

DESCRIPTION

Title of Invention

GRIPPER DEVICE, CONVEYANCE VEHICLE, AND
CONVEYANCE METHOD

5 Technical Field

[0001] The present disclosure relates to a gripper device that holds an article, a conveyance vehicle including the gripper device, and a conveyance method for holding to carry the article.

Background Art

10 [0002] A gripper device supporting storage containers is known, as described in Patent Document 1. This gripper device includes a center cone protruding downward at approximately a center of an elevating platform and a pair of finger sections that support storage containers from below. When the gripper device is lowered from above the storage
15 container, the pair of finger sections are guided into a flange section of the storage container and the center cone is inserted into an insertion hole of the flange section. As a result, the gripper device is positioned with respect to the storage container.

Citation List

20 Patent Literature

[0003] [Patent Document 1] Japanese Unexamined Patent Publication No. 2016-163001

Summary of Invention

Technical Problem

25 [0004] In the conventional gripper device described above, only one center cone is used for positioning, which may result in insufficient

positioning in a height direction. If positioning is performed by a center cone having a hemispherical outer surface, there is a risk of residual misalignment in a rotational direction around the center cone.

[0005] The present disclosure describes a gripper device, a conveyance vehicle, and a conveyance method capable of providing accurate positioning in a horizontal direction and a height direction for an article.

Solution to Problem

[0006] One aspect of the present disclosure is a gripper device that holds an article placed on a transfer section, the gripper device comprising: a holding portion that is attached to an elevating section capable of lifting and lowering above the transfer section to hold the article; a first positioning section that is attached to the elevating section and that positions the holding portion in a horizontal direction with respect to the article by contacting the article at two first contact positions in an upper part of the article; and a second positioning section that is attached to the elevating section and that positions the holding portion in a height direction with respect to the article by contacting the article at three second contact positions that are not located on a straight line in the upper part of the article.

[0007] According to this gripper device, the first positioning section contacts the article at the two first contact positions in the upper part of the article. Contact of the first positioning section provides positioning of the holding portion in the horizontal direction with respect to the article. The second positioning section contacts the article at the three second contact positions in the upper part of the article. Since these three second contact positions are not located on the straight line, the contact

of the second positioning section provides positioning of the holding portion in the height direction with respect to the article. Thus, the two contact positions in the horizontal direction and the three contact positions in the height direction are used, thereby allowing accurate positioning of the article in the horizontal direction and the vertical direction.

[0008] The first positioning section may contact the article at only the two first contact positions. When the first positioning section contacts the article at the three or more first contact positions, the position of the holding portion in the horizontal direction is not likely to be uniquely determined between two of the three positions and the other one thereof, resulting in inconsistencies. In other words, a fight may occur among the three or more first contact positions. When locations of the first contact positions are limited to only two locations, such inconsistencies, that is, the fight can be prevented.

[0009] A position detected portion provided on a top surface of the article has an opening opened upward and is formed with two guide holes of a tapered shape each having an inner diameter that decreases as a height of the tapered guide hole to the opening decreases, positions at which the two guide holes are respectively formed are the two first contact positions and the two second contact positions, and the first positioning sections may have two convex members that are capable of entering the respective two guide holes. In this case, the two first contact positions and the two second contact positions are made common, which makes it possible to reduce the number of positioning members.

[0010] The second positioning section may have at least one pressing

member including a horizontal surface portion that contacts the position
detected portion provided on the top surface of the article at at least one
of the second contact positions. According to the pressing member
including a horizontal surface portion, positioning in the height direction
5 can be performed accurately and easily.

[0011] There may be provided the four second contact positions at
respective four locations. In this case, positioning can be performed
more accurately in the height direction.

[0012] As another aspect of the present disclosure, there may be provided
10 a conveyance vehicle that includes either of the above-described gripper
devices and travels along a track provided on a ceiling. According to
this conveyance vehicle, the holding portion holds the article in a state of
being accurately positioned with respect to the article. Thus, the
carrying state of the article becomes stable, which makes it possible to
15 carry the article at a high speed.

[0013] Another aspect of the present disclosure is a conveyance method
for holding to carry an article placed on a transfer section by a gripper
device, in which the gripper device comprises: a holding portion that is
attached to an elevating section capable of lifting and lowering above the
20 transfer section to hold the article; a first positioning section that performs
positioning in a horizontal direction with respect to the article; and a
second positioning section that performs positioning in a height direction
with respect to the article, the method comprising: a lowering step of
lowering the elevating section; a first positioning step of positioning the
25 holding portion in the horizontal direction with respect to the article by
bringing the first positioning section into contact with the article at two

first contact positions in an upper part of the article, the first positioning step being performed after the lowering step; a second positioning step of positioning the holding portion in the height direction with respect to the article by bringing the second positioning sections into contact with the article at three second contact positions that are not located on a straight line in the upper part of the article, the second positioning step being performed after the lowering step; and a holding step of holding the article by the holding portion, the holding step being performed after the first positioning step and the second positioning step.

[0014] According to this conveyance method, the same actions and effects as described above are achieved. In other words, the two contact positions are used in the horizontal direction and the three contact positions are used in the height direction, thereby allowing accurate positioning of the article in the horizontal direction and the height direction.

Effects of Invention

[0015] According to the present disclosure, positioning in the horizontal direction and the height direction to an article can be accurately performed.

Brief Description of Drawings

[0016] [FIG. 1] FIG. 1 is a schematic diagram illustrating a conveyance vehicle including a gripper device according to one embodiment of the present disclosure.

[FIG. 2] FIG. 2 is a plan view of the gripper device in FIG. 1.

[FIG. 3] FIG. 3 is a perspective view of an article to be carried by a conveyance vehicle system of FIG. 1.

[FIG. 4] FIG. 4 is a cross-sectional view of a structure of a first positioning section.

[FIG. 5] FIG. 5 is a cross-sectional view of the structure of the second positioning section.

5 [FIG. 6] FIG. 6 is a diagram illustrating arrangement of the first positioning section and the held portion of the article in a first positioning process.

[FIG. 7] FIG. 7 is a diagram illustrating a state in which the elevating section is lowered following the state indicated in FIG. 6.

10 [FIG. 8] FIG. 8 is a diagram indicating a state in which the elevating section is lowered following the state indicated in FIG. 7.

[FIG. 9] FIG. 9 is a diagram indicating the state in which the holding portion has moved to the engaging position of the held portion following the state indicated in FIG. 8.

15 [FIG. 10] FIG. 10 is a diagram indicating the state in which the holding portion engages with the held portion to hold the article following the state illustrated in FIG. 8.

20 [FIG. 11] FIGS. 11(a) to 11(d) are diagrams indicating various variations on the arrangement of the first contact position and the second contact position.

Description of Embodiments

[0017] As illustrated in FIG. 1, an overhead conveyance vehicle (conveyance vehicle) 1 of one embodiment travels along a track 100 laid on a ceiling 110 of a clean room where semiconductor devices are manufactured. The overhead conveyance vehicle 1 of the one
25 embodiment carries a front opening unified pod (FOUP) (article) 200

accommodating a plurality of semiconductor wafers, and transfers the FOUP 200 to a load port 300 (transfer section) or the like that is a transfer section provided in a processing device that performs various types of processing on the semiconductor wafers. The track 100 is suspended from the ceiling 110 by a suspension column 108. The track 100 has a traveling rail 101 and a feeder rail 102 that is provided at a lower part of the traveling rail 101.

[0018] The overhead conveyance vehicle 1 includes a frame unit 2, a traveling unit 3a, a power receiving unit 3b, a lateral unit 4, a theta unit 5, an elevating drive unit 6, a gripper device 10, and a controller 8. The frame unit 2 has a center frame 21, a front frame 22, and a rear frame 23. The front frame 22 extends downward from an end of a front side (front side in a travel direction of the overhead conveyance vehicle 1) in the center frame 21 to a lower side thereof. The rear frame 23 extends downward from an end of a rear side (rear side in the travel direction of the overhead conveyance vehicle 1) in the center frame 21 to the lower side thereof.

[0019] The traveling unit 3a and the power receiving unit 3b are disposed on the upper side of the center frame 21. The traveling unit 3a is attached to the traveling rail 101. The power receiving unit 3b receives, for example, power supply in a non-contact manner from a high-frequency current line laid along the feeder rail 102. The power supply to the power receiving unit 3b causes the traveling unit 3a to travel along the track 100. The lateral unit 4 is disposed on the lower side of the center frame 21. The lateral unit 4 moves the theta unit 5, the elevating drive unit 6, and the gripper device 10 to move laterally (side in the travel

direction of the overhead conveyance vehicle 1). The theta unit 5 is disposed on a lower side of the lateral unit 4. The theta unit 5 rotates the elevating drive unit 6 and the gripper device 10 in a horizontal surface.

[0020] The elevating drive unit 6 is disposed on the lower side of the theta unit 5. The elevating drive unit 6 lifts and lowers gripper device 10. The gripper device 10 is disposed on the lower side of the elevating drive unit 6. The gripper device 10 holds a flange section 202 of the FOUP 200. The controller 8 is disposed on the front frame 22 and the rear frame 23. The controller 8 is an electronic control unit including a CPU, ROM, and RAM. The controller 8 controls each part of the overhead conveyance vehicle 1.

[0021] To the front frame 22 and the rear frame 23, four lower drop preventing sections 26 and two lid drop preventing sections 27 that each prevent the FOUP 200 from dropping from the frame unit 2 are attached.

The lower drop preventing sections 26 are correspondingly attached to the lower end of the front frame 22 and the lower end of the rear frame 23 at the four corner positions of the frame unit 2 and correspondingly face the front end and the rear end of the bottom of the FOUP 200. The lid drop preventing sections 27 are attached to the lower part of the front frame 22 and the lower part of the rear frame 23, respectively, and face the FOUP 200 from the lid 205 side (see FIG. 3). These lower drop preventing sections 26 and the lid drop preventing sections 27 are opened and closed at appropriate timing in association with transfer of the FOUP 200.

[0022] The overhead conveyance vehicle 1 configured as described above operates, as an example, as described below. When the FOUP

200 is transferred from a load port 300 to the overhead conveyance vehicle 1, the overhead conveyance vehicle 1 that does not hold the FOUP 200 stops above the load port 300. When a horizontal position of the gripper device 10 deviates from the position directly above the load port 300, the horizontal position and an angle of a holding unit are fine-tuned by driving the lateral unit 4 and the theta unit 5 to fine-tune the whole elevating drive unit 6. Subsequently, the elevating drive unit 6 lowers the gripper device 10, and the gripper device 10 holds the flange section 202 of the FOUP 200 that is placed on the load port 300. The elevating drive unit 6 then lifts the gripper device 10 to a lifting end and disposes the FOUP 200 between the front frame 22 and the rear frame 23. The lower drop preventing sections 26 and the lid drop preventing sections 27 are closed. The overhead conveyance vehicle 1 holding the FOUP 200 then begins traveling.

[0023] When the FOUP 200 is transferred from the overhead conveyance vehicle 1 to the load port 300, the overhead conveyance vehicle 1 holding the FOUP 200 stops above the load port 300. The lower drop preventing section 26 and the lid drop preventing section 27 are opened. When the horizontal position of the gripper device 10 (FOUP 200) deviates from a position directly above the load port 300, the horizontal position and the angle of the holding unit are fine-tuned by driving the lateral unit 4 and the theta unit 5 to fine-tune the whole elevating drive unit 6. Subsequently, the elevating drive unit 6 lowers the gripper device 10 to place the FOUP 200 on the load port 300, and the gripper device 10 releases its holding of the flange section 202 of the FOUP 200. The elevating drive unit 6 then lifts the gripper device 10 to the lifting end

thereof. The overhead conveyance vehicle 1 that does not hold the FOUP 200, then begins traveling.

[0024] As illustrated in FIG. 2, the gripper device 10 has an elevating section 11 that forms a body of the gripper device 10 and a holding portion 9 that holds the FOUP 200. The holding portion 9 has a motor 16 fixed to the elevating section 11, a single link mechanism 20 connected to the motor 16 via an output shaft 16a of the motor 16, and a pair of finger sections (engaging portions) 12 attached to respective tips of the link mechanism 20. The motor 16, the link mechanism 20, and the pair of finger sections 12 are attached to the elevating section 11. The motor 16 and the link mechanism 20 are included in a drive section 7 that moves the pair of finger sections 12. Each of the pair of finger sections 12 may be driven by a ball screw, a belt, or the like, for example, instead of the link mechanism 20. The elevating section 11 is suspended by, for example, four belts 6a that are included in the elevating drive unit 6 described above. The elevating section 11 is capable of lifting and lowering above the FOUP 200 (above the load port 300) when the elevating drive unit 6 is controlled by the controller 8. It should be noted that the elevating drive unit 6 may have three belts 6a and the elevating section 11 may be suspended by the three belts 6a.

[0025] Referring to FIG. 3, the FOUP 200 held by the gripper device 10 of the present embodiment is described. The FOUP 200 has a body 201 having a rectangular parallelepiped shape, for example. A lid 205 is attached to a side surface of the body 201 (a surface of a side in the travel direction of the overhead conveyance vehicle 1) so as to be opened and closed freely. The FOUP 200 accommodates a plurality of

semiconductor wafers in the body 201. The FOUP 200 may accommodate a plurality of semiconductor panels that each are a rectangular-shaped substrate, within the body 201. A top surface 201a, having a rectangular shape, of the body 201 is provided with a pair of
5 flange sections 202 that are held by the gripper device 10. The pair of flange sections 202 are spaced apart in a direction along the top surface 201a and corresponding to the travel direction of the overhead conveyance vehicle 1 (X direction indicated in the figure). In the following description, this direction is referred to as a "first direction".

10 The pair of flange sections 202 are disposed at ends 201b and 201b in an X direction of the top surface 201a and each extend long in a direction along the top surface 201a and orthogonal to the above-described first direction (Y direction indicated in the figure). In the following description, a direction orthogonal to this first direction is referred to as a
15 "second direction". These terms of the first direction and the second direction is able to be used to describe the FOUP 200, and is able to also be used to describe the gripper device 10 that holds the FOUP 200. As described above, the first direction corresponds to the travel direction of the overhead conveyance vehicle 1 in a state where the elevating drive
20 unit 6 and the gripper device 10 are aligned with the frame unit 2.

[0026] More specifically, a plurality of pairs (three pairs in the present embodiment) of columns 203 are erected on the top surface 201a of the FOUP 200 at each of the ends 201b and 201b. Each of the columns 203 extends perpendicular to the top surface 201a, and its lower end is fixed
25 to the top surface 201a. At one end 201b in the first direction of the top surface 201a, three equal-length columns 203, for example, are erected,

and one plate of the flange section 202 is fixed to the upper end of each of these columns 203 by welding or bolts. At the other end 201b in the first direction of the top surface 201a, for example, three columns 203 having an equal length are erected, and one plate of the flange section 202 is fixed to the upper end of each of these columns 203 by welding or bolts. The pair of flange sections 202 extend parallel, for example, to the top surface 201a of the FOUP 200. As explained above, the FOUP 200 has the pair of flange sections 202 provided on the top surface 201a and spaced apart in the first direction along the top surface 201a.

[0027] When the column 203 is provided, a predetermined space is formed between the top surface 201a and the flange section 202. As illustrated in FIG. 1, the pair of flange sections 202 fall within a length of the body 201 in the first direction (the overall length of the FOUP 200). The finger section 12 of the gripper device 10 is inserted into a space between the top surface 201a and the flange section 202, from the center of the top surface 201a to the end 201b. The FOUP 200 is held (supported) from below by the finger section 12 that is moved from inside to outside and inserted into the above-described space.

[0028] The pair of finger sections 12 of the gripper device 10 moves along the first direction (X direction indicated in the figure). When the gripper device 10 holds the FOUP 200, the finger sections 12 advance to be closer to the flange section 202. When the gripper device 10 releases its holding on the FOUP 200, the finger sections 12 retreat so as to be away from the flange section 202.

[0029] As illustrated in FIG. 2, the link mechanism 20 is a mechanism for moving the finger section 12. The link mechanism 20 includes: a

single central link 17 that is connected to the output shaft 16a of the motor 16 and rotates about the output shaft 16a; a pair of first links 18 the first ends of which are rotatably connected to a pair of shafts 17a provided at both ends of the central link 17; and a pair of second links 19 the base ends of which are rotatably connected to a pair of shafts 18a provided at the second ends of the first links 18. As the output shaft 16a rotates, the central link 17 rotates, and the first link 18 and the second link 19 on one side and the first link 18 and the second link 19 on the other side move synchronously. The finger section 12 is attached to the tip of each of the pair of second links 19. The finger section 12 has a notch 12a that accepts the central column 203.

[0030] The gripper device 10 of the present embodiment is provided with a mechanism for positioning the holding portion 9 with respect to the FOUP 200. The need for proper positioning for articles is as described in the above-described Patent Document 1. Proper positioning ensures that the finger section 12 (holding portion 9) of the gripper device 10 has a correct position and orientation and a suitable engagement and retention with the FOUP 200. The positioning mechanism provided in the gripper device 10 enables more accurate positioning in cooperation with the position detected portion and the contact position that the FOUP 200 has.

[0031] As illustrated in FIG. 2, the gripper device 10 has the four positioning sections attached to the elevating section 11. More specifically, the gripper device 10 is provided with positioning sections at the four corner positions of the elevating section 11 having a rectangular shape in plan view. Two first positioning sections 40 are attached on one diagonal of the elevating section 11 (upper left and lower

right corners indicated in FIG. 2). These first positioning sections 40 basically position the holding portion 9 in the horizontal direction (along the XY plane) to the FOUP 200. Two second positioning sections 50 are attached on the other diagonal of the elevating section 11 (upper right and lower left corners indicated in FIG. 2). These second positioning sections 50 position the holding portion 9 in the height direction (Z direction indicated in FIG. 1) to the FOUP 200.

[0032] Before describing the structure of the first positioning section 40 and the second positioning section 50, the structure of the FOUP 200 according to the positioning mechanism is described with reference to FIG. 3. As illustrated in FIG. 3, the flange sections 202 of the FOUP 200 are long, flat plate members each extending long in the second direction and parallel to the top surface 201a of the FOUP 200. A flange top surface 202a of each flange section 202 is flat and parallel to the top surface 201a. The flange top surface 202a is a position detected surface (position detected portion) provided on the top surface 201a of the FOUP 200, and enables, when contacting the first positioning section 40 and the second positioning section 50, positioning of the holding portion 9 in the height direction.

[0033] Two guide holes 206 are formed at both ends of each flange section 202 in the second direction. These guide holes 206 have the same size and shape. Each of the guide holes 206 has an inverted conical trapezoidal shape and penetrates the flange section 202 in a thickness direction. Each of the guide holes 206 has a circular opening that is open upward and has a conical tapered shape with a smaller inner diameter downward. In other words, in each of the guide holes 206, the

lower the height of the top end to the opening, the smaller the inside diameter. In the pair of flange sections 202, the guide holes 206 are symmetrical with respect to a hypothetical central plane orthogonal to the first direction (plane containing an axis of the output shaft 16a). The positions of these four guide holes 206 correspond to the positions of the first positioning sections 40 and the second positioning sections 50 in plan view. More precisely, when the holding portion 9 is in an exact position with respect to the FOUP 200, the positions of the central axes of the four guide holes 206 coincide with the positions of the shafts 42 of the first positioning section 40 and the shafts 52 of the second positioning section 50, as described below. Of the four guide holes 206, the two guide holes 206 disposed on the first diagonal enable, when contacting the first positioning section 40, positioning in the horizontal direction of the holding portion 9. At the same time, the two guide holes 206 disposed on the first diagonal also enable, when contacting the two first positioning sections 40, positioning of the holding portion 9 in the height direction. [0034] The two second positioning sections 50, out of the four guide holes 206, do not contact the two guide holes 206 disposed on the second diagonal. In the present embodiment, the two second positioning sections 50 only contact the flange top surface 202a at the position where the two guide holes 206 disposed on the second diagonal are formed. The versatility of FOUP 200 is enhanced by the fact that the FOUP 200 has four guide holes 206. The four guide holes 206 can be used, for example, when the FOUP 200 is handled by an automated guided vehicle (AGV), which is another transport system different from the overhead conveyance vehicle 1 in the present embodiment.

[0035] Referring to FIGS. 2, 4, and 5, the structures of the first positioning section 40 and the second positioning section 50, respectively, are described. As illustrated in FIGS. 2 and 4, the first positioning section 40 has a sensor box 45 fixed to a corner of the elevating section 11, a shaft 42 capable of moving in a vertical direction with respect to the sensor box 45, and a convex member 41 fixed to the lower end of the shaft 42. The sensor box 45, for example, is open in a vertical direction and its side surface is fixed to an outer side surface of the elevating section 11. The convex member 41 may include a conical surface portion 41a. The conical surface portion 41a has a shape corresponding to the guide hole 206, for example, to engage with the guide hole 206 in the flange section 202. In other words, a portion of the conical surface portion 41a of the convex member 41 has a shape that substantially coincides with a peripheral wall surface of the guide hole 206. A spring 43 is interposed between the bottom of the sensor box 45 and the convex member 41 around the shaft 42. The spring 43 exerts a force with respect to the convex member 41 and the sensor box 45 in a direction of being spaced apart from each other.

[0036] A position detection plate 44 is fixed to an upper end of the shaft 42. A seating sensor 46 and a presence sensor 47 are installed in opposing positions in an upper part of the inside of the sensor box 45. The seating sensor 46 and the presence sensor 47 are fixed to the sensor box 45 and detect presence of a first detected piece 44a and a second detected piece 44b according to a relative movement of the position detection plate 44 in the sensor box 45. The seating sensor 46 is a sensor that detects seating of the holding portion 9 (i.e., whether the convex

member 41 is inserted into the guide hole 206 of the flange section 202).
The presence sensor 47 is a sensor that detects the presence of the FOUP
200 in a state in which the FOUP 200 is lifted. For example, if the FOUP
200 is absent, the presence sensor 47 is turned off and an abnormal alarm
5 is issued. As absence of the FOUP 200, for example, loss of
engagement of the FOUP 200 to the finger section 12 due to falling of the
flange section 202 can be thought. Cables to output signals to the
controller 8 are connected to the seating sensor 46 and the presence sensor
47. The detection operations of these sensors associated with the lifting
10 and lowering of the elevating section 11 and the holding of the FOUP 200
by the gripper device 10 are described below.

[0037] As illustrated in FIGS. 2 and 5, the second positioning section 50
has a box 55 fixed to a corner of the elevating section 11, a shaft 52
capable of moving in a vertical direction with respect to the box 55, and
15 a flat plate-shaped pressing member 51 fixed to the lower end of the shaft
52. The box 55, for example, is open in a vertical direction, and its side
surface is fixed to the outer side surface of elevating section 11. The
pressing member 51 may include a horizontal surface portion 51a that
contacts the flange top surface 202a of the FOUP 200. The lower end
20 of the shaft 52 may somewhat protrude from a bottom surface of the
pressing member 51. In a state in which the horizontal surface portion
51a is in contact with the flange top surface 202a, a protruding portion of
the shaft 52 is disposed inside the guide hole 206. A spring 53 is
interposed between the bottom of the box 55 and the pressing member 51
25 around a shaft 52. The spring 53 exerts a force with respect to the
pressing member 51 and the box 55 in the direction of being spaced apart

from each other.

[0038] In the first positioning section 40 and the second positioning section 50, the height of the convex member 41 to the guide hole 206 and the height of the pressing member 51 to the flange top surface 202a are equal. In other words, in a state in which the conical surface portion 41a of the convex member 41 contacts the peripheral wall surface of the guide hole 206 and the horizontal surface portion 51a of the pressing member 51 contacts the flange top surface 202a, and the force (repulsive force) received from the spring 43 and the force from spring 53 are equal, the elevating section 11 and the holding portion 9 are parallel with respect to the top surface 201a of the FOUP 200 in the posture. In other words, the holding portion 9 is positioned in the height direction with respect to the FOUP 200. In other words, in a state in which the convex member 41 contacts the peripheral wall surface of the guide hole 206 (convex member 41 fits into the guide hole 206), the pressing member 51 contacts (rides on) the flange top surface 202a, and the elevating section 11 and the holding portion 9 that are suspended by the four belts 6a are on the flange section 202 with their own weights, the holding portion 9 is positioned in the height direction with respect to the FOUP 200. Moreover, in this state, the holding portion 9 is also positioned horizontally with respect to the FOUP 200 by fitting (fitting of a tapered shape) of the convex member 41 with respect to the guide hole 206.

[0039] In the gripper device 10 and the FOUP 200 having the above-described configuration, as illustrated in FIG. 3, positions at which the two guide holes 206 disposed on the first diagonal in the flange section 202 are formed are two first contact positions Pa that the first positioning

section 40 contacts. The holding portion 9 is positioned in the horizontal direction with respect to the FOUP 200 when the first positioning section 40 contacts the FOUP 200 at the two first contact positions Pa in the upper part of the FOUP 200.

5 [0040] In the flange section 202, the two guide holes 206 disposed on the first diagonal are also the two second contact positions Pb that the first positioning section 40 contacts. In addition, positions at which the two guide holes 206 disposed on the second diagonal are formed are the two second contact positions Pb that the second positioning section 50
10 contacts. The holding portion 9 is positioned in the height direction with respect to the FOUP 200, when the first positioning section 40 and the second positioning section 50 contact the FOUP 200 at the four second contact positions Pb in the upper part of the FOUP 200.

[0041] The first contact position Pa is a contact position for positioning
15 of the holding portion 9 in the horizontal direction in the upper part of the FOUP 200. The second contact position Pb is a contact position for positioning of the holding portion 9 in the height direction in the upper part of the FOUP 200. In the present embodiment, positions at which the two guide holes 206 disposed on the first diagonal are formed are the
20 two first contact positions Pa and the two second contact positions Pb. The first positioning section 40 has two convex members 41 that are capable of entering the respective two guide holes 206. This configuration allows the first positioning section 40 to also position the holding portion 9 in the height direction and to perform (serve) the same
25 function as the second positioning section 50.

[0042] In other words, in the present embodiment, the first positioning

section 40 contacts the FOUP 200 at only the two first contact positions Pa for positioning in the horizontal direction. The four second contact positions Pb for positioning in the height direction are provided at four respective locations. In other words, the gripper device 10 positions the holding portion 9 in the horizontal direction and the vertical direction by bringing the convex member 41 of the first positioning section 40 into contact with the two guide holes 206 as the first contact position Pa and the second contact position Pb. The gripper device 10 positions the holding portion 9 in the height direction by bringing the pressing member 51 of the second positioning section 50 into contact with the two guide holes 206 as the second contact position Pb. The first positioning section 40 performs (serves) the same function as the second positioning section 50 in some of the locations (two locations in the present embodiment) out of the required three or more locations of positioning in the height direction. These second contact positions Pb are not located on the straight line. In other words, when three of the four second contact positions Pb are selected, they are not located on the straight line. The phrase "three second contact positions are not located on the straight line" means, for example, that if contact portions (contact surfaces) at the respective second contact positions have an area, a line connecting three center points of those contact portions is not in a straight line. The phrase "the three second contact positions are not located on the straight line" means that the plane containing the three center points is uniquely defined.

[0043] The following describes the conveyance method of the FOUP 200 by the gripper device 10 and the overhead conveyance vehicle 1 of the

present embodiment. First, when the elevating section 11 arrives above the load port 300, the controller 8 lowers the elevating section 11 (lowering step). In this lowering step, the elevating section 11 is lowered until the seating sensor 46 turns ON. After the lowering step, the holding portion 9 is positioned in the horizontal direction with respect to the FOUP 200 by bringing the first positioning section 40 into contact with the FOUP 200 at the two first contact positions Pa in the upper part of the FOUP 200 (first positioning step). After the lowering step, the holding portion 9 is positioned in the height direction with respect to the FOUP 200 by bringing the first positioning section 40 and the second positioning section 50 into contact with the FOUP 200 at the four second contact positions Pb that are not located on the straight line in the upper part of the FOUP 200 (second positioning step). The first positioning step and the second positioning step are performed at substantially the same time. After these first and second positioning steps, the FOUP 200 is held by the holding portion 9 (holding step).

[0044] Referring to FIGS. 6 to 10, the following describes the first positioning step and the holding step. In accordance with the lowering of the elevating section 11, as illustrated in FIG. 6, the convex member 41 enters (is inserted) into the guide hole 206. At this point, the conical surface portion 41a of the convex member 41 contacts the peripheral wall surface of the guide hole 206 for the first time. Next, as illustrated in FIG. 7, the elevating section 11 and holding portion 9 are further lowered, and the seating sensor 46 turns ON. During this time, the presence sensor 47 switches from OFF to ON and then to OFF, but this switching of the presence sensor 47 is ignored because the seating sensor 46 remains

OFF. Next, as illustrated in FIG. 8, when the elevating section 11 and the holding portion 9 are further lowered for a predetermined distance, their lowering stops. The series of steps described above completes the first positioning step. At the same time, the second positioning step is completed.

[0045] Next, as illustrated in FIG. 9, with the seating sensor 46 turned on, the drive section 7 moves the finger section 12, and the finger section 12 is inserted into the space below the flange section 202. Then, as illustrated in FIG. 10, the elevating section 11 and holding portion 9 are lifted and the flange section 202 (FOUP 200) is held by the finger section 12. The foregoing step completes the holding step. Then, the elevating section 11 and holding portion 9 are lifted until they reach inside the frame unit 2.

[0046] According to the gripper device 10 of the present embodiment and the above-described conveyance method, the first positioning section 40 contacts the FOUP 200 at the two first contact positions Pa in the upper part of the FOUP 200. The contact of the first positioning section 40 provides positioning of the holding portion 9 in the horizontal direction with respect to the FOUP 200. The first positioning section 40 and the second positioning section 50 contact the FOUP 200 at at least three second contact positions Pb (four in the embodiment) in the upper part of the FOUP 200. Since these second contact positions Pb are not located on the straight line, the contact of the first positioning section 40 and the second positioning section 50 provides positioning of the holding portion 9 in the height direction with respect to the FOUP 200. Thus, two contact positions in the horizontal direction and at least three contact

positions in the height direction are used, positioning with respect to the FOUP 200 in the horizontal and height directions can be accurately performed.

[0047] When the first positioning section 40 contacts the FOUP 200 at three or more first contact positions, the position of the holding portion 9 in the horizontal direction is not likely to be uniquely determined at two of the three positions and at one other position, resulting in inconsistencies. In other words, a fight may occur among the three or more first contact positions. If the number of locations of the first contact position Pa is limited to only two locations, such inconsistency, that is, a fight, is suppressed.

[0048] The first positioning section 40 functions similarly to the second positioning section by having two convex members 41 capable of entering the respective two guide holes 206. The two first contact positions and the two second contact positions are made common, which makes it possible to reduce the number of components for positioning.

[0049] According to the pressing member 51 including the horizontal surface portion 51a, positioning in the height direction can be performed accurately and easily.

[0050] Since the four second contact positions are provided at the respective four locations, positioning can be performed in the height direction more precisely.

[0051] According to the overhead conveyance vehicle 1, the holding portion holds the FOUP 200 in a state of being precisely positioned with respect to the FOUP 200. Therefore, the FOUP 200 can be transported in a stable condition, and thereby the FOUP 200 can be carried at high

speed.

[0052] Although the embodiment of the present disclosure has been described above, the invention is not limited to the above-described embodiment. For example, the arrangement of the first contact position

5 Pa and the second contact position Pb may be modified to provide various aspects. As illustrated in FIG. 11(a), the two first contact positions Pa (which also serve as the second contact positions due to the tapered shape) may be set on one flange section 202 and the two second contact positions Pb may be set on the other flange section 202. It is not limited

10 to a case where the contact positions of the same type are disposed on the diagonal as in the above-described embodiment, but the contact positions of the same type may be disposed on the same side in the second direction, as illustrated in FIG. 11(b). In this case also, the first contact position Pa also serves as the second contact position due to the tapered shape.

15 As illustrated in FIG. 11(c), the two first contact positions Pa (which also serve as the second contact positions due to the tapered shape) may be set on one flange section 202 and one second contact position Pb may be set on the other flange section 202. As illustrated in FIG. 11(d), the two first contact positions Pa (which also serve as the second contact positions due to the tapered shape) may be set on one flange section 202 and one large (extensive) second contact position Pb on the other flange section 202. Having the extensive second contact position Pb provides the same stability as including a plurality of the second contact positions Pb.

20 [0053] The position detected portion that the first positioning section and the second positioning section contact may be provided at an appropriate position on the upper part of the article. The flange section need not be

installed on the top surface of the article, and the position detected portion may be provided on a part other than the flange section. The position detected portion can be set as a horizontal surface (surface parallel to the top surface 201a of the body 201). It is not limited to a case where the holding portion engages with the flange section, and the holding portion may engage with any portion of the upper part (including a side surface) of the article. The configuration of the holding portion is not limited to the above-described embodiment. The aspect of the engaging portion of the holding portion is not limited to an aspect in which the engaging portion of the holding portion is moved from the inside to the outside. The engaging portion of the holding portion may be moved from the outside toward the inside.

[0054] The aspect of the first positioning section and the second positioning section is not limited to an aspect in which positioning includes a spring mechanism. The first positioning section and the second positioning section may include elastic members other than springs or need not include elastic members. The first positioning section and the second positioning section may include a damper mechanism. The second positioning section may be a flat plate member in which a position with respect to the elevating section 11 is fixed.

[0055] In the above-described embodiment, sensors (seating sensor 46 and presence sensor 47) are installed in the first positioning section 40. In contrast to this aspect, no sensor need be installed in the first positioning section 40, and a sensor (for example, the seating sensor or the presence sensor that is similar to that disclosed in the above-described embodiments) may be installed in the second positioning section 50.

These sensors may be installed in both the first positioning section 40 and the second positioning section 50. In other words, these sensors may be installed at the four corners of the elevating section 11.

[0056] In the above-described embodiment, a guide hole 206 is provided that passes through the flange section 202. The aspect is not limited to this aspect, and a guide hole of a tapered shape having a bottom (not passing through the flange section 202) may be provided. Furthermore, the aspect is not limited to an aspect in which the conical guide hole 206 is formed in the article. For example, the first positioning section may have a cylindrical convex member and a cylindrical hole (a through-hole) may be formed at any portion on the upper part of the article. In this case, because positioning cannot be performed at the first positioning section in the height direction, at least three second contact positions need to be provided on the article, at locations other than those of the two first contact positions.

[0057] In other words, the aspect is not limited to the aspect in which the first contact position also serves as the second contact position. The two first contact positions and the three or more second contact positions may be provided separately. Alternatively, one of the two first contact positions may also serve as the second contact position. In both aspects, the gripper device includes the first positioning section corresponding to the first contact position and the second positioning section corresponding to the second contact position. When a certain first contact position also serves as a second contact position in the article, the first positioning section corresponding to that certain first contact position in the gripper device performs the same function as the second

positioning section.

[0058] An article is not limited to the FOUP 200. The article may be a standard mechanical interface (SMIF) pod or a front opening shipping box (FOSB), or the like.

5 **Reference Signs List**

[0059] 1... Overhead conveyance vehicle (conveyance vehicle)

7... Drive section

9... Holding portion

10... Gripper device

10 11... Elevating section

12... Finger section

16... Motor

20... Link mechanism

40... First positioning section

15 41... Convex member

41a... Conical surface portion

50... Second positioning section

51... Pressing member

51a... Horizontal surface portion

20 200... FOUP (article)

201... Body

201a... Top surface

202... Flange section

202a... Flange top surface (position detected portion)

25 206... Guide hole

300... Load port (transfer section)

Pa... First contact position

Pb... Second contact position

CLAIMS

1. A gripper device that holds an article placed on a transfer section, the gripper device comprising:

a holding portion that is attached to an elevating section capable of lifting and lowering above the transfer section to hold the article;

a first positioning section that is attached to the elevating section and that positions the holding portion in a horizontal direction with respect to the article by contacting the article at two first contact positions in an upper part of the article; and

a second positioning section that is attached to the elevating section and that positions the holding portion in a height direction with respect to the article by contacting the article at three second contact positions that are not located on a straight line in the upper part of the article.

2. The gripper device according to claim 1, wherein the first positioning section contacts the article at only two first contact positions.

3. The gripper device according to claim 1 or 2, wherein

a position detected portion provided on a top surface of the article has an opening opened upward and is formed with two guide holes of a tapered shape each having an inner diameter that decreases as a height of the tapered guide hole to the opening decreases, positions at which the two guide holes are respectively formed are the two first contact positions and the two second contact positions, and

the first positioning sections have two convex members that are capable of entering the respective two guide holes.

4. The gripper device according to any one of claims 1 to 3, wherein

the second positioning section has at least one pressing member including a horizontal surface portion that contacts a position detected portion provided on a top surface of the article at at least one of the second contact positions.

5 5. The gripper device according to any one of claims 1 to 4, wherein the four second contact positions are provided at respective four locations.

6. A conveyance vehicle comprising the gripper device according to any one of claims 1 to 5, traveling along a track provided on a ceiling.

7. A conveyance method for holding to carry an article placed on a transfer section by a gripper device, wherein the gripper device comprises: a holding portion that is attached to an elevating section capable of lifting and lowering above the transfer section to hold the article; a first positioning section that performs positioning in a horizontal direction with respect to the article; and a second positioning section that performs positioning in a height direction with respect to the article, the method comprising:

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 a lowering step of lowering the elevating section;

 a first positioning step of positioning the holding portion in the horizontal direction with respect to the article by bringing the first positioning section into contact with the article at two first contact positions in an upper part of the article, the first positioning step being performed after the lowering step;

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 a second positioning step of positioning the holding portion in the height direction with respect to the article by bringing the second positioning sections into contact with the article at three second contact positions that are not located on a straight line in the upper part of the

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article, the second positioning step being performed after the lowering step; and

a holding step of holding the article by the holding portion, the holding step being performed after the first positioning step and the second positioning step.

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