

DESCRIPTION

Title of Invention: PASSENGER BOARDING BRIDGE

Technical Field

[0001] The present disclosure relates to a passenger boarding bridge.

Background Art

[0002] A passenger boarding bridge is known as boarding/disembarking equipment for passengers, which is used between an aircraft and a terminal building of an airport. The cab of the passenger boarding bridge is brought into connection with the entrance of the aircraft. At the time, the passenger boarding bridge is used to form a passenger walkway to the aircraft.

[0003] Specifically, the passenger boarding bridge includes a tunnel unit including a plurality of tunnels that are fitted together in a nested manner, and drive columns are coupled to a suitable part of the tunnel unit in a manner to sandwich the tunnel unit from both the right and left sides. When tires of a drive device provided at the lower end of the drive columns run on the apron ground, motive power for expanding or contracting movement in the front-rear direction and/or motive power for horizontal movement is/are applied to the tunnel unit. When the overall length of the tunnel unit is expanded as a result of the application of the motive power, the cab disposed at the front end of the tunnel unit is brought into connection with the entrance of the aircraft.

[0004] At the time, if the aircraft moves upward or downward due to boarding or disembarking of passengers and the like, a vertical expansion/contraction mechanism of the drive columns is controlled such that the cab follows the upward or downward movement of the aircraft. For example, Patent Literatures 1 and 2 propose automatic levelers for performing such control. Such an automatic leveler has a function of detecting a vertical moving amount of an aircraft. With this function, the amount of deviation in a relative distance between the floor surface of the cab and the floor surface of the entrance of the aircraft can be detected. When the detected amount of deviation in the relative distance is greater than or equal to a predetermined value, the drive columns are controlled such that the cab follows upward/downward movement of the aircraft.

Citation List

Patent Literature

[0005] PTL 1: Japanese Patent No. 2747906

PTL 2: Japanese Examined Utility Model Application Publication No. H03-49999

Summary of Invention**Technical Problem**

[0006] However, the above conventional art does not fully consider factors that cause a change in the relative distance between the floor surface of the entrance of the aircraft and the floor surface of the cab, and also, even if the relative distance has changed, in some cases, it is not appropriate to operate the drive columns. More details in this respect will be given in an embodiment described below.

[0007] One aspect of the present disclosure has been made in view of the above, and provides a passenger boarding bridge that is capable of causing a cab connected to the entrance of an aircraft to follow upward/downward movement of the aircraft in a more appropriate manner than the conventional art.

Solution to Problem

[0008] In order to solve the above-described problems, a passenger boarding bridge according to one aspect of the present disclosure includes: a rotunda connected to a terminal building; a tunnel unit connected to the rotunda, such that the tunnel unit is liftable and lowerable; a lifting/lowering device configured to support the tunnel unit such that the tunnel unit is lifted or lowered; a cab provided at a front end of the tunnel unit; a distance measuring device configured to measure a reference distance from a ground to the cab or the tunnel unit; a level measuring device configured to measure, after the cab is connected to an entrance of an aircraft, an amount of deviation in a relative distance between a floor surface of the entrance of the aircraft and a floor surface of the cab; and a control device configured to control the lifting/lowering device based on a measurement value of the distance measuring device and a measurement value of the level measuring device, such that the cab connected to the entrance of the aircraft follows upward/downward movement of the aircraft.

Advantageous Effects of Invention

[0009] The passenger boarding bridge according to the one aspect of the present disclosure provides an advantage of being able to cause the cab connected to the entrance of the aircraft to follow upward/downward movement of the aircraft in a more appropriate manner than the conventional art.

Brief Description of Drawings

[0010] Fig. 1 shows one example of a passenger boarding bridge of one embodiment.

Fig. 2 shows one example of a cab of the passenger boarding bridge of the embodiment.

Fig. 3 shows one example of the cab of the passenger boarding bridge of the embodiment.

Fig. 4 is a diagram for describing one example of operations of the passenger boarding bridge of the embodiment.

Fig. 5 is a flowchart showing one example of operations of the passenger boarding bridge of the embodiment.

Fig. 6 is a flowchart showing one example of operations of the passenger boarding bridge of the embodiment.

Description of Embodiments

[0011] (Embodiment)

Diligent studies were conducted on factors causing a change in the relative distance between the floor surface of the entrance of the aircraft and the floor surface of the cab. As a result of the studies, the findings described below were obtained.

[0012] Factors that cause a change in the relative distance between the floor surface of the entrance of the aircraft and the floor surface of the cab include, other than upward/downward movement of the aircraft, a change in a reference distance from the ground to the cab or the tunnel unit. In a state where no operation command is given to the drive columns, if the reference distance from the ground to the cab or the tunnel unit has changed, it is highly possible that an emergency such as a failure in the passenger boarding bridge has occurred. For example, if the drive device provided at the lower end of the drive columns gets a flat tire, the reference distance from the ground to the cab changes, causing the amount of deviation in the relative distance to become greater than or equal to the predetermined value. Accordingly, in a conventional passenger boarding bridge, even though the position (height) of the entrance of the aircraft has not changed, the wheel of the automatic leveler rotates, and as a result, a drive signal is outputted to the drive columns. In this case, however, it is not appropriate to operate the drive columns. In fact, it is necessary to stop the passenger boarding bridge from operating.

[0013] In order to solve the above-described problems, the inventors of the present invention have arrived at the idea of providing the passenger boarding bridge with a distance measuring device (e.g., a laser sensor) configured to measure the reference distance from the ground to the cab.

[0014] Specifically, a passenger boarding bridge according to a first aspect of the present disclosure has been invented based on the above-described findings, and includes: a rotunda connected to a terminal building; a tunnel unit connected to the rotunda, such that the tunnel unit is liftable and lowerable; a lifting/lowering device configured to support the tunnel unit such that the tunnel unit is lifted or lowered; a cab provided at a front end of the tunnel unit; a distance measuring device configured to measure a reference distance from a ground to the cab or the tunnel unit; a level measuring device configured to measure, after the cab is connected to an entrance of an aircraft, an amount of deviation in a relative distance between a floor surface of the entrance of the aircraft and a floor surface of the cab; and a control device configured to control the lifting/lowering device based on a measurement value of the distance measuring device and a measurement value of the level measuring device, such that the cab connected to the entrance of the aircraft follows upward/downward movement of the aircraft.

[0015] The above configuration makes it possible to cause the cab connected to the entrance of the aircraft to follow upward/downward movement of the aircraft in a more appropriate manner than the conventional art.

[0016] Specifically, a passenger boarding bridge according to a second aspect of the present disclosure is configured such that, in the passenger boarding bridge according to the first aspect, the control device determines based on the measurement value of the level measuring device whether or not the amount of deviation in the relative distance is greater than or equal to a predetermined value, and determines based on the measurement value of the distance measuring device whether or not the reference distance has changed, and if the amount of deviation in the relative distance is greater than or equal to the predetermined value and the reference distance has not changed, the control device causes the cab to follow upward/downward movement of the aircraft.

[0017] Factors that cause a change in the relative distance between the floor surface of the entrance of the aircraft and the floor surface of the cab include, other than upward/downward movement of the aircraft, a change in the reference distance from the ground to the cab. In view of this, in the passenger boarding bridge according to the above aspect, a change in the reference distance is monitored by using the distance measuring device, and in accordance with a change in the amount of deviation in the relative distance between the floor surface of the entrance of the aircraft and the floor surface of the cab, the cab can be caused to follow upward/downward movement of the aircraft in a more appropriate manner than the conventional art.

[0018] A passenger boarding bridge according to a third aspect of the present disclosure is

configured such that, in the passenger boarding bridge according to the second aspect, if the amount of deviation in the relative distance is greater than or equal to the predetermined value and the reference distance has changed, the control device stops the passenger boarding bridge.

[0019] In the passenger boarding bridge according to the above aspect, if the reference distance from the ground to the cab has changed, it is highly possible that an emergency such as a failure in the passenger boarding bridge has occurred. Therefore, in this case, the passenger boarding bridge can be brought to an emergency stop.

[0020] A passenger boarding bridge according to a fourth aspect of the present disclosure is configured such that, in the passenger boarding bridge according to any one of the first to third aspects, the distance measuring device is a laser sensor, and the level measuring device is an automatic leveler.

[0021] Hereinafter, one embodiment of the present disclosure is described with reference to the accompanying drawings. The embodiment described below shows specific examples of the present disclosure. Numerical values, shapes, components, the arrangement and the manner of connection of the components, steps, the order of the steps, etc., shown in the embodiment below are mere examples, and do not limit the scope of the present disclosure. Moreover, among the components in the embodiment below, components not recited in the independent claim defining the most generic part of the concept of the present disclosure are described as optional components. In the description below, in some cases, the description of components that are denoted by the same reference signs in the drawings may be omitted. The drawings show each component schematically in order to facilitate the understanding thereof. Therefore, in some cases, the drawings may not display precise shapes, dimensional ratios, etc.

[0022] [Overall Apparatus Configuration]

Fig. 1 shows one example of a passenger boarding bridge of the embodiment. Fig. 1 shows a state where the overall length of a tunnel unit 10 is expanded.

[0023] Hereinafter, for the sake of convenience of the description, the direction in which the overall length of the tunnel unit 10 of the passenger boarding bridge 100 is expanded and contracted is referred to as a front-rear direction; the direction in which gravity is exerted on the passenger boarding bridge 100 is referred to as a vertical direction; and the width direction of the passenger boarding bridge 100 (i.e., the direction orthogonal to the front-rear direction and the vertical direction) is referred to as a right-left direction. In addition, as shown in Fig. 1, the aircraft 200 side of the passenger boarding bridge 100 is referred to as a “front” side, and the terminal building (not shown) side of the passenger boarding bridge 100 is referred to as a “rear” side in the description below.

[0024] The passenger boarding bridge 100 of the present embodiment includes: a rotunda (a rear round room) 12 connected to the terminal building; the tunnel unit 10 connected to the rotunda 12, such that the tunnel unit 10 is liftable and lowerable; a cab (a front round room) 20 provided at the front end of the tunnel unit 10; drive columns 15 configured to support the tunnel unit 10 such that the tunnel unit 10 is lifted and lowered; and auxiliary stairs 16.

[0025] The tunnel unit 10 is configured such that adjoining tunnels 10A and 10B thereof are fitted together in such a manner that the inner tunnel is nested in the outer tunnel, and the overall length of the tunnel unit 10 can be expanded and contracted in the front-rear direction.

[0026] The drive columns 15 (lifting/lowering device) are coupled to the tunnel unit 10, and used for upward/downward movement of the tunnel unit 10. Specifically, the drive columns 15 are coupled a suitable part of the outer tunnel 10B (to be specific, the front part of the tunnel 10B) in a manner to sandwich the tunnel unit 10 from both the right and left sides. Accordingly, the tunnel unit 10 and the cab 20 are allowed to swing in the vertical direction with respect to the rotunda 12, which is positioned near an entrance of the terminal building.

[0027] A drive device is disposed at the lower end of the drive columns 15. The drive device supports the drive columns 15, and is used for expanding/contracting movement and/or horizontal movement of the tunnel unit 10. For example, when tires 14 of the drive device run on an apron ground 18 in the right-left direction, motive power for horizontal movement is applied to the tunnel unit 10. When the tires 14 of the drive device run on the apron ground 18 in the front-rear direction, motive power for expanding/contracting movement in the front-rear direction is applied to the tunnel unit 10. As a result of the overall length of the tunnel unit 10 being expanded, the cab 20 disposed at the front end of the tunnel unit 10 reaches an entrance 201 of the aircraft 200, and thereby a walkway (not shown in Fig. 1) for passengers is formed between the entrance (not shown) of the terminal building of the airport and the entrance 201 of the aircraft 200.

[0028] The cab 20 is turnably disposed at the front end of the tunnel unit 10. A control board is installed in the cab 20, and an operator can operate devices (e.g., the drive columns 15) of the passenger boarding bridge 100 by using a joystick of the control board. The configuration of the cab 20 will be described below in detail.

[0029] The auxiliary stairs 16 are provided on the side of the tunnel unit 10 in a manner to connect between the inside of the tunnel unit 10 and the apron ground 18. The auxiliary stairs 16 are used, for example, to allow the operator to get in and out of the cab 20.

[0030] [Configuration of Cab]

Hereinafter, one example of the cab of the embodiment is described with reference

to the drawings.

[0031] Fig. 2 and Fig. 3 show one example of the cab of the passenger boarding bridge of the embodiment. Fig. 2 is a plan view of the front end portion of the cab 20 of Fig. 1 as seen in the vertical direction, and Fig. 3 is a front view of the cab 20 of Fig. 1.

[0032] The cab 20 includes a walkway 21, a cab frame 22, and a closure 24.

[0033] The walkway 21 includes: a fixed floor (not shown) coupled to the distal end of the tunnel unit 10 (see Fig. 1); and an inclined floor 21A connected to the fixed floor and configured to be inclinable in a width direction 300. It should be noted that since the inclination mechanism of the inclined floor 21A is known, the inclination mechanism is not described in detail herein, but is described below briefly.

[0034] For example, the fixed floor and the inclined floor 21A are coupled to each other via a coupling hinge or the like that is not shown. The right end portion or left end portion of the inclined floor 21A is vertically moved by motive power generated by an unshown motive power generator, such as a power cylinder, electric motor, or the like. At the time, the front end portion of the inclined floor 21A can swing about the coupling hinge. In this manner, the inclined floor 21A can be inclined in the width direction 300. It should be noted that a bumper 21B made of synthetic rubber is disposed on the front end portion of the inclined floor 21A. The bumper 21B has a function of reducing an impact shock when the inclined floor 21A comes into contact with the entrance 201 of the aircraft 200, and has a function of keeping a space between the front end portion of the inclined floor 21A and the entrance 201 of the aircraft 200.

[0035] The closure 24 includes: a bellows portion 24A (see Fig. 4) capable of expanding and contracting in the front-rear direction; a gate-shaped contacting portion 24B provided on the front end of the bellows portion 24A and coming into contact with the aircraft 200; and an accommodating portion 24C configured to accommodate the bellows portion 24A when the bellows portion 24A contracts, the accommodating portion 24C being coupled to and integrated with the fixed floor or the cab frame. Accordingly, when the cab 20 is brought into connection with the aircraft 200, the contacting portion 24B can come into contact with the aircraft 200 around the entrance 201 by inclining forward.

[0036] The cab frame 22 is a part of a cab structure, and protrudes downward from the body of the cab 20. A distance measuring device 23 is disposed on the cab frame 22. The distance measuring device 23 is a sensor configured to measure a reference distance H_1 (see Fig. 1) from the apron ground 18 to the cab 20. The distance measuring device 23 may be any device, so long as the device is capable of measuring the reference distance H_1 . The distance measuring device 23 may be a laser sensor, for example.

[0037] In the present embodiment, the distance measuring device 23 is disposed on the cab frame 22. However, the position of the distance measuring device 23 is not limited to this example. Alternatively, the distance measuring device 23 may be disposed on the lower surface of the accommodating portion 24C. The cab frame 22 and the accommodating portion 24C are members disposed at the forefront side of the cab 20. Since the cab frame 22 and the accommodating portion 24C are not connected to the inclined floor 21A and do not incline together with the inclined floor 21A, each of these members is convenient as the installation position of the distance measuring device 23.

[0038] A level measuring device 25 is disposed on a side wall (the accommodating portion 24C) of the cab 20. The level measuring device 25 is a device configured to measure, after the cab 20 is connected to the entrance 201 of the aircraft 200, an amount of deviation ΔH_2 in a relative distance H_2 (see Fig. 4) between the floor surface of the entrance 201 of the aircraft 200 and the floor surface of the cab 20. The level measuring device 25 may be any device, so long as the device is capable of measuring the amount of deviation ΔH_2 in the relative distance H_2 . In the present embodiment, an automatic leveler 25 described below is used as the level measuring device 25.

[0039] For example, the automatic leveler 25 includes: a wheel 25A; a contact limit switch (not shown) intended for when the wheel 25A moves forward; and a rotation limit switch (not shown) intended for when the wheel 25A rotates.

[0040] The contact limit switch is pre-adjusted such that the pressure of the wheel 25A applied to the surface of the fuselage of the aircraft 200 is optimal. In a case where the automatic leveler 25 moves forward, the forward movement can be stopped at a desirable moving amount as a result of the contact limit switch being turned ON. This allows the automatic leveler 25 to press the wheel 25A against the surface of the fuselage of the aircraft 200 with optimal pressure, and properly detect the vertical position of the passenger boarding bridge 100 relative to the aircraft 200. Specifically, the wheel 25A of the automatic leveler 25 rotates when the aircraft 200 moves upward or downward. Based on the rotation angle of the wheel 25A, the position of the passenger boarding bridge 100 relative to the aircraft 200 is detected. In this manner, the amount of deviation ΔH_2 in the relative distance H_2 between the floor surface of the entrance 201 of the aircraft 200 and the floor surface of the cab 20 can be measured by the automatic leveler 25.

[0041] It should be noted that the rotation limit switch is pre-adjusted such that the rotation limit switch is turned ON when the wheel 25A rotates clockwise or counterclockwise by a predetermined angle. The drive columns 15 are controlled such that when the rotation limit

switch is turned ON, the cab 20 follows upward/downward movement of the aircraft 200.

[0042] A control device 50 is disposed in the control board of the cab 20. The control device 50 controls the drive columns 15 based on a measurement value of the distance measuring device 23 and a measurement value of the level measuring device 25, such that the cab 20 connected to the entrance 201 of the aircraft 200 follows upward/downward movement of the aircraft 200.

[0043] Specifically, the control device 50 determines based on the measurement value of the level measuring device 25 whether or not the amount of deviation ΔH_2 in the relative distance H_2 between the floor surface of the entrance 201 of the aircraft 200 and the floor surface of the cab 20 is greater than or equal to a predetermined value, and determines based on the measurement value of the distance measuring device 23 whether or not the reference distance H_1 from the apron ground 18 to the cab 20 has changed. If the amount of deviation ΔH_2 in the relative distance H_2 is greater than or equal to the predetermined value and the reference distance H_1 has not changed, the control device 50 causes the cab 20 to follow upward/downward movement of the aircraft 200. On the other hand, if the amount of deviation ΔH_2 in the relative distance H_2 is greater than or equal to the predetermined value and the reference distance H_1 has changed, the control device 50 stops the passenger boarding bridge 100 (emergency stop). It should be noted that operations of the control device 50 will be described below in detail.

[0044] The control device 50 may be configured in any manner, so long as the control device 50 has control functions. The control device 50 includes, for example, an arithmetic operation circuit (not shown) and a storage circuit (not shown) storing a control program. Examples of the arithmetic operation circuit include a PLC, an MPU, and a CPU. The storage circuit is a semiconductor memory, for example. The control device 50 may be configured as a single controller, or may be configured as a plurality of controllers.

[0045] [Operations]

Fig. 4 is a diagram for describing one example of operations of the passenger boarding bridge of the embodiment.

[0046] Fig. 5 and Fig. 6 are flowcharts each showing one example of operations of the passenger boarding bridge of the embodiment.

[0047] Automatic control operations of the passenger boarding bridge 100 described below are performed in accordance with the control program of the control device 50. However, performing the automatic control operations described below by the control device 50 is not essential. An operator may perform part of the operations.

[0048] In the above operations of the passenger boarding bridge 100, for example, the order

of steps can be changed as necessary. Also, other known steps can be added to the operations as necessary. For example, in the present embodiment, after the passenger boarding bridge 100 is set to an automatic leveling mode in step S9, the distance measuring device 23 is set to ON in step S10. However, the operation of step S9 and the operation of step S10 may be performed concurrently, or the order of steps S9 and S10 may be reversed. Between step S9 and step S10, for example, a known step of expanding the bellows portion 24A of the closure 24 forward may be added.

[0049] First, steps S1 to S8 of Fig. 5 are described. Fig. 5 shows operations that are performed when the passenger boarding bridge 100 moves from a parking position to an attaching position where the passenger boarding bridge 100 is attached to the aircraft 200.

[0050] It should be noted that these steps S1 to S8 may be the same as operations of a known automatic docking function.

[0051] In step S1, an operator pushes an aircraft type selection button on an operating panel (not shown) of the control board to select the aircraft type of the aircraft 200. Based on the selected aircraft type, a predetermined attaching position corresponding to the aircraft type is selected among a plurality of predetermined attaching positions set in advance.

[0052] Next, when the operator pushes a start button on the operating panel, automatic control described below is started. It should be noted that, in the present embodiment, the start button is in an ON state only while the operator is pushing the button, i.e., configured as a dead man's switch. Accordingly, when the operator releases their hand from the button, the automatic control described below is stopped forcibly.

[0053] In step S2, based on the above selection of the aircraft type and detection results from any suitable angle sensor (not shown) and position sensor (not shown), various control amounts to reach the attaching position (e.g., the turning angle of the cab 20, the amount of upward/downward movement of the tunnel unit 10, and the turning angle and the running distance of the tires 14 of the drive device disposed at the lower end of the drive columns 15) are calculated.

[0054] Next, based on the results of the calculation, the cab 20 is turned in step S4, and the tunnel unit 10 is moved upward/downward in step S5.

[0055] At the same time, the drive device is controlled in steps S3 and S6. Specifically, in step S3, the tires 14 of the drive device are turned in the direction of the attaching position (target position), and then in step S6, the tires 14 of the drive device run on the apron ground 18 in this direction.

[0056] Next, in step S7, based on a detection result from a photoelectric distance sensor (not

shown), it is determined whether or not the distance between the bumper 21B of the inclined floor 21A of the cab 20 and the aircraft 200 is a predetermined distance set in advance (e.g., 1 m).

[0057] If the result of the determination in step S7 is NO, the above-described operation is kept performed. On the other hand, if the result of the determination in step S7 is YES, the flow proceeds to step S8.

[0058] In step S8, inclination angle automatic control of the inclined floor 21A of the cab 20 in the width direction 300 is performed based on an output signal from an angle adjustment detector (not shown) that detects the inclination angle of the inclined floor 21A in the width direction 300. Specifically, the motive power generator is controlled based on the output signal from the angle adjustment detector, such that the inclination angle of the inclined floor 21A is a predetermined target value. For example, the motive power generator is controlled such that the inclined floor 21A is parallel to the apron ground 18. Accordingly, if the floor surface of the inclined floor 21A of the cab 20 and the floor surface 201A (see Fig. 4) of the entrance 201 of the aircraft 200 are not parallel to each other, the control device 50 automatically controls the inclination angle of the inclined floor 21A in the width direction 300 based on the output signal from the angle adjustment detector.

[0059] Thereafter, the cab 20 is connected to the entrance 201 of the aircraft 200 by manual operation by the operator, and thus the attaching of the cab 20 to the aircraft 200 is completed.

[0060] Next, steps S9 to S16 of Fig. 6 are described. Fig. 6 shows operations of the passenger boarding bridge 100 that are performed after the attaching of the cab 20 to the aircraft 200 is completed.

[0061] By manual operation by the operator using a key switch (not shown) on the control board, the passenger boarding bridge 100 is set to an automatic leveling mode in step S9, and the distance measuring device 23 is set to ON in step S10.

[0062] Next, in step S11, the reference distance H_1 from the apron ground 18 to the cab 20 is measured by the distance measuring device 23, and in step S12, the amount of deviation ΔH_2 in the relative distance H_2 between the floor surface 201A of the entrance 201 of the aircraft 200 and the floor surface of the inclined floor 21A of the cab 20 is measured by the automatic leveler 25.

[0063] Next, in step S13, it is determined whether or not the amount of deviation ΔH_2 in the relative distance H_2 in step S12 is greater than or equal to the predetermined value.

[0064] As previously described, the automatic leveler 25 includes the rotation limit switch intended for when the wheel 25A rotates. Accordingly, if the amount of deviation ΔH_2 is such an amount that the rotation limit switch is not turned ON (i.e., the result of the determination in

step S13 is NO), the cab 20 is not caused to follow upward/downward movement of the aircraft 200. In this case, the operations of steps S11 and S12 are performed again.

[0065] On the other hand, if the amount of deviation ΔH_2 in the relative distance H_2 is greater than or equal to the predetermined value (i.e., the result of the determination in step S13 is YES), the rotation limit switch of the automatic leveler 25 is turned ON. In this case, the flow proceeds to the next determination step S14.

[0066] In step S14, it is determined whether or not the reference distance H_1 in step S11 has changed.

[0067] If the reference distance H_1 in step S11 has not changed (i.e., the result of the determination in step S14 is NO), then in step S15, the cab 20 is caused to follow upward/downward movement of the aircraft 200. That is, the passenger boarding bridge 100 (the tunnel unit 10) is moved upward/downward by using the drive columns 15, such that the amount of deviation ΔH_2 in the relative distance H_2 becomes zero. In this manner, for example, when the aircraft 200 moves upward or downward due to boarding or disembarking of passengers and the like, the cab 20 can be caused to follow the upward or downward movement of the aircraft 200.

[0068] On the other hand, if the reference distance H_1 in step S11 has changed (i.e., the result of the determination in step S14 is YES), then in step S16, the passenger boarding bridge 100 is stopped (emergency stop).

[0069] As described above, the passenger boarding bridge 100 of the present embodiment is capable of causing the cab 20 connected to the entrance 201 of the aircraft 200 to follow upward/downward movement of the aircraft 200 in a more appropriate manner than the conventional art.

[0070] Specifically, factors that cause a change in the relative distance H_2 between the floor surface 201A of the entrance 201 of the aircraft 200 and the floor surface of the inclined floor 21A of the cab 20 include, other than upward/downward movement of the aircraft 200, a change in the reference distance H_1 from the apron ground 18 to the cab 20. In view of this, in the passenger boarding bridge of the present embodiment, a change in the reference distance H_1 is monitored by using the distance measuring device 23, and in accordance with a change in the amount of deviation ΔH_2 in the relative distance H_2 between the floor surface 201A of the entrance 201 of the aircraft 200 and the floor surface of the inclined floor 21A of the cab 20, the cab 20 can be caused to follow upward/downward movement of the aircraft 200 in a more appropriate manner than the conventional art.

[0071] In the passenger boarding bridge 100 of the present embodiment, if the reference

distance H_1 from the apron ground 18 to the cab 20 has changed, it is highly possible that an emergency such as a failure in the passenger boarding bridge 100 has occurred. Therefore, in this case, the passenger boarding bridge 100 can be brought to an emergency stop.

[0072] From the foregoing description, numerous modifications and other embodiments of the present disclosure are obvious to a person skilled in the art. For example, in the present embodiment, the distance measuring device 23 is disposed on the cab frame 22, and the reference distance H_1 from the ground 18 to the cab 20 is measured. However, the present embodiment is not thus limited. Alternatively, the distance measuring device may be disposed on the tunnel unit 10, and the reference distance from the ground 18 to the tunnel unit 10 may be measured. Also in this case, by controlling the drive columns 15 based on a measurement value of the distance measuring device and a measurement value of the level measuring device 25 so as to follow upward/downward movement of the aircraft 200, the same functional advantages can be obtained. However, a change in the reference distance from the ground 18 can be more readily detected at a position that is away from the rotunda 12. For this reason, measuring the reference distance from the ground 18 to the distal-side (front-side) tunnel 10B is preferable to measuring the reference distance from the ground 18 to the proximal-side (rear-side) tunnel 10A, and measuring the reference distance from the ground 18 to the tunnel unit 10 at a position forward of the drive columns 15 is more preferable. It is even more preferable to measure the reference distance H_1 from the ground 18 to the cab 20 as in the present embodiment.

[0073] The detection of a change in the reference distance used in the present disclosure includes the detection in a case where a predetermined detection range (threshold) is exceeded.

[0074] Therefore, the foregoing description should be interpreted only as an example and is provided for the purpose of teaching the best mode for carrying out the present disclosure to a person skilled in the art. The structural and/or functional details may be substantially altered without departing from the spirit of the present disclosure.

Industrial Applicability

[0075] The passenger boarding bridge according to one aspect of the present disclosure is capable of causing the cab connected to the entrance of the aircraft to follow upward/downward movement of the aircraft in a more appropriate manner than the conventional art. Therefore, the one aspect of the present disclosure is applicable to, for example, a passenger boarding bridge.

Reference Signs List

[0076]	10	tunnel unit
	10A	tunnel
	10B	tunnel
	12	rotunda
	14	tire
	15	drive column
	16	auxiliary stairs
	18	ground
	20	cab
	21	walkway
	21A	inclined floor
	21B	bumper
	22	cab frame
	23	distance measuring device
	24	closure
	24A	bellows portion
	24B	contacting portion
	24C	accommodating portion
	25	level measuring device (automatic leveler)
	25A	wheel
	50	control device
	100	passenger boarding bridge
	200	aircraft
	201	entrance
	201A	floor surface

CLAIMS

1. A passenger boarding bridge comprising:
 - a rotunda connected to a terminal building;
 - a tunnel unit connected to the rotunda, such that the tunnel unit is liftable and lowerable;
 - a lifting/lowering device configured to support the tunnel unit such that the tunnel unit is lifted or lowered;
 - a cab provided at a front end of the tunnel unit;
 - a distance measuring device configured to measure a reference distance from a ground to the cab or the tunnel unit;
 - a level measuring device configured to measure, after the cab is connected to an entrance of an aircraft, an amount of deviation in a relative distance between a floor surface of the entrance of the aircraft and a floor surface of the cab; and
 - a control device configured to control the lifting/lowering device based on a measurement value of the distance measuring device and a measurement value of the level measuring device, such that the cab connected to the entrance of the aircraft follows upward/downward movement of the aircraft.
2. The passenger boarding bridge according to claim 1, wherein
 - the control device determines based on the measurement value of the level measuring device whether or not the amount of deviation in the relative distance is greater than or equal to a predetermined value, and determines based on the measurement value of the distance measuring device whether or not the reference distance has changed, and
 - if the amount of deviation in the relative distance is greater than or equal to the predetermined value and the reference distance has not changed, the control device causes the cab to follow upward/downward movement of the aircraft.
3. The passenger boarding bridge according to claim 2, wherein
 - if the amount of deviation in the relative distance is greater than or equal to the predetermined value and the reference distance has changed, the control device stops the passenger boarding bridge.

4. The passenger boarding bridge according to any one of claims 1 to 3, wherein the distance measuring device is a laser sensor, and the level measuring device is an automatic leveler.