile of the yarn threading robot.
FIG. 10 shows a detection area of the area sensor when the yarn threading robot is running.
FIG. 11 shows a detection area of the area sensor when the yarn threading is performed.
FIG. 12 shows a detailed lower end portion of a robot main body of a modification and its surroundings.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0037] The following will describe an embodiment of the present invention. For the sake of convenience, directions shown in FIG. 1 are referred to as forward, rearward, leftward, rightward, upward, and downward directions. The up-down direction is a vertical direction in which the gravity acts. The left-right direction (a first direction of the present invention) is a predetermined direction orthogonal to (intersecting with) the up-down direction. In this regard, the left side in the left-right direction is equivalent to one side in the first direction of the present invention. The right side in the left-right direction is equivalent to the other side in the first direction of the present invention. The front-rear direction (a second direction of the present invention) is a direction orthogonal to both the up-down direction and the left-right direction. In this regard, the front side in the front-rear direction is equivalent to one side in the second direction of the present invention. The rear side in the front-rear direction is equivalent to the other side in the second direction of the present invention. A direction in which each yarn Y runs is referred to as a yarn running direction.

(Outline of Spun Yarn Take-Up System)

[0038] FIG. 1 is a front view of a spun yarn take-up system 1 of an embodiment of the present invention. The spun yarn take-up system 1 includes plural spinning apparatuses 2, plural spun yarn take-up machines 3 (yarn winders of the present invention), and a yarn threading robot 4. The spinning apparatuses 2 are aligned in the left-right direction, and each spinning apparatus 2 is configured to spin out plural yarns Y. The spun yarn take-up machines 3 are provided below the spinning apparatuses 2. The spun yarn take-up machines 3 are aligned in the left-right direction to correspond to the respective spinning apparatuses 2. Each spun yarn take-up machine 3 is configured to take up yarns Y spun out from a spinning apparatus 2 and to simultaneously wind the yarns Y onto bobbins B, so as to form packages P. The yarn threading robot 4 is movable in the left-right direction. The yarn threading robot 4 is configured to perform an operation (i.e., yarn threading) to thread the yarns Y to parts forming each spun yarn take-up machine 3.

(Spun Yarn Take-Up Machine)

[0039] The following will describe each spun yarn take-up machine 3 with reference to FIG. 2. FIG. 2 is a profile of the spun yarn take-up machine 3.

[0040] As shown in FIG. 2, the spun yarn take-up machine 3 includes a take-up unit 5 and a winding unit 6. The take-up unit 5 is configured to take up yarns Y spun out from a spinning apparatus 2. The winding unit 6 is configured to wind the yarns Y taken up by the take-up unit 5 onto bobbins B. The take-up unit 5 includes an aspirator 11, a first regulatory guide 12, a first godet roller 13, a second regulatory guide 14, and a second godet roller 15.

[0041] The aspirator 11 is provided at a front end portion of the spun yarn take-up machine 3. The aspirator 11 is configured to suck and retain the yarns Y spun out from the spinning apparatus 2 in advance, before yarn threading to the spun yarn take-up machine 3.

[0042] The first regulatory guide 12 is, e.g., a known comb-teeth-shaped yarn guide. The first regulatory guide 12 is arranged to cause the yarns Y to be aligned in the left-right direction. The first regulatory guide 12 is arranged to restrict the movement of the yarns Y in the left-right direction. The first regulatory guide 12 is provided below the aspirator 11. When the yarns Y are threaded, the first regulatory guide 12 regulates an interval between adjacent yarns Y to a predetermined distance.

[0043] The first godet roller 13 is a roller having an axis

substantially in parallel to the left-right direction. The first godet roller 13 is provided below the first regulatory guide 12. The first godet roller 13 is rotationally driven by a first godet motor 111 (see FIG. 3) so as to send the yarns Y to the downstream side in the yarn running direction.

[0044] The second regulatory guide 14 is, e.g., a known comb-teeth-shaped yarn guide similar to the first regulatory guide 12. When the yarns Y are threaded, the second regulatory guide 14 restricts the movement of the yarns Y in the left-right direction. The second regulatory guide 14 is provided above and rearward of the first godet roller 13.

[0045] The second godet roller 15 is a roller having an axis substantially in parallel to the left-right direction. The second godet roller 15 is provided above and rearward of the second regulatory guide 14. The second godet roller 15 is rotationally driven by a second godet motor 112 (see FIG. 3) so as to send the yarns Y to the downstream side in the yarn running direction. The second godet roller 15 is movably supported by, e.g., a guide rail 16. For example, the guide rail 16 extends obliquely upward and rearward. The second godet roller 15 is movable along the guide rail 16 by, e.g., an unillustrated movement mechanism. With this arrangement, the second godet roller 15 is movable between a winding position (indicated by full lines in FIG. 2) where winding of the yarns Y is performed and a yarn threading position (indicated by one-dot chain lines in FIG. 2) where (i) the second godet roller 15 is close to the first godet roller 13 and (ii) yarn threading is performed.

[0046] In the take-up unit 5 structured as described above, as the first godet roller 13 and the second godet roller 15 on which the yarns Y are placed rotate, the yarns Y spun out from the spinning apparatus 2 are taken up and are sent toward the downstream side in the yarn running direction.

[0047] The winding unit 6 is configured to form the packages P by winding the yarns Y onto the bobbins B. The winding unit 6 is provided below the take-up unit 5. As shown in FIG. 2, the winding unit 6 includes a frame 20, fulcrum guides 21, traverse guides 22, a turret 23, two bobbin holders 24, and a contact roller 25.

[0048] The frame 20 is a member which is placed on, e.g., a floor of a factory, and to which components of the winding unit 6 are attached or in which components of the winding unit 6 are accommodated. Each fulcrum guide 21 functions as a fulcrum when a yarn Y is traversed by each traverse guide 22. Each fulcrum guide 21 is arranged to guide a yarn Y to the downstream side in the yarn running direction. As shown in FIG. 2, the fulcrum guides 21 are provided for the respective yarns Y. The fulcrum guides 21 are aligned in the front-rear direction. The fulcrum guides 21 are movable (not illustrated) between winding positions where the yarns Y are respectively wound onto the bobbins B and yarn threading positions where the fulcrum guides 21 are gathered on the front side of those at the winding positions.

[0049] The traverse guides 22 are provided for the respective yarns Y. The traverse guides 22 are aligned in the front-rear direction. Each traverse guide 22 is driven by a traverse motor 113 (see FIG. 3), and configured to reciprocate in the front-rear direction. With this arrangement, the yarns Y threaded to the traverse guides 22 are traversed about the fulcrum guides 21. The turret 23 is a disc-shaped member having an axis substantially in parallel to the front-rear direction. The turret 23 is rotationally driven by a turret motor 114 (see FIG. 3). The two bobbin holders 24 are rotatably supported at an upper end portion and a lower end portion of the turret 23. An axis of each bobbin holder 24 is substantially in parallel to the front-rear direction. Each bobbin holder 24 supports bobbins B which are aligned in the front-rear direction. Each of the two bobbin holders 24 is rotationally driven by an individual winding motor 115 (see FIG. 3). The contact roller 25 is provided immediately above the upper bobbin holder 24. An axis of the contact roller 25 is substantially in parallel to the front-rear direction. The contact roller 25 is configured to make contact with the surfaces of the packages P supported by the upper bobbin holder 24. With this arrangement, the contact roller 25 applies a contact pressure to the surfaces of the unfinished packages P so as to adjust the shape of each package P.

[0050] In the winding unit 6 structured as described above, when the upper bobbin holder 24 is rotationally driven, the yarns Y traversed by the traverse guides 22 are wound onto the bobbins B so as to form the packages P. When the formation of the packages P is completed, the turret 23 is rotated so as to switch over the upper and lower positions of the two bobbin holders 24. Because of this, the bobbin holder 24 having been at the lower position is accordingly moved to the upper position. The yarns Y are wound on the respective bobbins B attached to the upper bobbin holder 24, so as to form the packages P. In this regard, the bobbin holder 24 to which the fully-formed packages P are attached is moved to the lower position. Furthermore, the fully-formed packages P are collected by, e.g., an unillustrated package collector.

(Yarn Threading Robot)

[0051] The following will describe the yarn threading robot 4 with reference to FIG. 4, FIG. 5(a), and FIG. 5(b). FIG. 4 is a front view of the yarn threading robot 4. FIG. 5(a) is a plan view of the yarn threading robot 4. FIG. 5(b) is a view of a later-described running portion 38 viewed along an arrow V(b).

[0052] The yarn threading robot 4 is configured to thread the yarns Y to the first regulatory guide 12, first godet roller 13, second regulatory guide 14, second godet roller 15, fulcrum guides 21, etc. of each spun yarn take-up machine 3. As shown in FIG. 4, the yarn threading robot 4 includes a robot main body 31 and a movable portion 32.

[0053] The robot main body 31 is, e.g., a hollow mem-

ber which is substantially rectangular parallelepiped in shape. Inside the robot main body 31, a robot controller 102 (see FIG. 3) is provided to control operations of the movable portion 32, etc. The robot main body 31 is suspended from a rail member 37 (a rail of the present invention). The rail member 37 is provided in front of plural spun yarn take-up machines 3 (see FIG. 2), and extends in the left-right direction (see FIG. 5(a) and FIG. 5(b)). To be more specific, the running portion 38 is provided at an upper end portion of the robot main body 31 in order to allow the entire yarn threading robot 4 to run. The running portion 38 includes, e.g., two wheels 39 (see FIG. 5(a) and FIG. 5(b)) aligned in the left-right direction. The two wheels 39 are placed on the rail member 37. The two wheels 39 are driven by a movement motor 121 (see FIG. 3). With this arrangement, the entire yarn threading robot 4 including the robot main body 31 is configured to run in the left-right direction along the rail member 37.

[0054] The movable portion 32 is configured to perform yarn threading by moving relative to the robot main body 31 in a predetermined movable area. The movable portion 32 is attached to the robot main body 31. As shown in FIG. 4, the movable portion 32 includes a robotic arm 33 (an arm mechanism of the present invention), a yarn threading unit 34, a supply pipe 35, and a discharge pipe 36. As shown in FIG. 4, at least a part of the movable portion 32 is provided on the right side of the robot main body 31 in the left-right direction. At least a part of the movable area is also provided on the right side of the robot main body 31 in the left-right direction. A combination of the supply pipe 35 and the discharge pipe 36 is equivalent to a pipe portion of the present invention.

[0055] It is noted that the movable area does not encompass every area in which the movable portion 32 can be provided with respect to the robot main body 31. Although not illustrated, the movable area is defined as "the entire space in which parts forming the movable portion 32 are provided from the start to end of yarn threading". Information regarding operations of the movable portion 32 is stored in, e.g., the robot controller 102.

[0056] The robotic arm 33 is attached to a lower surface of the robot main body 31. The robotic arm 33 includes plural arms 33a and plural joints 33b connecting the arms 33a with one another. Each joint 33b incorporates therein an arm motor 122 (see FIG. 3). As arm motors 122 are driven, the arms 33a are swung about the joints 33b.

[0057] The yarn threading unit 34 is attached to a leading end portion of an arm 33a which is provided on the leading end side of the remaining arms 33a. The yarn threading unit 34 is configured to move relative to the robot main body 31 in accordance with the movement of the robotic arm 33. The yarn threading unit 34 includes a suction 34a (a sucking unit of the present invention) which is able to suck and retain the running yarns Y and a cutter 34b configured to cut the yarns Y. The suction 34a is provided on an intermediate portion of a path of compressed air (fluid of the present invention). This path of compressed air includes the supply pipe 35 and the discharge pipe 36. The suction 34a is configured to suck and retain the yarns Y by means of negative pressure generated by a flow of the compressed air which is supplied from the supply pipe 35 and discharged to the discharge pipe 36. The yarns Y sucked by the suction 34a are discharged through the discharged pipe 36 along with the compressed air. The cutter 34b is used for cutting intermediate portions of the yarns Y when the yarn threading unit 34 takes up the yarns Y spun out from each spinning apparatus 2. Other apparatuses included in the yarn threading unit 34 are not described.

[0058] The discharge pipe 35 is a pipe for supplying the compressed air to apparatuses including the suction 34a. The supply pipe 35 is attached to the robot main body 31. One part of the supply pipe 35 is provided outside the robot main body 31, for example. For example, at least a flexible hose is this part of the supply pipe 35 provided outside the robot main body 31. One end of the supply pipe 35 is connected to the yarn threading unit 34. That is, a part of the supply pipe 35 is configured to move in accordance with the movement of the yarn threading unit 34. Another part of the supply pipe 35 is housed in, e.g., the robot main body 31. The other end of the supply pipe 35 is detachably attached to, e.g., a supply duct (not illustrated) provided in the vicinity of each spun yarn take-up machine 3. The supply duct extends in, e.g., the left-right direction. The supply duct is connected to a supply source (not illustrated) of the compressed air.

[0059] The discharge pipe 36 is a pipe for discharging the compressed air supplied to the suction 34a, etc. through the supply pipe 35. The discharge pipe 36 is attached to the robot main body 31. One part of the discharge pipe 36 is provided outside the robot main body 31, for example. For example, at least a flexible hose is this part of the discharge pipe 36 provided outside the robot main body 31. One end of the discharge pipe 36 is connected to the yarn threading unit 34. That is, a part of the discharge pipe 36 is configured to move in accordance with the movement of the yarn threading unit 34. Another part of the discharge pipe 36 is housed in, e.g., the robot main body 31. The other end of the discharge pipe 36 is detachably attached to, e.g., an exhaust duct (not illustrated) provided in the vicinity of each spun yarn take-up machine 3. The exhaust duct extends in, e.g., the left-right direction. The exhaust duct is connected to, e.g., a waste box (not illustrated) where the yarns Y are wasted.

[0060] To the robot main body 31, two area sensors 40 (i.e., a first area sensor 41 and a second area sensor 42) are attached in order to detect an object (obstacle). The first area sensor 41 and the second area sensor 42 are electrically connected to the robot controller 102. The first area sensor 41 and the second area sensor 42 will be detailed later.

(Electric Structure of Spun Yarn Take-Up System)

[0061] The following will describe an electric configuration of the spun yarn take-up system 1 with reference to a block diagram in FIG. 3. As shown in FIG. 3, the spun yarn take-up system 1 is structured so that a winding controller 101 is provided in each spun yarn take-up machine 3. The winding controller 101 is configured to control the first godet motor 111, the second godet roller motor 112, the traverse motor 113, the turret motor 114, each winding motor 115, and the like. Although each spun yarn take-up machine 3 includes two winding motors 115, FIG. 3 shows only one winding motor 115. Furthermore, while FIG. 3 shows only one traverse motor 113, each spun yarn take-up machine 3 may include plural traverse motors 113.

[0062] The spun yarn take-up system 1 is structured so that the robot controller 102 is provided in the yarn threading robot 4. As described above, the robot controller 102 is provided in, e.g., the robot main body 31. The robot controller 102 includes members such as a CPU, a ROM, and a RAM, and is configured to control the yarn threading unit 34, the movement motor 121, the arm motor 122, and the like. The robot controller 102 is configured to control the robotic arm 33 based on operation information of the movable portion 32. While the robotic arm 33 includes the arm motors 122 corresponding to the respective joints 33b, FIG. 3 shows only one arm motor 122. FIG. 3 does not show other arm motors 122.

[0063] The robot controller 102 is able to receive signals regarding the detection of objects by the first area sensor 41 and the second area sensor 42. When receiving a signal indicating the detection of an object from the first area sensor 41 or the second area sensor 42, the robot controller 102 controls the movement motor 121 and the arm motor 122 to stop the movement (running, yarn threading, etc.) of the yarn threading robot 4.

[0064] The spun yarn take-up system 1 further includes an integrated controller 100 configured to control the entire system. The integrated controller 100 is, e.g., a typical computer. The integrated controller 100 is electrically connected with the winding controllers 101 of the spun yarn take-up machines 3 and the yarn robot controller 102. The integrated controller 100 is configured to control the entire spun yarn take-up system 1 in association with the winding controllers 101 and the robot controller 102.

(Outline of Yarn Threading by Yarn Threading Robot)

[0065] The following will outline yarn threading to a spun yarn take-up machine 3 by the yarn threading robot 4, with reference to FIG. 6(a) to FIG. 6(d). Each of FIG. 6(a) to FIG. 6(d) illustrates the yarn threading onto the first regulatory guide 12, the first godet roller 13, the second regulatory guide 14, and the second godet roller 15. The following mainly describes controls performed by the robot controller 102. The robot controller 102 is configured to communicate with the integrated controller 100 according to need. The integrated controller 100 requests the winding controller 101 of the spun yarn take-up machine 3 which is the target of the yarn threading to perform predetermined control.

[0066] Before the start of the yarn threading, the winding controller 101 of the spun yarn take-up machine 3 which is the target of the yarn threading moves the second godet roller 15 along the guide rail 16 to a yarn threading position which is close to the first godet roller 13 (see one-dot chain lines in FIG. 2). Furthermore, the winding controller 101 gathers the fulcrum guides 21 to the yarn threading positions on the front side of the winding positions in the front-rear direction so that the fulcrum guides 21 are close to one another.

[0067] In the state described above, the robot controller 102 controls the movement motor 121 to move the robot main body 31 to a position overlapping, in the front-rear direction, the spun yarn take-up machine 3 which is the target of the yarn threading. Subsequently, the robot controller 102 controls the arm motors 122 and the yarn threading unit 34 to cause the suction 34a to suck and hold the yarns Y (see FIG. 6 (a)) spun out from the spinning apparatus 2. To be more specific, while causing the suction 34a to suck the yarns Y, the robot controller 102 causes the cutter 34b to cut the yarns Y. As a result, the cut yarns Y are sucked and retained by the suction 34a (see FIG. 6(b)).

[0068] Subsequently, the robot controller 102 moves a leading end portion of the yarn threading unit 34 downward by means of the robotic arm 33 (see FIG. 6(c)). The robot controller 102 then moves the leading end portion of the yarn threading unit 34 so as to thread the yarns Y to the first regulatory guide 12, to the first godet roller 13, to the second regulatory guide 14, and to the second godet roller 15 in order (see FIG. 6(d)).

[0069] Furthermore, the robot controller 102 causes the movable portion 32 to perform the yarn threading to the fulcrum guides 21. The robot controller 102 then controls the movable portion 32 to perform the yarn threading to the traverse guides 22 and to unillustrated slits of the bobbins B. For details of this yarn threading, see Japanese Laid-Open Patent Publication No. 2017-082379, for example.

[0070] In recent years, yarn threading robots 4 become increasingly compact, and the robot main body 31 tends to become thinner in the front-rear direction. If the attaching position of the area sensor 40 in the front-rear direction is changed in accordance with the thinning of the robot main body 31, the area sensor 40 becomes far from the space (working space) which opposes the spun yarn take-up machine 3 over the yarn threading robot 4 in the front-rear direction. On the other hand, an area (movable area) in which the movable portion 32 is movable is not largely changed. As a result, the possibility of a detection error due to overlap between the detection area of the area sensor 40 and the movable area of the movable portion 32 is increased at the time of the yarn threading,

and necessary monitoring may not be possible. On this account, the area sensor 40 is required to protrude toward the working space in the front-rear direction to some degree. However, when the area sensor 40 protrudes in this way, the area sensor 40 may obstruct other devices when the yarn threading robot 4 is running. For example, the above-described unillustrated package collector runs in the left-right direction in the same manner as the yarn threading robot 4 so as to collect a package P from each spun yarn take-up machine 3. On this account, in the working space, the package collector typically runs in the vicinity of the yarn threading robot 4. On this account, when the area sensor 40 protrudes toward the working space in the front-rear direction while the yarn threading robot 4 is running, the running of the package collector may be obstructed or the area sensor 40 may collide with the package collector.

[0071] In order to achieve monitoring of a wide area at the time of yarn threading by the yarn threading robot 4 and to avoid the area sensor 40 from obstructing other devices when the yarn threading robot 4 is running, the yarn threading robot 4 is structured as described below.

(Area Sensor)

[0072] To begin with, each of the two area sensors 40 (the first area sensor 41 and the second area sensor 42) provided at the yarn threading robot 4, will be outlined with reference to FIG. 4, FIG. 7(a), and FIG. 7(b). FIG. 7(a) shows the area sensor 40 viewed in a direction orthogonal to a predetermined axial direction. FIG. 7(b) shows the area sensor 40 viewed in the axial direction. The up-down direction to the sheet of FIG. 7(a) is referred to as the axial direction. The lower side in the sheet of FIG. 7(a) is referred to as one side in the axial direction. The upper side in the sheet of FIG. 7(a) is referred to as the other side in the axial direction. A radial direction of a detecting portion 40b (described later) in FIG. 7(b) is referred to as the radial direction. A direction orthogonal to both the axial direction and the radial direction is referred to as the circumferential direction.

[0073] The area sensor 40 is, e.g., a known reflective area sensor. That is, the area sensor 40 is able to determine the existence of an object in a predetermined flat area by emitting laser light with high directivity and good convergence and detecting the laser light reflected by the object. The laser light (i.e., a kind of light) is equivalent to a detection medium of the present invention.

[0074] As shown in FIG. 7(a) and FIG. 7(b), the area sensor 40 includes, e.g., a housing 40a and the detecting portion 40b. The housing 40a is, e.g., roughly rectangular parallelepiped in shape. The shape of the housing 40a is not limited to this. The housing 40a may be substantially cylindrical in shape, for example, or may be differently shaped. The housing 40a is able to house various components forming the area sensor 40. The detecting portion 40b is fixed to the housing 40a. The housing 40a is provided on one side of the detecting portion 40b in the axial direction.

[0075] The detecting portion 40b is, e.g., roughly disc-shaped. The detecting portion 40b is fixed to the housing 40a. The detecting portion 40b is provided on the other side of the housing 40a in the axial direction, and protrudes to be the other side of the housing 40a in the axial direction. The detecting portion 40b includes, e.g., a light emitter (not illustrated) configured to emit laser light and a light receiver (not illustrated) configured to detect laser light.

[0076] A predetermined detection origin (see FIG. 7(b)) is defined in the detecting portion 40b. The detecting portion 40b is able to detect an object in a detection area A which is set by using the detection origin OD as a reference point. The detection area A is substantially flat. That is, the detection area A is an area with a predetermined size on a predetermined virtual plane. The shape and size of the detection area A can be changed at will, in accordance with the specifications of the area sensor 40. The detecting portion 40b is able to change the settings of the detection area A at a desired timing. For example, the robot controller 102 is configured to control the detecting portion 40b to set the initial settings of the detection area A or change the settings of the same. For a specific example, the detection area A is set as an area which is substantially fan-shaped, whose center is the detection origin OD, and whose central angle is referred to as θ. The central angle and radius of the detection area A can be changed at will as long as the changes are within the specifications. The central angle of the detection area A may be changed in a range of, e.g., 30° to 270°. The radius of the detection area A may be changed in a range of, e.g., 2000 mm to 8000 mm. The shape of the detection area A may be more complicated than a fan shape.

[0077] In the present embodiment, the first area sensor 41 and the second area sensor 42 are structured in the same manner. That is, the first area sensor 41 includes a housing 41a and a detecting portion 41b (a first detecting portion of the present invention). A first detection area A1 is set by the detecting portion 41b. The shape and size of the first detection area A1 can be set at will, in accordance with the specifications of the first area sensor 41. The first detection area A1 may be set as an area which is substantially fan-shaped, whose center is a detection origin OD of the detecting portion 41b (a first detection origin OD1), and whose central angle is referred to as $\theta 1$. The second area sensor 42 includes a housing 42a and a detecting portion 42b (a second detecting portion of the present invention). A second detection area A2 is set by the detecting portion 42b. The shape and size of the second detection area A2 can be set at will, in accordance with the specifications of the first area sensor 42. The second detection area A2 may be set as an area which is substantially fan-shaped, whose center is a detection origin OD of the detecting portion 42b (a second detection origin OD2), and whose central angle is referred to as $\theta 2$. The angles $\theta 1$ and $\theta 2$ may be different from each other. The radius of the first detection area A1

may be different from that of the second detection area A2.

[0078] As shown in FIG. 4, the first area sensor 41 is attached to, e.g., a left part of a lower end portion of the robot main body 31. An axis of the first area sensor 41 is substantially in parallel to, e.g., the up-down direction. That is, the first detection area A1 is substantially in parallel to the horizontal direction. Note that the first area sensor 41 is provided so that, e.g., the housing 41a is provided above the detecting portion 41b. That is, the upper side in the up-down direction (i.e., the upper side in the sheet of FIG. 4) is equivalent to one side in the axial direction.

[0079] As shown in FIG. 4, for example, the detecting portion 41b of the first area sensor 41 is provided below the robot main body 31. The detecting portion 41b is provided inside the movable area of the movable portion 32 in the up-down direction. To be more specific, for example, the detecting portion 41b is provided above the lowest part of the supply pipe 35 and the lowest part of the discharge pipe 36.

[0080] As shown in FIG. 4, the second area sensor 42 is housed in the robot main body 31. To be more specific, for example, a housing 31a housing the second area sensor 42 is provided at an upper-right end portion of a front end portion of the robot main body 31. The position of the housing 31a is not limited to this. An opening 31b is provided at a right part of the housing 31a. The opening 31b is provided so that the detecting portion 42b is able to emit laser light to the outside of the housing 31a and to detect the laser light returned from the outside of the housing 31a.

[0081] An axis of the second area sensor 42 is tilted from, e.g., the up-down direction. In other words, the second detection area A2 is tilted from the horizontal direction (see FIG. 4). To be more specific, for example, when viewed in the front-rear direction, the second detection area A2 extends rightward and downward (i.e., at least toward the lower side) from the second detection origin OD2. For example, the first detection area A1 is tilted from the second detection area A2. The position and angle of the second area sensor 42 are fixed with respect to the robot main body 31 so that the second detection area A2 does not overlap an arrangement area of the robot main body 31 (an area in which the robot main body 31 is provided) and the movable area of the movable portion 32. With this arrangement, when the yarn threading robot 4 runs, and when the yarn threading robot 4 performs yarn threading, the intrusion of the robot main body 31 and the movable portion 32 into the second detection area A2 is avoided. The second area sensor 42 makes it possible to avoid a detection error caused by the robot main body 31 and the movable portion 32, and to detect an obstacle on the right side of the yarn threading robot 4.

(Robot Main Body 31)

[0082] The following will detail the robot main body 31 with reference to FIG. 4, FIG. 8, FIG. 9(a), and FIG. 9(b). FIG. 8 is a perspective view of the lower end portion of the robot main body 31 and its surroundings. Each of FIG. 9(a) and FIG. 9(b) is a profile of the yarn threading robot 4. FIG. 9(a) shows the yarn threading robot 4 when the first area sensor 41 and a later-described cover 43 are at later-described running positions. FIG. 9(b) shows the yarn threading robot 4 when the first area sensor 41 and the cover 43 are at later-described yarn threading positions.

[0083] The robot main body 31 includes, e.g., a cover 43 covering at least a part of the housing 41a of the first area sensor 41. The cover 43 is provided at the lower end portion of the robot main body 31 (indicated by thick lines in FIG. 4). The cover 43 is provided at the front end portion of the robot main body 31 (indicated by two-dot chain lines in FIG. 8 and thick lines in FIG. 9(a) and FIG. 9 (b) The cover 43 is substantially the same length as, e.g., the robot main body 31 in the left-right direction. The cover 43 is provided in front of the housing 41a. The housing 41a is fixed to the cover 43 by, e.g., an unillustrated fastener. When viewed from the front, the cover 43 is provided to cover and hide at least a part of the housing 41a. This improves and balances the appearance of the robot main body 31 in the left-right direction. It is therefore possible to increase the beauty of appearance of the entire yarn threading robot 4. The cover 43 also functions as a protection cover protecting the housing 41a, etc. against dirt and an obstacle.

[0084] The cover 43 includes: a front end portion 43a (see FIG. 4) extending in the left-right direction and up-down direction; and a lower end portion 43b extending rearward from a lower end of the front end portion 43a. The lower end portion 43b is provided with, e.g., a cutout portion 43c and a pipe accommodation unit 43d. The cutout portion 43c is formed along the outer shape of the housing 41a. The pipe accommodation unit 43d is provided for housing a part of the supply pipe 35 and a part of the discharge pipe 36 in a space behind the cover 43.

[0085] The robot main body 31 further includes a moving unit 44 (see FIG. 8, FIG. 9(a), and FIG. 9(b)) configured to move members such as the cover 43. The moving unit 44 is configured to move the first area sensor 41, the cover 43, the supply pipe 35, and the discharge pipe 36 in the front-rear direction. The moving unit 44 includes, for example, a first supporting member 45, a second supporting member 46, and an air cylinder 47 (see FIG. 3).

[0086] The first supporting member 45 (see FIG. 8, FIG. 9(a), and FIG. 9(b)) is configured to support, e.g., the first area sensor 41 and the cover 43. The first area sensor 41 and the cover 43 are fixed to, e.g., the first supporting member 45. The first supporting member 45 is attached to a lower end portion of the robot main body 31 through, for example, the air cylinder 47, to be movable forward and rearward. The first supporting member 45 is

configured to support the second supporting member 46.

[0087] The second supporting member 46 extends in, e.g., the left-right direction. The second supporting member 46 is, e.g., a metal member. The second supporting member 46 is fixed to, e.g., the first supporting member 45 and protrudes to be the right side of the first supporting member 45 in the left-right direction. For example, when viewed from above, the second supporting member 46 may be substantially U-shaped and open to the left side. A part of the supply pipe 35 and a part of the discharge pipe 36 may be provided between linear portions 46a and 46b of the second supporting member 46 in the front-rear direction. The linear portions 46a and 46b are aligned in the front-rear direction, and extend in the left-right direction. The cover 43 may be fixed to the second supporting member 46.

[0088] A part of the supply pipe 35 and a part of the discharge pipe 36 may be fixed to the second supporting member 46. For example, a part of the supply pipe 35 is provided outside the robot main body 31 and an intermediate part of this part may be formed of a joint 48. The joint 48 may be a known metal elbow member. A part of the discharge pipe 36 is provided outside the robot main body 31 and an intermediate part of this part may be formed of a joint 49. Being similar to the joint 48, the joint 49 may be a known metal elbow member. The joints 48 and 49 are equivalent to "a part of the pipe portion" of the present invention. The joints 48 and 49 are fixed to the second supporting member 46 by, e.g., welding. Alternatively, the joints 48 and 49 may be fixed to the second supporting member 46 with a means (e.g., by means of an unillustrated fastener) different from the welding.

[0089] Alternatively, the joints 48 and 49 may not be fixed to the second supporting member 46 but may be simply sandwiched between the linear portions 46a and 46b.

[0090] The air cylinder 47 (see FIG. 3) is capable of moving the first supporting member 45 and the second supporting member 46 in the front-rear direction. A cylinder tube (not illustrated) of the air cylinder 47 is fixed to, for example, a lower end portion of the robot main body 31. The air cylinder 47 is configured to extend and contract a piston rod (not illustrated) in the front-rear direction by means of compressed air. The supply and discharge of compressed air to and from the air cylinder is controlled by, for example, switching of an electromagnetic valve (not illustrated) provided at an intermediate portion of a passage of the compressed air. The solenoid valve is controlled by, for example, a robot controller 102. The first supporting member 45 is fixed to a piston rod (not illustrated) of the air cylinder 47, for example. The piston rod is provided to be able to extend and contract in the front-rear direction. The air cylinder 47 is arranged to move members (which will be collectively termed a member group for simplicity) such as the first supporting member 45, the second supporting member 46, the first area sensor 41, the cover 43, the joint 48, and the joint 49 together between a running position and a yarn threading position. The running position (see FIG. 9(a)) is a position where the member group is provided when the yarn threading robot 4 is running in the left-right direction. The yarn threading position (see FIG. 9(b)) is a position on the front side of the running position. To put it differently, the running position is a position on the rear side of the yarn threading position. To be more specific, the member group at the running position is preferably on the rear side of the front end of the robot main body 31, for example. In other words, the member group at the running position is preferably positioned between the both ends of the robot main body 31 in the front-rear direction.

[0091] As described above, the member group including the first area sensor 41 can be moved between the running position and the yarn threading position by the moving unit 44.

(Running Position and Yarn Threading Position)

[0092] The following will describe a state of the yarn threading robot 4 when the member group is at the running position and a state of the yarn threading robot 4 when the member group is at the yarn threading position, with reference to FIG. 9(a), FIG. 9(b), FIG. 10, and FIG. 11. FIG. 10 shows the first detection area A1 of the first area sensor 41 and the second detection area A2 of the second area sensor 42 when the yarn threading robot 4 is running. FIG. 11 shows the first detection area A1 and the second detection area A2 when the yarn threading robot 4 performs yarn threading.

[0093] In the present embodiment, the first detection area A1 is substantially identical to a first virtual plane P1 (see FIG. 10 and FIG. 11) described below. The first virtual plane P1 is a fan-shaped virtual plane (see FIG. 10 and FIG. 11) extending from the first detection origin OD1 to the left side of both the arrangement area of the robot main body 31 and the movable area of the movable portion 32 without overlapping each of this arrangement area and the movable area (see FIG. 4). The first virtual plane P1 is substantially orthogonal to, e.g., the up-down direction. With this arrangement, the first area sensor 41 is able to detect at least an obstacle on the left side of the arrangement area of the robot main body 31 and the movable area of the movable portion 32.

[0094] The second detection area A2 is substantially identical to a second virtual plane P2 (see FIG. 10 and FIG. 11) described below. The second virtual plane P2 is a fan-shaped virtual plane (see FIG. 10 and FIG. 11). The second virtual plane P2 extends from the second detection origin OD2 to the right side of both the arrangement area of the robot main body 31 and the movable area of the movable portion 32 without overlapping each of this arrangement area and this movable area (see FIG. 4). The second virtual plane P2 extends at least downward from the second detection origin OD2. With this arrangement, the second area sensor 42 is able to detect an obstacle on the right side of the arrangement area of the robot main body 31 and the movable area of the movable

portion 32. When a member group is provided at a running position, the central angle and radius of the second detection area A2 are the same (see FIG. 10 and FIG. 11) as those in a case where the member group is provided at a yarn threading position.

[0095] When the member group is at the running position, as shown in FIG. 9(a), the cover 43 and the first area sensor 41 are on the rear side of the front end of the robot main body 31, for example. If the first detection area A1 in this state is assumed as a first detection area A1R (see FIG. 10), the first detection area A1R is included in a first virtual plane P1R as the first virtual plane P1. The central angle (above-described $\theta 1$) of the first virtual plane P1R is, for example, not less than 90° and less than 180°, but the angle may not fall within this range.

[0096] The first detection area A1R the first area sensor 41 is at the running position is narrower than a first detection area A1T (described later) when the first area sensor 41 is at the yarn threading position. However, when the yarn threading robot 4 is running, a primary task is to detect whether obstacles exist on both sides in the left-right direction (i.e., running direction) of the yarn threading robot 4. On this account, when the yarn threading robot 4 is running, obstacles that should detected are sufficiently detected even if the member group is positioned at the running position by the moving unit 44. Due to this, even when the robot main body 31 is very thin in the front-rear direction, protrusion of the member group from the running robot main body 31 is effectively suppressed. Consequently, collision between the running yarn threading robot 4 and other devices (e.g., the above-described package collector) due to the protrusion of members such as the first area sensor 41 is avoided. When the member group is at the running position, interference of the member group with other devices is avoided even in a state in which the yarn threading robot 4 does not run (and yarn threading is not performed). To be more specific, for example, the running package collector is allowed to pass through a location very close to the yarn threading robot 4 in the front-rear direction, without interfering with the yarn threading robot 4 which does not run and does not perform yarn threading.

[0097] When the member group is at the yarn threading position (i.e., at least when the yarn threading is being performed), as shown in FIG. 9(b), the cover 43 protrudes forward as compared to the front end of the robot main body 31, for example. At least parts of the housing 41a and detecting portion 41b of the first area sensor 41 protrude forward as compared to, e.g., the front end of the robot main body 31. To be more specific, the detecting portion 41b at the yarn threading position is preferably distanced from the robot main body 31 and on the front side of the robot main body 31 in the front-rear direction. At least when the yarn threading is being performed, the first detection origin OD1 is provided in front of the movable area of the movable portion 32.

[0098] If the first detection area A1 while the yarn threading is in execution is assumed as a first detection area A1T (see FIG. 11), the first detection area A1T is included in a first virtual plane P1T as the first virtual plane P1. The first virtual plane P1T includes a first virtual line segment L1 and a second virtual line segment L2. The first virtual line segment L1 is a virtual line segment extending from the first detection origin OD1 to the front side of both the arrangement area of the robot main body 31 and the movable area of the movable portion 32 without overlapping each of this arrangement area and the movable area. As an example of the first virtual line segment L1, FIG. 11 shows a virtual line segment extending along the front-rear direction. The second virtual line segment L2 is a virtual line segment extending from the first detection origin OD1 to the right side of both the arrangement area of the robot main body 31 and the movable area of the movable portion 32 without overlapping each of this arrangement area and this movable area.

[0099] At least while the yarn threading is in execution, the central angle of the first virtual plane P1 is, e.g., 180° or more (225° in a specific example of FIG. 11). That is, the above-described angle $\theta 1$ can be set to be 180° or more.

[0100] In this way, the first detection area A1T when the first area sensor 41 is at the yarn threading position is wider than the first detection area A1R when the first area sensor 41 is at the running position. On this account, at the time of the yarn threading, the first detection area A1 can be widened by moving the first area sensor 41 from the running position to the yarn threading position by the moving unit 44. Because the yarn threading robot 4 does not run when the yarn threading is performed, a human or an object may unintentionally approach the yarn threading robot 4 from the front. On this account, at the time of the yarn threading, detection of obstacles with the wide first detection area A1T by using the first area sensor 41 at the yarn threading position is effective.

[0101] As shown in FIG. 9(b), when the cover 43 is at the yarn threading position, the supply pipe 35 and the discharge pipe 36 are partially on the front side as compared to a case where the cover 43 is at the running position. To be more specific, when the cover 43 is at the yarn threading position, at least the joint 48, the joint 49, and their surroundings are far from the movable area of the robotic arm 33 in the front-rear direction, as compared to a case where the cover 43 is at the running position. On this account, at the time of yarn threading, it is possible to suppress the robotic arm 33 from being shaken due to collision with the supply pipe 35 and the discharge pipe 36.

(Control by Robot Controller)

[0102] The following will briefly describe how the robot controller 102 controls each section of the yarn threading robot 4. When the yarn threading robot 4 starts running, the robot controller 102 controls the moving unit 44 to

position the member group including the first area sensor 41 at the running position. If the member group is at the yarn threading position immediately before this control, the member group is moved from the yarn threading position to the running position by the moving unit 44. If the member group is at the running position immediately before the control, the position in the front-rear direction of the member group is maintained at the running position. Thereafter, the robot controller 102 controls the running portion 38 to start the running of the yarn threading robot 4. The robot controller 102 determines if an obstacle exists, while causing the yarn threading robot 4 to run. That is to say, based on detection results of the first area sensor 41 and the second area sensor 42, the robot controller 102 determines whether an obstacle exists in neither the first detection area A1R nor the second detection area A2. When it is determined that an obstacle exists in at least one of the first detection area A1R or the second detection area A2, the robot controller 102 urgently stops the running of the yarn threading robot 4 by controlling the running portion 38.

[0103] When the above-described yarn threading is performed, the robot controller 102 stops the running yarn threading robot 4 at a location immediately in front of a spun yarn take-up machine 3 that is the target of the yarn threading, by controlling the running portion 38. Subsequently, the robot controller 102 moves the member group from the running position to the yarn threading position by controlling the moving unit 44. As a result, the member group protrude forward as compared to the robot main body 31, for example. The robot controller 102 determines the presence of an obstacle while performing the yarn threading by controlling the movable portion 32. That is to say, based on detection results of the first area sensor 41 and the second area sensor 42, the robot controller 102 determines whether an obstacle exists in neither the first detection area A1T nor the second detection area A2. When it is determined that an obstacle exists in at least one of the first detection area A1T or the second detection area A2, the robot controller 102 urgently stops the yarn threading by controlling the movable portion 32. On the other hand, when the yarn threading is properly completed, the robot controller 102 moves the member group from the yarn threading position to the running position by controlling the moving unit 44. Furthermore, the robot controller 102 controls the running portion 38 in accordance with a command from the integrated controller 100, and moves the yarn threading robot 4 toward another spun yarn take-up machine 3 that is the next target of yarn threading.

[0104] As described above, the yarn threading robot 4 includes the moving unit 44. When the yarn threading robot 4 performs yarn threading, the detecting portion 41b is positioned at the yarn threading position. With this arrangement, the detecting portion 41b can be arranged to protrude forward at the time of the yarn threading. On this account, overlap of the detection area (first detection area A1) of the detecting portion 41b and the movable area of the movable portion 32, which tends to occur, is suppressed, and proper monitoring of a region forward of the robot main body 31 and the movable portion 32 is facilitated. It is therefore possible to monitor a wide area at the time of the yarn threading by the yarn threading robot 4. Furthermore, when the detecting portion 41b is at the running position, protrusion of the detecting portion 41b forward as compared to the robot main body 31 is suppressed. On this account, obstruction of other devices by the detecting portion 41b is suppressed at the time of the running of the yarn threading robot 4.

[0105] When the detecting portion 41b is at the yarn threading position, at least part of the detecting portion 41b protrudes forward as compared to the front end of the robot main body 31. Preferably, when the detecting portion 41b is at the yarn threading position, the detecting portion 41b is distanced from the robot main body 31 in the forward direction. Furthermore, when the detecting portion 41b is at the yarn threading position, the first detection origin OD1 is provided forward of the movable area of the movable portion 32. With this arrangement, the detecting portion 41b makes it possible to detect an obstacle in a wide area without being obstructed by the robot main body 31 and the movable portion 32.

[0106] At least when the yarn threading is being performed, the fan-shaped first virtual plane P1 on which the first detection area A1T is provided includes the first virtual line segment L1 and the second virtual line segment L2. With this arrangement, the detecting portion 41b makes it possible to detect an obstacle in a wide area without being obstructed by the robot main body 31 and the movable portion 32. It is therefore possible to avoid an increase in the number of area sensors 40, and to detect an obstacle in a sufficiently wide area.

[0107] The detecting portion 41b is able to change at least one of the shape and size of the first detection area A1 by the settings. On this account, as compared to, for example, an arrangement in which the orientation of the first detection area A1 is physically changed by rotating the detecting portion 41b within a plane including the first virtual plane P1, it is unnecessary to newly add a driving mechanism for rotating the detecting portion 41b. This suppresses the yarn threading robot 4 from being structurally complicated. Furthermore, the first detection area A1 is changeable with a relatively high degree of freedom by the settings. It is therefore possible to easily avoid erroneous detection of an object, which is not detected at the time of the yarn threading, as an obstacle, when the detecting portion 41b is moved to the running position.

[0108] At least at the time of the yarn threading, the central angle of the first virtual plane P1T is 180° or more. With this arrangement, the detecting portion 41b makes it possible to detect an obstacle in a wide area.

[0109] When the cover 43 is at the yarn threading position, at least the joint 48, the joint 49, and their surroundings are far from the movable area of the robotic arm 33 in the front-rear direction, as compared to a case where the cover 43 is at the running position. On this

account, at the time of yarn threading, it is possible to suppress the robotic arm 33 from colliding with the supply pipe 35 and the discharge pipe 36. It is therefore possible to effectively suppress the supply pipe 35 and the discharge pipe 36 from shaking. It is therefore possible to suppress the occurrence of a detection error of each area sensor 40.

[0110] In the present embodiment, the detecting portion 42b is provided so that the second virtual plane P2 extends to the right side of the movable area of the movable portion 32 while avoiding the movable area. A blind area may occur in the second detection area A2 and in the vicinity of the movable area of the movable portion 32, depending on the positional relationship between the second detection area A2 and the movable area of the movable portion 32. In this regard, at least during the execution of the yarn threading, the detecting portion 41b makes it possible to detect an obstacle in an area which is wide in the left-right direction without being obstructed by the robot main body 31 and the movable portion 32. With this arrangement, at least during the execution of the yarn threading, the detecting portion 41b (the first area sensor 41) is able to monitor an area which needs to be monitored and which cannot be monitored by the detecting portion 42b (the second area sensor 42). It is therefore possible to suppress the occurrence of a blind area.

[0111] The detecting portion 41b is provided inside the movable area of the movable portion 32 in the up-down direction. When the detecting portion 41b is provided outside the movable area of the movable portion 32 in the up-down direction, a space available for providing a member which is not the yarn threading robot 4 may be narrow. In the present embodiment, such narrowing of the space for providing another member by the detecting portion 41b is avoided.

[0112] The yarn threading robot 4 is suspended from the rail member 37. With this arrangement, the robot main body 31 is provided at a high position in the up-down direction. It is therefore possible to reduce the risk of contact of a person or an object with the yarn threading robot 4. It is also possible to provide a necessary apparatus and/or a member below the robot main body 31.

[0113] The yarn threading robot 4 includes the cover 43. At least a part of the housing 41a of the first area sensor 41 is covered by the cover 43. This suppresses the loss of beauty of appearance of the yarn threading robot 4. Furthermore, the cover 43 makes it possible to protect the housing 41a, etc. against dirt and an obstacle.

[0114] An obstacle is detected by each area sensor 40 which is a widely-available optical area sensor.

[0115] The following will describe modifications of the above-described embodiment. The members identical with those in the embodiment above will be denoted by the same reference numerals and the explanations thereof are not repeated.

(1) In the embodiment above, the joints 48 and 49 are fixed to the cover 43 by the second supporting member 46. However, a means of fixing the supply pipe 35 and the discharge pipe 36 to the cover 43 is not limited to this. For example, a part of the supply pipe 35 and a part of the discharge pipe 36 may be fixed to the cover 43 by an unillustrated clamp member.

(2) In the embodiment above, the positions of the joints 48 and 49 are fixed with respect to the cover 43. However, the disclosure is not limited to these arrangements. The positions of the joints 48 and 49 may be fixed with respect to, e.g., the robot main body 31. As shown in FIG. 12, for example, a fixed member 51 fixed to the robot main body 31 may be provided instead of the second supporting member 46. The fixed member 51 may include, e.g., linear portions 51a and 51b aligned in the front-rear direction. The joints 48 and 49 may be provided between the linear portions 51a and 51b in, e.g., the front-rear direction. The joints 48 and 49 may be fixed to the linear portions 51a and 51b by, e.g., welding or the like. With this arrangement, a part of the supply pipe 35 and a part of the discharge pipe 36 are provided outside the robot main body 31 and suppressed from swinging. It is therefore possible to suppress the occurrence of a detection error of each area sensor 40. A means of fixing the supply pipe 35 and the discharge pipe 36 to the robot main body 31 is not limited to this.

(3) A part of the supply pipe 35 and a part of the discharge pipe 36 are provided outside the robot main body 31, and may not be fixed to the cover 43 or the robot main body 31.

(4) In the embodiment above, each area sensor 40 is an optical area sensor using laser light as a detection medium. However, the disclosure is not limited to these arrangements. Each area sensor 40 may be configured to perform detection by using light which is not laser light as a detection medium. Each area sensor 40 may be configured to perform detection by using, e.g., an ultrasonic wave as a detection medium. Instead of the area sensors 40, two unillustrated cameras (the first detecting portion and the second detecting portion of the present invention) may be provided. Also in this case, the first detecting portion and the second detecting portion are able to detect an object in a predetermined flat area.

(5) In the embodiment above, the detecting portion 41b is provided inside the movable area of the movable portion 32 in the up-down direction. However, the disclosure is not limited to these arrangements. The detecting portion 41b may be provided outside the movable area of the movable portion 32 in the up-down direction.

(6) In the embodiment above, the second virtual plane P2 (and the second detection area A2) extends at least downward from the second detection origin OD2. However, the disclosure is not limited to these arrangements. The second virtual plane P2

(and the second detection area A2) may not extend downward from the second detection origin OD2, depending on the positional relationship between (i) the detecting portion 42b and (ii) the arrangement area of the robot main body 31 and the movable area of the movable portion 32.

(7) In the embodiment above, the robot main body 31 is suspended from the rail member 37. However, the disclosure is not limited to these arrangements. For example, the robot main body 31 may be configured to run on a track placed on the floor of the factory.

(8) In the embodiment above, at least at the time of the yarn threading, the central angle of the first virtual plane P1T is 180° or more. However, the disclosure is not limited to these arrangements. The central angle of the first virtual plane P1T may be slightly smaller than 180°. Also in this case, it is possible to detect objects on the left side, right side, and front side of the yarn threading robot 4.

(9) In the embodiment above, the detecting portion 41b is able to change at least one of the shape and size of the first detection area A1 by the settings. However, the disclosure is not limited to these arrangements. The detecting portion 41b may not be able to change the shape and size of the first detection area A1. The detecting portion 41b may be arranged, for example, to move (rotate) the first detection area A1 by rotating about an axis along the up-down direction. This makes it possible to differentiate the first detection area A1 between a case where the detecting portion 41b is at the running position and a case where the detecting portion 41b is at the yarn threading position.

(10) In the embodiment above, the detecting portion 41b is preferably distanced from the robot main body 31 and provided forward of the robot main body 31 at the time of the yarn threading. However, the disclosure is not limited to these arrangements. For example, only a part of the detecting portion 41b in the front-rear direction may be provided in front of the front end of the robot main body 31. At least a part of the housing 41a and a part of the detecting portion 41b protrude forward as compared to the front end of the robot main body 31 at the time of the yarn threading. However, the disclosure is not limited to these arrangements. The housing 41a and the detecting portion 41b may not protrude forward as compared to the front end of the robot main body 31 at the time of the yarn threading.

(11) In the embodiment above, the yarn threading robot 4 includes the cover 43. However, the disclosure is not limited to these arrangements. The yarn threading robot 4 may not include the cover 43.

(12) In the embodiment above, when the detecting portion 41b is at the yarn threading position, the first detection origin OD1 is provided forward of the movable area of the movable portion 32. However, the disclosure is not limited to these arrangements. When the detecting portion 41b is at the yarn threading position, the first detection origin OD1 may be provided, for example, rearward of the movable area of the movable portion 32. Furthermore, at least during the execution of the yarn threading, the first virtual plane P1T is fan-shaped, and includes the first virtual line segment L1 and the second virtual line segment L2. However, the disclosure is not limited to these arrangements. The first virtual plane P1T may not include the first virtual line segment L1 and/or the second virtual line segment L2. The first virtual plane P1T may not be fan-shaped. That is, the first detection area A1 may be shaped at will as long as it extends from the first detection origin OD1.

(13) In the embodiment above, the first detection area A1 is identical to the first virtual plane P1. The second detection area A2 is identical to the second virtual plane P2. However, the disclosure is not limited to these arrangements. The first detection area A1 may be a part of the first virtual plane P1. That is, the first virtual plane P1 may be defined to be wider than the first detection area A1 and not to overlap both the arrangement area of the robot main body 31 and the movable area of the movable portion 32. The first virtual plane P1 may not be fan-shaped, i.e., may be differently shaped. The shape of the first detection area A1 may be set to a shape which is not a fan-shape. Similarly, the second detection area A2 may be a part of the second virtual plane P2. That is, the second virtual plane P2 may be defined to be wider than the second detection area A2 and not to overlap both the arrangement area of the robot main body 31 and the movable area of the movable portion 32. The second virtual plane P2 may not be fan-shaped, i.e., may be differently shaped. The shape of the second detection area A2 may not be a fan-shape.

(14) The present invention may be applied not only to the yarn threading robot 4 configured to perform yarn threading to each spun yarn take-up machine 3, but also to a yarn threading robot (not illustrated) configured to perform yarn threading to a yarn winder (not illustrated) configured to wind a yarn (not illustrated).

Claims

1. A yarn threading robot (4) which is able to perform yarn threading to yarn winders (3) aligned in a first direction interesting with a vertical direction, the yarn threading robot (4) comprising:

a robot main body (31) which is able to run in the first direction and which is provided on one side of the yarn winders (3) in a second direction orthogonal to both the vertical direction and the first direction;

a movable portion (32) which is attached to the robot main body (31) and which is able to perform the yarn threading by moving relative to the robot main body (31) in a predetermined movable area;
a first detecting portion (41b) which is attached to the robot main body (31) and which is able to detect an object provided in a predetermined first detection area (A1); and
a moving unit (44) which is capable of moving the first detecting portion (41b) between a yarn threading position where the yarn threading is performed by the movable portion (32) and a running position which is on the other side of the yarn threading position in the second direction.

2. The yarn threading robot (4) according to claim 1, wherein, when the first detecting portion (41b) is at the yarn threading position, one end of the robot main body (31) is provided on the one side in the second direction, and at least a part of the first detecting portion (41b) protrudes to be on the one side of the one end of the robot main body (31) in the second direction.

3. The yarn threading robot (4) according to claim 2, wherein, when the first detecting portion (41b) is at the yarn threading position, the first detecting portion (41b) is distanced from the robot main body (31) and provided on the one side of the robot main body (31) in the second direction.

4. The yarn threading robot (4) according to any one of claims 1 to 3, wherein,

the first detection area (A1) extends from a predetermined first detection origin (OD1), and
when the first detecting portion (41b) is at the yarn threading position, the first detection origin (OD1) is provided on the one side of the movable area of the movable portion (32) in the second direction.

5. The yarn threading robot (4) according to any one of claims 1 to 4, wherein, the first detection area (A1) extends from a predetermined first detection origin (OD1) to at least one side of both an arrangement area of the robot main body (31) and the movable area of the movable portion (32) in the first direction,

a predetermined virtual plane which is a first virtual plane (P1) extends from the first detection origin (OD1) to the one side of both the arrangement area of the robot main body (31) and the movable area of the movable portion (32) in the first direction without overlapping each of the arrangement area and the movable area, and the first detecting portion (41b) is provided so that the first detection area (A1) is included in the first virtual plane (P1), and
at least while the yarn threading is in execution, the first virtual plane (P1) is fan-shaped and includes:

a first virtual line segment (L1) extending from the first detection origin (OD1) to the one side of both the arrangement area of the robot main body (31) and the movable area of the movable portion (32) in the second direction without overlapping the each of the arrangement area and the movable area; and
a second virtual line segment (L2) extending along the first direction from the first detection origin (OD1) to the other side of both the arrangement area of the robot main body (31) and the movable area of the movable portion (32) in the first direction without overlapping the each of the arrangement area and the movable area.

6. The yarn threading robot (4) according to claim 5, wherein, at least while the yarn threading is in execution, a central angle of the first virtual plane (P1) is 180° or more.

7. The yarn threading robot (4) according to claim 5 or 6, wherein, at least a part of the movable area of the movable portion (32) is provided on the other side of the robot main body (31) in the first direction,

the yarn threading robot (4) further comprising a second detecting portion (42b) which is attached to the robot main body (31) and which is able to detect an object provided in a predetermined second detection area (A2) extending from a predetermined detection origin (OD2) to at least the other side of both the arrangement area of the robot main body (31) and the movable area of the movable portion (32) in the first direction, wherein,
a predetermined virtual plane which is a second virtual plane (P2) extends from the second detection origin (OD2) to the other side of both the arrangement area of the robot main body (31) and the movable area of the movable portion (32) in the first direction without overlapping the each of the arrangement area and the movable area, and the second detecting portion (42b) is provided so that the second detection area (A2) is included in the second virtual plane (P2).

8. The yarn threading robot (4) according to any one of claims 1 to 7, wherein, the first detecting portion (41b) is able to change at least one of shape and size of the first detection area (A1) by settings.

9. The yarn threading robot (4) according to any one of claims 1 to 8, wherein, the movable portion (32) includes:

a sucking unit (34a) which is able to suck and retain a running yarn (Y); and
a pipe portion (35, 36) which is connected to the sucking unit (34a), which is able to supply fluid used for generating a negative pressure used for sucking and retaining the yarn (Y) to the sucking unit (34a), and which is able to discharge the fluid from the sucking unit (34a),
a part of the pipe portion (35, 36) is provided outside the robot main body (31), and a part of the part is fixed to the robot main body (31).

10. The yarn threading robot (4) according to any one of claims 1 to 9, wherein, the movable portion (32) includes:

a sucking unit (34a) which is able to suck and retain a running yarn (Y);
an arm mechanism (33) which is configured to move the sucking unit (34a) relative to the robot main body (31); and
a pipe portion (35, 36) which is connected to the sucking unit (34a), which is able to supply fluid used for generating a negative pressure used for sucking and retaining the yarn (Y) to the sucking unit (34a), and which is able to discharge the fluid from the sucking unit (34a),
a part of the pipe portion (35, 36) which is provided outside the robot main body (31) has a portion that is fixed in position relative to the first detecting portion (41b), and
when the first detecting portion (41b) is at the yarn threading position, the portion of the pipe portion (35, 36) is far from the movable area of the arm mechanism (33) in the second direction as compared to a state in which the first detecting portion (41b) is at the running position.

11. The yarn threading robot (4) according to any one of claims 1 to 10, wherein, the first detecting portion (41b) is provided inside the movable area of the movable portion (32) in an up-down direction.

12. The yarn threading robot (4) according to any one of claims 1 to 11, wherein, the robot main body (31) is suspended from a rail (37) extending in the first direction.

13. The yarn threading robot (4) according to any one of claims 1 to 12, further comprising: a housing (41a) which is attached to the robot main body (31) and to which the first detecting portion (41b) is fixed; and
a cover (43) provided to cover at least a part of the housing (41a) when viewed from the one side in the second direction.

14. The yarn threading robot (4) according to any one of claims 1 to 13, wherein, the first detecting portion (41b) is included in an area sensor which is able to detect a detection medium reflected by an object provided on a predetermined virtual plane.

Amended claims in accordance with Rule 137(2) EPC.

1. A yarn threading robot (4) which is able to perform yarn threading to yarn winders (3) aligned in a first direction interesting with a vertical direction, the yarn threading robot (4) comprising:

a robot main body (31) which is able to run in the first direction and which is provided on one side of the yarn winders (3) in a second direction orthogonal to both the vertical direction and the first direction;
a movable portion (32) which is attached to the robot main body (31) and which is able to perform the yarn threading by moving relative to the robot main body (31) in a predetermined movable area; and
a first detecting portion (41b) which is attached to the robot main body (31) and which is able to detect an object provided in a predetermined first detection area (A1); **characterized by** further comprising
a moving unit (44) which is capable of moving the first detecting portion (41b) between a yarn threading position where the yarn threading is performed by the movable portion (32) and a running position which is on the other side of the yarn threading position in the second direction.

2. The yarn threading robot (4) according to claim 1, wherein, when the first detecting portion (41b) is at the yarn threading position, one end of the robot main body (31) is provided on the one side in the second direction, and at least a part of the first detecting portion (41b) protrudes to be on the one side of the one end of the robot main body (31) in the second direction.

3. The yarn threading robot (4) according to claim 2, wherein, when the first detecting portion (41b) is at the yarn threading position, the first detecting portion (41b) is distanced from the robot main body (31) and provided on the one side of the robot main body (31) in the second direction.

4. The yarn threading robot (4) according to any one of claims 1 to 3, wherein,

the first detection area (A1) extends from a pre-

determined first detection origin (OD1), and when the first detecting portion (41b) is at the yarn threading position, the first detection origin (OD1) is provided on the one side of the movable area of the movable portion (32) in the second direction.

5. The yarn threading robot (4) according to any one of claims 1 to 4, wherein, the first detection area (A1) extends from a predetermined first detection origin (OD1) to at least one side of both an arrangement area of the robot main body (31) and the movable area of the movable portion (32) in the first direction,

a predetermined virtual plane which is a first virtual plane (P1) extends from the first detection origin (OD1) to the one side of both the arrangement area of the robot main body (31) and the movable area of the movable portion (32) in the first direction without overlapping each of the arrangement area and the movable area, and the first detecting portion (41b) is provided so that the first detection area (A1) is included in the first virtual plane (P1), and
at least while the yarn threading is in execution, the first virtual plane (P1) is fan-shaped and includes:

a first virtual line segment (L1) extending from the first detection origin (OD1) to the one side of both the arrangement area of the robot main body (31) and the movable area of the movable portion (32) in the second direction without overlapping the each of the arrangement area and the movable area; and
a second virtual line segment (L2) extending along the first direction from the first detection origin (OD1) to the other side of both the arrangement area of the robot main body (31) and the movable area of the movable portion (32) in the first direction without overlapping the each of the arrangement area and the movable area.

6. The yarn threading robot (4) according to claim 5, wherein, at least while the yarn threading is in execution, a central angle of the first virtual plane (P1) is 180° or more.

7. The yarn threading robot (4) according to claim 5 or 6, wherein, at least a part of the movable area of the movable portion (32) is provided on the other side of the robot main body (31) in the first direction,

the yarn threading robot (4) further comprising a second detecting portion (42b) which is attached to the robot main body (31) and which is able to detect an object provided in a predetermined second detection area (A2) extending from a predetermined detection origin (OD2) to at least the other side of both the arrangement area of the robot main body (31) and the movable area of the movable portion (32) in the first direction, wherein,
a predetermined virtual plane which is a second virtual plane (P2) extends from the second detection origin (OD2) to the other side of both the arrangement area of the robot main body (31) and the movable area of the movable portion (32) in the first direction without overlapping the each of the arrangement area and the movable area, and the second detecting portion (42b) is provided so that the second detection area (A2) is included in the second virtual plane (P2).

8. The yarn threading robot (4) according to any one of claims 1 to 7, wherein, the first detecting portion (41b) is able to change at least one of shape and size of the first detection area (A1) by settings.

9. The yarn threading robot (4) according to any one of claims 1 to 8, wherein, the movable portion (32) includes:

a sucking unit (34a) which is able to suck and retain a running yarn (Y); and
a pipe portion (35, 36) which is connected to the sucking unit (34a), which is able to supply fluid used for generating a negative pressure used for sucking and retaining the yarn (Y) to the sucking unit (34a), and which is able to discharge the fluid from the sucking unit (34a),
a part of the pipe portion (35, 36) is provided outside the robot main body (31), and a part of the part is fixed to the robot main body (31).

10. The yarn threading robot (4) according to any one of claims 1 to 9, wherein, the movable portion (32) includes:

a sucking unit (34a) which is able to suck and retain a running yarn (Y);
an arm mechanism (33) which is configured to move the sucking unit (34a) relative to the robot main body (31); and
a pipe portion (35, 36) which is connected to the sucking unit (34a), which is able to supply fluid used for generating a negative pressure used for sucking and retaining the yarn (Y) to the sucking unit (34a), and which is able to discharge the fluid from the sucking unit (34a),
a part of the pipe portion (35, 36) which is provided outside the robot main body (31) has a portion that is fixed in position relative to the first detecting portion (41b), and

when the first detecting portion (41b) is at the yarn threading position, the portion of the pipe portion (35, 36) is far from the movable area of the arm mechanism (33) in the second direction as compared to a state in which the first detecting portion (41b) is at the running position.

11. The yarn threading robot (4) according to any one of claims 1 to 10, wherein, the first detecting portion (41b) is provided inside the movable area of the movable portion (32) in an up-down direction.

12. The yarn threading robot (4) according to any one of claims 1 to 11, wherein, the robot main body (31) is suspended from a rail (37) extending in the first direction.

13. The yarn threading robot (4) according to any one of claims 1 to 12, further comprising: a housing (41a) which is attached to the robot main body (31) and to which the first detecting portion (41b) is fixed; and
a cover (43) provided to cover at least a part of the housing (41a) when viewed from the one side in the second direction.

14. The yarn threading robot (4) according to any one of claims 1 to 13, wherein, the first detecting portion (41b) is included in an area sensor which is able to detect a detection medium reflected by an object provided on a predetermined virtual plane.

FIG.1

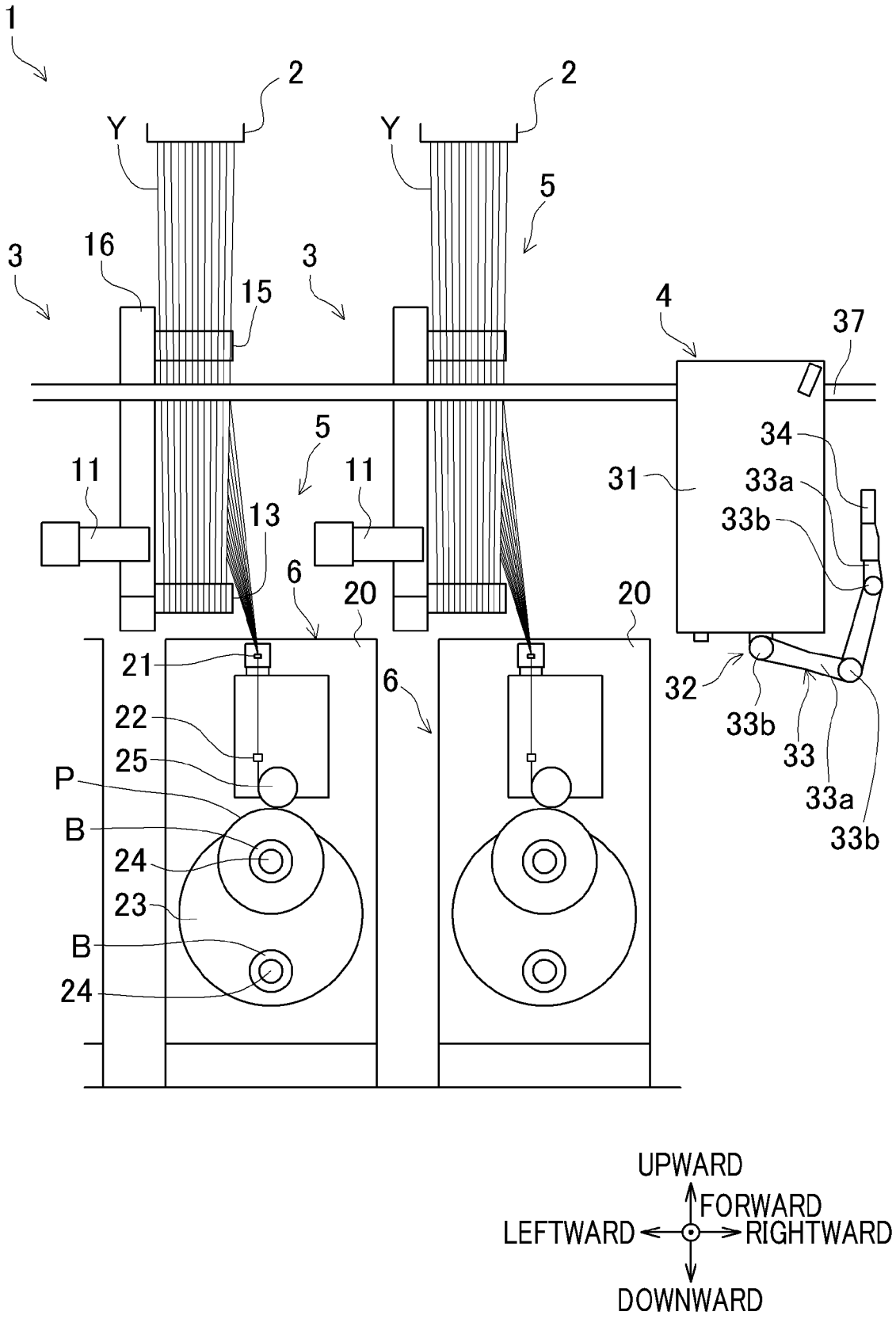

1
2
2
Y
Y
5
3
16
15
3
4
37
5
34
11
11
31
33a
13
33b
6
20
20
21
6
32
22
33b
25
33
P
33a
B
24
33b
23
B
24
UPWARD
FORWARD
LEFTWARD
RIGHTWARD
DOWNWARD

FIG.2

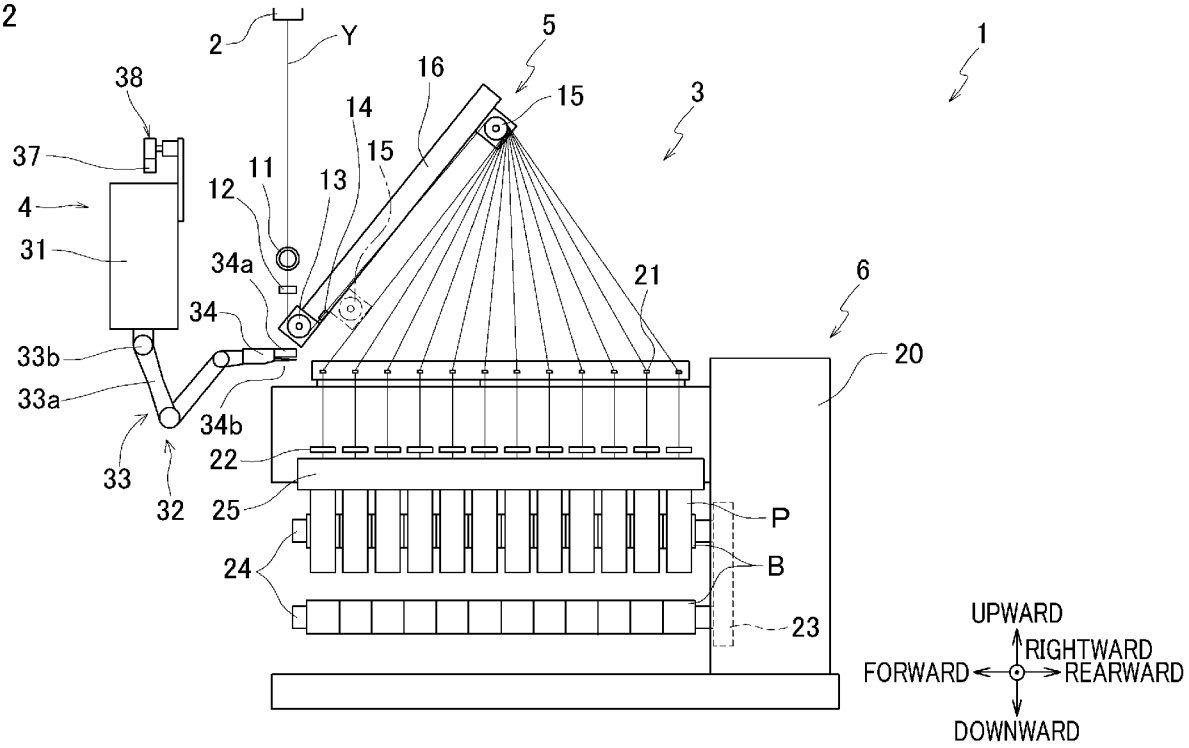

2
Y
5
1
38
16
15
3
14
37
15
11
13
12
4
31
34a
21
6
34
20
33b
33a
34b
22
33
32
25
P
24
B
23
UPWARD
RIGHTWARD
FORWARD
REARWARD
DOWNWARD

FIG.3

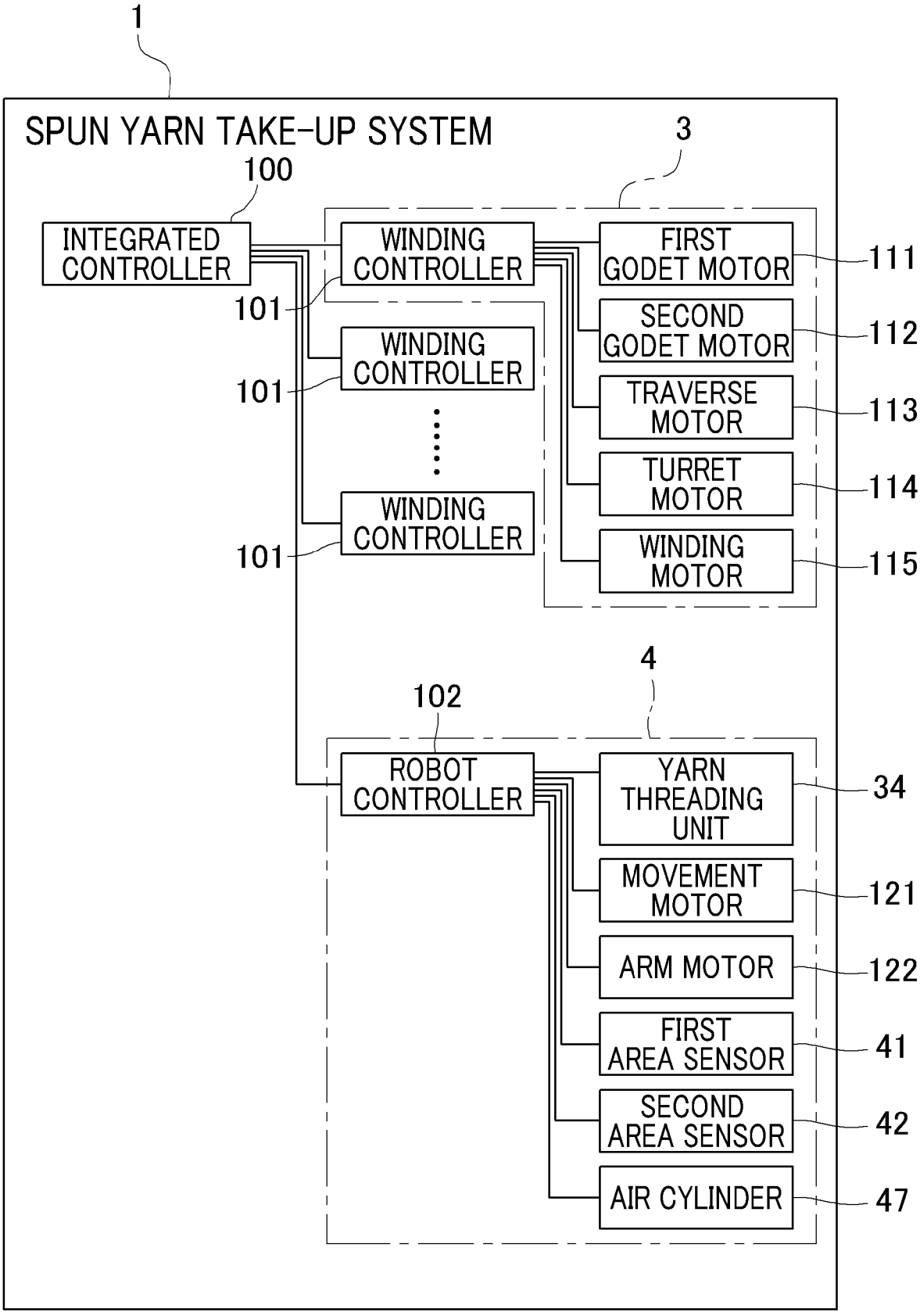

1
SPUN YARN TAKE-UP SYSTEM
3
100
INTEGRATED CONTROLLER
WINDING CONTROLLER
101
WINDING CONTROLLER
101
WINDING CONTROLLER
101
FIRST GODET MOTOR
111
SECOND GODET MOTOR
112
TRAVERSE MOTOR
113
TURRET MOTOR
114
WINDING MOTOR
115
4
102
ROBOT CONTROLLER
YARN THREADING UNIT
34
MOVEMENT MOTOR
121
ARM MOTOR
122
FIRST AREA SENSOR
41
SECOND AREA SENSOR
42
AIR CYLINDER
47

FIG.4

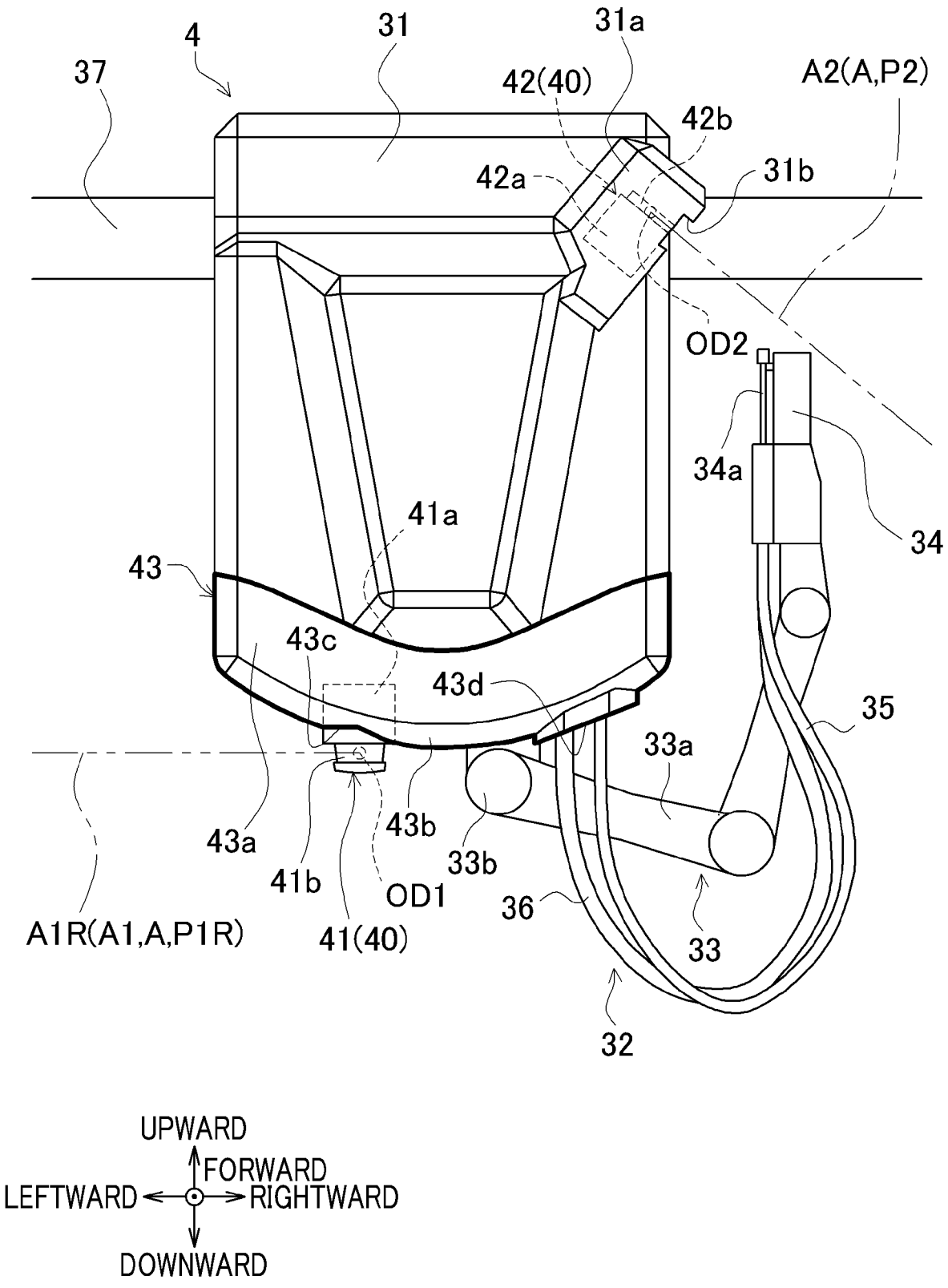

4
31
31a
37
42(40)
A2(A,P2)
42b
42a
31b
OD2
34a
34
41a
43
43c
43d
35
33a
43a
43b
33b
41b
OD1
36
A1R(A1,A,P1R)
41(40)
33
32
UPWARD
FORWARD
LEFTWARD
RIGHTWARD
DOWNWARD

FIG.5

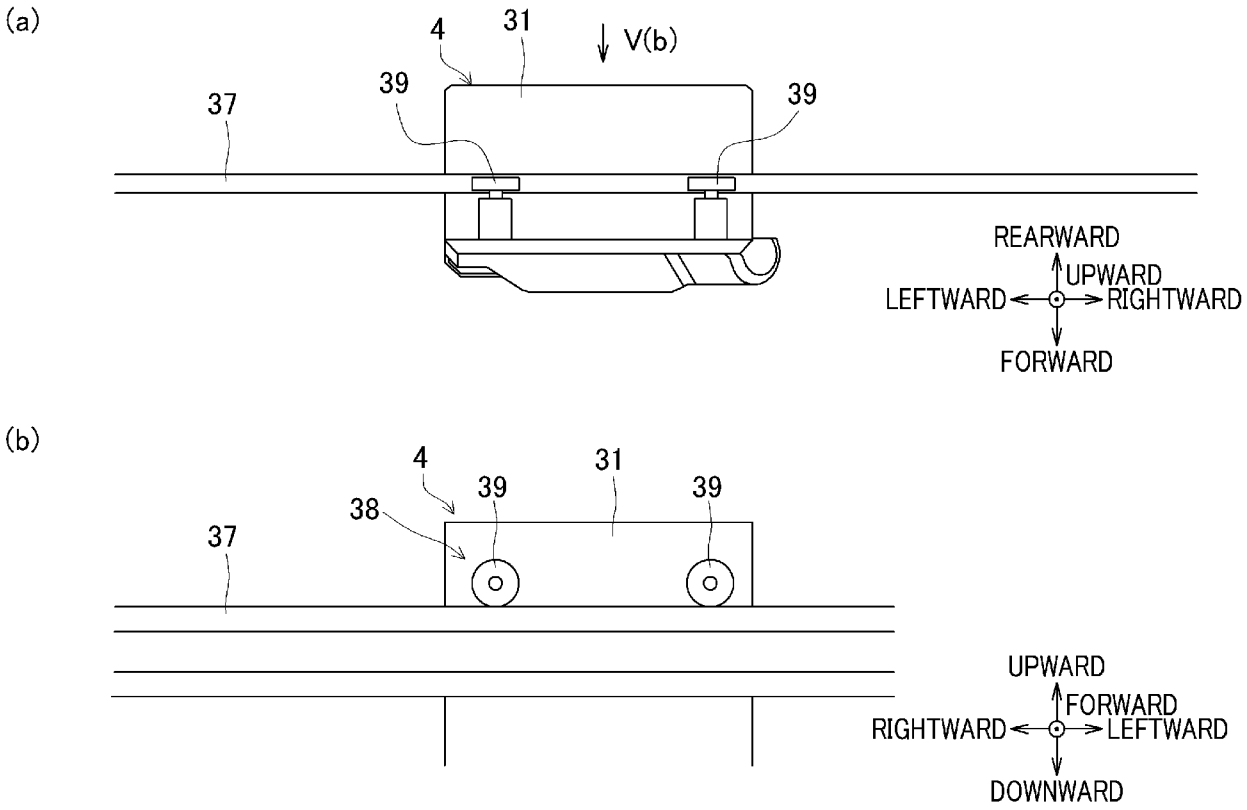

(a)
4
31
V(b)
39
39
37
REARWARD
UPWARD
LEFTWARD
RIGHTWARD
FORWARD
(b)
4
31
39
39
38
37
UPWARD
FORWARD
RIGHTWARD
LEFTWARD
DOWNWARD

FIG.6

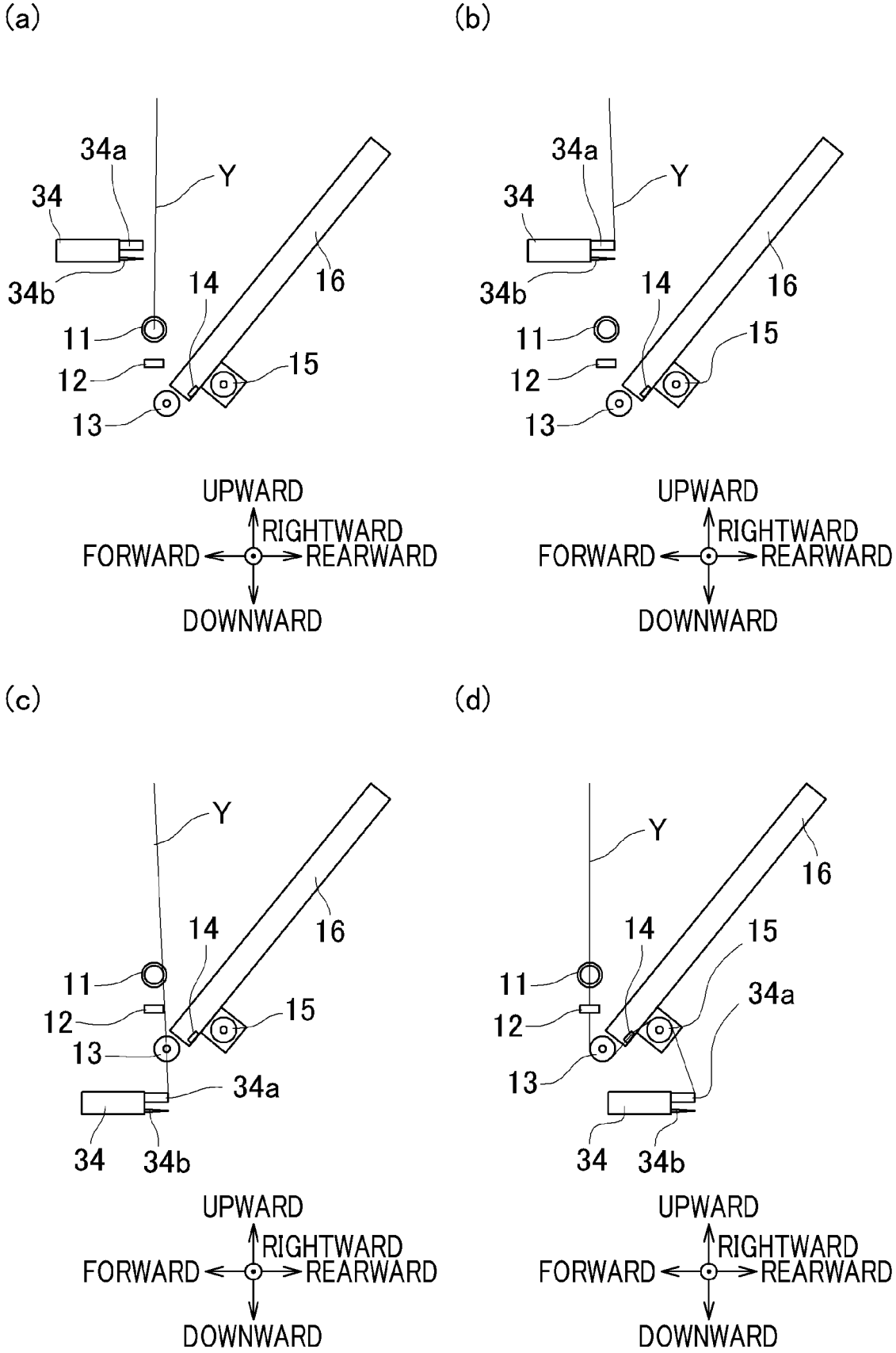
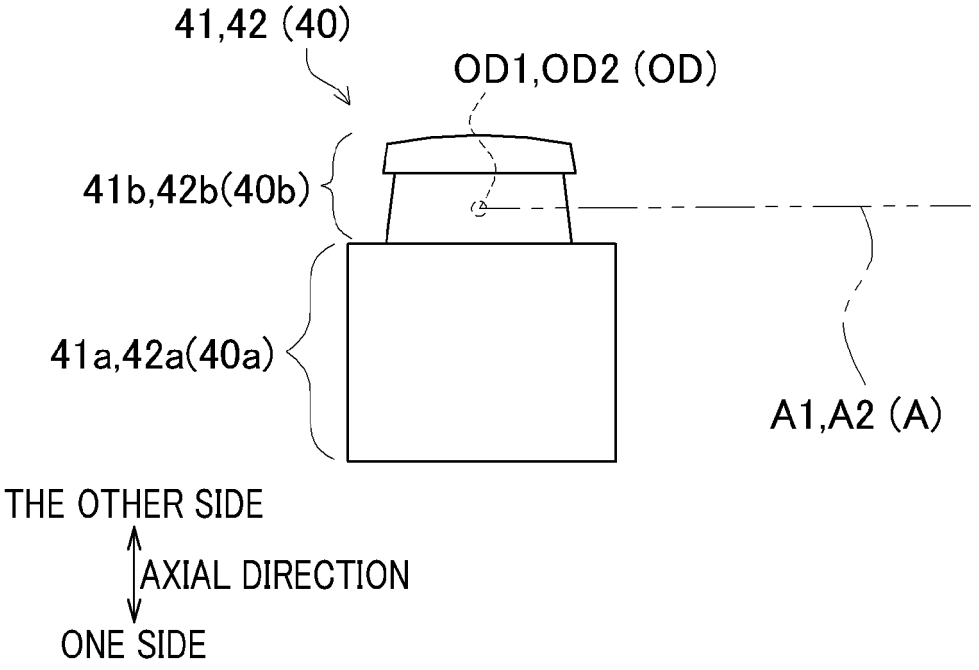

(a)
34a
Y
34
34b
14
16
11
12
15
13
UPWARD
RIGHTWARD
FORWARD
REARWARD
DOWNWARD
(b)
34a
Y
34
34b
14
16
11
15
12
13
UPWARD
RIGHTWARD
FORWARD
REARWARD
DOWNWARD
(c)
Y
14
16
11
12
15
13
34a
34
34b
UPWARD
RIGHTWARD
FORWARD
REARWARD
DOWNWARD
(d)
Y
16
14
15
11
34a
12
13
34
34b
UPWARD
RIGHTWARD
FORWARD
REARWARD
DOWNWARD

FIG.7

(a)


41,42 (40)
OD1,OD2 (OD)
41b,42b(40b)
41a,42a(40a)
A1,A2 (A)
THE OTHER SIDE
AXIAL DIRECTION
ONE SIDE

(b)

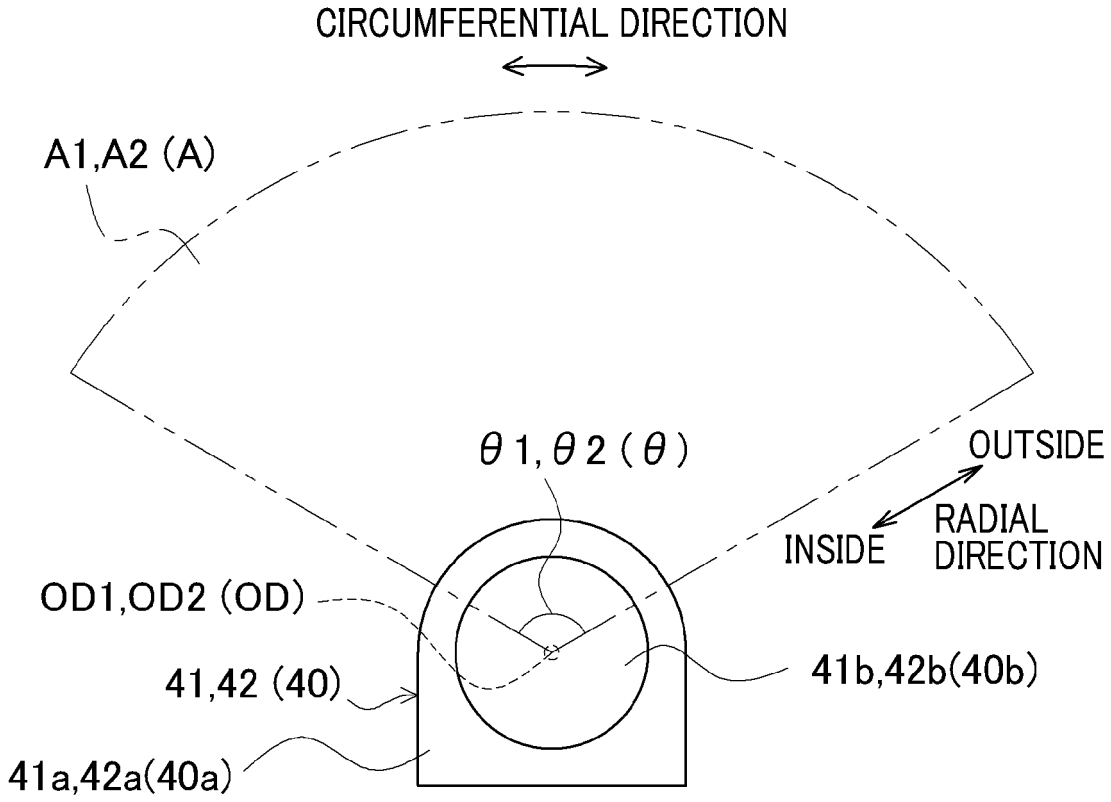

CIRCUMFERENTIAL DIRECTION
A1,A2 (A)
θ1, θ2 (θ)
OUTSIDE
INSIDE
RADIAL DIRECTION
OD1,OD2 (OD)
41,42 (40)
41a,42a(40a)
41b,42b(40b)

FIG.8

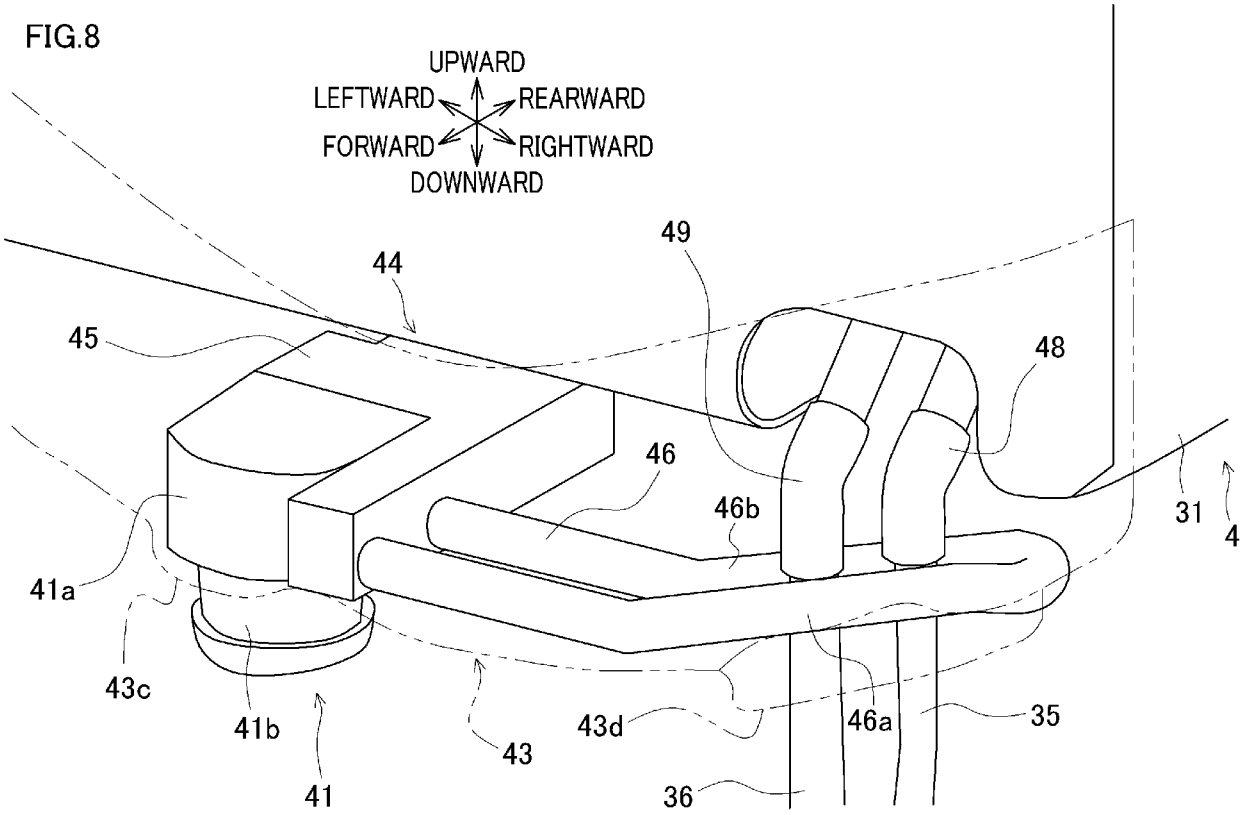

UPWARD
LEFTWARD
REARWARD
FORWARD
RIGHTWARD
DOWNWARD
44
49
45
48
46
46b
31
4
41a
43c
41b
41
43
43d
46a
35
36

FIG.9

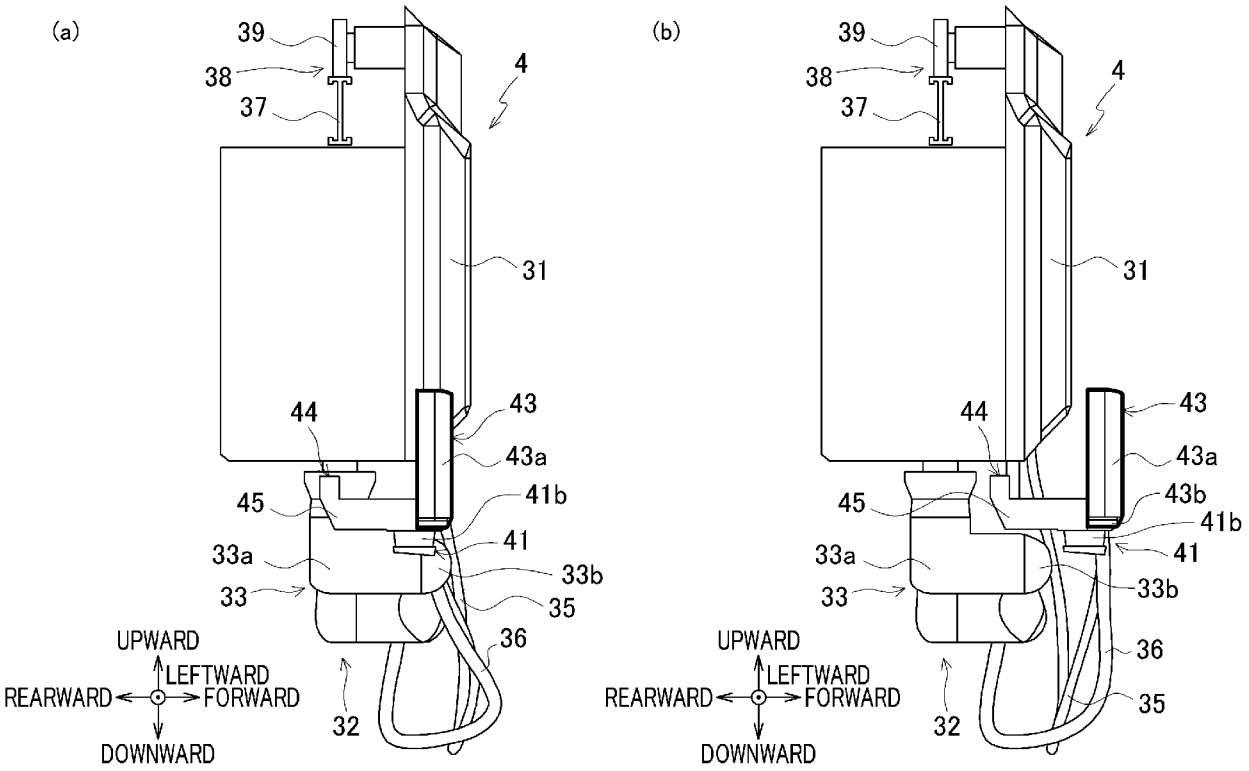

(a)
39
38
37
4
31
44
43
43a
45
41b
41
33a
33b
33
35
36
32
UPWARD
LEFTWARD
REARWARD
FORWARD
DOWNWARD
(b)
39
38
37
4
31
44
43
43a
45
43b
41b
41
33a
33
33b
36
35
32
UPWARD
LEFTWARD
REARWARD
FORWARD
DOWNWARD

FIG.10

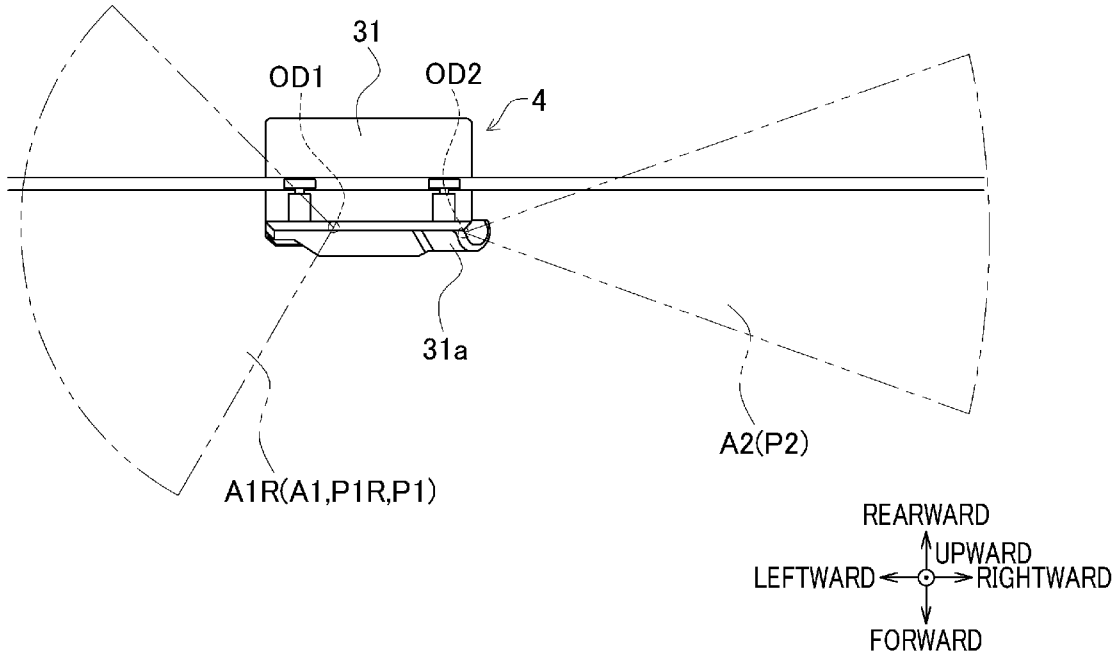

31
OD1
OD2
4
31a
A2(P2)
A1R(A1,P1R,P1)
REARWARD
UPWARD
LEFTWARD
RIGHTWARD
FORWARD

FIG.11

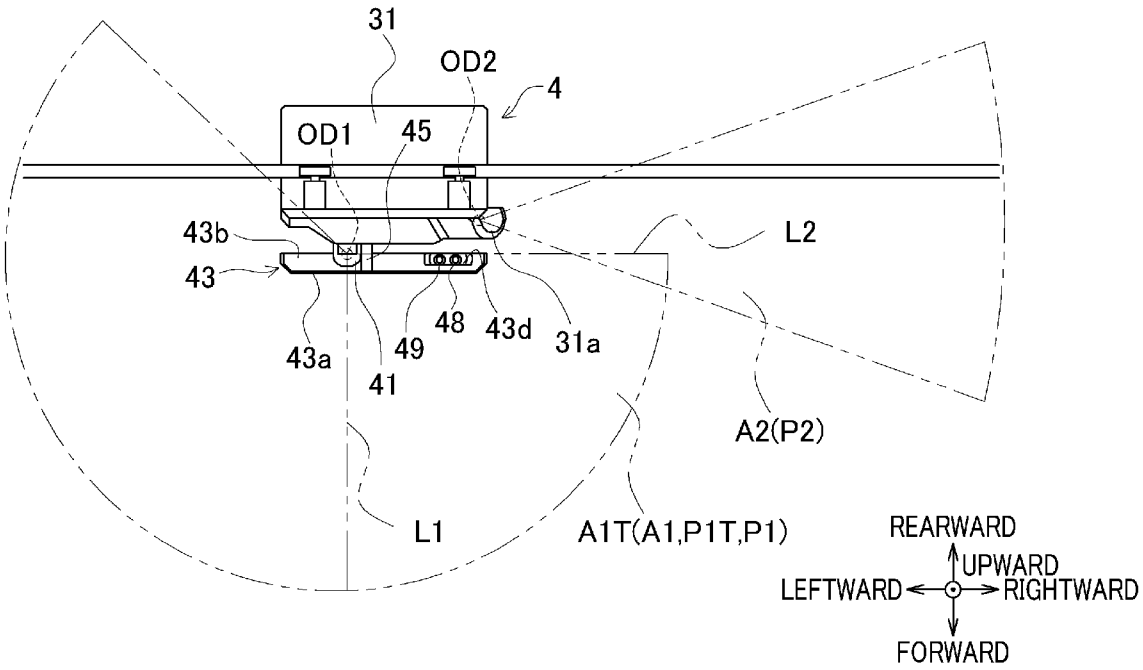
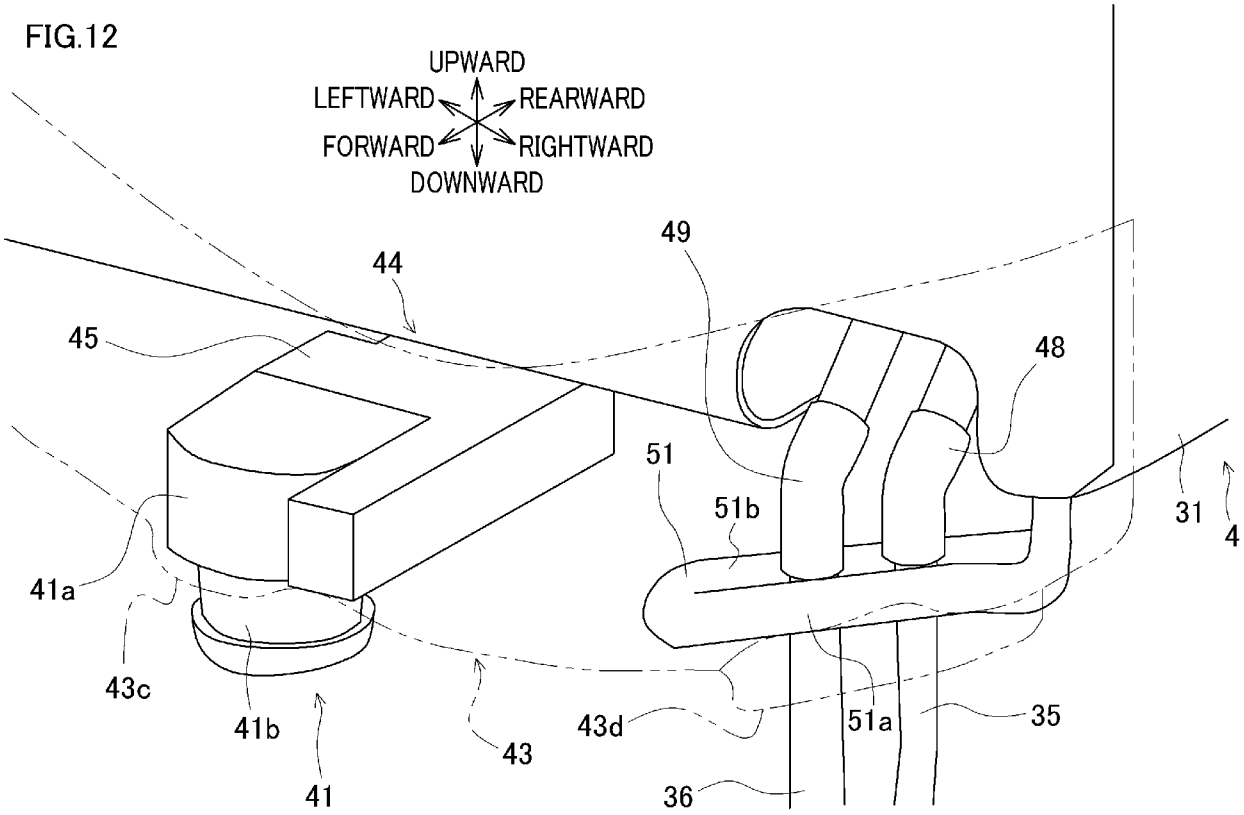

31
OD2
4
OD1
45
43b
43
43a
41
49
48
43d
31a
L2
A2(P2)
L1
A1T(A1,P1T,P1)
REARWARD
UPWARD
LEFTWARD
RIGHTWARD
FORWARD

FIG.12


UPWARD
LEFTWARD
REARWARD
FORWARD
RIGHTWARD
DOWNWARD
44
49
45
48
51
51b
31
4
41a
43c
41b
41
43
43d
51a
35
36

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EUROPEAN SEARCH REPORT

Application Number
EP 23 20 3737

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TECHNICAL FIELDS SEARCHED (IPC)

B65H

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	14 March 2024	Pussemier, Bart

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