

ARTICLE TRANSPORT APPARATUS

BACKGROUND OF THE INVENTION

1. Field of the Invention

5 [0001] The present invention relates to an article transport apparatus for transporting articles.

2. Description of the Related Art

10 [0002] For example, International Publication No. 2019/035286 (Patent Document 1) discloses a transport system. Hereinafter, in the description of this related art, names and symbols in Patent Document 1 will be cited in parentheses.

[0003] This transport system (SYS) includes an article transport apparatus (ceiling transport vehicle 10) that includes a moving body (traveling portion 11),
15 a cover (main body 12), a transfer mechanism (transfer portion 13), and a control unit (14). The moving body (traveling portion 11) travels along a track, and the cover (main body 12) is attached to the moving body (traveling portion 11), and is configured to be able to accommodate an article (M). The transfer mechanism (transfer portion 13) includes a holding section (15) that holds the
20 article (M), a turning section (rotation mechanism 19) that rotates the holding section (15) around a rotation axis (AX), and a moving section (moving mechanism 16) for moving the holding section (15) and the turning section (rotation mechanism 19) with respect to the cover (main body 12), and the control unit (14) controls the operation of the moving body (traveling portion
25 11) and each portion of the transfer mechanism (transfer portion 13). In the article transport apparatus (ceiling transport vehicle 10), rotation performed by the turning section (rotating mechanism 19) is allowed when the article (M) held by the holding section (15) is at an escape position of coming out of the cover (main body 12), and this prevents the article (M) from coming into contact
30 with an inner wall (23a) of the cover (main body 12).

SUMMARY OF THE INVENTION

[0004] Here, when the article transport apparatus undergoes maintenance and inspection, when the article transport apparatus breaks down, or the like,
35 the article transport apparatus is operated by an operation command from an operation terminal operated by a worker in some cases. In such a case, for

example, if the transfer mechanism is operated in response to an operation command to transition to a predetermined orientation while the holding section is accommodated in an accommodation region covered by the cover, there is a possibility that the transfer mechanism will interfere with (come into
5 contact with) the inner wall of the cover depending on the turning angle of the holding section at the time when the operation command is issued.

[0005] In view of this, it is desired to realize an article transport apparatus capable of avoiding interference of the transfer mechanism with the inner surface structure of the cover facing the accommodation region described above.

10 [0006] In view of the above, a characteristic configuration of the article transport apparatus is an article transport apparatus configured to transport an article, the article transport apparatus including: a moving body configured to move to transport the article; a cover that is supported by the moving body and at least partially covers a lateral peripheral portion of an accommodation
15 region in which the article is accommodated during transport; a transfer mechanism configured to hold the article and transfer the article to and from a transfer target location; and a control unit configured to control the moving body and the transfer mechanism, in which the transfer mechanism includes a holding section that is supported by the moving body and is capable of
20 changing between a holding state in which the holding section holds the article and a release state in which the holding section releases the article, a turning section configured to turn the holding section around a turning axis extending along an up-down direction, and a moving section configured to move the holding section between an internal position in the accommodation region and
25 an external position outside of the accommodation region, the cover includes an inner surface structure facing the accommodation region, while a turning angle of the holding section by the turning section is within a predetermined non-interference angle range, the transfer mechanism does not interfere with the inner surface structure even if the holding section is moved by the moving
30 section, and while the turning angle is outside of the non-interference angle range, the transfer mechanism interferes with the inner surface structure in some cases, depending on a movement route along which the holding section is moved by the moving section, the control unit is capable of executing a maintenance mode in which the control unit causes the transfer mechanism to
35 operate in accordance with a command from an operation terminal operated by a worker, and in response to the control unit receiving an operation command

for the transfer mechanism from the operation terminal in the maintenance mode, the control unit determines whether or not the turning angle is within the non-interference angle range, and (i) in response to the turning angle being within the non-interference angle range, the control unit causes the transfer
5 mechanism to operate in accordance with the operation command, and (ii) in response to the turning angle being outside of the non-interference angle range or the turning angle being unknown, the control unit causes the operation terminal to issue error information.

[0007] According to this characteristic configuration, even if the worker issues
10 an erroneous operation command for the transfer mechanism in the maintenance mode, the operating terminal can be caused to issue error information if there is a possibility that the transfer mechanism will interfere with the inner surface structure of the cover when the transfer mechanism is operated. Accordingly, even if the worker issues an erroneous operation
15 command for the transfer mechanism, the worker can be given an opportunity to confirm the operation command, and therefore it is possible to avoid interference of the transfer mechanism with the inner surface structure of the cover.

[0008] Further features and advantages of the technology according to the
20 present disclosure will become apparent from the following description of exemplary and non-limiting embodiments described with reference to the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

25 [0009] FIG. 1 is a diagram showing a usage mode of an article transport apparatus.

FIG. 2 is a side view of an article transport apparatus.

FIG. 3 is a diagram showing a state of an article accommodated in an accommodation region.

30 FIG. 4 is a diagram showing non-interference angle ranges.

FIG. 5 is a control block diagram relating to control of a transfer mechanism by a control unit.

FIG. 6 is a diagram showing an example of notification of alert information.

35 FIG. 7 is a flow chart showing a procedure of control of the transfer mechanism by the control unit.

FIG. 8 is a flow chart showing a procedure of control of the transfer mechanism by the control unit.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS

5 1. Embodiment of Article Transport Apparatus

[0010] An embodiment of an article transport apparatus will be described with reference to the drawings. As shown in FIG. 1, the article transport apparatus 1 transports an article W by moving along a movement route R provided between, for example, a plurality of transport target locations 90 in a
10 factory or plant, and the orientation of the article W can be changed when the article W is transported.

[0011] In the following description, the direction in which the article transport apparatus 1 travels along the movement route R is referred to as “progression direction X”, and the direction perpendicular to the progression direction X in
15 a plan view is referred to as “width direction Y”. Also, a direction perpendicular to both the progression direction X and the width direction Y will be described as “vertical direction Z”. Here, the frontward side in the progression direction X is referred to as “front side X1”, and the rearward side is referred to as “rear side X2”. Also, left and right are defined based on a
20 state of facing the front side X1 in the progression direction X, and specifically, toward the front side X1 in the traveling direction X, the left side in the width direction Y is described as “left side Y1”, and the right side is described as “right side Y2”.

[0012] The article W corresponds to a transport target object to be transported
25 by the article transport apparatus 1. In this embodiment, the article W is a container storing a semiconductor substrate, is in a cuboid shape, and can store a plurality of semiconductor substrates in a plurality of levels. The upper surface and the bottom surface of the article W are closed, and in particular, the upper surface is provided with a flange W1 (see FIG. 2) that is gripped by
30 the article transport apparatus 1 when the article W is transported. Also, one of the four side surfaces of the article W is provided with an opening for inserting and removing the semiconductor substrate. The remaining three sides of the article W are closed.

[0013] The transport target location 90 is a transport source or a transport
35 destination of the article W. As shown in FIG. 1, transport target locations 90 are provided at a plurality of locations along the movement route R. At the

transport target location 90, for example, the article W is processed. The transport target location 90 includes a processing apparatus 90a that processes a semiconductor substrate, and a delivery portion 90b for delivering an article W to and from the article transport apparatus 1. The delivery portion 90b is a so-called load port. When the semiconductor substrate stored in the article W received by the delivery portion 90b is retrieved by a retrieval device or the like included in the processing device 90a, the processing device 90a performs processing such as substrate cleaning, baking, and resist coating and stripping, for example.

[0014] The movement route R is a route along which the article transport apparatus 1 moves. In this embodiment, the movement route R is defined by a rail 99 (see FIG. 2) suspended from a ceiling of a building in which the article transport apparatus 1 is used. Accordingly, in this embodiment, the article transport apparatus 1 is configured as a so-called ceiling transport vehicle.

[0015] FIG. 2 is a side view of the article transport apparatus 1 transporting an article W. As shown in FIG. 2, the article transport apparatus 1 includes a moving body 2, a cover 3, a transfer mechanism 4, and a control unit 5. The moving body 2 moves to transport the article W. In this embodiment, the moving body 2 is located above the rail 99 and has traveling motors 2M that drive wheels 2A. The wheels 2A are rotationally driven by the traveling motors 2M, whereby a driving force in the progression direction X is applied to the moving body 2. The movement for transporting the article W means travel along the movement route R from the transport source of the article W to the transport destination of the article W. Accordingly, the moving body 2 travels along the movement route R from the transport source of the article W to the transport destination of the article W.

[0016] The cover 3 is supported by the moving body 2 and at least partially covers a lateral surrounding area of an accommodation region S in which the article W being transported is accommodated. “Supported by the moving body 2” means that the cover 3 is coupled and fixed to the moving body 2 and moves together with the movement of the moving body 2. In this embodiment, the cover 3 is suspended from the moving body 2, below the rail 99. The accommodation region S in which the article W being transported is accommodated refers to a region of the article transport apparatus 1 in which the article W is disposed while the article W is being transported from the transport source of the article W to the transport destination of the article W

along the movement route R, and the region being covered by the cover 3. The region in which such an article W is disposed is called the accommodation region S because it is covered from the sides by the cover 3. The accommodation region S may be covered by the cover 3 over the entire lateral side (entire peripheral portion) of the article W, or over part of the entire lateral side.

[0017] In the present embodiment, the cover 3 includes a pair of side covers 3B that cover the article W from the sides (horizontal direction) and an upper cover 3C that covers the article W from above. In the example of FIG. 2, each of the pair of side covers 3B and the upper cover 3C are coupled to each other to form the cover 3. Also, the side covers 3B extend downward from both ends of the upper cover 3C in the direction along the movement route R (progression direction X). As a result, the pair of side cover portions 3B cover the article W held by the holding section 10 from both sides in the progression direction X. Also, the cover 3 is in a shape in which both sides in the width direction Y and the lower side are open, and the cover 3 is in an angular inverted U shape in a view from the outside in the width direction Y. For this reason, the accommodation region S is in communication with the outside of the cover 3 on both sides in the width direction Y and the lower side.

[0018] The transfer mechanism 4 holds the article W and transfers the article W to and from the transport target location. Holding the article W means holding the article W so that the article W does not fall when the moving body 2 moves along the movement path R. For example, it is preferable to hold the article W by gripping the flange W1 provided on the article W. The transport target location corresponds to the transport source of the article W or the transport destination of the article W described above, that is, the transport target location 90. The transfer of the article W corresponds to the delivery of the article W. Accordingly, when the moving body 2 moves along the movement route R, the transfer mechanism 4 grips the flange W1 provided on the article W from above so that the article W does not fall, and performs delivery of the article W to and from a transport target location 90, which is the transport source or the transport destination of the article W.

[0019] In this embodiment, the transfer mechanism 4 includes a holding section 10, a turning section 20, and a moving section 30. The holding section 10 is supported by the moving body 2 and can be changed between a holding state in which the article W is held and a release state in which the article W

is released. “Supported by the moving body 2” means that, similarly to the cover 3, the holding section 10 is coupled to the moving body 2 and moves according to the movement of the moving body 2. The holding state in which the article W is held refers to a state in which the flange W1 provided on the article W described above is held. The release state in which the article W is released refers to a state in which the flange W1 provided on the article W is not gripped. In this embodiment, the holding section 10 has a gripping motor 10M and a pair of gripping claws 10C. The pair of gripping claws 10C can be driven by the gripping motor 10M to change between a gripping orientation and a release orientation. The pair of gripping claws 10C enter the gripping orientation by moving toward each other, and enter the release orientation by moving away from each other. When the pair of gripping claws 10C grip the flange W1 of the article W in the gripping orientation, the holding section 10 enters a holding state in which the article W is held, and when the pair of gripping claws 10C enter the release orientation from the state in which the flange W1 is gripped, the holding section 10 enters the release state in which the article W is released from being held. Since the holding section 10 holds the flange W1, the holding section 10 corresponds to a chuck.

[0020] The turning section 20 turns the holding section 10 around a turning axis 4b extending along an up-down direction. In this embodiment, the turning section 20 changes the orientation of the article W by turning the article W around the turning axis 4b extending along the vertical direction Z. In this embodiment, the turning section 20 is provided with a turning shaft (not shown) extending in the vertical direction Z and a turning motor 20M for driving the turning shaft. The turning shaft is coupled to the holding section 10, and is driven by the turning motor 20M to turn together with the holding section 10. As a result, the holding section 10 and the article W gripped by the holding section 10 can be turned around the turning axis 4b extending along the vertical direction Z.

[0021] The moving section 30 moves the holding section 10 between an internal position in the accommodation region S and an external position outside of the accommodation region S. As described above, in the present embodiment, the accommodation region S is covered by the cover 3 while both sides in the width direction Y and the lower part are open. A position in this accommodation region S (that is, a position included in the accommodation region S) corresponds to an internal position. Accordingly, the article W

indicated by the solid line in FIG. 2 is supported at an internal position. On the other hand, a position outside of the accommodation region S (that is, a position not included in the accommodation region S) corresponds to an external position. As indicated by the broken line in FIG. 2, when the article

5 W is placed on the delivery portion 90b, the article W is supported at an external position. The moving section 30 is able to move the holding section 10 (the article W held by the holding section 10) between such an internal position and an external position.

[0022] In this embodiment, the moving section 30 includes an elevating

10 section 31 and a sliding section 32. The elevating section 31 moves the holding section 10 up and down. In this embodiment, according to the up and down movement of the holding section 10 performed by the elevating section 31, the article W held by the holding section 10 is moved up and down between the internal position of the accommodation region S and the position where the

15 delivery portion 90b is provided. In this embodiment, the elevating section 31 has an elevating belt 30A coupled to the holding section 10, and an elevating motor 31M that drives an elevating pulley (not shown) to wind or unwind the elevating belt 30A. As a result, by driving the elevating motor 31M, the article W held by the holding section 10 can be raised or lowered between the

20 internal position in the accommodation region S and the delivery portion 90b. By moving the article W up and down by the elevating section 31, the article W can be transferred to the transport target location 90 located at a different position in the up-down direction (the lower side in this example) with respect to the movement route R. Also, at this time, it is possible to adjust positional

25 deviation of the holding section 10 with respect to the transport target location 90 in the vertical direction Z by adjusting the elevation height of the holding section 10 by the elevating section 31.

[0023] The sliding section 32 slides the holding section 10 along the horizontal direction. In this embodiment, the article W held by the holding section 10 is

30 slid according to the sliding movement of the holding section 10 by the sliding section 32. In this embodiment, the sliding section 32 is attached to the cover 3, and has a slide belt (not shown) and a slide motor 32M that drives a slide pulley (not shown) to wind or unwind the slide belt. The sliding section 32 slides the holding section 10 and the article W held by the holding section 10

35 along the width direction Y as the slide motor 32M is driven. By sliding the article W in the width direction Y with the sliding section 32, it is possible to

adjust positional deviation in the width direction Y with respect to the transport target location 90 when the article W is transferred.

[0024] The control unit 5 controls the moving body 2 and the transfer mechanism 4. Controlling the moving object 2 means controlling traveling and stopping along the movement route R performed by the moving body 2. Controlling the transfer mechanism 4 means controlling the holding of the article W performed by the transfer mechanism 4 and the delivery of the article W from the transport source of the article W to the transport destination of the article W. Specifically, the control unit 5 controls the holding and release of the holding of the article W performed by the holding section 10, and controls the movement and turning of the article W performed by the turning section 20, the elevating section 31, and the sliding section 32 in such a manner as to perform delivery of the article W from the transport source to the transport destination. Although FIG. 2 shows that the control unit 5 is provided in the cover 3, the control unit 5 may be provided at another location different from the cover 3.

[0025] Here, as described above, the cover 3 forms the accommodation region S, and the cover 3 has an inner surface structure facing the accommodation region S. The “inner surface structure facing the accommodation region S” corresponds to a surface defining the outer edge of the accommodation region S. This inner surface structure includes an inner wall surface 3A of the cover 3 and all structures disposed on the accommodation region S side of the inner wall surface 3A. Specifically, the inner surface structure includes the inner wall surface 3A of the cover 3, a fall restricting section 6 for restricting downward falling of the article W, a swing restricting mechanism 7 for restricting swinging of the article W held by the holding section 10, a sensor provided in such a manner as to protrude in the accommodation region S, and the like.

[0026] The fall restricting section 6 is below the article W accommodated in the accommodation region S and protrudes toward the accommodation region S from the inner wall surface 3A of the cover 3. The fall restricting section 6 is provided on a pair of side surfaces of the inner wall surface 3A of the cover 3 that face each other with the article W held by the holding section 10 interposed therebetween. Also, the fall restricting section 6 has a link mechanism (not shown), and enters a protruding orientation of protruding toward the accommodation region S due to a pair of regulating body driving

portions 6M each operating the link mechanism while the article W held by the holding section 10 is accommodated in the accommodation region S. The fall restricting section 6 is disposed so that at least a part thereof overlaps with the article W in a view in the vertical direction Z when in the protruding orientation. As a result, even if the holding section 10 enters the release state while the article W is being transported, the fall regulating portion 6 supports the article W from below, and therefore, for example, it is possible to restrict falling of the article W to the floor. Also, the fall restricting section 6 assumes a retracted orientation when the transfer mechanism 4 moves the article W to an external position of the accommodation region S, such as when the article W is transferred. The fall restricting section 6 is arranged in such a manner as not to overlap with the article W in a view in the vertical direction Z when in the retracted orientation.

[0027] The swing restricting mechanism 7 includes supports 7A, contact portions 7B, and contact driving portions 7M. The supports 7A support the contact portions 7B. The swing restricting mechanism 7 is provided on a pair of side surfaces of the inner wall surface 3A of the cover 3 that face each other with the article W held by the holding section 10 interposed therebetween. In this example, the swing restricting mechanism 7 is provided on each of the pair of side surfaces on which the fall restricting section 6 is provided. Also, in the present embodiment, due to the supports 7A being driven by the contact driving portions 7M, the orientation is changed to a protruding orientation in which the contact portions 7B protrude from the cover 3 toward the accommodation region S, and a retracted orientation in which the contact portions 7B are retracted toward the cover 3 relative to the protruding orientation. When the article W held by the holding section 10 is accommodated in the accommodation region S, due to the pair of contact portions 7B assuming the protruding orientation, the pair of contact portions 7B come into contact with the side surfaces of the article W from both sides. As a result, the article W is restricted from swinging when the article W is transported or transferred by the transfer mechanism 4. On the other hand, when the transfer mechanism 4 moves the article W to an external position outside the accommodation region S, such as when the article W is transferred, the pair of contact portions 7B enter the retracted orientation, whereby the pair of contact portions 7B are spaced apart from the article W. As a result, the article W can be moved appropriately.

[0028] Here, FIG. 3 is a diagram showing the state of the article W accommodated in the accommodation region S, and FIG. 4 is an illustrative diagram of non-interference angle ranges in this embodiment. While the turning angle of the holding section 10 by the turning section 20 is within a predetermined non-interference angle range, the transfer mechanism 4 does not interfere with the inner surface structure even if the holding section 10 is moved by the moving section 30, but while the turning angle is outside of the non-interference angle range, the transfer mechanism 4 interferes with the inner surface structure in some cases, depending on the movement route along which the holding section 10 is moved by the moving section 30. As described above, the holding section 10 is turned around the turning axis 4b extending along the vertical direction Z by the turning section 20. Therefore, the turning angle of the holding section 10 by the turning section 20 corresponds to the angle of the holding section 10 turned by the turning section 20. In FIG. 3, such a turning angle is indicated as θ . “Moving the holding section 10 by the moving section 30” corresponds to the up-and-down movement of the article W by the elevating section 31 and the sliding movement of the article W by the sliding section 32 in this embodiment. The inner surface structure is a surface that constitutes the accommodation region S, and in this embodiment, the inner wall surface 3A of the cover 3, the fall restricting section 6, the swing control mechanism 7, a sensor provided in such a manner as to protrude to the accommodation region S, and the like. Interference means contact in this embodiment. The “movement route of the holding section 10” is a route along which the holding section 10 passes when the holding section 10 turns, moves up and down, or slides.

[0029] Here, as shown in FIG. 3, when a point that is at a position along the edge of the left side Y1 in the width direction Y and at the center in the progression direction X of the article W held by the transfer mechanism 4 is set as a point Q, and the turning center when the article W is subjected to a turning movement is set as a point O, the turning angle at which a line segment OQ is parallel to the width direction Y is 0 degrees. Then, if the turning angle is within a predetermined angle range ($\pm\alpha^\circ$) on both sides in the turning direction using 0 degrees as a reference, the transfer mechanism 4 does not come into contact with the inner surface structure of the cover 3 (the inner wall surface 3A, the fall restricting section 6, the swing restricting mechanism 7, the sensor provided in such a manner as to protrude in the accommodation region S, etc.),

even if the elevating section 31 moves the article W up and down or the sliding section 32 slides the article W. However, if the turning angle does not fall within the predetermined angle range ($\pm\alpha^\circ$) on both sides in the turning direction using 0 degrees as a reference, as indicated by the two-dot chain line in FIG. 3, the transfer mechanism 4 may come into contact with the inner surface structure of the cover 3 if the elevating section 31 moves the article W up and down or the sliding section 32 slides the article W.

[0030] Such a turning angle range in which the transfer mechanism 4 does not come into contact with the inner surface structure is within the non-interference angle range, and a turning angle range in which the transfer mechanism 4 may come into contact with the inner surface structure is outside the non-interference angle range. Such a non-interference angular range is shown in FIG. 4. As shown in FIG. 4, non-interference angle ranges are provided in four directions. In this embodiment, the four non-interference angle ranges are defined as a first non-interference angle range R1, a second non-interference angle range R2, a third non-interference angle range R3, and a fourth non-interference angle range R4. If the turning angle when the above-mentioned line segment OQ faces the left side Y1 in the width direction Y is 0 degrees, the first non-interference angle range R1 is a range of " $0\pm\alpha^\circ$ ".

Also, even when the line segment OQ faces the front side X1 in the progression direction X, the transfer mechanism 4 does not come into contact with the inner surface structure. For this reason, the second non-interference angle range R2 is a range of " $90\pm\alpha^\circ$ ". Similarly, the transfer mechanism 4 does not come into contact with the inner surface structure even if the line segment OQ faces the right side Y2 in the width direction Y, and therefore the third non-interference angle range R3 is a range of " $180\pm\alpha^\circ$ ", and furthermore, the transfer mechanism 4 does not come into contact with the inner surface structure even if the line segment OQ faces the rear side X2 in the progression direction X, and therefore the fourth non-interference angle range R4 is a range of " $270\pm\alpha^\circ$ ". Accordingly, if the point Q set on the article W is included in one of the four non-interference angle ranges, the transfer mechanism 4 does not interfere with the inner surface structure of the cover 3 even if the elevating section 31 moves the article W up and down or the sliding section 32 slides the article W. Here, the predetermined angular range " α° " on both sides in the turning direction, which defines the width of the interference angular range, is 8° , for example.

[0031] As shown in FIG. 5, in the article transport apparatus 1, the control unit 5 can operate the transfer mechanism 4 in accordance with a command from an operation terminal 100 operated by a worker. The worker is a person who performs management, maintenance, and the like of the article transport apparatus 1. The operation terminal 100 is a terminal that is connected to the control unit 5 by wire or wirelessly, and is capable of remotely operating each functional unit of the above-described article transport apparatus 1 including the transfer mechanism 4. When performing maintenance and inspection of the article transport apparatus 1, when the article transport apparatus 1 malfunctions, or the like, the worker can operate the operation terminal 100 to issue an operation command, and thus can operate the moving body 2 of the article transport apparatus 1 and the transfer mechanism 4 including the holding section 10, the turning section 20, and the moving section 30 (the moving section 30 having the elevating section 31 and the sliding section 32). In particular, a mode in which the transfer mechanism 4 is operated in accordance with a command from the operation terminal 100 operated by the worker is called “maintenance mode”.

[0032] In this maintenance mode, the control unit 5 determines whether or not the turning angle is within the non-interference angle range when an operation command for the transfer mechanism 4 is received from the operation terminal 100. In this example, the operation command for the transfer mechanism 4 is a command for a reference orientation return operation for setting the orientations of the moving section 30 and the turning section 20 to a predetermined reference orientation. As described above, since the moving section 30 includes the elevating section 31 and the sliding section 32, the operation command for the transfer mechanism 4 includes commands for the elevating section 31, the sliding section 32, and the turning section 20. When the control unit 5 receives the above-described reference orientation return operation command, the control unit 5 first sets the elevating section 31 to the reference orientation, then sets the sliding section 32 to the reference orientation, and thereafter sets the turning section 20 to the reference orientation. The predetermined reference orientation is an orientation that serves as a reference defined in advance. For example, the reference orientation of the elevating section 31 is an orientation in which the holding section 10 is located near the upper limit of the elevation movement range. For example, the reference orientation of the sliding section 32 is an orientation

in which the holding section 10 is located near the center of the slide movement range. For example, the reference orientation of the turning section 20 is an orientation in which the above-described turning angle is 0 degrees. Accordingly, in this example, the entirety of the article W held by the holding

5 section 10 is accommodated inside the accommodation region S when the elevating section 31, the sliding section 32, and the turning section 20 are all in the reference orientation. Thus, the reference orientation is a so-called home position. An operation command for returning the orientations of the moving section 30 and the turning section 20 to such a reference orientation

10 corresponds to a command for a reference orientation return operation. Upon receiving a command for a reference orientation return operation from the operation terminal 100, the control unit 5 determines whether or not the turning angle of the holding section 10 is within the non-interference angle range. The turning angle may be determined by acquiring information

15 indicating the current turning angle from the turning section 20, or the control unit 5 itself may acquire information indicating the turning angle according to the turning performed by the turning section 20 and determine the turning angle based on that information.

[0033] While the turning angle is within the non-interference angle range, the

20 transfer mechanism 4 does not come into contact with the inner surface structure of the cover 3 even if the moving section 30 moves the holding section 10 between an internal position inside the accommodation region S and an external position outside the accommodation region S. In view of this, if it is determined that the turning angle is within the non-interference angle range

25 as a result of the determination described above, the control unit 5 executes the operation of the transfer mechanism 4 in accordance with the operation command from the operation terminal 100. Specifically, the control unit 5 drives each of the gripping motor 10M, the turning motor 20M, the elevating motor 31M, and the sliding motor 32M. As a result, the transfer mechanism

30 4 operates in accordance with the command of the worker who operates the operation terminal 100.

[0034] On the other hand, while the turning angle is outside the non-interference angle range or the turning angle is unknown, there is a possibility that the transfer mechanism 4 will come into contact with the inner surface

35 structure of the cover 3 when the moving section 30 moves the holding section 10 between an internal position in the accommodation region S and an external

position outside of the accommodation region S. In view of this, if the turning angle is outside of the non-interference angle range or the turning angle is unknown, the control unit 5 causes the operation terminal 100 to issue error information. Here, a case where the turning angle is outside the non-interference angle range is a case where it is determined that the turning angle is outside the non-interference angle range as a result of the above determination. The case where the turning angle is unknown corresponds to a case where information indicating the current turning angle cannot be obtained from the turning section 20 in the above determination, and as a result, the turning angle cannot be calculated, or a case where the control unit 5 cannot recognize the turning angle, such as when the power supply to the control unit 5 is stopped and the information indicating the turning angle is lost, for example. The error information is the display of characters or graphics displayed on the operation screen of the operation terminal 100, or the output of audio, a warning sound, or the like emitted from the operation terminal 100, and is information for expressing to the worker that the turning angle is outside of the non-interference angle range or that the turning angle is unknown. Specifically, for example, as shown in FIG. 6, it is preferable to display a message saying "The turning angle is outside of the non-interference angle range" on the display screen 100A of the operation terminal 100, or display a graphic indicating that the transfer mechanism 4 is in an orientation that will or may come into contact with the inner surface structure of the cover 3. Alternatively, it is preferable to output audio saying "The turning angle is outside of the non-interference angle range" from the speaker 100B of the operation terminal 100. Of course, display of other messages or output of other audio is also possible.

[0035] In this way, the control unit 5 performs an issuance command to cause the operation terminal 100 to issue error information if there is a possibility that the current orientation of the transfer mechanism 4 will come into contact with the inner surface structure of the cover 3 when the moving section 30 moves the holding section 10 between the internal position in the accommodation region S and the external position outside of the accommodation region S. As a result, it is possible to prevent the transfer mechanism 4 from coming into contact with the inner surface structure of the cover 3 due to an operation error of a worker or the like.

[0036] Also, in the maintenance mode, the control unit 5 issues alert

information when an operation command of the transfer mechanism 4 is received from the operation terminal 100, and if an operation command of the transfer mechanism 4 is received again after the alert information is issued, and the turning angle is within the non-interference angle range, the control unit 5 can cause the transfer mechanism 4 to operate in accordance with the operation command. The maintenance mode is a mode in which the transfer mechanism 4 is operated in accordance with a command from the operation terminal 100 operated by the worker. In response to an operation command for the transfer mechanism 4 being received from the operation terminal 100, the control unit 5 issues alert information. The alert information is the display of characters or graphics displayed on the operation screen of the operation terminal 100, or the output of audio, a warning sound, or the like emitted from the operation terminal 100, and is information for alerting the worker as to whether or not the operation command is intended by the worker. If, after causing the operation terminal 100 to issue the alert information, the control unit 5 receives an operation command from the operation terminal 100 again, and the turning angle of the holding section 10 is within the non-interference angle range, the control unit 5 determines that the transfer mechanism 4 will not come into contact with the inner surface structure of the cover 3 even if the transfer mechanism 4 is moved, and it can be assumed that an operation command was given again via the operation terminal 100. In view of this, the control unit 5 causes the elevating section 31, the sliding section 32, and the turning section 20 to operate in accordance with the newly-received operation command. As a result, the control unit 5 can cause the transfer mechanism 4 to operate in accordance with the operation command from the operation terminal 100 operated by the worker.

[0037] FIG. 7 is a flow chart showing the processing of the control unit 5 as described above. First, when the control unit 5 receives an operation command from the operation terminal 100 (step #10: Yes), the control unit 5 instructs the operation terminal 100 to perform notification of alert information (step #11). As a result, the operation terminal 100 performs notification of the alert information. It is preferable that this notification is for confirming whether or not the operation command from the operation terminal 100 is what the worker intended. For example, it is preferable to display a message or output audio for prompting the worker for confirmation, such as "Are you sure you want to operate the transfer mechanism?". When

the control unit 5 receives an operation command to operate the transfer mechanism 4 from the operation terminal 100 after issuing the instruction to perform notification of the alert information (step #12: Yes), the control unit 5 determines the turning angle of the holding section 10. If the turning angle is within the non-interference angle range (step #13: Yes), the control unit 5 causes the transfer mechanism 4 to operate in accordance with the received operation command (step #14). When the operation in accordance with the operation command is completed, the control unit 5 ends the processing. Note that the operation of the transfer mechanism 4 by the control unit 5 in step #14 can be performed, for example, after a sensor detects that there is no person in the area around the transfer mechanism 4.

[0038] In step #13, if the turning angle of the holding section 10 determined by the control unit 5 is not within the non-interference angle range (step #13: No), the control unit 5 instructs the operation terminal 100 to issue error information (step #15). As a result, in the operation terminal 100, notification of information indicating that the turning angle of the holding section 10 is not within the non-interference angle range is performed as issuance of error information.

[0039] On the other hand, in step #12, if the state where no operation command for operating the transfer mechanism 4 is newly received from the operation terminal 100 (step #12: No) continues until the elapse of a pre-set set time (e.g., 30 minutes) after the control unit 5 issues the instruction to perform notification of the alert information (step #16: Yes), the control unit 5 ends the processing. In step #16, if the control unit 5 newly receives an operation command to operate the transfer mechanism 4 from the operation terminal 100 (step #12: Yes) before the pre-set set time (e.g., 30 seconds) elapses (step #16: No), the control unit 5 continues the processing from step #13.

[0040] If the operation command is received from the operation terminal 100, the control unit 5 causes the operation terminal 100 to perform notification of the alert information, and thereafter, if the operation terminal 100 issues another operation command and the turning angle is not within the interference angle range, the control unit 5 can issue error information, thereby preventing the transfer mechanism 4 from coming into contact with the inner surface structure of the cover 3. Also, if there is another operation command from the operation terminal 100 described above and the turning angle is within the non-interference angle range, the transfer mechanism 4 can

be operated in accordance with the operation command.

[0041] Alternatively, as another embodiment, when the control unit 5 receives an operation command for the transfer mechanism 4 from the operation terminal 100 in the maintenance mode and the turning angle is outside the non-interference angle range, after the error information is issued, the control unit 5 causes the turning section 20 to turn the holding section 10 in such a manner that the turning angle is within the non-interference angle range, and causes the transfer mechanism 4 to operate in accordance with the operation command. In this case, after notifying the operation terminal 100 of the alert information, the control unit 5 causes the holding section 10 to be turned in accordance with an operation on the operation terminal 100 performed by the worker before executing the operation based on the operation command received from the operation terminal 100. Thereafter, the control unit 5 preferably executes the operation of the transfer mechanism 4 except for the turning operation in the operation command, in accordance with the operation command. This makes it possible to avoid contact with the inner surface structure of the cover 3 by the transfer mechanism 4.

[0042] FIG. 8 is a flow chart showing the processing of the control unit 5 in this case. First, when the control unit 5 receives an operation command from the operation terminal 100 (step #20: Yes), the control unit 5 instructs the operation terminal 100 to perform notification of the alert information (step #21). As a result, the operation terminal 100 performs notification of the alert information. It is preferable that this notification is for confirming whether or not the operation command from the operation terminal 100 is what the worker intended. For example, it is preferable to display a message or output audio for prompting the worker for confirmation, such as “Are you sure you want to operate the transfer mechanism?”. When the control unit 5 newly receives an operation command to operate the transfer mechanism 4 from the operation terminal 100 after issuing the instruction to perform notification of the alert information (step #22: Yes), the control unit 5 determines the turning angle of the holding section 10. If the turning angle is within the non-interference angle range (step #23: Yes), the control unit 5 causes the transfer mechanism 4 to operate in accordance with the received operation command (step #24). When the operation in accordance with the operation command is completed, the control unit 5 ends the processing. Note that the operation of the transfer mechanism 4 by the control unit 5 in step #24 can also be

performed, for example, after a sensor detects that there is no person in the surrounding area of the transfer mechanism 4.

[0043] In step #22, after the control unit 5 issues an instruction to perform notification of the alert information, if the state in which no operation command for operating the transfer mechanism 4 is newly received from the operation terminal 100 (step #22: No) continues until a pre-set set time (e.g., 30 seconds) elapses (step #31: Yes), the control unit 5 ends the processing. In step #31, if the control unit 5 newly receives an operation command to operate the transfer mechanism 4 from the operation terminal 100 (step #22: Yes) before a pre-set set time (e.g., 30 seconds) elapses (step #31: No), the control unit 5 continues the processing from step #23.

[0044] In step #23, if the turning angle of the holding section 10 determined by the control unit 5 is not within the non-interference angle range (step #23: No), the control unit 5 instructs the operation terminal 100 to issue error information (step #25). As a result, in the operation terminal 100, notification of information indicating that the turning angle of the holding section 10 is not within the non-interference angle range is performed as issuance of error information.

[0045] After the turning angle of the holding section 10 is adjusted within the non-interference angle range in response to the operation of the operation terminal 100 performed by the worker who has recognized the alert information (error issuance) notified by the operation terminal 100 (step #26: Yes), and when the control unit 5 receives the operation command from the operation terminal 100 (step #27: Yes), the control unit 5 instructs the operation terminal 100 to perform notification of the alert information (step #28). As a result, the operation terminal 100 performs notification of the alert information. Similarly to the above, this notification need only be for confirming whether or not the operation command from the operation terminal 100 is intended by the worker. Note that the turning of the holding section 10 in accordance with the operation performed by the worker in step #26 can be performed, for example, after a sensor detects that there is no person in the surrounding area of the holding section 10.

[0046] If the control unit 5 newly receives an operation command to operate the transfer mechanism 4 from the operation terminal 100 after issuing the instruction to perform notification of the alert information (step #29: Yes), the control unit 5 operates the transfer mechanism 4 in accordance with the

received operation command (step #24). When the operation in accordance with the operation command is completed, the control unit 5 ends the processing.

[0047] In step #29, after the control unit 5 issues an instruction to perform notification of the alert information, if the state in which no operation command for operating the transfer mechanism 4 is newly received from the operation terminal 100 (step #29: No) continues until the pre-set set time elapses (step #30: Yes), the control unit 5 ends the processing. Also, in step #26, if the turning angle of the holding section 10 is not adjusted within the non-interference angle range (step #26: No), or if the control unit 5 does not receive an operation command from the operation terminal 100 in step #27 (step #27: No), the control unit 5 ends the processing. Note that, although not shown in the drawings, the determination in step #27 is preferably performed by determining whether or not an operation command has been received before the pre-set time elapses.

[0048] If the turning angle has been recognized, when there is a series of operations (specifically, reception of an operation command, notification of alert information, and reception of an operation command) after the turning angle is adjusted in accordance with the operation of the operation terminal 100 performed by the worker, the control unit 5 causes the transfer mechanism 4 to operate in this manner, whereby it is possible to prevent the transfer mechanism 4 from coming into contact with the inner surface structure of the cover 3 while causing the transfer mechanism 4 to operate in accordance with the operation command.

[0049] Note that the control unit 5 may automatically perform the turning of the holding section 10 in accordance with the operation performed by the worker in step #26 of FIG. 8. In this case, it is preferable that the control unit 5 causes the turning section 20 to turn the holding section 10 in such a manner that the rotation angle of the holding section 10 is within the non-interference angle range. Thereafter, the control unit 5 preferably executes the operation of the transfer mechanism 4 except for the turning operation in the operation command, in accordance with the operation command. This makes it possible to avoid contact with the inner surface structure of the cover 3 by the transfer mechanism 4.

2. Other Embodiments of Article Transport Apparatus

[0050] Next, another embodiment of the article transport apparatus 1 will be described.

[0051] (1) In the above embodiment, the article transport apparatus 1 has been described as an example configured as a so-called ceiling transport vehicle.

5 However, there is no limitation to such a configuration, and for example, the article transport apparatus 1 may be various types of transport vehicles such as an unmanned transport vehicle and a track-guided cart. Alternatively, a transport device (e.g., a drone, etc.) that does not move along the rail 99 may be used.

10 [0052] (2) In the above embodiment, an example of a case in which the moving section 30 includes the elevating section 31 and the sliding section 32 has been described. However, there is no limitation to such a configuration, and the moving section 30 may have only the function of moving the holding section 10 up and down, or the moving section 30 may have only the function of sliding

15 the holding section 10 horizontally.

[0053] (3) In the above-described embodiment, the inner surface structure has been described as being a surface that forms the accommodation region S, and as corresponding to the inner wall surface 3A of the cover 3, the fall restricting section 6, the swing restricting mechanism 7, and the sensor provided so as to

20 protrude in the accommodation region S. However, the inner surface structure corresponds only to the inner wall surface 3A of the cover 3 if the fall restricting section 6, the swing control mechanism 7, the sensor provided so as to protrude into the accommodation region S, and the like are not provided.

[0054] (4) In the above-described embodiment, a case in which the four non-interference angle ranges are the range of " $0 \pm \alpha^\circ$ ", the range of " $90 \pm \alpha^\circ$ ", the

25 range of " $180 \pm \alpha^\circ$ ", and the range of " $270 \pm \alpha^\circ$ ", and " $\alpha = 8$ " has been described as an example. However, these numerical values are mere examples, and are preferably set as appropriate according to the interval between the inner wall surface 3A of the cover 3 and the inner surface structure.

30 [0055] (5) In the above-described embodiment, the operation command has been described as being a command for the reference orientation return operation for setting the orientations of the moving section 30 and the turning section 20 to the predetermined reference orientation. However, there is no limitation to such a configuration, and the operation command may be another

35 orientation different from the predetermined reference orientation (e.g., an orientation that facilitates maintenance, etc.).

[0056] (6) Note that the configurations disclosed in the embodiments described above can also be applied in combination with the configurations disclosed in other embodiments as long as there is no contradiction. Regarding other configurations as well, the embodiments disclosed in this specification are merely examples in all respects. Accordingly, various modifications can be made as appropriate without departing from the scope of the present disclosure.

3. Overview of Above-Described Embodiment

[0057] An overview of the article transport apparatus described above will be described below.

[0058] The article transport apparatus is an article transport apparatus configured to transport an article, the article transport apparatus including: a moving body configured to move to transport the article; a cover that is supported by the moving body and at least partially covers a lateral peripheral portion of an accommodation region in which the article is accommodated during transport; a transfer mechanism configured to hold the article and transfer the article to and from a transfer target location; and a control unit configured to control the moving body and the transfer mechanism, in which the transfer mechanism includes a holding section that is supported by the moving body and is capable of changing between a holding state in which the holding section holds the article and a release state in which the holding section releases the article, a turning section configured to turn the holding section around a turning axis extending along an up-down direction, and a moving section configured to move the holding section between an internal position in the accommodation region and an external position outside of the accommodation region, the cover includes an inner surface structure facing the accommodation region, while a turning angle of the holding section by the turning section is within a predetermined non-interference angle range, the transfer mechanism does not interfere with the inner surface structure even if the holding section is moved by the moving section, and while the turning angle is outside of the non-interference angle range, the transfer mechanism interferes with the inner surface structure in some cases, depending on a movement route along which the holding section is moved by the moving section, the control unit is capable of executing a maintenance mode in which the control unit causes the transfer mechanism to operate in accordance with

a command from an operation terminal operated by a worker, and in response to the control unit receiving an operation command for the transfer mechanism from the operation terminal in the maintenance mode, the control unit determines whether or not the turning angle is within the non-interference angle range, and (i) in response to the turning angle being within the non-interference angle range, the control unit causes the transfer mechanism to operate in accordance with the operation command, and (ii) in response to the turning angle being outside of the non-interference angle range or the turning angle being unknown, the control unit causes the operation terminal to issue error information.

[0059] According to this configuration, even if the worker issues an erroneous operation command for the transfer mechanism in the maintenance mode, if there is a possibility that the transfer mechanism will interfere with the inner surface structure of the cover portion when the transfer mechanism is operated, the operation terminal can be caused to issue error information. Accordingly, even if the worker issues an erroneous operation command for the transfer mechanism, the worker can be given an opportunity to confirm it, and therefore it is possible to avoid a case in which the transfer mechanism interferes with the inner surface structure of the cover.

[0060] Here, it is preferable that in the maintenance mode, in response to the control unit receiving an operation command for the transfer mechanism from the operation terminal, the control unit performs notification of alert information, and in response to the control unit receiving the operation command for the transfer mechanism again after performing notification of the alert information and furthermore the turning angle being within the non-interference angle range, the control unit causes the transfer mechanism to operate in accordance with the operation command.

[0061] According to this configuration, in response to an operation command being issued again after giving the worker an opportunity to confirm, and furthermore the turning angle being within the non-interference angle range, the operation of transfer mechanism is executed in accordance with the instruction performed by the worker. Accordingly, the transfer mechanism can be operated in accordance with the operation command issued by the worker. For example, when power supply is started to an article transport apparatus that is not being supplied with power, the control unit often cannot recognize the turning angle. It is preferable that this operation is executed if

the turning angle is unknown in this manner.

[0062] Also, it is preferable that in the maintenance mode, in response to the control unit receiving an operation command for the transfer mechanism from the operation terminal and furthermore the turning angle being outside of the non-interference angle range, the control unit causes the operation terminal to issue the error information, and thereafter the control unit causes the turning section to turn the holding section in such a manner that the turning angle is within the non-interference angle range, and causes the transfer mechanism to operate in accordance with the operation command.

[0063] According to this configuration, the operation of the transfer mechanism is executed according to the operation command after the turning angle is set within the non-interference angle range, and therefore it is possible to avoid a case in which the transfer mechanism comes into contact with the inner surface structure of the cover while operating the transfer mechanism in accordance with the operation command issued by the worker.

[0064] Also, it is preferable that the operation command is a command for a reference orientation return operation for setting orientations of the moving section and the turning section to a predetermined reference orientation.

[0065] In the article transport apparatus, since the moving section and the turning section perform a combined operation in the reference orientation return operation, the worker is not likely to notice the interference of the transfer mechanism. In view of this, according to this configuration, in such a case, it is possible to appropriately give the worker an opportunity to confirm.

[0066] Also, it is preferable that the moving section includes an elevating section configured to move the holding section up and down and a sliding section configured to slide the holding section horizontally, and in response to the control unit receiving the command for the reference orientation return operation, the control unit first sets the elevating section to a reference orientation, then sets the sliding section to a reference orientation, and thereafter sets the turning section to a reference orientation.

[0067] When the command for the reference orientation return operation is received, if the turning section performs turning first, the turning may cause interference between the holding section and the inner surface structure. In view of this, according to this configuration, it is easy to prevent the occurrence of interference even if the turning section performs turning by setting the elevating section to the reference orientation first.

[0068] Also, the inner surface structure may include a fall restricting section configured to restrict downward falling of the article, and the fall restricting section may be below the article accommodated in the accommodation region and protrudes toward the accommodation region from an inner wall surface of the cover.

[0069] If the fall restricting section is provided as in this configuration, interference between the transfer mechanism and the inner surface structure is likely to occur particularly during movement of the holding section by the moving section. In view of this, it is particularly preferable to perform the above control.

Industrial Applicability

[0070] The technique according to the present disclosure can be used for an article transport apparatus that transports an article.

DESCRIPTION OF REFERENCE SIGNS

[0071]	1	Article transport apparatus
	2	Moving body
	3	Cover
20	3A	Inner wall surface
	4	Transfer mechanism
	4b	Turning axis
	5	Control unit
	6	Fall restricting section
25	10	Holding section
	20	Turning section
	30	Moving section
	31	Elevating section
	32	Sliding section
30	100	Operation terminal
	S	Accommodation region
	W	Article

What Is Claimed Is:

1. An article transport apparatus configured to transport an article,
the article transport apparatus comprising:
 - 5 a moving body configured to move to transport the article;
a cover that is supported by the moving body and at least partially
covers a lateral peripheral portion of an accommodation region in which the
article is accommodated during transport;
a transfer mechanism configured to hold the article and transfer the
10 article to and from a transfer target location; and
a control unit configured to control the moving body and the transfer
mechanism,
wherein the transfer mechanism includes:
 - a holding section that is supported by the moving body and is
15 capable of changing between a holding state in which the holding section holds
the article and a release state in which the holding section releases the article;
a turning section configured to turn the holding section around a
turning axis extending along an up-down direction; and
a moving section configured to move the holding section between
20 an internal position in the accommodation region and an external position
outside of the accommodation region,
the cover includes an inner surface structure facing the accommodation
region,
while a turning angle of the holding section by the turning section is
25 within a predetermined non-interference angle range, the transfer mechanism
does not interfere with the inner surface structure even if the holding section
is moved by the moving section, and while the turning angle is outside of the
non-interference angle range, the transfer mechanism interferes with the
inner surface structure in some cases, depending on a movement route along
30 which the holding section is moved by the moving section,
the control unit is capable of executing a maintenance mode in which
the control unit causes the transfer mechanism to operate in accordance with
a command from an operation terminal operated by a worker, and
in response to the control unit receiving an operation command for the
35 transfer mechanism from the operation terminal in the maintenance mode, the
control unit determines whether or not the turning angle is within the non-

interference angle range, and (i) in response to the turning angle being within the non-interference angle range, the control unit causes the transfer mechanism to operate in accordance with the operation command, and (ii) in response to the turning angle being outside of the non-interference angle range or the turning angle being unknown, the control unit causes the operation terminal to issue error information.

2. The article transport apparatus according to claim 1,
wherein in the maintenance mode, in response to the control unit receiving an operation command for the transfer mechanism from the operation terminal, the control unit performs notification of alert information, and in response to the control unit receiving the operation command for the transfer mechanism again after performing notification of the alert information and furthermore the turning angle being within the non-interference angle range, the control unit causes the transfer mechanism to operate in accordance with the operation command.

3. The article transport apparatus according to claim 1,
wherein in the maintenance mode, in response to the control unit receiving an operation command for the transfer mechanism from the operation terminal and furthermore the turning angle being outside of the non-interference angle range, the control unit causes the operation terminal to issue the error information, and thereafter the control unit causes the turning section to turn the holding section in such a manner that the turning angle is within the non-interference angle range, and causes the transfer mechanism to operate in accordance with the operation command.

4. The article transport apparatus according to any one of claims 1 to 3,
wherein the operation command is a command for a reference orientation return operation for setting orientations of the moving section and the turning section to a predetermined reference orientation.

5. The article transport apparatus according to claim 4,
wherein the moving section includes:
an elevating section configured to move the holding section up and down; and

a sliding section configured to slide the holding section horizontally,
and

in response to the control unit receiving the command for the reference
orientation return operation, the control unit first sets the elevating section to
5 a reference orientation, then sets the sliding section to a reference orientation,
and thereafter sets the turning section to a reference orientation.

6. The article transport apparatus according to any one of claims 1 to 5,
wherein the inner surface structure includes a fall restricting section
10 configured to restrict downward falling of the article, and
the fall restricting section is below the article accommodated in the
accommodation region and protrudes toward the accommodation region from
an inner wall surface of the cover.