

BOARDING BRIDGE

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to a boarding bridge (passenger loading bridge) used for transferring passengers between a terminal building and an aircraft or vessel (passenger ferry).

Description of the Related Art

[0002] Typical boarding bridges are known as facilities used for providing a passageway between an airport terminal building and a parked aircraft to embark and disembark passengers. Once connected to the entrance of an aircraft, the boarding bridge forms a passageway that leads to the aircraft. This enables direct passenger embarkation and disembarkation between the terminal building and the aircraft.

[0003] The lower end of the door provided in the entrance of the aircraft is located at a position lower than the floor portion of the entrance of the aircraft. Therefore, if there is no difference in level between the floor portion of the entrance and the boarding bridge, the door bumps against the boarding bridge causing troubles, when the door is opened or closed.

[0004] For this reason, the position of the boarding bridge needs to be lower than the floor portion of the entrance, for example, by about a hundred and several tens of mm. This however presents such a problem that the level difference between the floor portion of the entrance and the passageway of the boarding bridge sometimes hampers passenger embarkation and disembarkation. A passenger in a wheelchair, for example, encounters difficulties when boarding onto an aircraft from a terminal, owing to the presence of such a level difference.

[0005] With the intent of solving this problem, there has been proposed a structure according to which a floor designed to be movable up and down is provided at the leading end of the interior part of the cab of the boarding bridge (see Patent Literature 1).

[0006] According to the boarding bridge disclosed in Patent Literature 1, the leading end of the boarding bridge can be connected to an aircraft,

with the movable floor of the boarding bridge being located at a position lower than the floor portion of the entrance. This enables opening and closing of the door of the entrance of the aircraft. After the door has been fully opened, the movable floor of the boarding bridge is lifted to substantially the same height as the floor portion of the entrance. This eliminates the level difference between the floor portion of the entrance and the movable floor of the boarding bridge so that a passenger (e.g., wheelchair passenger) can easily step onto the movable floor from the aircraft. Subsequently, the movable floor of the boarding bridge is lowered to substantially the same height as the floor portion of the cab. This eliminates the level difference between the movable floor and the floor portion of the cab so that the passenger can easily move to the terminal, passing through the passageway of the boarding bridge.

Patent Literature 1: JP-A-2004-155257

[0007] However, the boarding bridge of Patent Literature 1 requires lifting and lowering of the movable floor whenever a wheelchair passenger, for example, embarks onto or disembarks from the aircraft, which hampers smooth passenger embarkation and disembarkation. Thus, the technique disclosed in Patent Literature 1 still leaves room for improvement with regard to smooth passenger embarkation and disembarkation.

[0008] Another disadvantage is such that since there exists a level difference between the movable floor and each side of the cab when the movable floor is lifted, the wheelchair passenger feels insecurity, worrying that his wheelchair might run off.

SUMMARY OF THE INVENTION

[0009] Embodiments of the invention provide a boarding bridge capable of easing the anxiety of passengers and more particularly wheelchair passengers and allowing them to smoothly get on and off a mobile object.

[0010] According to an aspect, there is provided a boarding bridge comprising: a walkway; a liftable passage; which is located within a plane of the walkway when its plan view is viewed and can be lifted and lowered in order that it is connected to an entrance of a mobile object; and which is configured such that when lifted, one end to be connected to the entrance rises, while the other end, located away from the one end, being kept in a condition in which substantially no level difference exists between the other end and the walkway, whereby a passage including a rampway located between the one end and the other end and having no step-like level difference is formed, and

a protective member which projects upward along a side of the liftable passage when the liftable passage is lifted, wherein the protective member is operated in conjunction with the lifting operation of the liftable device.

[0011] According to this arrangement, a liftable passage is provided which is configured to be lifted such that the one end rises while the other end is kept in a condition in which substantially no level difference exists between the other end and the walkway, whereby a passage including a rampway located between the one end and the other end and having no step-like level difference is formed.

This enables it to eliminate a level difference between the liftable passage and the entrance of the mobile object. Furthermore, there is no need to lift or lower the liftable passage, for example, whenever a wheelchair passenger embarks onto or disembarks from the aircraft, which leads to smooth passenger embarkation onto and disembarkation from the mobile object.

[0012] A protective member is also provided, which projects upward along a side of the liftable passage when the liftable passage is lifted. This eases, for example, the anxiety of a wheelchair passenger who worries that his wheelchair would run off the liftable passage.

[0013] The protective member may be configured to move to a position higher than the passage surface of the liftable passage when the liftable passage is lifted and to be retracted to a position of the same height as

the passage surface of the liftable passage or a lower position when the liftable passage is lowered.

[0014] A first link mechanism may be further provided, for coupling the protective member to the liftable passage in order to move the protective member upward and downward in accordance with rising and lowering of the liftable passage, such that when the liftable passage is lifted, the protective member moves to a position higher than the passage surface of the liftable passage and when the liftable passage is lowered, the protective member is retracted to a position of the same height as the passage surface of the liftable passage or a lower position.

[0015] In this arrangement, since the protective member is operated by the first link mechanism so as to move in conjunction with rising and lowering of the liftable passage, there is no need to employ a dedicated driving mechanism used for operating the protective member.

[0016] A clearance portion may be provided between a side of the liftable passage and the walkway to accommodate the protective member, and a lid may be provided for covering the upper end of the clearance portion when the protective member is retracted to the position of the same height as the passage surface of the liftable passage or a lower position.

[0017] In this arrangement, the use of the lid enables it to prevent penetration of dust etc. into the clearance portion.

[0018] A second link mechanism may be further provided for coupling the lid to the liftable passage in order to open or close the lid in accordance with rising and lowering of the liftable passage such that when the liftable passage starts to rise, the lid is opened thereby opening the upper end of the clearance portion and when the liftable passage is lowered with the protective member being retracted to the position of the same height as the passage surface of the liftable passage or a lower position, the lid is closed.

[0019] In this arrangement, the second link mechanism operates the lid in conjunction with rising and lowering of the liftable passage, which eliminates the need for a dedicated driving mechanism used for opening

and closing the lid.

[0020] The liftable passage may include: a liftable deck including the one end connectable to the entrance of the mobile object; a lifting mechanism for lifting and lowering the liftable deck; and a driven slope having a fixed end pivotally attached to the liftable deck and a free end that serves as the other end and is freely movable in a passenger walking direction along a main surface of the walkway, wherein the free end moves along the main surface of the walkway as the liftable deck moves, thereby forming the rampway between the liftable deck and the walkway. The protective member may be provided at both sides of the liftable passage.

[0021] In this arrangement, the simple rising and lowering movement of the liftable deck enables height adjustments of the liftable deck and therefore the liftable deck can be maintained in a substantially horizontal condition without tilting the floor of the liftable deck. This advantageously facilitates positioning of the liftable deck relative to the floor of the entrance.

[0022] In addition, the liftable deck may include a sliding mechanism capable of sliding in the passenger walking direction. This liftable deck may be configured to be moved to a position of the same height as a floor of the entrance by the lifting mechanism and to be brought into contact with the entrance by the sliding mechanism.

[0023] In this arrangement, even if a slight gap is created between the liftable deck and the entrance (outer wall) of the mobile object, not only a level difference but also such a gap can be eliminated because the liftable deck can be slid by the sliding mechanism to a position where it comes into contact with the entrance.

[0024] In addition, the walkway may include a tiltable floor for adjusting the inclination of the liftable deck and the driven slope in a width direction and a tilting mechanism for tilting the tiltable floor in the width direction. The liftable deck and the driven slope may be mounted within a plane of the tiltable floor when a plan view of the tiltable floor is viewed.

[0025] In this arrangement, if the edge of the floor of the liftable deck is not parallel to the edge of the floor of the entrance of the mobile object, they can be made parallel to each other, using the tiltable floor. Effective connection between the liftable deck and the entrance can be established through the parallelism adjustment of the liftable deck to the entrance by the tiltable floor, for example, even during the movement of the drive columns of the boarding bridge.

[0026] The above and further embodiments, features and advantages of the invention will more fully be apparent from the following detailed description with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027] Fig. 1 is a layout view showing one example of boarding bridge systems having a boarding bridge constructed according to an embodiment of the invention.

[0028] Fig. 2 is a view showing a whole configuration of the boarding bridge according to the embodiment of the invention.

[0029] Fig. 3 schematically illustrates one constitutional example of a cab incorporated in the boarding bridge according to the embodiment of the invention.

[0030] Fig. 4 is a view showing one constitutional example of an adjustment passage and its surrounding structure, which view is taken in the direction of arrows Y of Fig. 3.

[0031] Fig. 5 is a view showing one constitutional example of the spherical slide bearing shown in Fig. 3.

[0032] Fig. 6 is a view showing the constitutional example of the adjustment passage and its surrounding structure, which view is taken in the direction of arrows X of Fig. 3.

[0033] Fig. 7 is a view showing the constitutional example of the surrounding structure of the adjustment passage, which view is taken in the direction of arrows Z of Fig. 6.

[0034] Fig. 8 is a view for use in describing one example of an operation for connecting the boarding bridge according to the embodiment of the

invention to an entrance of an aircraft.

[0035] Fig. 9 is a view for use in describing the example of the operation for connecting the boarding bridge according to the embodiment of the invention to the entrance of the aircraft.

[0036] Fig. 10 is a plan view showing the details of a liftable passage and its peripheral part, which are provided in the boarding bridge according to the embodiment of the invention.

[0037] Fig. 11A is a view showing one constitutional example of a guard plate lifting mechanism, which view is taken in the direction of arrows A of Fig. 10, whereas Fig. 11B is a view showing the constitutional example of the guard plate lifting mechanism, which view is taken in the direction of arrows C of Fig. 11A.

[0038] Fig. 12 is a view showing one example of a state in which a guard plate projects to a maximum extent.

[0039] Fig. 13A is a view showing one constitutional example of a guard cover opening/closing mechanism, which view is taken in the direction of arrows B of Fig. 10, whereas Fig. 13B is a view showing the condition of the guard cover opening/closing mechanism when the guard cover shown in Fig. 13A is opened.

[0040] Fig. 14A is a view showing the constitutional example of the guard cover opening/closing mechanism, which view is taken in the direction of arrows D of Fig. 13A, whereas Fig. 14B is a view showing the constitutional example of the guard cover opening/closing mechanism, which view is taken in the direction of arrows E of Fig. 13A.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0041] Referring now to the accompanying drawings, one embodiment of the invention will be described below. Those parts that are substantially equivalent or function substantially similarly to one another are indicated by the same reference numerals in all figures and needless repetition of description of the equivalent parts is omitted herein.

[0042] It is apparent that the invention is not limited to the particular embodiments described herein. This means that the following concrete

description of the embodiment merely exemplifies the features of the "boarding bridge" of the invention. It should therefore be understood that in the following specific example with appropriate reference numerals given to parts corresponding to particular constituent elements of the "boarding bridge" of the invention, these parts are only one example of the constituent elements of the "boarding bridge" of the invention. For example, the "aircraft 11" appearing in the following description is merely one example of the "mobile object" which is a constituent element of the invention. Therefore, specific examples of the "mobile object" are not limited to aircrafts but may include others such as "cruisers".

[0043] (Embodiment)

Fig. 1 is a layout view showing one example of boarding bridge systems including a boarding bridge according to an embodiment of the invention.

[0044] As illustrated in Fig. 1, a boarding bridge system 1 for use with a passenger aircraft includes a passenger aircraft boarding bridge 20 (hereinafter referred to, shortly, as a "boarding bridge 20") connected to a passenger gate of an airport terminal building 10. Use of such a boarding bridge 20 enables effective passenger embarkation and disembarkation onto and from an aircraft 11.

[0045] Fig. 2 illustrates the whole configuration of the boarding bridge according to the embodiment of the invention. In this embodiment, the side of the boarding bridge 20 proximate to the aircraft 11 is referred to as "front" and the side of the boarding bridge 20 proximate to a terminal building 10 is referred to as "rear" for the sake of convenience as illustrated, for example, in Fig. 2. Also, the terms "right" and "left" of the boarding bridge 20 are with reference to the width direction 300 of the boarding bridge 20. In the following description, the longitudinal direction 200 of the boarding bridge 20 is sometimes called the "walking direction 200" of the walking people (passengers).

[0046] As shown in Fig. 2, the boarding bridge 20 has a rotunda (rear circular room) 24 connected to a gateway 10A of the terminal building 10,

a tunnel section 25 connected to the rotunda 24, a cab (front circular room) 26 located at the front end of the tunnel section 25, and an auxiliary stairway 23 provided in a side wall of the tunnel section 25, being located near the cab 26.

[0047] The rotunda 24 is rotatably disposed at the rear end of the tunnel section 25 such that the tunnel section 25 can swing about an axis 24A (hereinafter referred to as a "vertical axis") that extends in a vertical direction (i.e., a direction perpendicular to the paper plane of Fig. 2). This allows the rotunda 24 to serve as a joint between the terminal building 10 and the tunnel section 25.

[0048] The cab 26 is rotatably disposed at the front end of the tunnel section 25 such that the cab 26 can whirl by itself around a vertical axis 26A with its front end swinging from side to side.

[0049] An operating panel 30 (see Fig. 3) is provided in the cab 26 so that the operator can operate various instruments (such as drive columns) incorporated in the boarding bridge 20, using a joystick (not shown) of the operating panel 30.

[0050] The auxiliary stairway 23 is provided on a side of the tunnel section 25 in order to make the interior part of the tunnel section 25 communicate with the ground (apron). The auxiliary stairway 23 is used, for example, by an operator who is getting in or out of the cab 26.

[0051] The tunnel section 25 corresponds to a box-shaped passage part that constitutes a passageway for transferring the passengers between the terminal building 10 and an entrance 11A of the aircraft 11. As shown in Fig. 2, the tunnel section 25 has first, second and third tunnels 25A, 25B, 25C and the adjacent pair of tunnels 25A, 25B and the adjacent pair of tunnels 25B, 25C are respectively partially nested. More specifically, the first to third tunnels 25A, 25B and 25C are constructed in the same box-like form (rectangular parallelepiped) but have different cross-sectional areas such that they are telescopically nested in their associated tunnels.

[0052] The above-described tunnel section 25 includes a known sliding structure (not shown) so that it can telescopically extend by sliding along

the longitudinal direction (lengthwise direction) of the tunnel section 25 while the first to third tunnels 25A to 25C being kept in an overlapped condition.

[0053] Drive columns 27 are connected to the third tunnel 25C so as to hold the third tunnel 25C therebetween. Therefore, when the drive wheels provided at the lower ends of the drive columns move over the apron, a force is transmitted to the tunnel section 25, which causes extension and contraction (sliding movement) of the tunnel section 25 in the longitudinal direction as well as the swing motion (whirling motion) of the tunnel section 25 about the vertical axis 24A. In addition, such drive columns are configured to be extendable in a vertical direction. Extension and contraction of the drive columns allows the tunnel section 25 and the cab 26 to swing up and down with respect to the rotunda 24 serving as a base end.

[0054] Next, the configuration of the cab 26 of the boarding bridge 20 according to this embodiment will be described in detail with reference to the drawings.

[0055] Fig. 3 is a view schematically illustrating one constitutional example of the cab incorporated in the boarding bridge according to the embodiment of the invention.

[0056] As shown in Fig. 3, the cab 26 constitutes, together with the passageway of the tunnel section 25, a walkway 31 through which the passengers move along the walking direction 200 between the terminal building 10 and the aircraft 11.

[0057] The walkway 31 includes a fixed passage 32 integral with the passageway of the tunnel section 25 and an adjustment passage 33 used for adjusting the connection relative to the entrance 11A of the aircraft 11.

[0058] As described earlier, the fixed passage 32 has the vertical axis 26A that is located substantially at the center of the fixed passage 32 with respect to the width direction 300. This allows the front end of the cab 26 to swing from side to side while the fixed passage 32 whirls about the vertical axis 26A.

[0059] The adjustment passage 33 is comprised of a widthwise tiltable floor 34 (hereinafter referred to as a "tiltable floor 34"), a connector floor 39, a liftable deck 35 and a driven slope 36.

[0060] As illustrated in Fig. 3, a substantially rectangular opening 34A having long sides extending in the walking direction 200 is provided at a position on the right side of the tiltable floor 34. In a plan view of the tiltable floor 34 when viewed from above, the rectangular liftable deck 35 and the driven slope 36 are positioned within the plane of the tiltable floor 34 (i.e., within the plane of the walkway 31) so as to cover the substantially entire area of the opening 34A.

[0061] In the boarding bridge 20 of this embodiment, since various structural parts can access the rear surface of the liftable deck 35 from underneath through the opening 34A, driving forces for lifting and sliding the liftable deck 35 can be easily applied to the liftable deck 35. The details will be described later.

[0062] A liftable passage 21 is configured so as to include the liftable deck 35 having a bumper 51 and the driven slope 36. The liftable passage 21 and the neighborhood thereof are depicted in detail in Fig. 10. As illustrated in Fig. 10, guard plates 101A, 101B are stored on both sides, respectively, of the liftable passage 21, which plates 101A, 101B serve as protective members extendable upwardly from the passage surface of the liftable passage 21. Guard covers 131A, 131B are provided to lid the openings through which the guard plates 101A, 101B are taken in and out. It should be noted that the guard plates 101A, 101B and the guard covers 131A, 131B are omitted from Fig. 3 for simplicity.

[0063] In this embodiment, when the liftable deck 35 of the liftable passage 21 starts to rise, the guard covers 131A, 131B firstly open (see Fig. 13B) and then the upper portions of the guard plates 101A, 101B move (project) upwardly from the passage surface of the liftable passage 21 (see Fig. 12). When the liftable deck 35 lowers from its lifted state, the guard plates 101A, 101B lower immediately before completion of the lowering of the liftable deck 35 and then the guard covers 131A, 131B

are closed so that the condition before the liftable deck 35 was lifted is restored (see Fig. 13A). The details of the guard plates 101A, 101B and the guard covers 131A, 131B will be described later with reference to Fig. 10 and the later figures.

[0064] [Configuration of Tilttable Floor 34 and Tilting Mechanism]

First, the structure of the tilttable floor 34 and the tilting mechanism for the tilttable floor 34 will be described in detail.

[0065] As illustrated in Fig. 3, the connector floor 39 having a substantially right triangular shape is connected to the fixed passage 32 through a first coupling hinge 37 and to the tilttable floor 34 through a second coupling hinge 38. In this way, the tilttable floor 34 is coupled (connected) to the fixed passage 32, using the connector floor 39.

[0066] The second coupling hinge 38 linearly extends from a position proximate to a spherical slide bearing 42 (rod end 42 the details of which will be described later) to the right end of the cab 26 in a direction (width direction 300) substantially perpendicular to the walking direction 200. The first coupling hinge 37 linearly extends from a position proximate to the rod end 42 to the right end of the cab 26 in a direction that makes a specified acute angle θ with the walking direction 200. Specifically, the region located between the first coupling hinge 37 and the second coupling hinge 38 is the connector floor 39 described above.

[0067] As illustrated in Fig. 3, the screw shaft of a first electric cylinder 43 (screw cylinder) is fixed to the right end of the tilttable floor 34. In this configuration, the extension and contraction strokes of the screw shaft of the first electric cylinder 43 in a vertical direction causes the right end of the tilttable floor 34 to move up and down.

[0068] Fig. 4 is a view showing one constitutional example of the adjustment passage and its surrounding structure, which view is taken in the direction of arrows Y of Fig. 3. Fig. 5 shows one constitutional example of the spherical slide bearing (rod end) 42 shown in Fig. 3.

[0069] As shown in Fig. 4, the tilttable floor 34 has a bumper 40 made of synthetic rubber. The bumper 40 is attached to the front end of the tilttable floor 34 so as to extend throughout the length of the front end in

the width direction 300. Specifically, the bumper 40 extends in a direction parallel to the second coupling hinge 38.

[0070] With the above configuration, the bumper 40 cushions the shock occurring when the boarding bridge 20 is brought into contact with the aircraft 11 and has the function of keeping a spacing between the front end of the adjustment passage 33 and the entrance 11A of the aircraft 11.

[0071] As shown in Fig. 4, a support roller 41 (cam follower 41) is attached to a housing 40A for the bumper 40, and a roller holder 41A for holding the head of the cam follower 41 from above and underneath is coupled to the fixed passage 32 through a coupling member (not shown). This enables the tiltable floor 34 to slide in parallel with the main surface of the tiltable floor 34, relative to the fixed passage 32, using the cam follower 41.

[0072] As shown in Fig. 5, a housing for the rod end 42 is fixed to a frame 32A of the fixed passage 32, whereas a rod 42B passing through a ball 42A of the rod end 42 is coupled to the tiltable floor 34 through a plate-like material (not shown). This enables it to turn the rod 42B so as to take various angular positions owing to the spherical sliding of the ball 42A, so that the tiltable floor 34 can freely swing relative to the fixed passage 32, using the rod end 42.

[0073] In the above configuration, while the right end of the tiltable floor 34 being moved up and down by the driving force of the first electric cylinder 43, the front end of the tiltable floor 34 swings about the first coupling hinge 37 and about the second coupling hinge 38 as well. As a result, the tiltable floor 34 can be tilted in the width direction 300. In other words, the tiltable floor 34 can seesaw about a virtual linear line 400 that connects the cam follower 41 and the rod end 42.

[0074] At that time, the above linear line 400 shifts parallelly and the connector floor 39 swings up and down, owing to the sliding movement of the cam follower 41 within the plane of the tiltable floor 34 and to the universal swinging movement of the rod end 42. Therefore, in the boarding bridge 20 of this embodiment, the tiltable floor 34 can smoothly

perform the seesaw movement.

[0075] In the above configuration, if the edge of the tiltable floor 34 (i.e., the edge of the floor of the liftable deck 35 described later) is not in parallel with the edge of a floor section 11B (see Figs. 8 and 9) provided in the entrance 11A of the aircraft 11, these edges can be made parallel to each other, using the tiltable floor 34. For example, the height of the entrance 11A of the aircraft 11 varies depending upon the size of the aircraft 11. In order to compensate for such variations in height, the tunnel section 25 is sometimes tilted with the front and rear portions of the tunnel section 25 being positioned at different levels. In this condition, if the fixed passage 32 whirls about the vertical axis 26A, the adjustment passage 33 swings from side to side at the same time, so that the edge of the floor of the liftable deck 35 does not become parallel to the edge of the floor section 11B of the entrance 11A of the aircraft 11 in some cases. In this case, the seesaw movement of the above tiltable floor 34 effectively works.

[0076] Next, the liftable deck 35, the driven slope 36 and their surrounding structure will be described by way of an example.

[0077] Fig. 6 is a view showing the constitutional example of the adjustment passage and its surrounding structure, which view is taken in the direction of arrows X of Fig. 3. Fig. 7 is a view showing the constitutional example of the surrounding structure of the adjustment passage, which view is taken in the direction of arrows Z of Fig. 6.

[0078] As shown in Figs. 6 and 7, the adjustment passage 33 of the boarding bridge 20 according to the present embodiment has, in the proximity of the opening 34A of the tiltable floor 34, a lifting mechanism for lifting the liftable deck 35, a swinging mechanism for swinging the driven slope 36, and a sliding mechanism for sliding the liftable deck 35 in the walking direction 200.

[0079] [Lifting Mechanism for Liftable Deck 35]

The lifting mechanism (lifting mechanism for the liftable passage 21) for the liftable deck 35 will be hereinafter described in detail.

[0080] As shown in Fig. 6, the lifting mechanism for the liftable deck 35

includes a second electric cylinder 70 (screw cylinder) and a bracket board 60 having, in a plan view, a substantially C-shape (more precisely, a substantially semi-circular shape having two bends).

[0081] The leading end of a screw shaft 70A of the second electric cylinder 70 is coupled to one end of the bracket board 60 through a first rotation supporting point 61. The main body 70B of the second electric cylinder 70 is coupled to a supporting bracket 71 through a fourth rotation supporting point 72, whereas the supporting bracket 71 is fixed to the tiltable floor 34 by use of suitable fixing means (such as supporting members and bolts (not shown)). Coupled to a bend 60A of the bracket board 60 through a second rotation supporting point 62 are a pair of frames 73A, 73B (see also Fig. 7) which are fixed to the tiltable floor 34 by use of suitable fixing means (such as supporting members and bolts (not shown)). Coupled to the other end of the bracket board 60 through a third rotation supporting point 63 are a pair of first and second coupling members 64A, 64B. The first coupling member 64A is coupled to the second coupling member 64B by means of a pin 64C inserted into a long hole, such that the first coupling member 64A can swing.

[0082] As seen from Fig. 6 (and Fig. 7), the lifting mechanism for the liftable deck 35 includes a supporting frame 65; a pair of first and second linear guides 68A, 68B each of which is comprised of a table 66 and a vertically extending rail 67; and a laterally extending coupling frame 69. Although the supporting frame 65 described herein has the form of a substantially rectangular ring and is constituted by a pair of first and second frames 65A, 65B that are laterally extending and a pair of third and fourth frames 65C, 65D that are vertically extending, the configuration of the supporting frame 65 is not necessarily limited to this. The supporting frame 65 may have, for example, a curb-like shape.

[0083] The second coupling member 64B is fixed, by use of suitable fixing means (such as bolts), to the second frame 65B of the supporting frame 65 at a position that is substantially the center of the second frame 65B with respect to a lateral direction. The rails 67 of the first and

second linear guides 68A, 68B are fixed, by use of suitable fixing means (such as bolts), to the third and fourth frames 65C, 65D, respectively, of the supporting frame 65. The tables 66 of the first and second linear guides 68A, 68B are fixed, by use of suitable fixing means (such as supporting members and bolts), to desired right and left positions, respectively, of the coupling frame 69. The coupling frame 69 is fixed to the tiltable floor 34, using suitable fixing means (such as supporting members and bolts (not shown)).

[0084] The liftable deck 35 is supported by the first frame 65A of the supporting frame 65 through the sliding mechanism (the details of which will be described later), and the details of such a supporting structure for the liftable deck 35 will be described later.

[0085] In the above configuration, when the screw shaft 70A of the second electric cylinder 70 starts its expansion stroke, the first rotation supporting point 61 located at one end of the substantially C-shaped bracket board 60 is pushed forward and diagonally downward by the driving force of the second electric cylinder 70 (see dotted arrow 500 in Fig. 6). Then, the entire part of the bracket board 60 rotates about the second rotation supporting point 62 located at the bend of the bracket board 60 (see dotted arrow 501 in Fig. 6), which causes the third rotation supporting point 63 at the other end of the bracket board 60 to move upward (see dotted arrow 502 in Fig. 6).

[0086] As the entire part of the bracket board 60 rotates, the third rotation supporting point 63 slightly moves forward. Such a forward movement of the third rotation supporting point 63 is performed by the swinging movement of the first coupling member 64A about the pin 64C (see Fig. 8).

[0087] The third rotation supporting point 63 of the bracket board 60 moves upward as described above, which causes the entire part of the supporting frame 65 to slide upward, being guided by the first and second linear guides 68A, 68B. In consequence, the liftable deck 35 is lifted (see two-dot chain arrow 503 in Fig. 6).

[0088] After the liftable deck 35 is lifted, the screw shaft 70A of the

second electric cylinder 70 starts its contraction stroke, thereby lowering the supporting frame 65 and the liftable deck 35. The behavior of each part of the lifting mechanism at that moment can be easily understood by consideration of the above description. Therefore, a description of the operation of the lifting mechanism in the case of lowering the liftable deck 35 is omitted herein.

[0089] Accordingly, in the boarding bridge 20 of this embodiment, the liftable deck 35 is configured to be properly lifted by the lifting mechanism for the liftable deck 35.

[0090] [Swinging Mechanism for Driven Slope 36]

Next, the swinging mechanism for the driven slope 36 will be described in detail.

[0091] As shown in Figs. 3 and 6, the front end (fixed end) of the plate-like driven slope 36 is coupled to the rear end of the liftable deck 35 through a third coupling hinge 50 (coupling swinging shaft) such that the driven slope 36 can freely swing. In this configuration, the third coupling hinge 50 linearly extends to the right and left ends of the liftable deck 35 (driven slope 36) in a direction crossing the walking direction 200 (a direction crossing the walking direction 200 substantially at right angles in this embodiment).

[0092] In addition, the driven slope 36 is configured to relatively swing about the third coupling hinge 50 relative to the liftable deck 35. In a free state, the rear end (free end) of the driven slope 36 may sit on the tiltable floor 34 owing to the effect of gravity (own weight) of the driven slope 36, for example, as shown in the fragmentary view 6A of Fig. 6.

[0093] As described above, the liftable deck 35 is lifted (see two-dot chain arrow 503 in Fig. 6), causing the third coupling hinge 50 to be lifted, so that the tilt angle ϕ of the driven slope 36, which corresponds to the angle between the main surface of the liftable deck 35 and the main surface of the driven slope 36, continuously increases. At the same time, the rear end of the driven slope 36 moves forward (see two-dot chain arrow 504 in the fragmentary view 6A) while sliding over the tiltable floor 34 as illustrated in the fragmentary view 6A of Fig. 6.

[0094] On the other hand, when the liftable deck 35 is lowered after lifting the liftable deck 35, the third coupling hinge 50 lowers, so that the tilt angle ϕ of the driven slope 36 continuously decreases. At the same time, the rear end of the driven slope 36 moves backward, while sliding over the tiltable floor 34.

[0095] In the boarding bridge 20 of this embodiment, the lifting and lowering of the liftable deck 35 causes changes in the tilt angle ϕ of the driven slope 36 (in other words, it causes the driven slope 36 to relatively swing in relation to the liftable deck 35), so that the rear end of the driven slope 36 moves back and forth in the longitudinal direction. In this configuration, the driven slope 36 provides a rampway between the liftable deck 35 and the tiltable floor 34 (walkway 31).

[0096] Although the above description is associated with one example of the supporting structure for the rear end of the driven slope 36 according to which the rear end of the driven slope 36 sits on the tiltable floor 34 when it is in a free state, the supporting structure is not necessarily limited to this. In the case which is shown in Figs. 11A and 11B and described later, another example is adopted as the supporting structure for the rear part of the driven slope 36. In both cases, the rear end of the driven slope 36 is designed to be freely movable in a longitudinal direction (walking direction 200) along the main surface of the tiltable floor 34.

[0097] [Sliding Mechanism for Liftable Deck 35]

Next, the sliding mechanism for the liftable deck 35 will be described in detail.

[0098] As illustrated in Figs. 6 and 7, the sliding mechanism for the liftable deck 35 includes a third linear guide 83 constituted by a table 80 and a rail 81 extending in a longitudinal direction; and a pair of first and second biasing mechanisms 86A, 86B supported by the table 80 of the third linear guide 83.

[0099] The rear end of the central portion of the table 80 is provided with a cutout portion 80A (see Fig. 7) for preventing contacting interference by the bracket board 60.

[0100] The rail 81 of the third linear guide 83 is fixed to the first frame 65A of the supporting frame 65 by use of suitable fixing means (such as supporting members and bolts (not shown)).

[0101] *The first and second biasing mechanisms 86A, 86B each have a columnar spring shaft 85 extending in the longitudinal direction; a spring 84 (elastic body) fit in an area around the spring shaft 85; and a pair of stopper members 87, 88 which come into contact with the end of the spring 84.*

[0102] Both ends of the spring shaft 85 are each threaded and provided with a suitable fixing means (such as a nut) threadedly engaged therewith, whereby the movement of the stopper members 87, 88 in the longitudinal direction can be regulated.

[0103] The stopper member 88 located at the rear end of the spring 84 is fixed to the table 80 of the third linear guide 83 by use of suitable fixing means (such as bolts). On the other hand, the stopper member 87 located at the front end of the spring 84 is fixed to the rear surface of the liftable deck 35 by use of suitable fixing means (such as supporting members and bolts).

[0104] Specifically, the liftable deck 35 is mounted on the table 80 through the first and second biasing mechanisms 86A, 86B. Therefore, when the table 80 slides in the longitudinal direction, the liftable deck 35 (and the driven slope 36 coupled to the liftable deck 35) slides in the longitudinal direction. The biasing function of the first and second biasing mechanisms 86A, 86B will be described later.

[0105] The sliding mechanism for the liftable deck 35 includes a driving mechanism capable of applying a longitudinal slide driving force to the table 80.

[0106] More concretely, the driving mechanism includes, as illustrated in Fig. 7, a motor 89A and a rack-and-pinion mechanism comprised of a pinion gear (not shown) coupled to the rotary shaft of the motor 89A and a rack 89B fixed to the table 80.

[0107] With such a rack-and-pinion mechanism, the torque of the motor 89A is converted into a longitudinal linear kinetic force for the table 80.

As a result, the longitudinal slide driving force is applied to the table 80.

[0108] In addition, the sliding mechanism for the liftable deck 35 includes, as illustrated in Fig. 7, a pair of fourth and fifth linear guides 92A, 92B each of which is comprised of a table 90 and a longitudinally extending rail 91.

[0109] The fourth linear guide 92A is located in the proximity of the third frame 65C of the supporting frame 65 and the rail 91 of the fourth linear guide 92A is fixed to the third frame 65C by use of suitable means (such as frames). The fifth linear guide 92B is located in the proximity of the fourth frame 65D of the supporting frame 65 and the rail 91 of the fifth linear guide 92B is fixed to the fourth frame 65D by use of suitable means (such as frames). Further, the liftable deck 35 is supported by the respective tables 90 of the fourth and fifth linear guides 92A, 92B.

[0110] With this configuration, the longitudinal sliding movement of the liftable deck 35 is stably performed while the liftable deck 35 is properly supported.

[0111] In the boarding bridge 20 of this embodiment, the liftable deck 35 is allowed to slide in the longitudinal direction by use of the sliding mechanism for the liftable deck 35 as described above, while being supported to the supporting frame 65 through the sliding mechanism.

[0112] [Example of Operation for Connecting Boarding Bridge 20 to Entrance 11A of Aircraft 11]

Next, one example of the operation for connecting the boarding bridge 20 of this embodiment to the entrance 11A of the aircraft 11 will be described.

[0113] Figs. 8 and 9 are views for use in describing one example of the operation for connecting the boarding bridge of the embodiment of the invention to the entrance of the aircraft. Fig. 8 shows a state in which the connection of the liftable deck 35 to the entrance 11A of the aircraft 11 has been halfway done, whereas Fig. 9 shows a state in which the connection of the liftable deck 35 to the entrance 11A of the aircraft 11 has been completed.

[0114] The operation for connecting the boarding bridge 20 of this

embodiment to the entrance 11A of the aircraft 11 is performed in the following way.

[0115] Firstly, the cab 26 (fixed passage 32) is allowed to rotate about the vertical axis 26A. At the same time, the adjustment passage 33 swings from side to side.

[0116] Subsequently, the boarding bridge 20 is allowed to get close to the aircraft 11 by moving the drive columns in such a way that the bumper 40 of the boarding bridge 20 is brought into contact with the aircraft 11. If the edge of the floor of the liftable deck 35 is not parallel to the edge of the floor section 11B of the entrance 11A of the aircraft 11 at that time, these edges can be made parallel to each other by use of the tiltable floor 34.

[0117] Since the liftable deck 35 of the boarding bridge 20 is located at a position lower than the floor section of the entrance 11A in this stage, the door of the entrance 11A of the aircraft 11 can be opened.

[0118] After the door of the entrance 11A of the aircraft 11 is opened, the liftable deck 35 is moved (lifted) to the same height as the floor section 11B of the entrance 11A of the aircraft 11 by means of the lifting mechanism for the liftable deck 35 as illustrated in Figs. 8 and 9 (lifting movement), and at the same time, the synthetic rubber bumper 51 is brought into contact with the floor section 11B of the entrance 11A of the aircraft 11 by means of the sliding mechanism for the liftable deck 35.

[0119] As shown in Fig. 3, the liftable deck 35 has the bumper 51 which is attached to the front end of the liftable deck 35 so as to extend throughout the length of the front end with respect to the width direction 300. Therefore, the shock occurring when the liftable deck 35 comes into contact with the entrance 11A of the aircraft 11 can be cushioned by the bumper 51. At that time, the tilt angle ϕ of the driven slope 36 automatically varies as the liftable deck 35 rises or lowers, so that the rear end of the driven slope 36 moves over the tiltable floor 34. In addition, as the liftable deck 35 moves in the longitudinal direction, the rear end of the driven slope 36 moves over the tiltable floor 34.

[0120] Next, the surrounding structure of the liftable passage 21 will be

described in detail with reference to the drawings. Fig. 10 is a plan view illustrating the details of the liftable passage 21 and its peripheral part.

[0121] The sheet-like guard plates (protective members) 101A, 101B are stored at the left and right sides, respectively, of the liftable passage 21 so as to be projectable upwardly from the passage surface of the liftable passage 21, and the guard covers 131A, 131B are provided in order to lid the outlets/entrances for the guard plates 101A, 101B respectively. The guard covers 131A, 131B are opened upward, exposing the outlets/entrances immediately after the liftable deck 35 has started to rise, and the guard plates 101A, 101B rise through these exposed outlets/entrances. When the liftable deck 35 lowers from the lifted state, the guard plates 101A, 101B descend with the guard covers 131A, 131B being closed just before completion of the lowering of the liftable deck 35, so that the initial condition is restored.

[0122] The two, left and right guard plates 101A, 101B and their driving mechanisms respectively have bilateral symmetry, and the two, left and right guard covers 131A, 131B and their driving mechanisms respectively have bilateral symmetry. Therefore, one guard plate 101A and one guard cover 131A will be explained whereas explanation of the other guard plate 101B and the other guard cover 131B will be omitted in the following description.

[0123] [Lifting Mechanism for Guard Plate]

Next, a guard plate lifting mechanism (first link mechanism) will be described in detail.

[0124] Fig. 11A is a view showing one constitutional example of the lifting mechanism for the guard plate 101A, which view is taken in the direction of arrows A of Fig. 10, whereas Fig. 11B is a view showing the constitutional example of the lifting mechanism for the guard plate 101A, which view is taken in the direction of arrows C of Fig. 11A.

[0125] A supporting plate 102 is fixed to a side plate 36A of the driven slope 36 by use of suitable fixing means (such as bolts (not shown)). Fixed to the front and rear portions, respectively, of the supporting plate 102 are rails 105, 108 provided in linear guides 106, 109 which rails are

parallel to each other and extend in a direction perpendicular to the main surface of the driven slope 36. Two tables 103, 104 provided in the linear guide 106 and a table 107 provided in the linear guide 109 are respectively fixed in place to the guard plate 101A. This allows the guard plate 101A to be attached so as to be slidable in a direction perpendicular to the main surface of the driven slope 36. In addition, an operating section 110, which has a groove extending in the longitudinal direction, is fixed in place to the substantially central portion of the guard plate 101A.

[0126] A T-shaped member 111, which is constituted by a first member 111A and a second member 111B fixed to the first member 111A, is coupled to the supporting plate 102 through a fifth rotation supporting point 113. More specifically, the T-shaped member 111 is attached to the supporting plate 102 so as to be freely pivotable about the fifth rotation supporting point 113. One end of the first member 111A of the T-shaped member 111 is slidably fitted in the groove through a cam follower 112, the groove being formed in the operating section 110, extending in the longitudinal direction. The other end of the first member 111A has a roller 114 attached thereto.

[0127] A regulating plate 118, which comes into contact with the roller 114 when the guard plate 101A is in its stored state, is fixed to the coupling frame 69 by use of suitable fixing means (such as supporting members and bolts).

[0128] A biasing means 117 is coupled, at one end, to the leading end of the second member 111B of the T-shaped member 111 through a sixth rotation supporting point 115, and, at the other end, to a desired position of the supporting plate 102 through a seventh rotation supporting point 116. More specifically, one end of the biasing means 117 is pivotally attached to the leading end of the second member 111B whereas the other end thereof is pivotally attached to a desired position of the supporting plate 102. The biasing means 117 is designed to bias in a direction in which the biasing means 117 itself expands and one example of the biasing means 117 is, for example, a gas spring. The biasing

means 117 described herein is designed to apply a force to the T-shaped member 111 to cause the T-shaped member 111 to pivot about the fifth rotation supporting point 113 counterclockwise in Fig. 11A. The pivotal movement of the T-shaped member 111 is inhibited by the regulating plate 118, in the state shown in Fig. 11A.

[0129] As has been described, as the liftable deck 35 starts to rise, followed by rising of the front portion of the driven slope 36, the supporting plate 102 fixed to the driven slope 36 starts to rise. Then, the T-shaped member 111 starts to pivot counterclockwise in Fig. 11A about the fifth rotation supporting point 113, while the biasing means 117 pressing the roller 114 against the regulating plate 118. Subsequently, the cam follower 112 located at the rear end of the T-shaped member 111 moves upward (pivoting) so that the operating section 110 coupled to the cam follower 112 moves upward. At that time, the guard plate 101A fixed to the operating section 110 moves upward while being guided by the linear guides 106, 109, so that the upper portion of the guard plate 101A becomes higher than (projects from) the main surface of the driven slope 36.

[0130] Fig. 12 shows one example of the state in which the guard plate 101A projects to a maximum extent.

[0131] After the liftable deck 35 has been lifted, the front portion of the driven slope 36 subsequently rises so that the driven slope 36 inclines, for example, as shown in Fig. 12.

[0132] As described earlier, the T-shaped member 111 pivots counterclockwise about the fifth rotation supporting point 113. Subsequently, the operating section 110 moves upwards as illustrated in Fig. 12, coming into contact with the supporting plate 102, so that the pivotal movement of the T-shaped member 111 is interrupted. At that time, the upper portion of the guard plate 101A is brought into a state (complete projection state) in which it projects upward from the main surface of the driven slope 36. After the liftable deck 35 is further lifted, the roller 114 moves away from the regulating plate 118 while the complete projection state being kept and the front portion of the driven

slope 36 is further lifted. The state at that time is shown in Fig. 12.

[0133] A supporting member 36B for supporting the rear portion of the driven slope 36 is attached to the underside of each of the right and left sides of the rear portion of the driven slope 36, and a roller 36C, which travels on a rail 34B, is rotatably attached to the rear end of the supporting member 36B. Disposed under the tiltable floor 34 is the rail 34B which extends in the longitudinal direction in parallel with the main surface of the tiltable floor 34. This rail 34B is fixed to the tiltable floor 34, by use of suitable fixing means (such as supporting members and bolts (not shown)). More specifically, the front end of the driven slope 36 is pivotally attached to the liftable deck 35, whereas the rear portion of the driven slope 36 is supported by the roller 36C so as to be movable on the rail 34B in the longitudinal direction. Accordingly, the driven slope 36 is configured such that its rear end 36e is freely movable in the longitudinal direction (walking direction 200) along the main surface of the tiltable floor 34.

[0134] Suppose that a linear line is depicted in Fig. 11A, which passes through the edge of the rear end of the driven slope 36 and is perpendicular to the main surface of the tiltable floor 34. The center of the roller 36C is located slightly behind this linear line. With this configuration, when the liftable deck 35 is lifted accompanied by tilting of the driven slope 36, the edge of the rear end of the driven slope 36 is not pressed against the tiltable floor 34, but an extremely small gap is created between the edge of the rear end of the driven slope 36 and the tiltable floor 34. This gap is limited to the point that the difference in level between the edge of the rear end of the driven slope 36 and the tiltable floor 34 is virtually unnoticeable.

[0135] This allows the rear end 36e of the driven slope 36 to move on the main surface of the tiltable floor 34 in the longitudinal direction with the extremely small gap existing between the rear end 36e and the main surface, not only when the liftable deck 35 is lifted but also when the liftable deck 35 moves in the longitudinal direction after lifted. Therefore, damage to the main surface of the tiltable floor 34 can be

prevented, compared to the case where the rear end of the driven slope 36 moves, sliding over the tiltable floor 34 as illustrated in the fragmentary view 6A of Fig. 6.

[0136] When the liftable deck 35 moves forward from the state shown in Fig. 12, the guard plate 101A moves forward together with the driven slope 36, while keeping the tilted condition shown in Fig. 12.

[0137] When the state shown in Fig. 11A is restored from the state shown in Fig. 12, the liftable deck 35 is lowered. At that time, the tilt angle of the guard plate 101A is gradually reduced together with that of the driven slope 36, during the lowering of the liftable deck 35. After the roller 114, attached to the T-shaped member 111, has come into contact with the regulating plate 118, the lowering of the driven slope 36 causes the T-shaped member 111 to pivot clockwise so that the guard plate 101A lowers relative to the driven slope 36. Upon completion of the lowering of the liftable deck 35, the state shown in Fig. 11A is restored.

[0138] The lifting mechanism for the right guard plate 101B has the same structure as the one described above and therefore the left and right guard plates 101A, 101B are configured to perform the same operation at the same time.

[0139] Although the embodiment described herein is associated with a configuration in which the guard plates 101A, 101B are operated in conjunction with the lifting operation of the liftable passage 21 (operation of the driven slope 36), a dedicated driving mechanism used for independently operating the guard plates 101A, 101B may be additionally employed. However, the configuration described herein can eliminate the need for a dedicated driving mechanism used for guard plates.

[0140] [Opening/closing Mechanism for Guard Cover]

Next, an opening/closing mechanism (second link mechanism) for a guard cover (lid) will be described in detail.

[0141] As illustrated in Fig. 10, the guard cover 131A is constituted by a long hinge extending along the left side portion of the liftable passage 21. Similarly, the guard cover 131B is constituted by a long hinge extending

along the right side portion of the liftable passage 21.

[0142] Figs. 13A and 13B are views showing one constitutional example of the opening/closing mechanism for the guard cover 131A which views are taken in the direction of arrows B of Fig. 10. Specifically, Fig. 13A illustrates a condition where the guard cover 131A is closed whereas Fig. 13B illustrates a condition where the guard cover 131A is opened. Fig. 14A is a view showing the constitutional example of the opening/closing mechanism for the guard cover 131A, which view is taken in the direction of arrows D of Fig. 13A, whereas Fig. 14B is a view showing the constitutional example of the opening/closing mechanism for the guard cover 131A, which view is taken in the direction of arrows E of Fig. 13A. Note that the roller 137 is omitted in Fig. 14A.

[0143] An attachment plate 139 is fixed to the housing 40A for the bumper 40 provided in the tiltable floor 34, by use of two bolts 142.

[0144] One of the two blades of the hinge that constitutes the guard cover 131A is fixed to the tiltable floor 34 with a bolt or the like, whereas a small rectangular coupling member 132 is fixed to the underside of the other blade with a bolt or the like. The underside of the coupling member 132 is coupled to the coupling member 134 with a spring hinge 133. This spring hinge 133 houses a spring used for biasing the guard cover 131A in a direction in which it opens.

[0145] As illustrated in Fig. 14A, the coupling member 134 has a first surface portion 134a and a second surface portion 134b which are perpendicular to each other and the spring hinge 133 is mounted on the upper portion of the first surface portion 134a. Fixed to the upper portion of the second surface portion 134b is a spring mounting part 134d to which the upper end of a spring 135 is attached. The lower portion of the second surface portion 134b is provided with a small long hole 134c through which a spring mounting part 136a passes, the spring mounting part 136a being fixed to one end of an L-shaped member 136. Attached to this spring mounting part 136a is the lower end of the spring 135.

[0146] The L-shaped member 136 is attached, at a corner portion 138

thereof, to the attachment plate 139 such that the L-shaped member 136 is freely pivotable. Fixed to the other end of the L-shaped member 136 is a spring mounting part 136b to which one end of a spring 140 is attached. The other end of the spring 140 is attached to a spring mounting part 139a fixed to the attachment plate 139.

[0147] The L-shaped member 136 has a roller 137 that is pivotally mounted to a desired position between the spring mounting part 136a and the corner portion 138. As illustrated in Fig. 14B, this roller 137 is pressed from above by the bumper 51 of the liftable deck 35 when the guard cover 131A is closed. As illustrated in Fig. 13B, a stopper member 141 is attached to the attachment plate 139, for inhibiting further pivotal movement of the L-shaped member 136 when the guard cover 131A is opened by pivoting of the L-shaped member 136.

[0148] For example, when the liftable deck 35 is in its stored state (where it is lowered to a maximum extent) as shown in Fig. 13A, the roller 137 is pressed from above by the bumper 51 of the liftable deck 35 as stated earlier. However, when the liftable deck 35 starts to rise, the bumper 51 also rises, so that the pull force of the spring 140 causes the L-shaped member 136 to pivot on the corner portion 138 in a direction in which the roller 137 rises. Then, the coupling member 134 and the spring hinge 133 attached thereto are pushed up while the guard cover 131A is opened as shown in Fig. 13B by the biasing force of the spring hinge 133. Even if the liftable deck 35 further rises, the guard cover 131A is kept in the opened state shown in Fig. 13B.

[0149] When the liftable deck 35 lowers from the lifted state, the bumper 51 of the liftable deck 35 comes into contact with the roller 137 upon the liftable deck 35 reaching the position shown in Fig. 13B. Furthermore, the lowering of the liftable deck 35 causes the L-shaped member 136 to pivot in the direction in which the roller 137 descends, which causes lowering of the coupling member 134 and the spring hinge 133. Upon completion of the lowering of the liftable deck 35, the state shown in Fig. 13A is established.

[0150] The opening/closing mechanism for the right guard cover 131B

has the same structure as the one described above and the left and right guard covers 131A, 131B are configured to perform the same operation at the same time.

[0151] More specifically, after the liftable deck 35 has started to rise from its stored state, the left and right guard covers 131A, 131B start to open, while the front portion of the driven slope 36 being uplifted. As a result, the left and right guard plates 101A, 101B start to rise. The left and right guard covers 131A, 131B are configured to open quickly at that time in order not to come into contact with the left and right guard plates 101A, 101B.

[0152] In the case where the liftable deck 35 lowers from its lifted state, the left and right guard plates 101A, 101B start to close just before completion of the lowering of the liftable deck 35 after storing of the left and right guard plates 101A, 101B starts. The left and right guard covers 131A, 131B are configured to close slowly at that time in order not to come into contact with the left and right guard plates 101A, 101B.

[0153] As described above, the boarding bridge 20 of this embodiment has the walkway 31 and the liftable passage 21 which is located within the plane of the walkway 31 when its plan view is viewed and which can be lifted and lowered in order that it is connected to the entrance 11A of the aircraft 11. The liftable passage 21 includes a front end (one end (e.g., the front end of the liftable deck 35)) to be connected to the entrance 11A and a rear end (the other end located away from the one end (e.g., the rear end 36e of the driven slope 36)) which is different from and opposite to the front end. The boarding bridge 20 is configured such that, when the liftable passage 21 is lifted, the front end rises while the rear end being kept in a condition in which substantially no level difference exists between the rear end and the walkway 31 (tiltable floor 34), whereby a passage, including a rampway located between the front end and the rear end and having no step-like level difference, is formed. This rampway is higher at its forepart (i.e., the part located on the side of the front end) than at its posterior part (i.e., the part located on the side of the rear end).

[0154] The liftable passage 21 described herein includes, for example, the liftable deck 35 used for connection to the entrance 11A of the aircraft 11; the lifting mechanism for lifting the liftable deck 35; and the driven slope 36 the fixed end of which is coupled to the liftable deck 35 by use of the third coupling hinge 50 whereas its free end (the rear end 36e) is freely movable in the walking direction 200 along the main surface of the tiltable floor 34. As the liftable deck 35 moves, the driven slope 36 rotates about the axis of the third coupling hinge 50 while the rear end 36e moving in the walking direction 200 along the main surface of the tiltable floor 34, so that the driven slope 36 forms a continuous rampway between the liftable deck 35 and the walkway 31 (tiltable floor 34).

[0155] With the above configuration, the level difference between the floor section 11B of the entrance 11A and the liftable passage 21 (e.g., the liftable deck 35) of the boarding bridge can be eliminated so that a continuous passageway can be formed between them.

[0156] Accordingly, the boarding bridge 20 of this embodiment provides no level difference relative to the entrance 11A of the aircraft 11 and does not need to lift or lower the liftable passage 21 (liftable deck 35) whenever passengers, for example, a passenger in wheelchair, embarks onto or disembark from the aircraft 11, which leads to smooth embarkation and disembarkation of the passengers.

[0157] In particular, the boarding bridge 20 of this embodiment is designed to adjust the height of the liftable deck 35 through the simple up-and-down movement of the liftable deck 35, which enables it to keep the liftable deck 35 substantially horizontal without tilting the floor of the liftable deck 35. This provides such an advantage that positioning of the liftable deck 35 relative to the floor section 11B of the entrance 11A can be easily performed.

[0158] The configuration of the liftable passage 21 is not necessarily limited to the one described herein above in which the liftable passage 21 includes the liftable deck 35 and the driven slope 36. For example, an alternative configuration is such that when the liftable passage 21 is

lifted, one end (front end) to be connected to the entrance 11A rises, while the other end (rear end), which is located away from the one end, being kept in a condition in which substantially no level difference exists between the rear end and the walkway 31 (tiltable floor 34), so that a rampway is formed between the one end and the other end.

[0159] In the boarding bridge 20 of this embodiment, the liftable deck 35 has the sliding mechanism for sliding the liftable deck 35 in the passenger walking direction. The liftable deck 35 is moved to the same height as the floor section 11B of the entrance 11A by the lifting mechanism and brought into contact with the entrance 11A by the sliding mechanism.

[[0160] With the above configuration, the liftable deck 35 can be slid by the sliding mechanism to the position where it comes into contact with the entrance 11A even if a slight gap is created between the liftable deck 35 and the entrance 11A of the aircraft 11, and therefore not only a level difference but also such a gap can be eliminated.

[0161] In addition, the boarding bridge 20 of this embodiment has the sheet-like guard plates 101A, 101B that project, as protective members, upwardly from the passage surface of the liftable passage 21 along the left and right sides, respectively, of the liftable passage 21 when the liftable passage 21 is lifted.

[0162] The above configuration eases, for example, the anxiety of a wheelchair passenger who worries that his wheelchair would run off the liftable passage 21.

[0163] In addition, since the guard plates 101A, 101B are configured to operate in conjunction with the rising/lowering movement of the liftable passage 21 (i.e., the tilting movement of the driven slope 36 following the rising/lowering movement of the liftable deck 35), there is no need to employ a dedicated driving mechanism used for operating the guard plates 101A, 101B.

[0164] Besides, the guard covers 131A, 131B act as lids for covering the respective upper ends of clearances between the sides of the liftable passage 21 and the tiltable floor 34, the clearances serving as the

entrances/outlets for the guard plates 101A, 101B. This prevents penetration of dust or the like into the above clearances. Further, since the guard covers 131A, 131B are configured to operate in conjunction with the rising/lowering movement of the liftable passage 21 (the rising/lowering movement of the liftable deck 35), the need for a dedicated driving mechanism used for operating the guard covers 131A, 131B can be eliminated.

[0165] In the boarding bridge 20 of this embodiment, the walkway 31 has the tiltable floor 34 for adjusting the widthwise inclination of the liftable deck 35 and the driven slope 36 and the tilting mechanism for tilting the tiltable floor 34 in the width direction 300. When viewing a plan view of the tiltable floor 34, the liftable deck 35 and the driven slope 36 are mounted within the plane of the tiltable floor 34.

[0166] The above configuration makes it possible to parallelize the edge of the floor of the liftable deck 35 and the edge of the floor section 11B of the entrance 11A of the aircraft 11 by use of the tiltable floor 34 if they are not parallel to each other. In the boarding bridge 20 of this embodiment, such parallelism adjustment for the liftable deck 35 and the entrance 11A by the tiltable floor 34 can be performed even during the movement of the drive columns of the boarding bridge 20. This particularly enables effective connection between the liftable deck 35 and the entrance 11A.

[0167] In the boarding bridge 20 of this embodiment, a force for biasing the liftable deck 35 (bumper 51) to the aircraft 11 is generated by sliding the table 80 by use of the first and second biasing mechanisms 86A, 86B of the sliding mechanism such that the liftable deck 35 is further pressed against the entrance 11A from the position where the bumper 51 of the liftable deck 35 is in contact with the entrance 11A. More specifically, by sliding the table 80 such that the liftable deck 35 is pressed against the entrance 11A from the above-described contact position, the stopper member 88 is allowed to move forward along the spring shaft 85, acting against the reactive force of the spring 84 as shown in Figs. 8 and 9. Then, the stopper members 87, 88 compress the spring 84 and, the force

for biasing the liftable deck 35 (bumper 51) to the aircraft 11 is generated based on the reactive force of the spring 84.

[0168] With the above configuration, in the boarding bridge 20 of this embodiment, even if the gap between the liftable deck 35 (bumper 51) and the entrance 11A (outer wall) of the aircraft 11 varies owing to the ups and downs of the aircraft 11 caused by passenger embarkation and disembarkation, the liftable deck 35 (bumper 51) can be moved back and forth by the function of the first and second biasing mechanisms 86A, 86B of the sliding mechanism so as to compensate for the ups and downs of the aircraft 11, so that occurrence of the gap can be properly prevented.

[0169] As this invention may be embodied in several forms without departing from the spirit of essential characteristics thereof, the present embodiments are therefore illustrative and not restrictive, since the scope of the invention is defined by the appended claims rather than by the description preceding them, and all changes that fall within metes and bounds of the claims, or equivalence of such metes and bounds thereof are therefore intended to be embraced by the claims.

CLAIMS

1. A boarding bridge comprising:

a walkway;

a liftable passage;

which is located within a plane of the walkway when its plan view is viewed and can be lifted and lowered in order that it is connected to an entrance of a mobile object; and

which is configured such that when lifted, one end to be connected to the entrance rises, while the other end, located away from the one end, being kept in a condition in which substantially no level difference exists between the other end and the walkway, whereby a passage including a rampway located between the one end and the other end and having no step-like level difference is formed, and

a protective member which projects upward along a side of the liftable passage when the liftable passage is lifted,

wherein the protective member is operated in conjunction with the lifting operation of the liftable device.

2. The boarding bridge according to Claim 1,

wherein the protective member is configured to move to a position higher than a passage surface of the liftable passage when the liftable passage is lifted and to be retracted to a position of the same height as the passage surface of the liftable passage or a lower position when the liftable passage is lowered.

3. The boarding bridge according to Claim 1 or 2, further comprising:

a first link mechanism for coupling the protective member to the liftable passage in order to move the protective member upward and downward, in accordance with rising and lowering of the liftable passage, such that when the liftable passage is lifted, the protective member moves to a position higher than the passage surface of the liftable passage and when the liftable passage is lowered, the protective member is retracted to a position of the same height as the passage surface of the liftable passage or a lower position.

4. The boarding bridge according to Claim 2 or 3,
wherein a clearance portion is provided between a side of the liftable passage and the walkway to accommodate the protective member, and
which further comprises a lid for covering the upper end of the clearance portion when the protective member is retracted to the position of the same height as the passage surface of the liftable passage or a lower position.
5. The boarding bridge according to Claim 4, further comprising:
a second link mechanism for coupling the lid to the liftable passage in order to open or close the lid in accordance with rising and lowering of the liftable passage such that when the liftable passage starts to rise, the lid is opened thereby opening the upper end of the clearance portion and when the liftable passage is lowered with the protective member being retracted to the position of the same height as the passage surface of the liftable passage or a lower position, the lid is closed.
6. The boarding bridge according to any one of the preceding Claims,
wherein the liftable passage comprising:
a liftable deck including the one end to be connected to the entrance of the mobile object;
a lifting mechanism for lifting and lowering the liftable deck;
and
a driven slope having a fixed end pivotally attached to the liftable deck and a free end that serves as the other end and is freely movable in a passenger walking direction along a main surface of the walkway,
wherein the free end moves along the main surface of the walkway as the liftable deck moves, thereby forming the rampway between the liftable deck and the walkway,
wherein the protective member is provided at both sides of the liftable passage.

7. The boarding bridge according to Claim 6,
wherein the liftable deck includes a sliding mechanism capable of sliding in the passenger walking direction, and
wherein the liftable deck is configured to be moved to a position of the same height as a floor of the entrance by the lifting mechanism and to be brought into contact with the entrance by the sliding mechanism.
8. The boarding bridge according to Claim 6 or 7,
wherein the walkway comprising:
a tiltable floor for adjusting the inclination of the liftable deck and the driven slope in a width direction and
a tilting mechanism for tilting the tiltable floor in the width direction,
wherein the liftable deck and the driven slope are mounted within a plane of the tiltable floor when a plan view of the tiltable floor is viewed.