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(54) **DISH WASHER**

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(52) **U.S. Cl.**

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(57)

**ABSTRACT**

A dish washer is configured to recognize when a user intends to open a door while a washing course in a tub is in progress. The dish washer includes a handle driver, a controller, and a handle configured to protrude in a frontward direction when the washing process has been stopped, thereby securing convenience and safety.

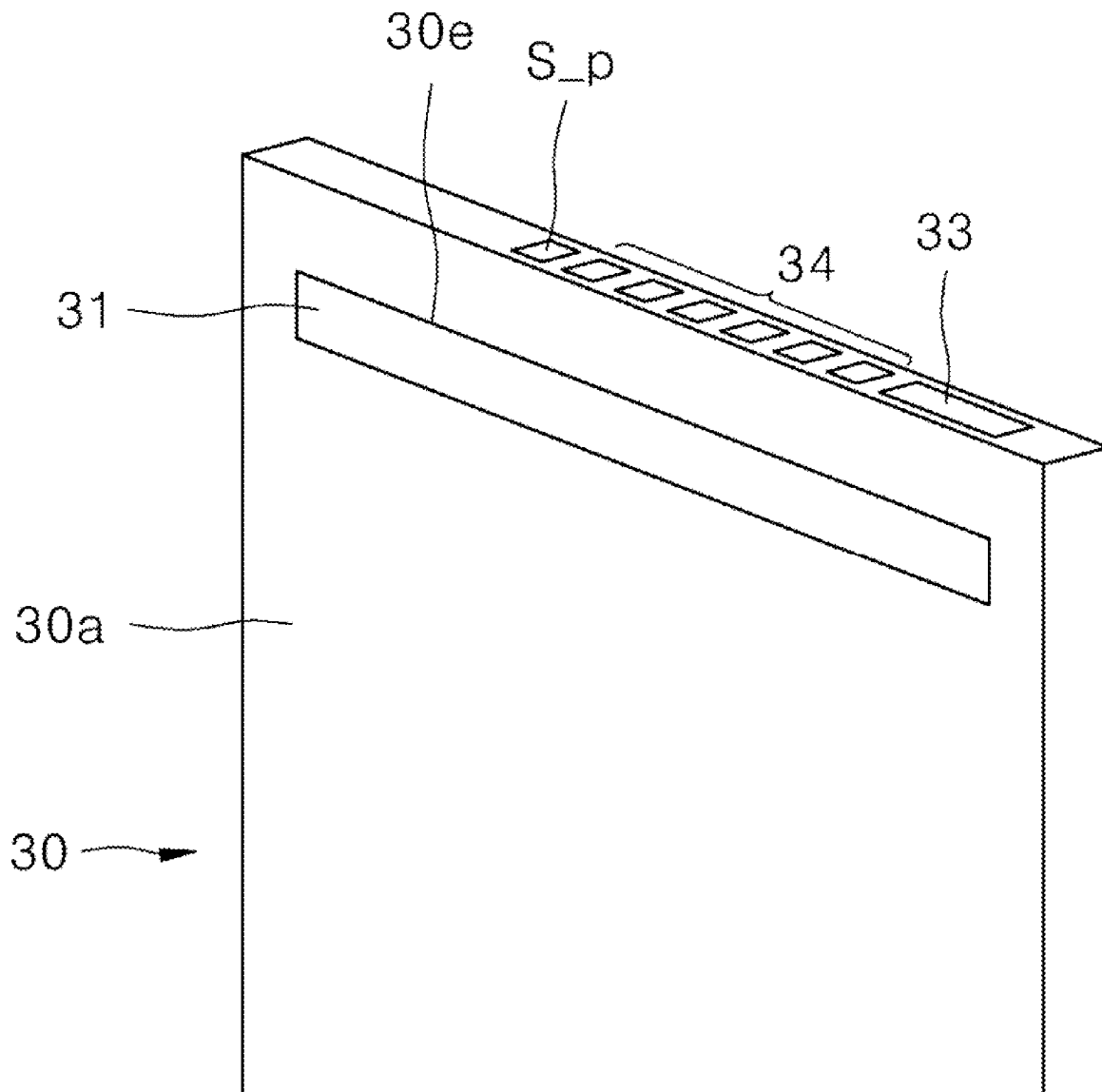


FIG. 1

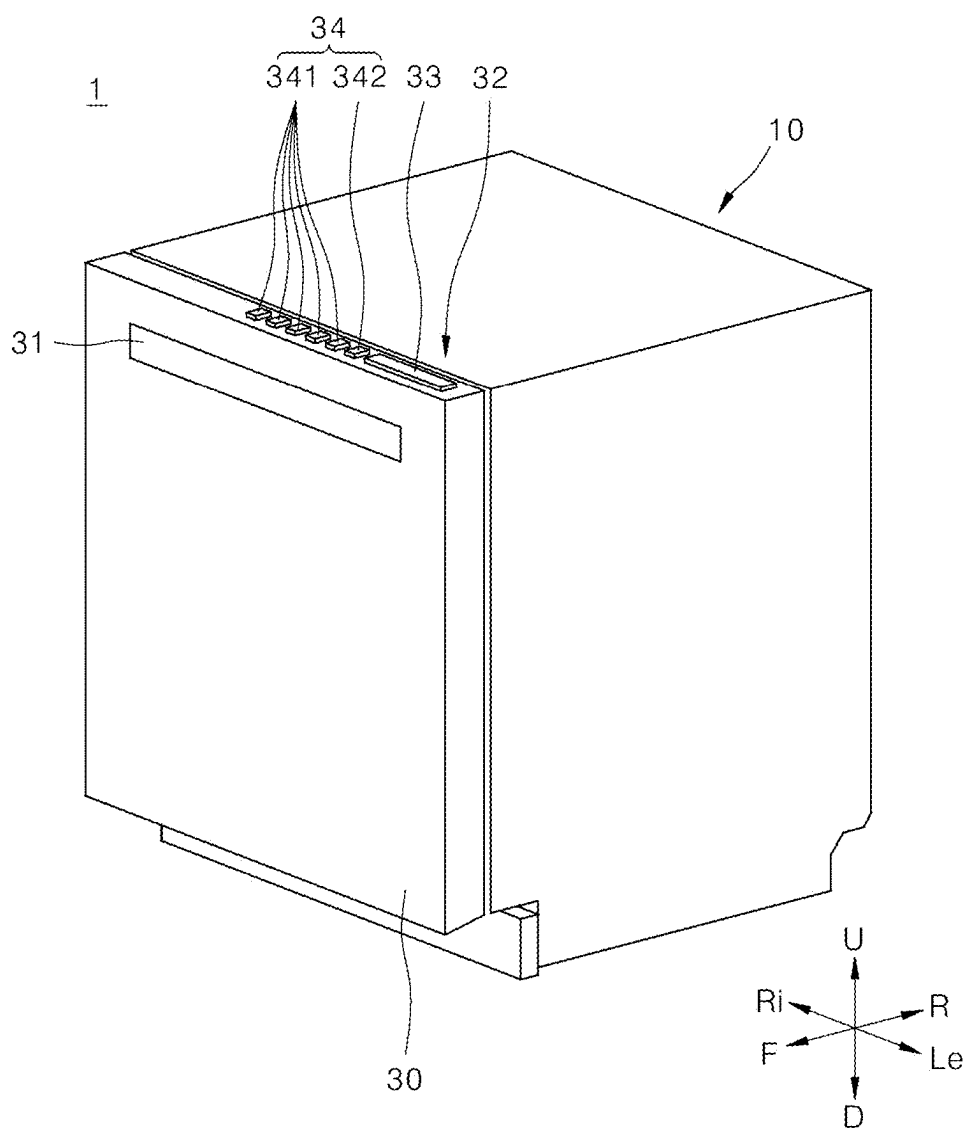


FIG. 2

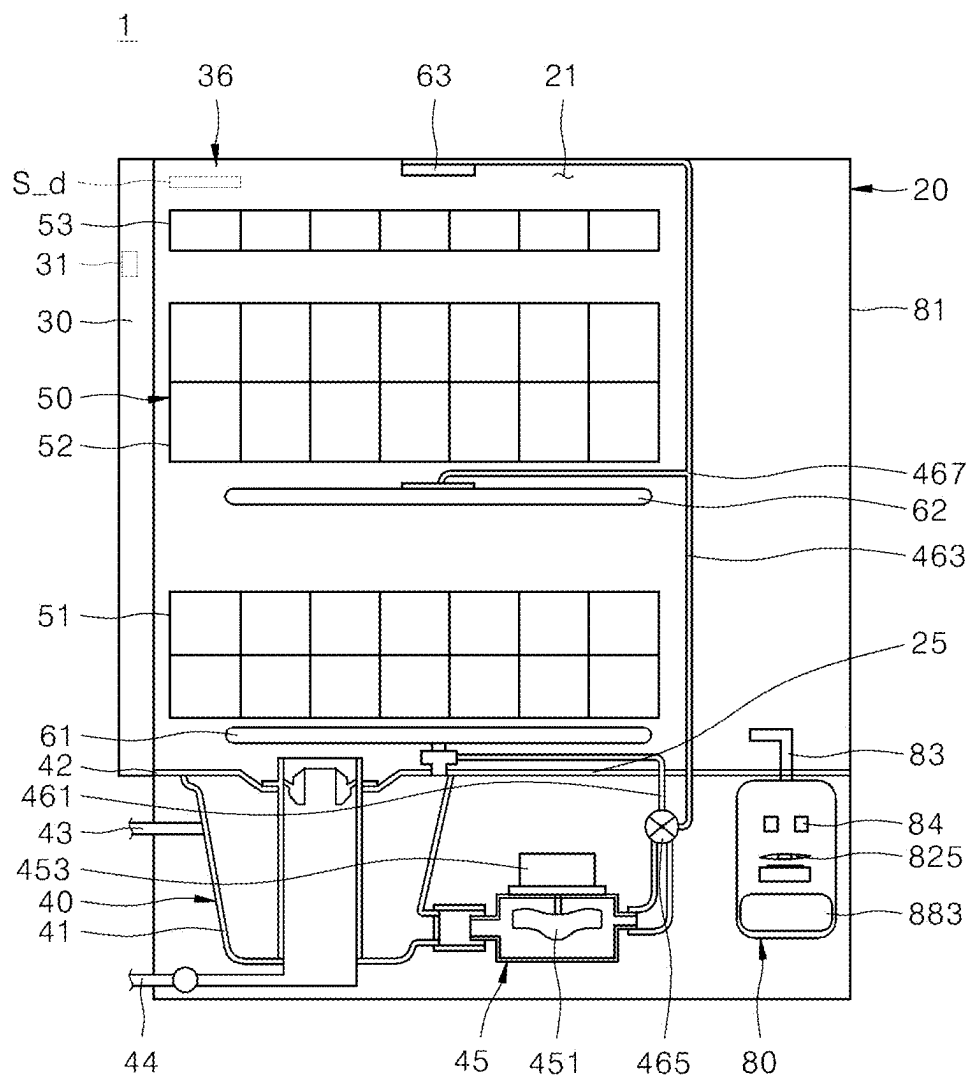


FIG. 3

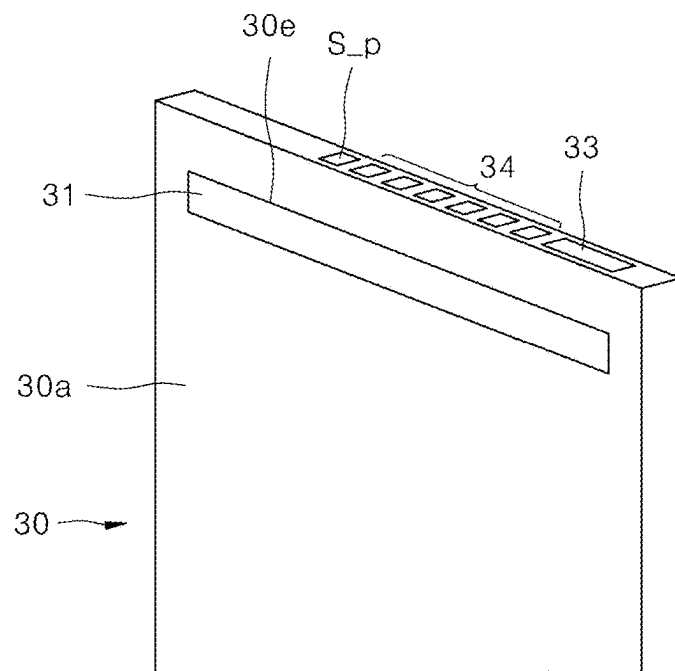


FIG. 4

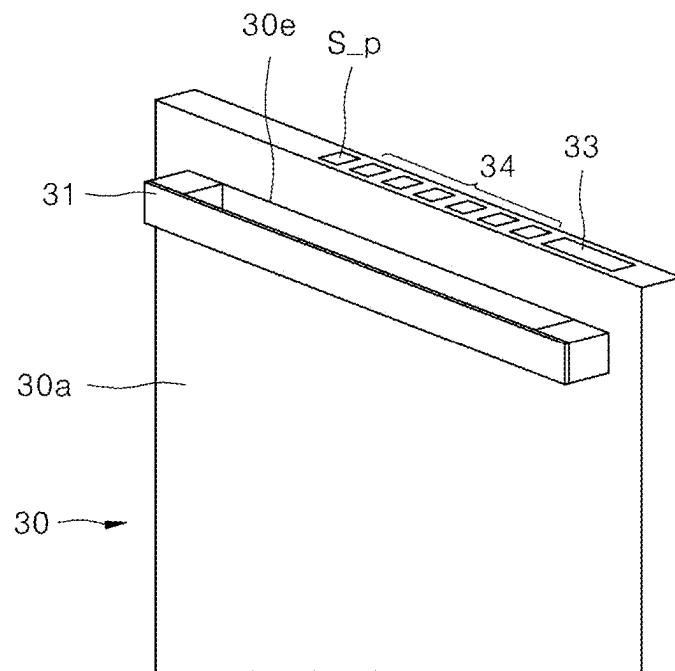


FIG. 5

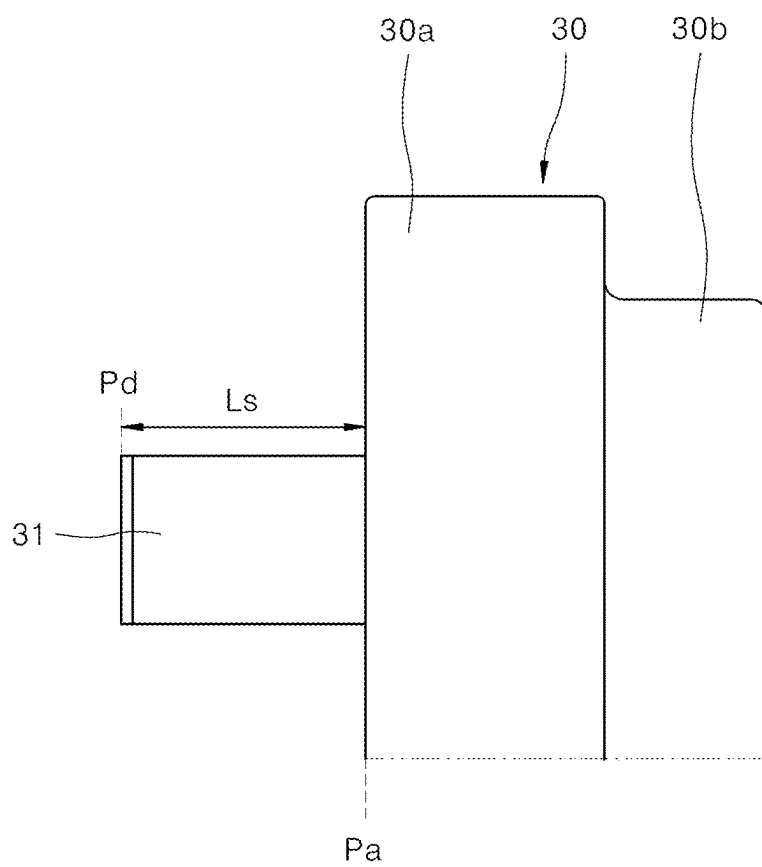


FIG. 6

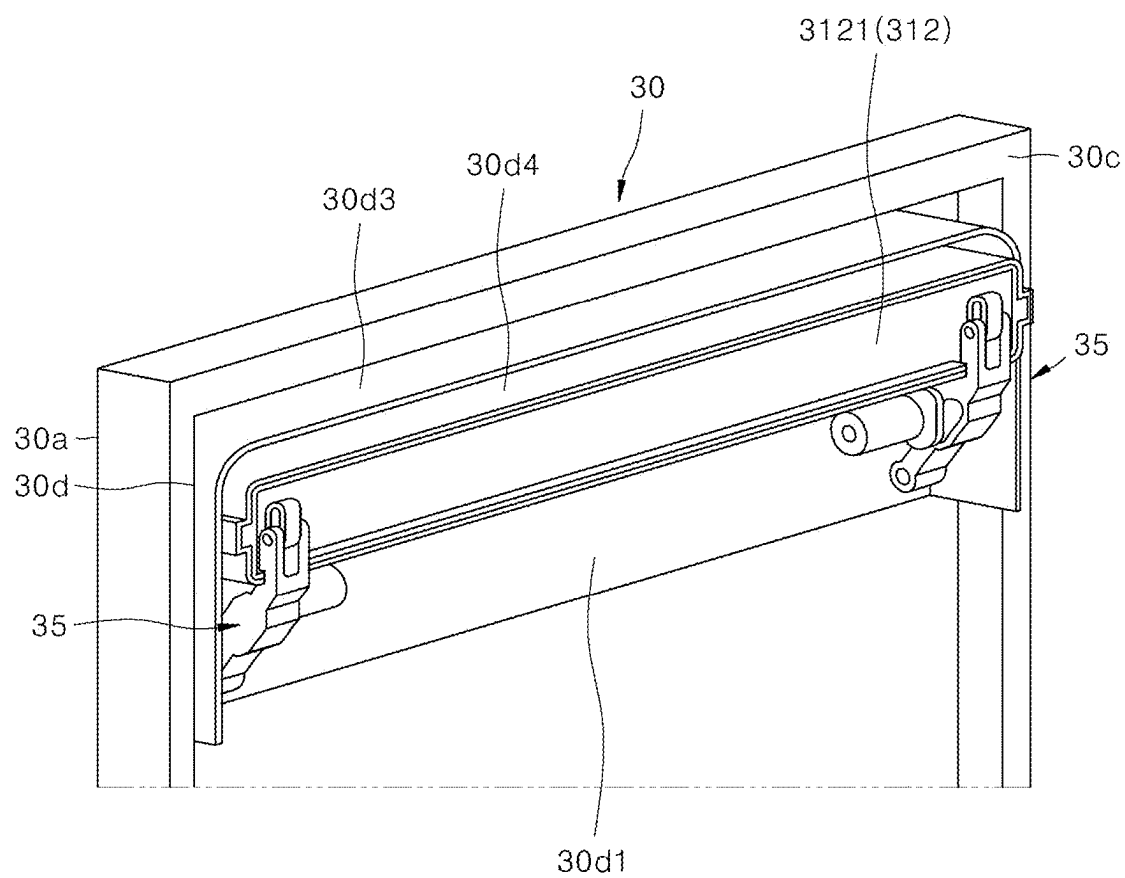


FIG. 7

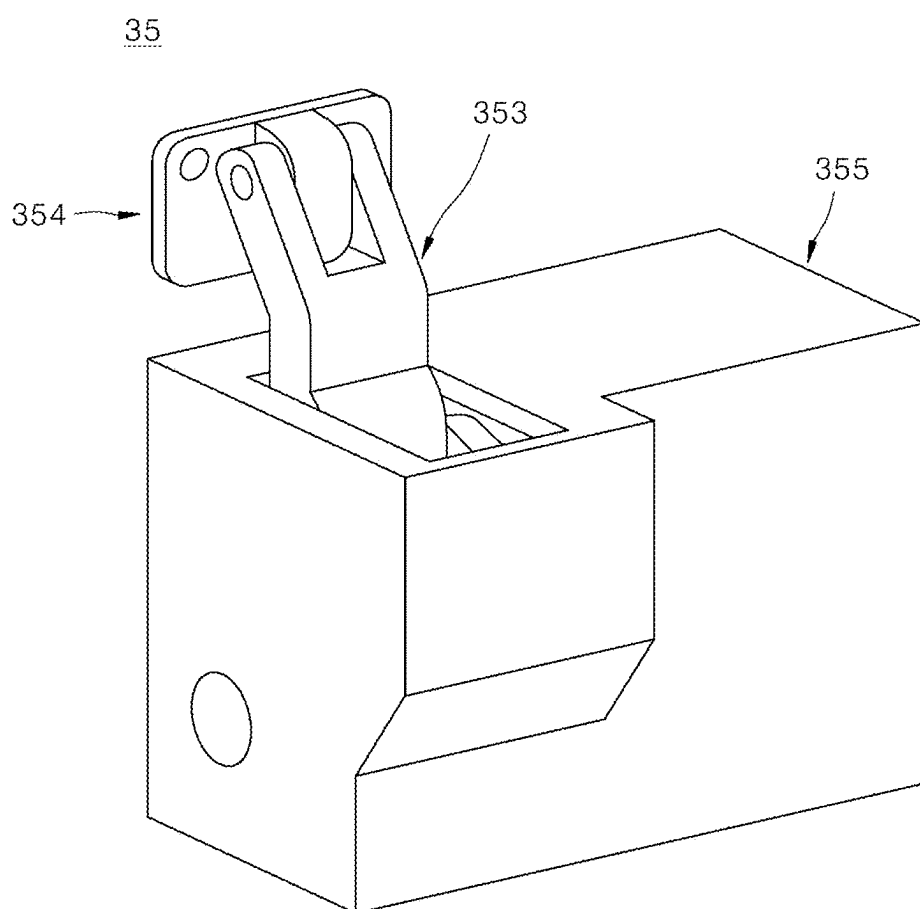




FIG. 8

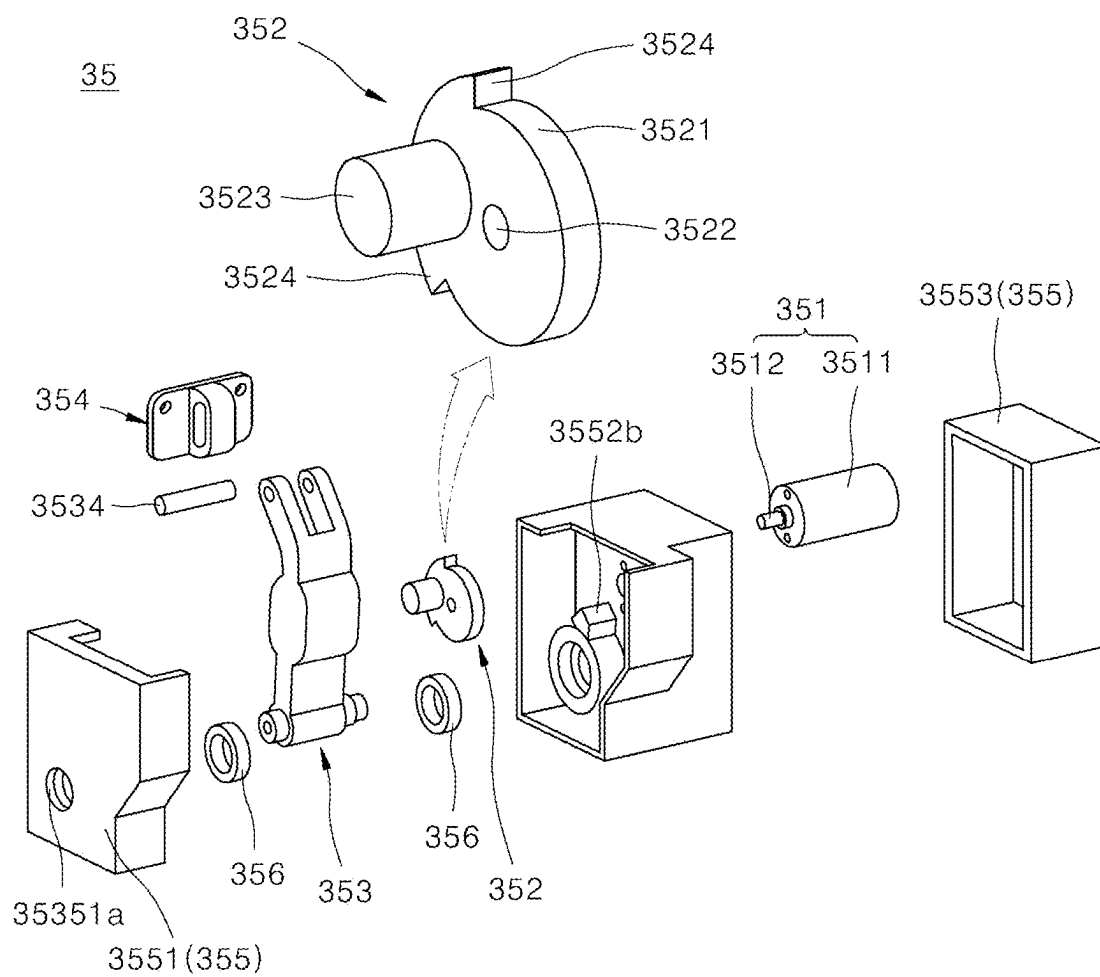


FIG. 9

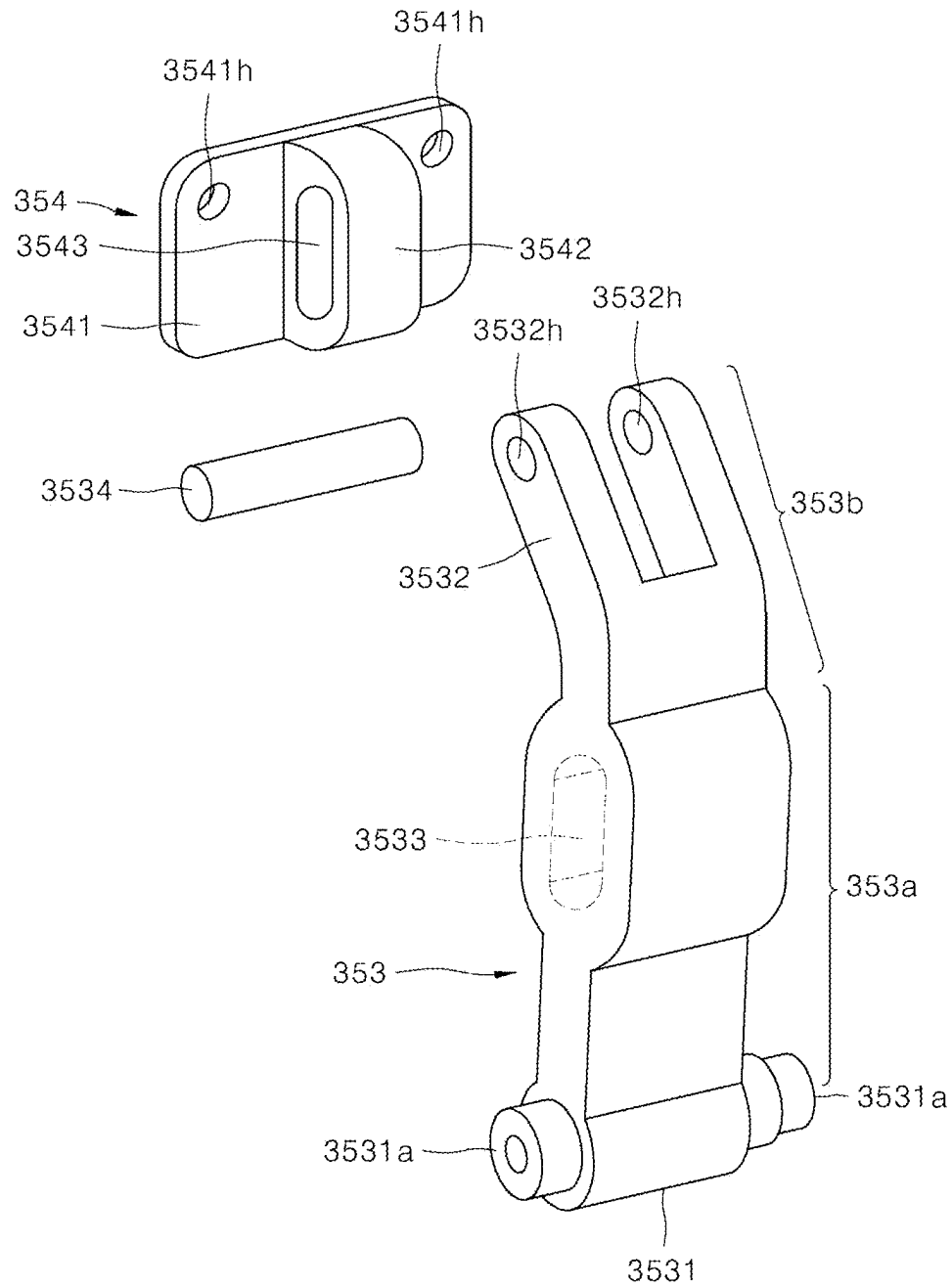


FIG. 10

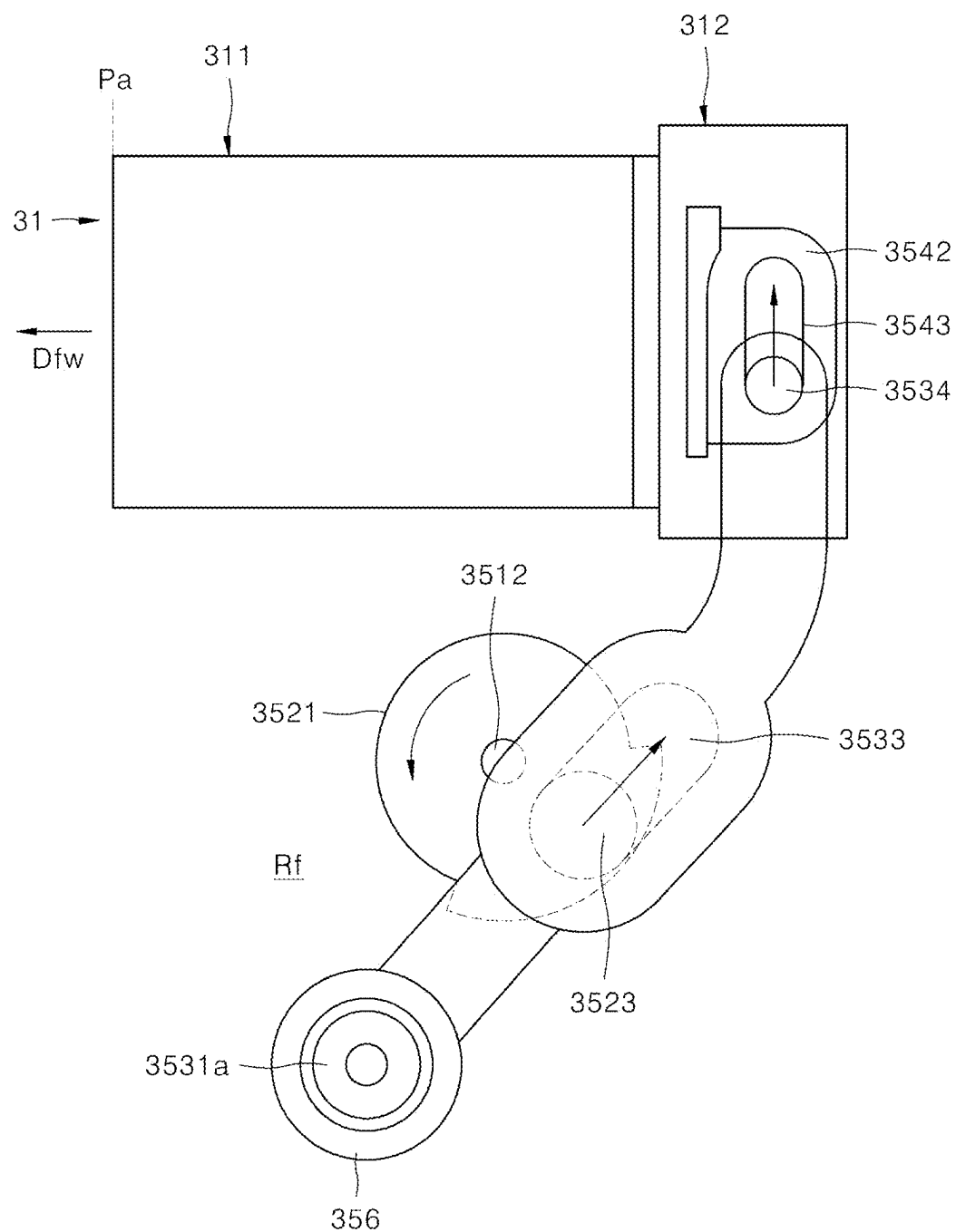


FIG. 11

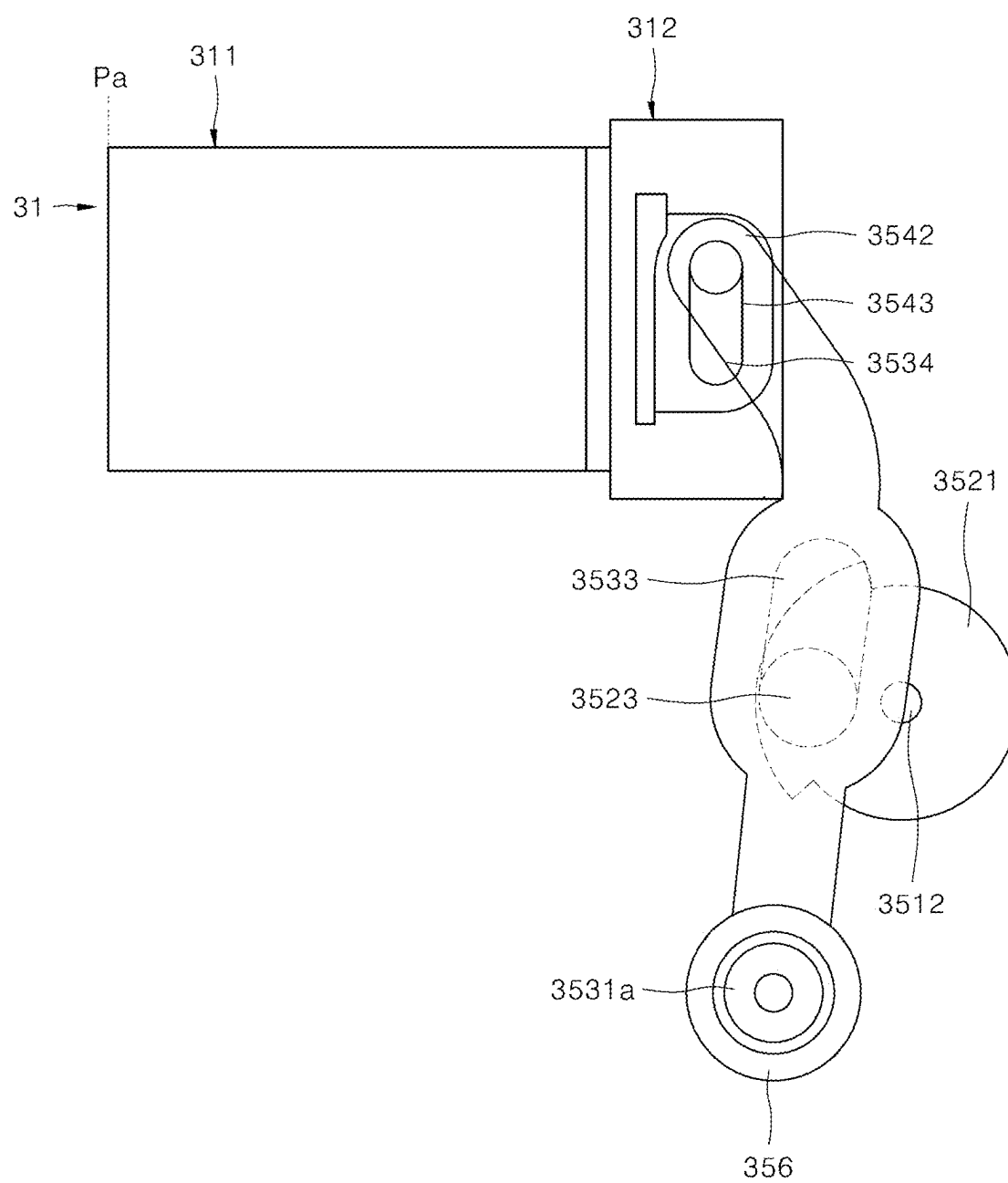


FIG. 12

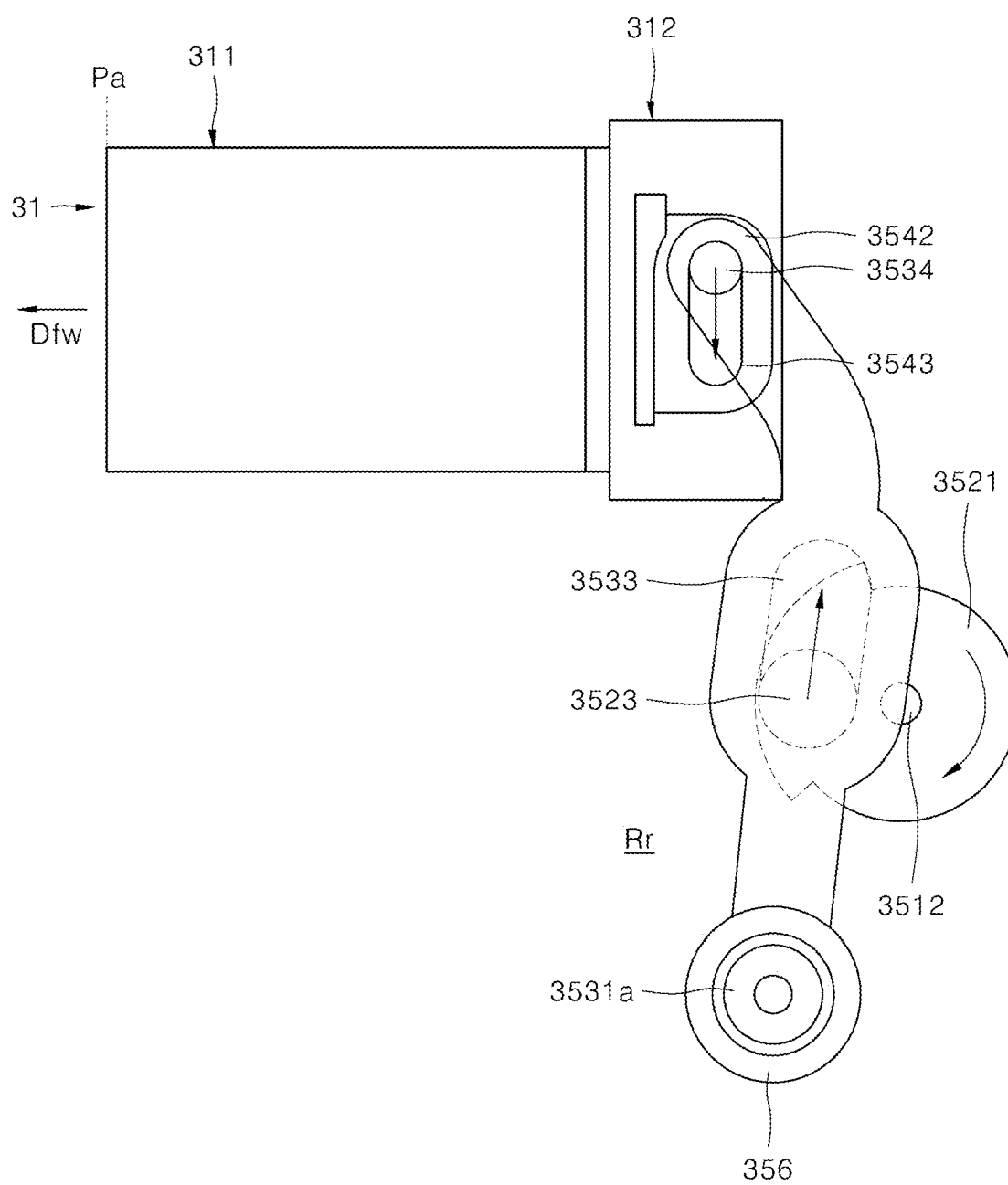


FIG. 13

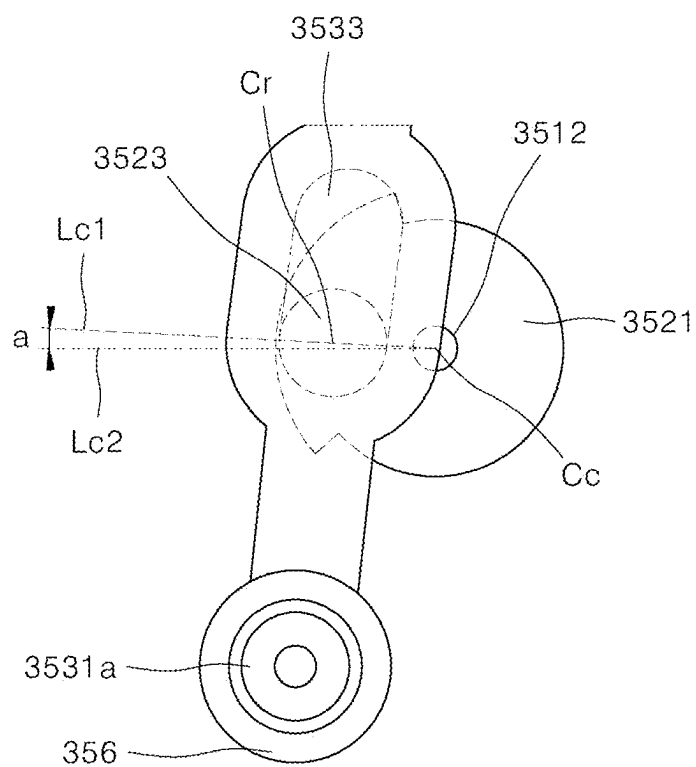


FIG. 14

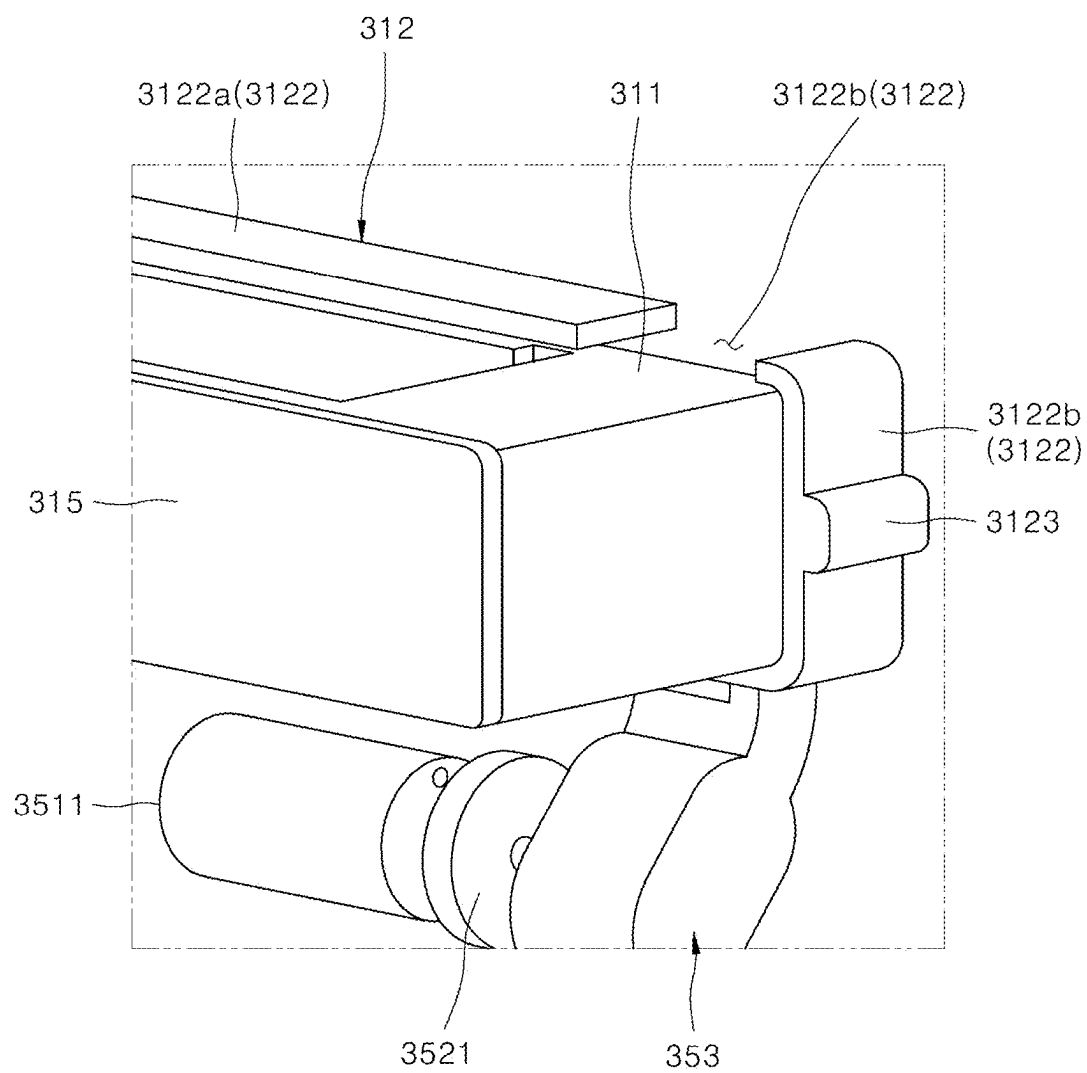


FIG. 15

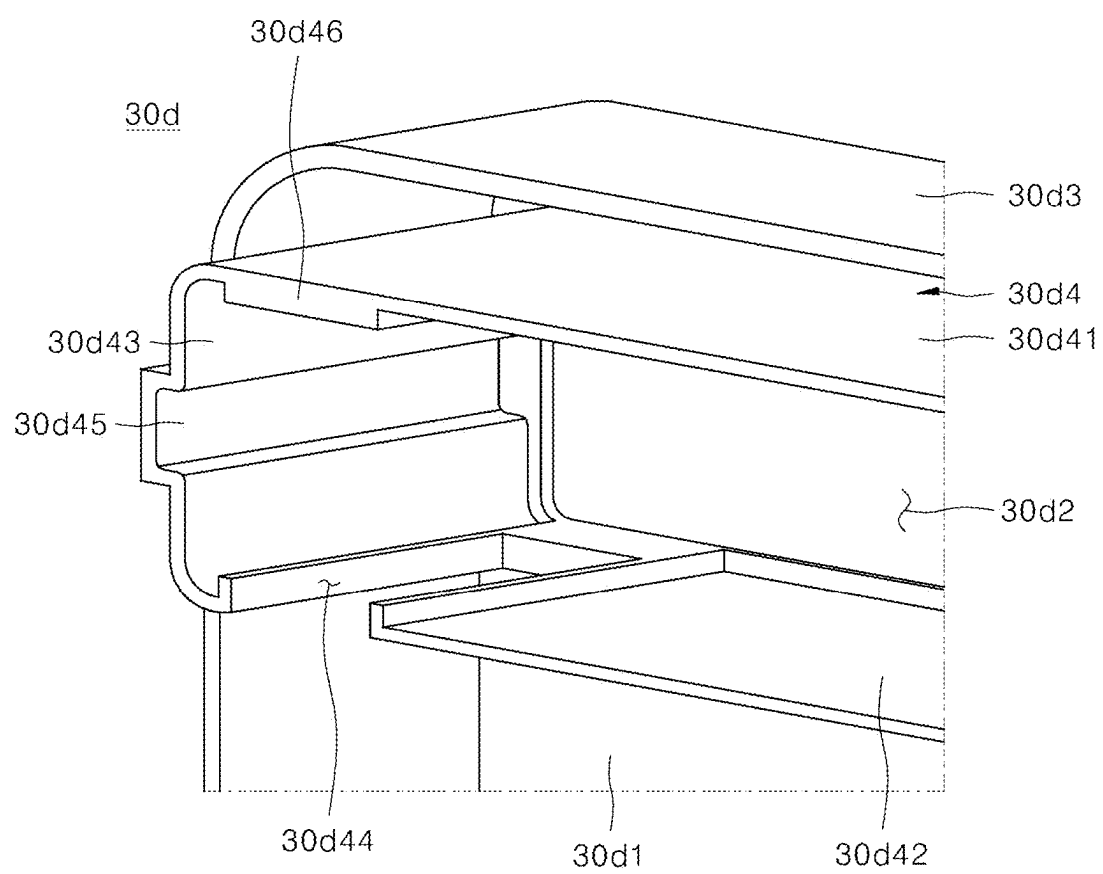




FIG. 16

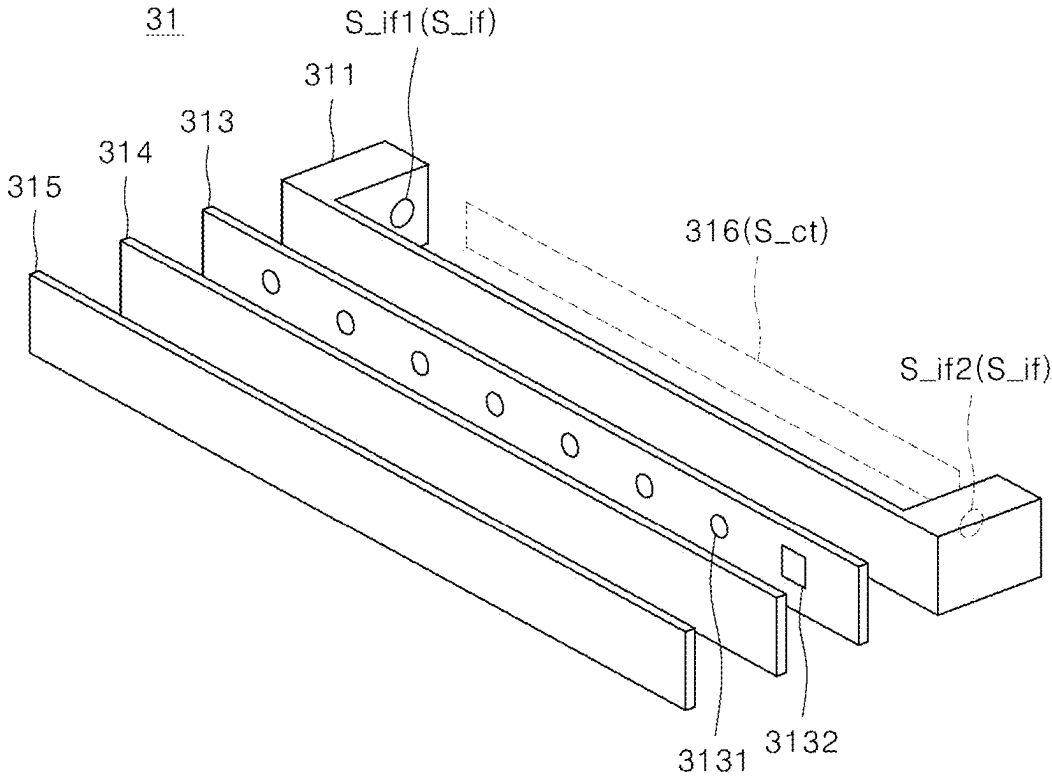


FIG. 17

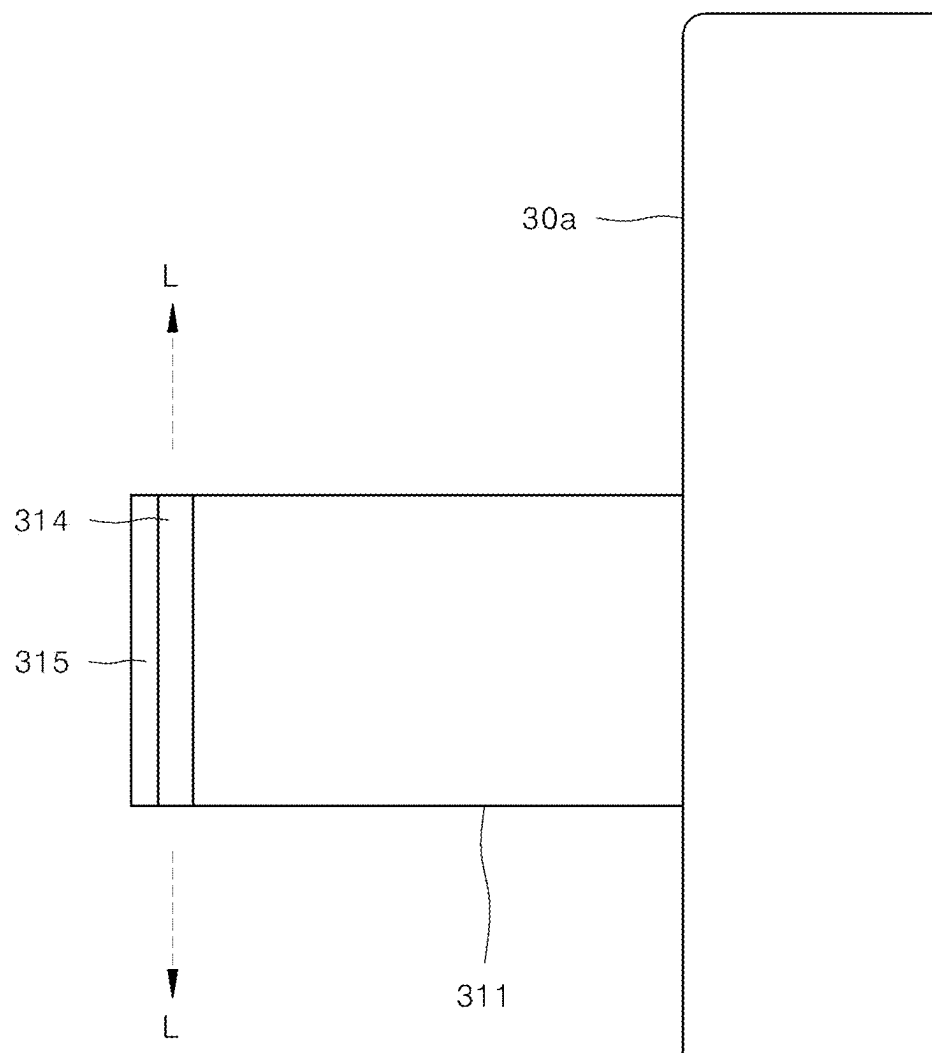


FIG. 18

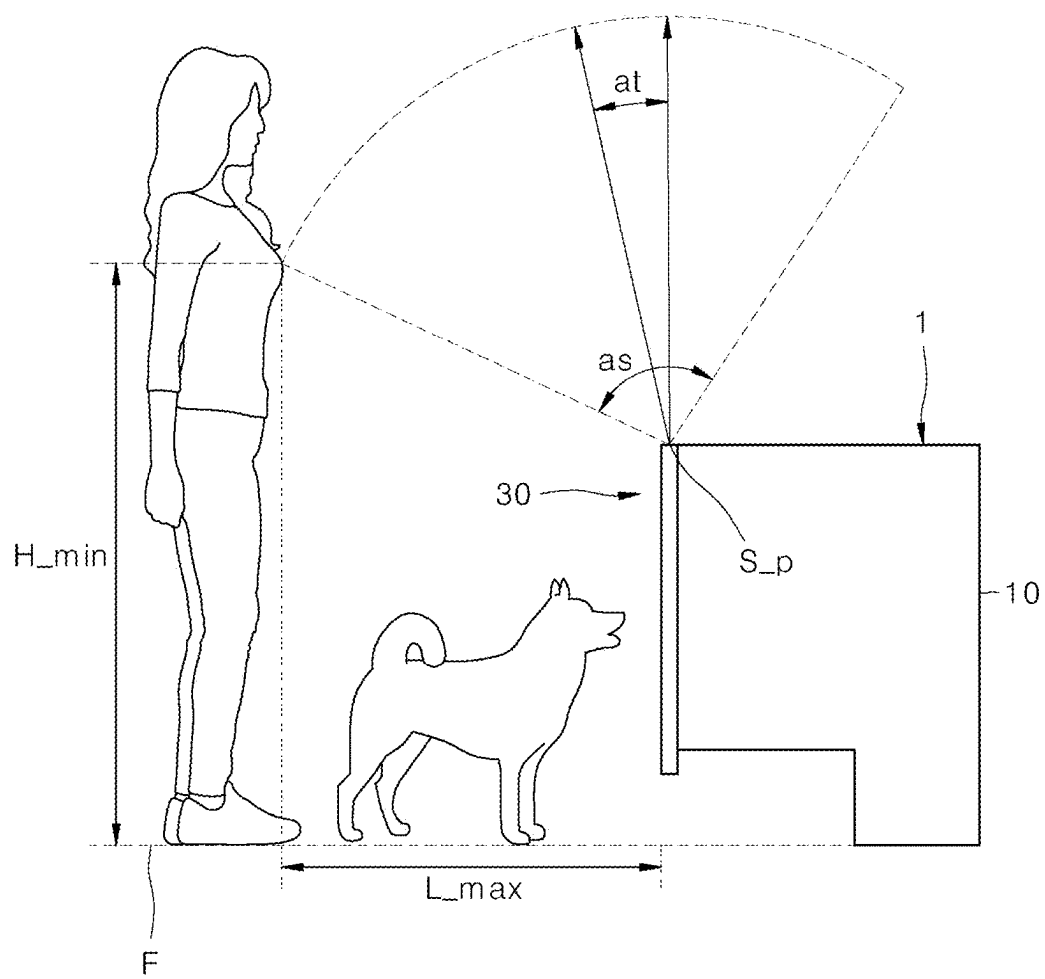


FIG. 19

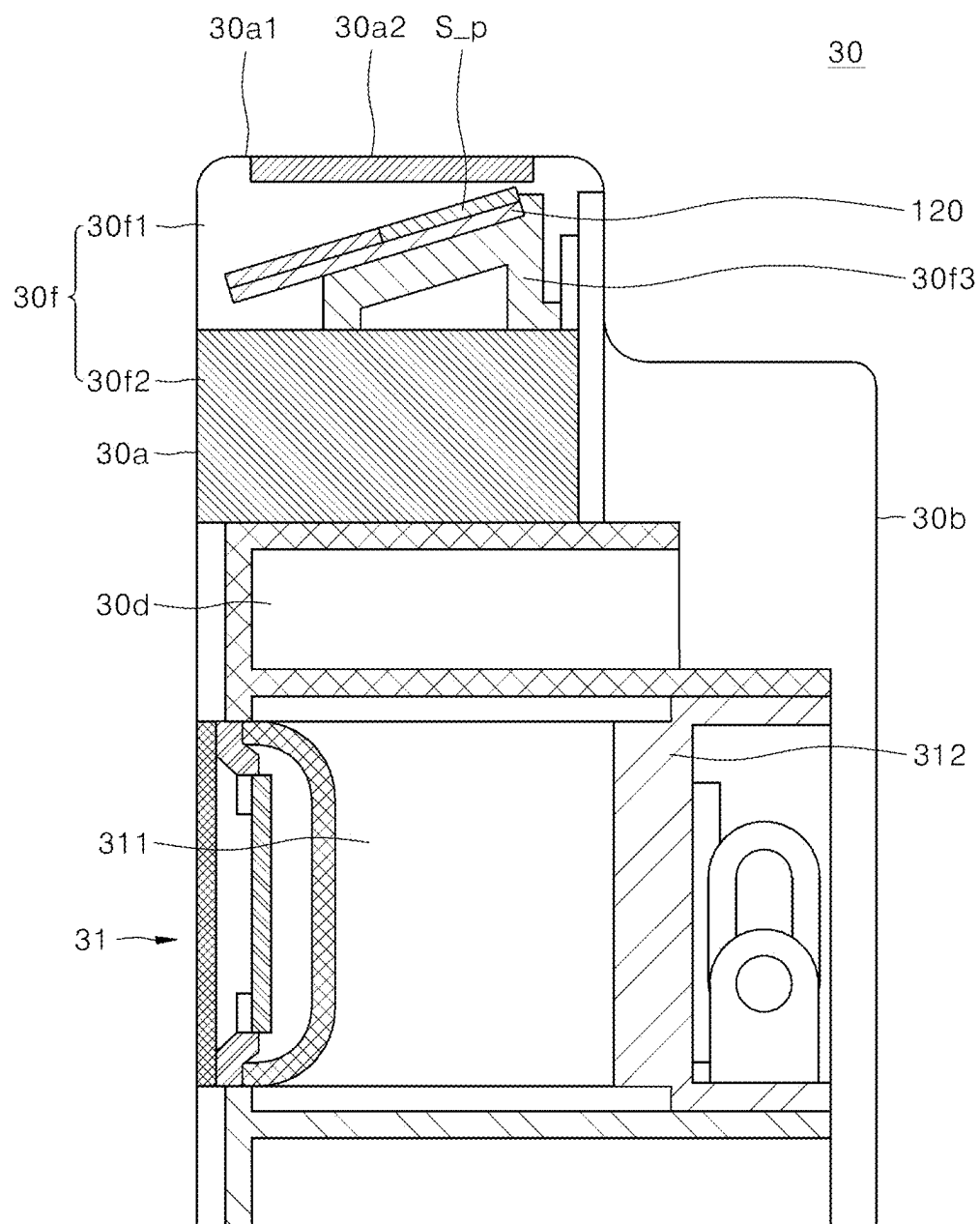


FIG. 20

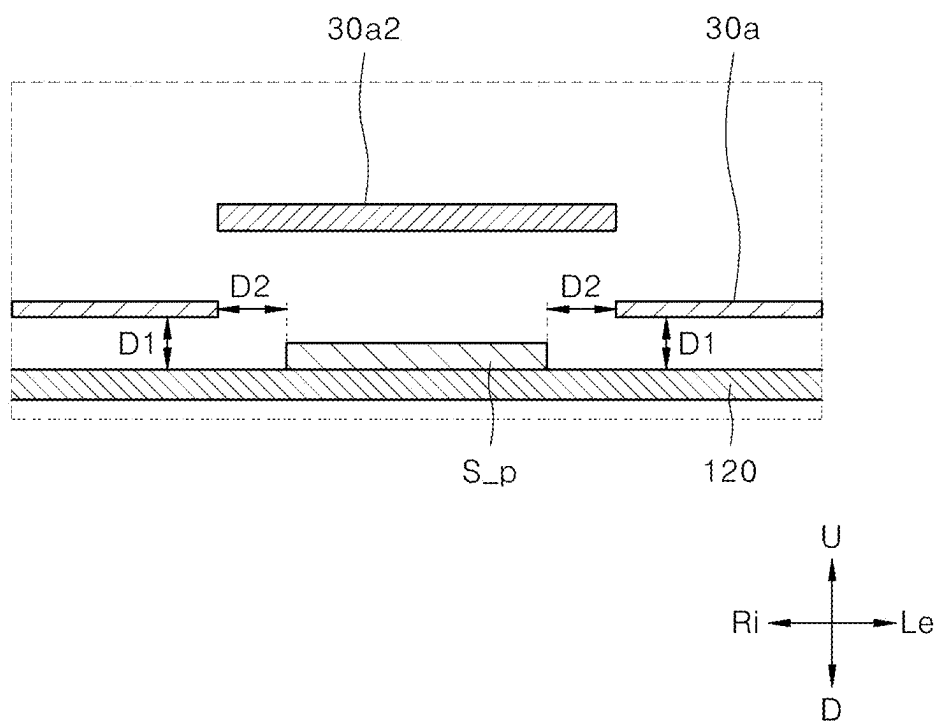


FIG. 21

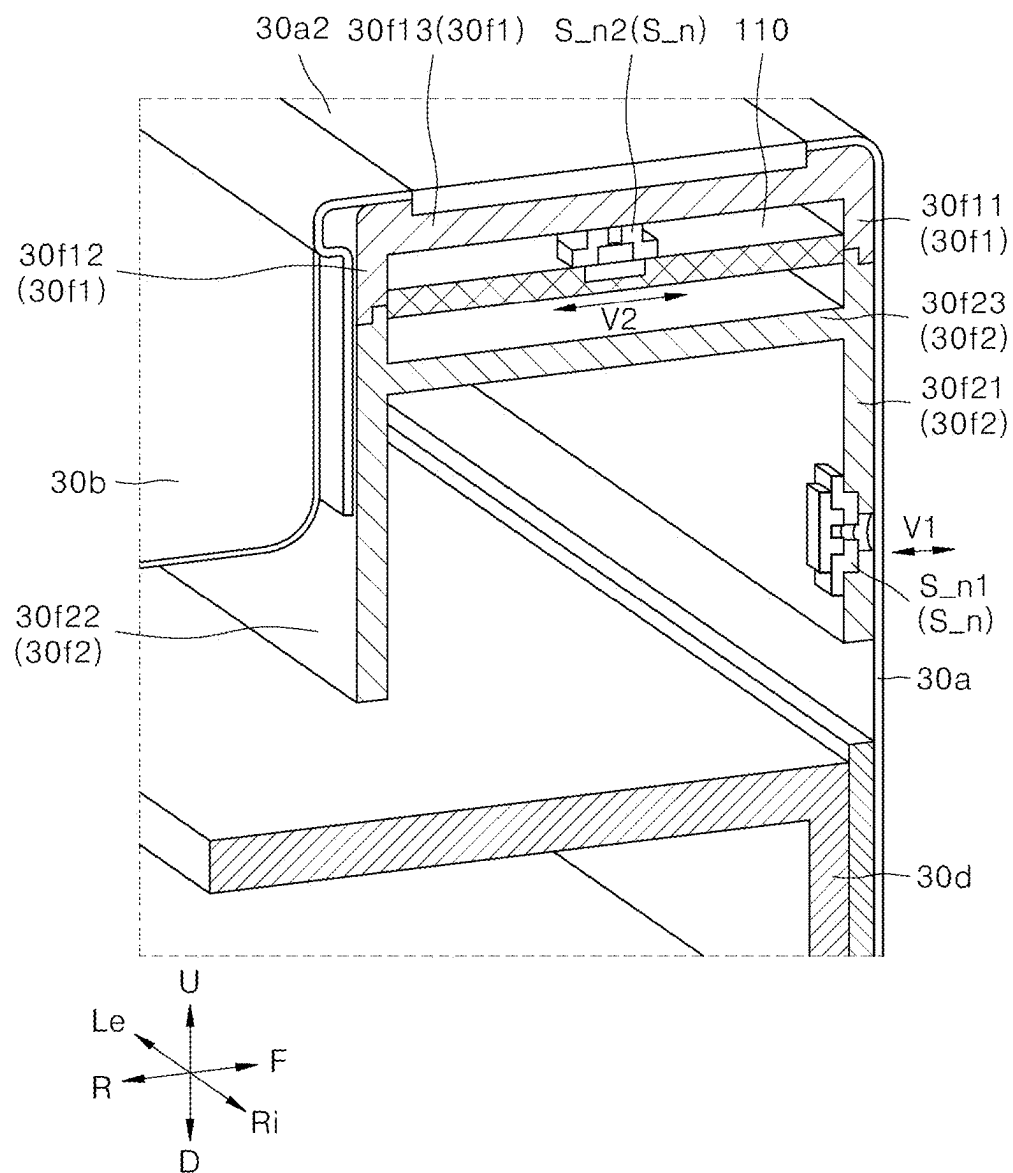


FIG. 22

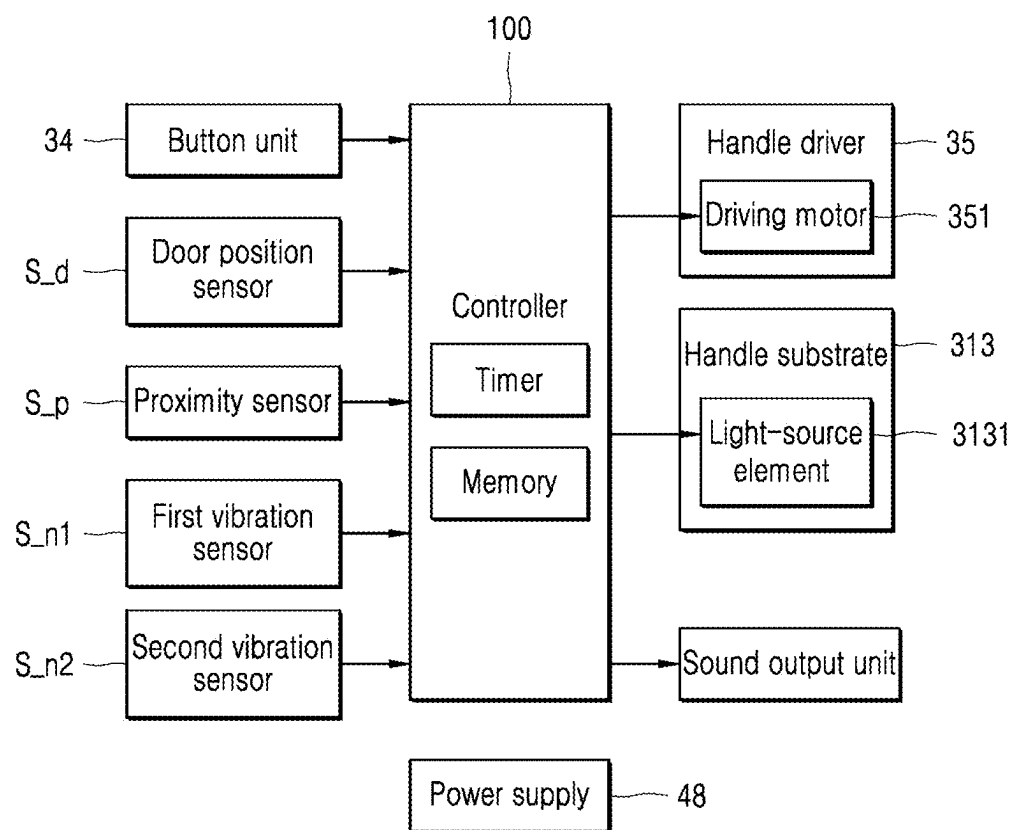


FIG. 23

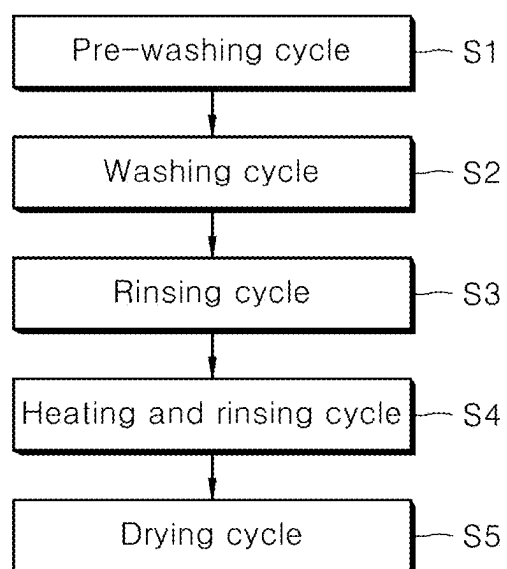




FIG. 24

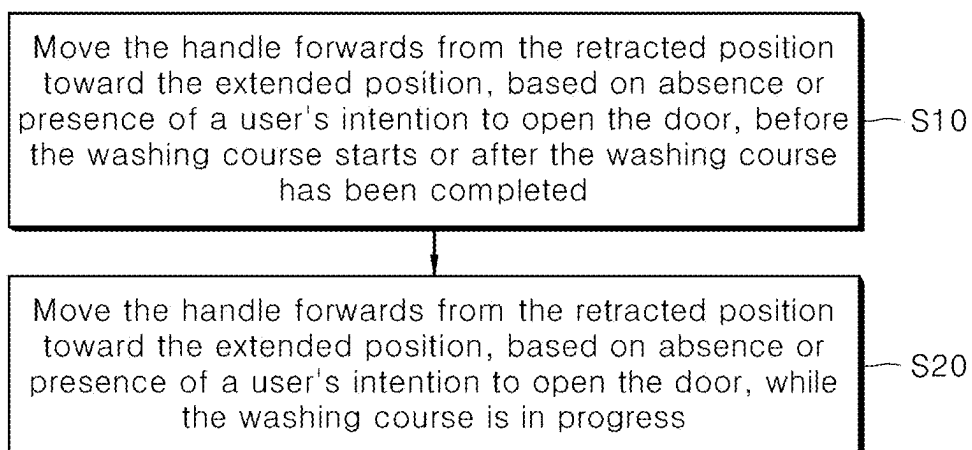


FIG. 25

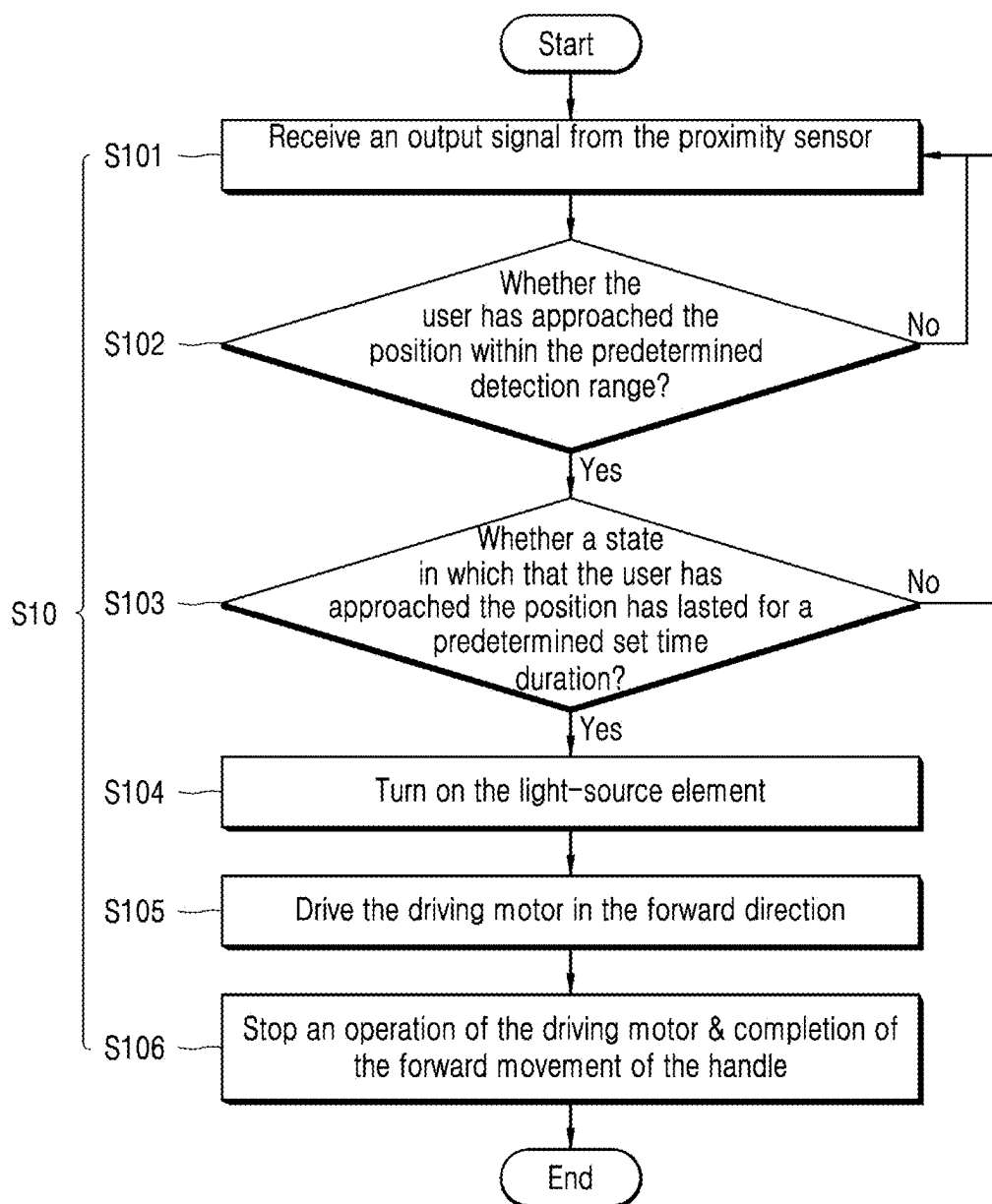
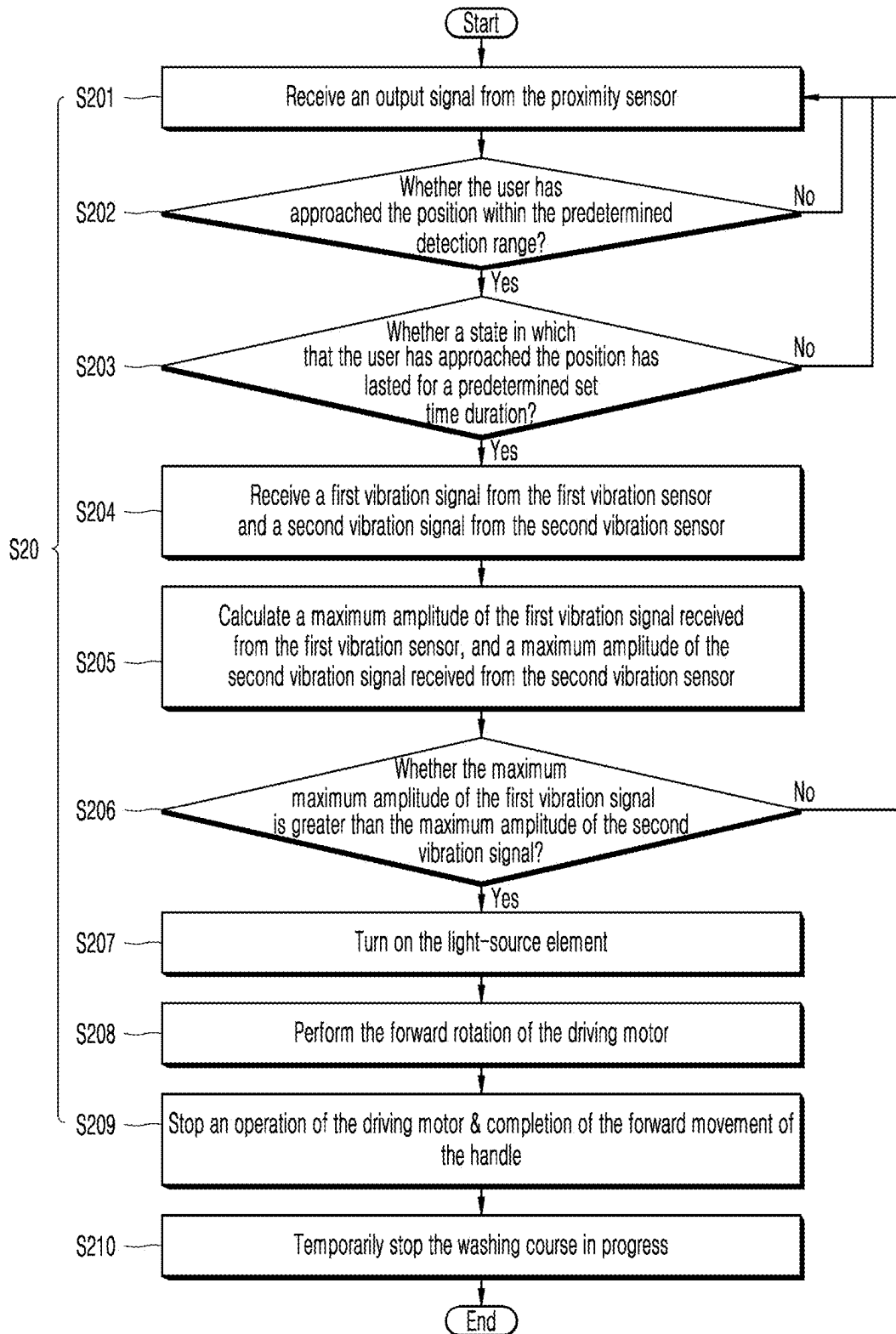


FIG. 26



**DISH WASHER****CROSS-REFERENCE TO RELATED APPLICATION**

**[0001]** This application claims priority to and benefit of Korean Patent Application No. 10-2024-0022964, filed on Feb. 16, 2024, which is hereby incorporated by reference as when fully set forth herein.

**TECHNICAL FIELD**

**[0002]** The present disclosure relates to a dish washer. More specifically, the present disclosure relates to a dish washer configured such that when a user's intention to open a door is identified as being present while a washing course is in progress, a handle extends to protrude in a frontward direction while the washing process in progress has been stopped, thereby securing convenience and safety simultaneously.

**BACKGROUND**

**[0003]** A dish washer is an apparatus that washes dishes and cooking utensils as washing targets stored therein by spraying washing water thereto. The washing water may contain washing detergent.

**[0004]** Using a dish washer may allow a time and effort for washing the dishes and other washing targets after a meal to be reduced, thereby contributing to user convenience.

**[0005]** In order to store dishes inside the dish washer before a washing cycle, and to withdraw the washed and dried dishes after the washing cycle, the user may open and close the door.

**[0006]** The dish washer may include a door with a handle that the user may grasp to open and close the door.

**[0007]** In some cases, a dish washer may include a depressed type handle provided in the door. For instance, the handle of the dish washer may be provided in a form of a grip groove configured to be depressed from a front surface of the door toward a rear surface thereof by a predetermined depth.

**[0008]** In some cases, the handle is provided in a depressed form from a portion of the front surface of the door toward an inside of the door. A separate cover, etc., may not be disposed on the handle, and thus the handle may be always exposed to an outside. In some cases, the handle structure may accumulate external foreign substances such as dusts in the depressed space into which the hand of the user is inserted. The user may frequently clean the handle, thereby causing inconvenience to the user. In some cases, the handle may deteriorate the aesthetic sense of the front surface appearance of the door because the portion of the front surface of the door is concavely depressed.

**[0009]** In some cases, a dish washer may include a protruding type handle disposed on the door. For instance, the handle of the dish washer may have a predetermined protruding height in a frontward direction from a front surface of the door, and may be always in a protruding state and have a 90 degrees-rotated U shape. In some cases, a user who does not recognize the protruding portion from the front surface of the door may collide with the protruding portion, thereby causing injury to the user. In some cases, the handle may collide with dishes and other kitchenware when the dishes are withdrawn from the dish washer, and thus causing damage to the handle itself or items such as dishes.

**SUMMARY**

**[0010]** The present disclosure describes a dish washer configured such that the handle is configured to extend in a protruding manner in a frontward direction from the door only when necessary, such as when opening or closing the door, so that external foreign substances such as dusts are prevented from accumulating on the handle, thereby maintaining a clean state of the handle and improving user convenience.

**[0011]** The present disclosure further describes a dish washer configured such that the handle is configured to at least partially retract into the inside of the door when the use of the handle is unnecessary, thereby reducing the possibility of user injury and handle damage that may occur due to collision of the user with the handle.

**[0012]** The present disclosure further describes a dish washer configured such that when a user's intention to open a door is identified as being present while a washing course is in progress, a handle extends to protrude in a frontward direction while the washing process in progress has been stopped, thereby securing convenience and safety simultaneously.

**[0013]** According to one aspect of the subject matter described in this application, a dish washer includes a tub that defines a washing space configured to accommodate one or more objects to be washed therein, the tub having an open front surface in fluid communication with the washing space, a door configured to open and close the open front surface of the tub, a handle configured to reciprocate between (i) an extended position in which the handle protrudes forward from the door and (ii) a retracted position in which the handle is at least partially accommodated within the door, a handle driver disposed within the door and configured to move the handle from the retracted position toward the extended position or from the extended position toward the retracted position, and a controller configured to determine whether to operate the handle driver and to control power to be supplied to the handle driver. The controller is configured to determine whether a user intends to open the door, and based on determining that a user is to open the door, control the handle driver to move the handle forward from the retracted position toward the extended position.

**[0014]** Implementations according to this aspect can include one or more of the following features. For example, the controller may be further configured to control the handle driver to move the handle forward from the retracted position toward the extended position (i) before a washing course starts or (ii) after the washing course has been completed. In some examples, the controller may be further configured to determine whether the user intends to open the door before the washing course starts or after the washing course has been completed, and based on a determination that the user intends to open the door, supply power to the handle driver to operate the handle driver to cause the handle to move forward from the retracted position toward the extended position.

**[0015]** In some implementations, the dish washer may further include a proximity sensor configured to detect whether the user is located at a position within a predetermined detection range from the door, where the controller may be further configured to receive an output signal from the proximity sensor, determine whether the user is disposed at the position within the predetermined detection range

based on the output signal received from the proximity sensor, based on a determination that the user is disposed at the position within the predetermined detection range, determine whether the user has stayed at the position for a predetermined set time duration, and based on a determination that the user has stayed at the position for the predetermined set time duration, determine that the user intends to open the door. In some examples, the predetermined set time duration is in a range from 0.9 seconds to 1.1 seconds.

**[0016]** In some examples, the door may have a sensor hole defined at a top surface of the door, where the proximity sensor includes a radar sensor disposed inside the door and configured to detect, through the sensor hole, whether the user is disposed within the predetermined detection range. The radar sensor may have a sensing surface that is tilted and faces the top surface of the door in a frontward and upward direction. In some examples, a tilting angle of the sensing surface of the radar sensor is in a range from 25 degrees to 35 degrees with respect to the top surface of the door.

**[0017]** In some examples, the controller may be further configured to, based on determining (i) that the user has a height greater than or equal to a minimum detection height of the proximity sensor in a vertical direction and (ii) that the user is disposed in a distance less than or equal to a maximum detection distance from the proximity sensor in a horizontal direction, determine that the user is disposed at the position within the predetermined detection range. In some examples, the minimum detection height is in a range from 100 cm to 110 cm. In some examples, the maximum detection distance is in a range from 75 cm to 85 cm.

**[0018]** In some implementations, the dish washer may further include a light-source disposed inside the handle and configured to receive power to generate visible light, the light-source being configured to irradiate the visible light to an outside of the handle, where the controller may be further configured to, based on determining that the user intends to open the door, supply power to the light-source to thereby turn on the light-source before an operation of the handle driver is started or simultaneously with a start of the operation of the handle driver.

**[0019]** In some implementations, the controller may be further configured to control the handle driver to move the handle forward from the retracted position toward the extended position while a washing course is in progress. In some examples, the controller may be further configured to determine whether the user intends to open the door while the washing course is in progress, and based on a determination that the user intends to open the door while the washing course is in progress, supply power to the handle driver to operate the handle driver to cause the handle to move forward from the retracted position toward the extended position.

**[0020]** In some implementations, the dish washer may further include a proximity sensor configured to detect whether the user is disposed at a position within a predetermined detection range from the door, and a first vibration sensor and a second vibration sensor that are respectively positioned at different locations inside the door and configured to detect a knock-on input of the user through the door. The controller may be further configured to receive an output signal from the proximity sensor, determine whether the user is disposed at the position within the predetermined detection range based on the output signal received from the proximity sensor, based on a determination that the user is

disposed at the position within the predetermined detection range, determine whether the user has stayed at the position for a predetermined set time duration, based on a determination that the user has stayed at the position for the predetermined set time duration, receive (i) a first vibration signal from the first vibration sensor and (ii) a second vibration signal from the second vibration sensor, determine (i) a maximum amplitude of the first vibration signal received from the first vibration sensor and (ii) a maximum amplitude of the second vibration signal received from the second vibration sensor, compare the maximum amplitude of the first vibration signal with the maximum amplitude of the second vibration signal, and based on a determination that the maximum amplitude of the first vibration signal is greater than the maximum amplitude of the second vibration signal, determine that the user intends to open the door.

**[0021]** In some examples, the first vibration sensor may be located closer to a front surface of the door than the second vibration sensor is. In some examples, the first vibration sensor may be configured to detect vibration in a first axial direction, and the second vibration sensor may be configured to detect vibration in a second axial direction orthogonal to the first axial direction. In some examples, the first vibration signal corresponds to vibration in a horizontal direction, and the second vibration signal corresponds to vibration in a vertical direction orthogonal to the horizontal direction.

**[0022]** In some implementations, the dish washer may further include a light-source disposed inside the handle and configured to receive power to generate visible light, the light-source being configured to irradiate the visible light to an outside of the handle, where the controller may be further configured to, based on a determination that the maximum amplitude of the first vibration signal is greater than the maximum amplitude of the second vibration signal, supply power to the light-source to thereby turn on the light-source before or simultaneously with a start of an operation of the handle driver.

**[0023]** In some examples, the controller may be further configured to, after the handle driver starts to operate, pause the washing course in progress, and based on a forward movement of the handle to the extended position having been completed after operating the handle driver, stop an operation of the handle driver. In some examples, the controller may be further configured to pause the washing course in progress before the operation of the handle driver is stopped or simultaneously with a stop of the operation of the handle driver.

**[0024]** In some implementations, external foreign substances such as dusts may be prevented from accumulating on the handle, thereby maintaining a clean state of the handle and improving user convenience.

**[0025]** In some implementations, in the retracted state of the handle, the user feels a sense of unity of the handle and the door with each other, thereby improving the aesthetics of the appearance of the dish washer.

**[0026]** In some implementations, the dish washer may reduce the possibility of user injury and handle damage that may occur due to collision of the user with the handle.

**[0027]** In some implementations, when a user's intention to open the door is identified as being present while a washing course is in progress, the handle extends to protrude in a frontward direction while the washing process in progress has been stopped, thereby securing convenience and safety simultaneously.

[0028] In addition to the above-mentioned effects, the specific effects of the present disclosure as not mentioned will be described below along with the descriptions of the specific details for carrying out the present disclosure.

#### BRIEF DESCRIPTION OF DRAWINGS

[0029] FIG. 1 is a front perspective view showing an example of a dish washer.

[0030] FIG. 2 is a schematic cross-sectional view of the dish washer as shown in FIG. 1.

[0031] FIG. 3 is a front perspective view showing an example state of a handle of a dish washer that has been displaced to a retracted position.

[0032] FIG. 4 is a front perspective view showing an example state in which the handle as shown in FIG. 3 has been displaced to an extended position.

[0033] FIG. 5 is an enlarged side view of FIG. 3.

[0034] FIG. 6 is a rear perspective view of the door as shown in FIG. 3 and shows a state in which a rear panel of the door is removed.

[0035] FIG. 7 is a rear perspective view of a handle driver as shown in FIG. 5.

[0036] FIG. 8 is an exploded perspective view of the handle driver as shown in FIG. 7.

[0037] FIG. 9 is an exploded perspective view showing an example of a pivot link, a link connector, and a connection pin among components of the handle driver as shown in FIG. 8.

[0038] FIG. 10 is a side view illustrating an example operation of the handle driver to initiate movement from the retracted position to the extended position for the handle.

[0039] FIG. 11 is a side view illustrating an example state in which movement to the extended position of the handle has been completed.

[0040] FIG. 12 is a side view illustrating an example operation of the handle driver to initiate movement from the extended position to the retracted position of the handle.

[0041] FIG. 13 is an enlarged view of a portion of FIG. 11, and is a diagram illustrating an example structure that prevents the handle from being moved backwards under an external force applied to the handle.

[0042] FIG. 14 is a partial enlarged view showing an example state in which the handle and the handle driver have been removed from the door.

[0043] FIG. 15 is a rear perspective view illustrating an example of a handle frame on which the handle and the handle driver are installed which supports the handle and the handle driver.

[0044] FIG. 16 is an exploded perspective view illustrating an example configuration of the handle.

[0045] FIG. 17 is a side view showing an example state in which light is irradiated to an outside from the handle during a process in which the handle is moving to the extended position.

[0046] FIG. 18 is a schematic diagram illustrating an example configuration for recognizing a user and a pet in a distinguishing manner from each other using a proximity sensor disposed on a top surface of a door to determine absence or presence of the user's intention to open the door.

[0047] FIG. 19 and FIG. 20 are vertical cross-sectional views illustrating an example state in which the proximity sensor as shown in FIG. 18 is disposed inside the door.

[0048] FIG. 21 is a vertical cross-sectional view illustrating an example of relative positions of a first vibration

sensor and a second vibration sensor that are configured to determine absence or presence of a user's intention to open the door are positioned, respectively.

[0049] FIG. 22 is a functional block diagram illustrating an example configuration of a controller and functional modules included in a dish washer.

[0050] FIG. 23 is a flow chart showing an example of a sequence of cycles performed in a dish washer.

[0051] FIGS. 24 to 26 are flow charts respectively showing steps of an example method for controlling a dish washer.

#### DETAILED DESCRIPTIONS

[0052] The above-mentioned purpose, features and advantages are described in detail below with reference to the attached drawings. Accordingly, a person skilled in the art in the technical field to which the present disclosure belongs will be able to easily implement the technical idea of the present disclosure. In describing the present disclosure, when it is determined that a detailed description of the known technology related to the present disclosure may unnecessarily obscure the gist of the present disclosure, the detailed description thereof is omitted. Hereinafter, one or more implementations will be described in detail with reference to the attached drawings. In the drawings, identical reference numerals are used to indicate identical or similar components.

[0053] Hereinafter, the present disclosure will be described with reference to the drawings.

[0054] Hereinafter, an overall structure of a dish washer 1 will be described in detail with reference to the attached drawings.

[0055] FIG. 1 is a front perspective view showing the dish washer 1. FIG. 2 is a simplified cross-sectional view briefly showing an internal structure of the dish washer 1.

[0056] As shown in FIG. 1 and FIG. 2, the dish washer 1 may include a casing 10 that constitutes an exterior appearance, a tub 20 installed in an inner space of the casing 10 and having a washing space 21 defined therein where the washing target is washed, wherein a front surface of the tub is open, a door 30 that opens/closes the open front surface of the tub 20, a driver 40 located under the tub 20 to supply, collect, circulate, and discharge the washing water for washing the washing target, a dish rack 50 removably provided in the inner washing space 21 of the tub 20 to receive therein the washing target, and a water sprayer installed adjacent to the dish rack 50 to spray the washing water for washing the washing target thereto.

[0057] In some examples, the washing target received in the dish rack 50 may be, for example, dishes such as bowls, plates, spoons, and chopsticks, and other cooking utensils. Hereinafter, unless otherwise specified, the washing target will be referred to as a dish.

[0058] The tub 20 may be formed in a box shape with an entirely open front surface, and have a configuration of a so-referred to as washing tub.

[0059] The washing space 21 may be defined inside the tub 20. The open front surface of the tub 20 may be opened/closing by the door 30.

[0060] The tub 20 may be formed via pressing of a metal plate resistant to high temperature and moisture, for example, a stainless steel plate.

[0061] Moreover, on an inner surface of the tub 20, a plurality of brackets may be disposed for the purpose of

supporting and installing functional components such as the dish rack 50 and the water sprayer which will be described later thereon within the tub 20.

[0062] In one example, the driver 40 may include a sump 41 that stores therein washing water, a sump cover 42 that distinguishes the sump 41 from the tub 20, a water supply 43 that supplies washing water from an external source to the sump 41, a water discharger 44 that discharges the washing water of the sump 41 to an outside, and a washing pump 45 and a supply flow path 46 that supply the washing water of the sump 41 to the water sprayer. The sump cover 42 may be disposed at a top of the sump 41 and may serve to distinguish the tub 20 and the sump 41 from each other.

[0063] Moreover, the sump cover 42 may have a plurality of collecting holes defined therein for collecting washing water sprayed into the washing space 21 through the water sprayer into the sump 41.

[0064] That is, the washing water sprayed from the water sprayer toward the dish may fall down to a bottom of the washing space 21, and may be collected again through the sump cover 42 and into the sump 41.

[0065] The washing pump 45 may be disposed at one side of the sump 41 and may serve to pressurize the washing water and supply the pressurized washing water to the water sprayer.

[0066] One end of the washing pump 45 may be connected to the sump 41 and the other end thereof may be connected to the supply flow path 46. The washing pump 45 may be equipped with an impeller 451 and a motor 453. When power is supplied to the motor 453, the impeller 451 may rotate, and thus the washing water in the sump 41 may be pressurized, and then may be supplied to the water sprayer through the supply flow path 46.

[0067] In some examples, a wash water heater may be provided in the washing pump 45 to heat the wash water supplied during a wash cycle or a heat rinse cycle.

[0068] In one example, the supply flow path 46 may serve to selectively supply the washing water supplied from the washing pump 45 to the water sprayer.

[0069] For example, the supply flow path 46 may include a first supply flow path 461 connected to a lower spraying arm 61, and a second supply flow path 463 connected to an upper spraying arm 62 and a top nozzle 63. The supply flow path 46 may be provided with a supply flow path switching valve 465 that selectively opens/closes the supply flow paths 461 and 463.

[0070] In some examples, the supply flow path switching valve 465 may be controlled so that the supply flow paths 461 and 463 are opened sequentially or simultaneously.

[0071] In one example, the water sprayer may be configured to spray the washing water to the dishes stored in the dish rack 50.

[0072] More specifically, the water sprayer may include the lower spraying arm 61 located under the tub 20 to spray the washing water to a lower rack 51, the upper spraying arm 62 located between the lower rack 51 and an upper rack 52 to spray the washing water to the lower rack 51 and the upper rack 52, and the top nozzle 63 located on top of the tub 20 to spray the washing water to a top rack 53 or the upper rack 52.

[0073] In particular, the lower spraying arm 61 and the upper spraying arm 62 may be rotatably disposed in the

washing space 21 of the tub 20 and may spray the washing water toward the dish of the dish rack 50 while being rotating.

[0074] The lower spraying arm 61 may be rotatably supported on a top of the sump cover 42 so as to spray the washing water toward the lower rack 51 while being rotating and being disposed under the lower rack 51.

[0075] Moreover, the upper spraying arm 62 may be rotatably supported by a spraying arm holder 467 so as to spray the washing water on the dish while being rotating and being disposed between the lower rack 51 and the upper rack 52.

[0076] In some examples, in order to increase washing efficiency, additional structure for diverting the washing water sprayed from the lower spraying arm 61 into an upward direction (diverting in a U-direction) may be provided at a lower surface 25 of the tub 20.

[0077] A description of the specific configuration of the water sprayer will be omitted below.

[0078] The dish rack 50 for storing the dish therein may be disposed in the washing space 21.

[0079] The dish rack 50 may be configured to extend or retract from or into the inner space of the tub 20 through the open front surface of the tub 20.

[0080] For example, referring to FIG. 2, the dish rack 50 includes the lower rack 51 located at a lower portion of the tub 20 to accommodate therein relatively large dishes, the upper rack 52 located on top of the lower rack 51 to accommodate therein medium-sized dishes, and the top rack 53 located at a top level of the tub 20 and capable of storing therein small dishes, etc. However, implementations of present disclosure are not limited thereto.

[0081] Hereinafter, an example in which the dish washer 1 includes the three dish racks 50 as shown is described.

[0082] In some implementations, each of the lower rack 51, the upper rack 52, and the top rack 53 may be configured to extend or retract from or into the inner space of the tub 20 through the open front surface of the tub 20.

[0083] In some examples, guide rails may be respectively disposed on both opposing inner side surfaces constituting an inner surface of the tub 20. By way of example, the guide rails may include an upper rail, a lower rail, and a top rail.

[0084] Wheels may be disposed on a bottom of each of the lower rack 51, the upper rack 52, and the top rack 53. The user may extend the lower rack 51, the upper rack 52, and the top rack 53 from the inner space of the tub 20 through the open front surface of the tub 20 and may place the dishes thereon, or easily withdraw the dishes that have been washed out thereof.

[0085] The guide rail may be implemented as a simple rail-type fixed guide rail to guide the extending or the retracting of the rack 50, or a telescopic guide rail capable of guiding the extending or the retracting of the rack 50 and at the same time, increasing an extension distance thereof as the rack 50 further extends from the inner space of the tub.

[0086] In one example, the door 30 is configured for opening/closing the open front surface of the tub 20 as described above.

[0087] A hinge around which the door 30 is closed or opened may be provided at a bottom of the open front surface. Thus, the door 30 may pivot around the hinge as a pivot axis.

[0088] In some examples, a handle 31 for opening the door 30 and a control panel 32 for controlling an operation of the dish washer 1 may be disposed on an outer side surface of the door 30.

[0089] As shown, the control panel 32 may include a display 33 that visually displays information regarding a current operating status of the dish washer 1, etc., and a button unit 34 including a selection button through which a user's course selection manipulation is input and a power button through which a user's manipulation for turning the dish washer on and off is input.

[0090] In one example, a rear panel 30b constituting an inner side surface of the door 30 may constitute one surface of the tub 20 when the door 30 has been closed, and may constitute a seat surface on which the lower rack 51 of the dish rack 50 is supported when the door 30 is fully opened.

[0091] In some examples, when the door 30 is fully opened downwardly, the rear panel 30b of the door 30 may constitute a horizontal plane extending in the same direction as a direction in which the guide rail guiding the displacement of the lower rack 51 extends.

[0092] In one example, unlike a conventional handle, the handle 31 of the dish washer 1 may be configured to be at least partially accommodated in an inside of the door 30 when the handle is not in use, and to automatically extend in a protruding manner in a frontward direction from the door 30 when it is necessary to open and close the door 30.

[0093] In that the handle is configured to retract so as to be at least partially accommodated in the inside of the door 30 or extend in a protruding manner in a frontward direction from the door 30 out of the inside of the door 30, the handle 31 may be referred to as various names such as a pop-up handle, a retractable handle, an extendable handle, etc.

[0094] Hereinafter, the handle 31 configured to retract into or extend from the door 30 of the dish washer 1 will be referred to as the pop-up handle 31.

[0095] In some examples, a detergent supply device for automatically supplying detergent into the inside of the tub 20 may be further installed on an inner side surface of the door 30.

[0096] Furthermore, a door position sensor 36 may be disposed on an outer top surface of the tub 20 and may be configured to detect whether the door 30 is in a closed or open state. For example, the door position sensor 36 may include a door position sensor S<sub>d</sub> or a latch sensor that detects a position of a door latch.

[0097] In one example, a drying air supply 80 may be disposed under the tub 20 and may be configured to generate and supply high-temperature or low-temperature drying air to the washing space inside the tub 20.

[0098] As shown, the drying air supply 80 may be configured to include a filter member 883 for filtering outside air, a blower fan 825 for generating a drying air stream, a heater 84 for heating the drying air stream, and an air stream guide 83 disposed inside the tub 20 so as to guide the drying air stream.

[0099] A drying air supply hole may be defined in a lower surface of the tub 20 so that high-temperature drying air generated by the drying air supply 80 may be introduced into the inside of the tub 20 through the drying air supply hole.

[0100] Thus, the high-temperature drying air or low-temperature drying air may be supplied from the drying air supply 80 into the inside of the tub 20 during the drying

cycle S5 such that the drying efficiency and sterilization effect on the dishes may be improved compared to a conventional dish washer.

[0101] In one example, the dish washer may be configured such that the air current supplied to the inside of the tub 20 and moistened while drying the dishes may be discharged to the outside, and the discharge of the air current may be accomplished via partial opening of the door 30 or via a separate air discharge device.

[0102] Hereinafter, with reference to FIGS. 3 to 5, the appearance and the operation of the pop-up handle 31 disposed at the door 30 of the dish washer 1 will be described in detail.

[0103] As described above, the door 30 of the dish washer 1 may be provided with the pop-up handle 31 that may be reciprocally movable.

[0104] In some examples, as described above, the door 30 may be configured to be pivotable around the hinge connected to a lower end of the door.

[0105] In consideration of the position of the hinge, as shown in FIG. 3 and FIG. 4, the pop-up handle 31 may be positioned at a position close to a top surface of the door 30 where the user may easily grasp the handle, and may be disposed at the front panel 30a constituting the front surface of the door 30.

[0106] Furthermore, the pop-up handle 31 may extend along an extension direction of a front edge of the top surface of the door 30 and along a left-right direction so that the user may easily grasp the handle. The handle 31 may be formed to have an approximate 90 degrees-rotated U shape.

[0107] In order to extend or retract the pop-up handle 31, an elongate opening 30e extending in a left-right direction and having a shape corresponding to an appearance of the pop-up handle 31 may be defined in the front panel 30a of the door 30 and extend along the extension direction of the front edge of the top surface of the door 30, and have a depth along a front-rear (F-R) direction

[0108] The pop-up handle 31 may be configured to reciprocate along the forward and backward directions through the opening 30e of the front panel 30a under an operation of a handle driver 35 as described below.

[0109] More specifically, the pop-up handle 31 may be disposed to reciprocate between the most forward position and the most rearward position under the operation of the handle driver 35.

[0110] For convenience, the most forward position to which the pop-up handle 31 is displaced in a forward direction is defined as an extended position Pd. The most rearward position to which the pop-up handle 31 is displaced in a backward direction is defined as a retracted position Pa.

[0111] FIG. 3 illustrates a state where the pop-up handle 31 has been displaced to the most rearward position, that is, the retracted position Pa, and thus has been retracted into the inside of the door 30.

[0112] As shown, when the pop-up handle 31 has been displaced to the retracted position Pa, the pop-up handle 31 has been at least partially retracted into the inside of the door 30.

[0113] In some examples, preferably, the pop-up handle 31 may passing through an entirety of the opening 30e of the door 30 and be retracted into the inside of the door 30.

[0114] Furthermore, when the pop-up handle 31 has been displaced to the retracted position Pa, the pop-up handle 31



may be in a state where the pop-up handle 31 does not protrude from the front panel 30a of the door 30 in a frontward direction.

[0115] Furthermore, when the pop-up handle 31 has been displaced to the retracted position Pa, a front end surface of the pop-up handle 31 may be coplanar with a front surface of the front panel 30a of the door 30 so as to form a continuous surface.

[0116] That is, a state in which no step is formed between the front surface of the front panel 30a of the door 30 and the front end surface of the pop-up handle 31 may be formed when the pop-up handle 31 has been displaced to the retracted position Pa.

[0117] Thus, when the pop-up handle 31 has been displaced to the retracted position Pa, the opening 30e of the front panel 30a is entirely blocked, and at the same time, no step is formed between the front surface of the front panel 30a and the front end surface of the pop-up handle 31, such that the phenomenon in which foreign substances such as dusts accumulate on a convex portion of the door 30 or on the handle itself as in the conventional approach may be fundamentally prevented.

[0118] In one example, as described below, the front end surface of the pop-up handle 31 may be a front surface of a decoration panel 315 that is provided separately from a first handle body 311 that constitute the overall appearance of the pop-up handle 31.

[0119] In some examples, the decoration panel 315 may include a material having the same texture as that of the front panel 30a of the door 30.

[0120] Thus, the user may feel a sense of unity the decoration panel 315 and the front panel 30a of the door 30, and thus the aesthetic sensibility of the outer appearance of the door 30 may be improved and the aesthetics of the door which the user perceives may be improved.

[0121] FIG. 4 and FIG. 5 illustrate a state in which the pop-up handle 31 has been displaced from the retracted position Pa to the extended position Pd as the most forward position.

[0122] As described above, the door 30 of the dish washer 1 should be opened and closed in order to store the dishes that need to be washed in the dish washer or to withdraw the dishes that have been washed out of the dish washer 1.

[0123] When the user's intention to open the door 30 is identified as being present at a time when opening/closing of the door 30, the pop-up handle 31 may be automatically moved from the retracted position Pa to the extended position Pd under the operation of the handle driver 35.

[0124] In some examples, the dish washer 1 may further be provided with a device for detecting the user's intention to open the door 30.

[0125] For example, the dish washer 1 may include a proximity sensor S<sub>p</sub> as a first device for detecting absence or presence of a user's intention to open the door 30.

[0126] The proximity sensor S<sub>p</sub> may be a sensor that may detect whether the user approached so as to be located within a specific detection range from the door 30.

[0127] For example, the proximity sensor S<sub>p</sub> may include any one of a radar sensor, an image sensor, or an infrared sensor (IR) Sensor.

[0128] However, implementations of the present disclosure are not limited thereto, and the proximity sensor S<sub>p</sub> may be applied without limitation in terms of the type thereof as long as the proximity sensor S<sub>p</sub> is a device that

may identify proximity of the user to the door. The following description will be based on an example in which the radar sensor is applied as the proximity sensor S<sub>p</sub>.

[0129] As shown in FIG. 3 and FIG. 4, the radar sensor as the proximity sensor S<sub>p</sub> may be disposed on the control panel 32 and at a location close to the existing display 33 so as to easily identify the proximity of the user to an area in front of the door, and to facilitate modularization thereof with the existing display 33.

[0130] Furthermore, in order to distinguish between a user and a non-user such as a pet, the radar sensor functioning as the proximity sensor S<sub>p</sub> may be disposed on the control panel 32 and at a location as close as possible to a center of the top surface of the door 30.

[0131] However, the dish washer 1 is not configured to immediately move the pop-up handle 31 even when the radar sensor recognizes that the user is located within a predetermined detection range from the door 30.

[0132] This is because there may be cases where the user simply passes by the dish washer 1 without any intention to open the door 30.

[0133] In some implementations, the dish washer 1 may be further configured to add a time condition to identify absence or presence of the intention to open the door 30 through the proximity sensor S<sub>p</sub> such as the radar sensor.

[0134] In some examples, when the dish washer 1 identifies that the user is present within a specific detection range from the door 30 through the radar sensor and continues to stay within the specific detection range for a specific time condition, the dish washer 1 may determine that the user has an intention to open the door 30.

[0135] In some examples, the specific detection range and the specific time condition may be set to vary depending on the environment in which the dish washer 1 is disposed and a physical condition of the user.

[0136] When the specific detection range condition and the specific time condition are satisfied, a controller 100 as described below is configured to initiate the operation of the handle driver 35 to move the pop-up handle 31 in the frontward direction from the retracted position Pa to the extended position Pd.

[0137] Details regarding the configuration for identifying absence or presence of the user's intention to open the door 30 using the proximity sensor S<sub>p</sub>, etc., will be described below with reference to FIG. 18.

[0138] FIG. 4 and FIG. 5 illustrate the state in which the pop-up handle 31 has completed the forward movement to the extended position Pd.

[0139] When the pop-up handle 31 has completed its movement to the extended position Pd, the first handle body 311 of the pop-up handle 31 may be entirely exposed to the outside of the door 30 and may be grasped by the user.

[0140] In some examples, a stroke L<sub>s</sub> by which the pop-up handle 31 is displaced from the retracted position Pa to the extended position Pd may be in a range of 40 mm inclusive to 50 mm inclusive, for example, 45 mm.

[0141] The stroke L<sub>s</sub> of the pop-up handle 31 is determined in consideration of that when the stroke L<sub>s</sub> is too small, such as smaller than 40 mm, it is not easy for the user to grasp the handle, while when the stroke L<sub>s</sub> is too large, such as larger than 50 mm, a size of the pop-up handle 31 in the forward and backward direction increases, thereby causing a problem in that the pop-up handle 31 does not retract entirely into the door 30.

[0142] However, the numerical value of the movement stroke  $L_s$  of the pop-up handle 31 is only an example and may be set to vary depending on the overall size of the dish washer 1 and the size in the forward and backward direction of the door 30.

[0143] In one example, as the pop-up handle 31 moves to the extended position Pd, the first handle body 311 of the pop-up handle 31 comes out of the opening 30e of the front panel 30a of the door 30 and is exposed to the outside of the door 30. Accordingly, the opening 30e is not blocked with the first handle body 311.

[0144] However, when the pop-up handle 31 moves to the extended position Pd as described below, a second handle body 312 connected to the first handle body 311 moves in the frontward direction together therewith, so that the opening 30e of the front panel 30a is blocked with the second handle body 312.

[0145] Therefore, even when the pop-up handle 31 has been moved to the extended position Pd, the opening 30e of the front panel 30a may be maintained in a blocked state, so that foreign substances such as dusts may be effectively prevented from entering the inside of the door 30.

[0146] Furthermore, since the observation of the inside of the door 30 through the opening 30e of the front panel 30a blocked with the second handle body 312, the deterioration of the aesthetic sense for the user may be effectively prevented.

[0147] Hereinafter, referring to FIG. 6 to FIG. 13, the detailed configuration of the handle driver 35 that actuates the pop-up handle 31 so that the pop-up handle 31 moves back and forth between the extended position Pd and the retracted position Pa is described.

[0148] Referring to FIG. 6, in consideration of a shape of each of the first handle body 311 and the second handle body 312 of the pop-up handle 31 that extends in an elongate manner in the left-right direction, a pair of handle drivers 35 may be disposed separately and respectively on a left end and a right end of the pop-up handle 31.

[0149] That is, the pair of handle drivers 35 may be separated from each other and spaced from each other along the left-right direction and may be respectively on a left end and a right end of the pop-up handle 31 so as to respectively transmit a driving force for moving the pop-up handle 31 to the left end and the right end of the pop-up handle 31 which are accommodated inside a handle housing 30d4.

[0150] In this way, the pair of handle drivers 35 are disposed in a state separated from each other and spaced from each other along the left-right direction, the driving force generated from each of the handle drivers 35 may be transmitted to each of the left and right ends of the pop-up handle 31.

[0151] Accordingly, since driving loads applied to the handle drivers 35 are distributed, the miniaturization of each of the handle drivers 35 may be achieved, and thus, the manufacturing cost may be reduced.

[0152] However, this is only an example. Alternatively, the pop-up handle 31 may be driven using only a single handle driver. Hereinafter, an implementation in which the pair of handle drivers 35 are provided will be described. However, implementations of present disclosure are not limited thereto.

[0153] As illustrated, the left handle driver 35 and the right handle driver 35 may have shapes symmetrical with each

other and may be arranged symmetrically with each other around the pop-up handle 31, and may be fixedly installed on a handle frame 30d.

[0154] Therefore, the right and left handle drivers 35 may be configured to be identical with each other except for the fact that the left handle driver 35 and the right handle driver 35 have shapes symmetrical with each other and are arranged symmetrically with each other around the pop-up handle 31.

[0155] Therefore, the following description will be based on the handle driver 35 disposed at the left side. Unless otherwise described, the following content may be equally applied to the handle driver 35 disposed at the right side.

[0156] As shown in FIG. 7 to FIG. 9, the handle driver 35 that generates the driving force for the reciprocating movement of the pop-up handle 31 may be configured to include a driving motor 351 that receives power and generates a rotational driving force, a driving cam 352 that spins under the rotational driving force of the driving motor 351, a pivot link 353 that pivots around one end thereof in conjunction with the spin motion of the driving cam 352 so as to push or pull the pop-up handle 31, a link connector 354 that connects the pivot link 353 and the pop-up handle 31 to each other, and a housing 355 that accommodates therein the driving motor 351, the driving cam 352, and the pivot link 353.

[0157] The driving motor 351 is configured to receive power and generate a rotational driving force.

[0158] As described above, the pop-up handle 31 may be configured to repeatedly move forwards from the retracted position Pa toward the extended position Pd and move backwards from the extended position Pd toward the retracted position Pa and thus to reciprocate between the extended position Pd and the retracted position Pa.

[0159] In order to easily implement such reciprocating movement, the driving motor 351 constituting the handle driver 35 may be configured to generate a bidirectional rotation driving force.

[0160] Accordingly, the driving motor 351 applied to the handle driver 35 may be applied without limitation in terms of the type thereof as long as the driving motor 351 is capable of generating the bidirectional rotation driving force.

[0161] Hereinafter, among the bidirectional rotation driving (forces), the driving (driving force) in the direction in which an output shaft 3512 of the driving motor 351 rotates to move the pop-up handle 31 in the frontward direction toward the extended position Pd is referred to as forward direction rotation driving (forward direction rotation driving force), while the driving (driving force) in the direction in which the output shaft 3512 of the driving motor 351 rotates to move the pop-up handle 31 backwards toward the retracted position Pa is referred to as reverse direction rotation driving (or reverse direction rotation driving force).

[0162] In one example, as shown in FIG. 8, a motor body 3511 of the driving motor 351 may be accommodated in an accommodation space formed between a second housing 3552 and a third housing 3553, and the output shaft 3512 of the driving motor 351 may extend through the second housing 3552 and be connected to the driving cam 352.

[0163] As described below, the output shaft 3512 of the driving motor 351 may be inserted into a shaft hole 3522 of the driving cam 352, and may be forcibly coupled to the shaft hole 3522.

[0164] Thus, the output shaft 3512 of the driving motor 351 may rotate integrally with the driving cam 352.

[0165] In one example, the driving cam 352 receives the rotation driving force from the output shaft 3512 of the driving motor 351 and transmits the received rotation driving force to the pivot link 353.

[0166] More specifically, when the driving cam 352 rotates in the forward direction in conjunction with the rotation of the output shaft 3512 of the driving motor 351, the driving cam 352 pressurizes the pivot link 353 so that the pivot link 353 pivots in the forward direction. When the driving cam 352 rotates in the reverse direction in conjunction with the rotation of the output shaft 3512 of the driving motor 351, the driving cam 352 pressurizes the pivot link 353 so that the pivot link 353 pivots in the backward direction.

[0167] In some examples, the driving cam 352 may be configured to include a cam body 3521 that spins under the rotation driving force transmitted from the output shaft 3512 of the driving motor 351, and a driving pin 3523 that is disposed on one side surface of the cam body 3521 and protrudes toward the pivot link 353.

[0168] The cam body 3521 may be provided in a form of a disk having an approximately uniform thickness, for example.

[0169] The shaft hole 3522 to which the output shaft 3512 of the driving motor 351 is forcibly inserted may extend through a center portion of the cam body 3521.

[0170] In order to easily implement integral rotation of the cam body 3521 and the motor shaft 3512 via the forcible coupling between the output shaft 3512 and the shaft hole 3522, the output shaft 3512 and the shaft hole 3522 may be connected to each other via a spline coupling, etc.

[0171] In one example, the driving pin 3523 plays a role of transmitting the rotation driving force of the cam body 3521 to the pivot link 353.

[0172] As illustrated, the driving pin 3523 may be formed to protrude from one side surface facing the pivot link of the cam body 3521 toward the pivot link 353, and may be positioned at a position spaced apart from the shaft hole 3522 by a predetermined distance in a radial direction.

[0173] Therefore, when the cam body 3521 spins around the shaft hole 3522, the driving pin 3523 revolves around the shaft hole 3522.

[0174] The driving pin 3523 is connected to the pivot link 353 while being inserted into a guide groove 3533 of the pivot link 353 as described later.

[0175] Accordingly, while the driving pin 3523 revolves around the shaft hole of the cam body 3521, the driving pin 3523 pressurizes the pivot link 353 so that the pivot link 353 pivots in a forward or backward direction.

[0176] In one example, a revolve range of the driving pin 3523 or a spin range of the cam body 3521 needs to be smaller than an extension length of the guide groove 3533 provided in the pivot link 353. This is because when the revolve range is larger than the extension length of the guide groove 3533, there is a possibility that the driving pin 3523 or the guide groove 3533 may be damaged.

[0177] A stopper protrusion 3524 acting as a structure for limiting the revolve range of the driving pin 3523 or the spin range of the cam body 3521 may be disposed on an edge of the cam body 3521 and protrude along a radial direction thereof.

[0178] As illustrated, the stopper protrusion 3524 may be implemented as a predetermined step formed on the edge of the cam body 3521.

[0179] The stopper protrusion 3524 implemented as the step may be provided as a pair of stopper protrusions spaced apart from each other along a circumferential direction of the cam body which may limit the revolve range of the driving pin 3523 or the spin range of the cam body 3521 in both opposing directions.

[0180] In this way, the stopper protrusion 3524 may limit the revolve range of the driving pin 3523 or the spin range of the cam body 3521 to a circumferential range defined between the pair of stopper protrusions 3524.

[0181] As shown in FIG. 9, a cam stopper 3552b corresponding to the pair of stopper protrusions 3524 may be provided inside the second housing 3552 that accommodates the driving cam 352.

[0182] In one example, the pivot link 353 receives the driving force from the driving pin 3523 of the driving cam 352 so as to push the pop-up handle 31 so that the pop-up handle 31 moves forwards or pull the pop-up handle 31 so that the pop-up handle 31 moves backwards.

[0183] As shown in FIG. 9, the pivot link 353 may be, for example, a bar-type link extending from a first end 3531 toward a second end 3532 thereof in a bar shape.

[0184] In some examples, the first end 3531 of the pivot link 353 as the bar-type link may be supported by the first housing 3551 and the second housing 3552 such that the pivot link only relatively rotates with respect to the first housing 3551 and the second housing 3552, that is, only pivots with respect to the first housing 3551 and the second housing 3552.

[0185] Accordingly, the pivot link 353 may pivot around the first end 3531 when the pressing force of the driving pin 3523 of the driving cam 352 is applied thereto.

[0186] In some examples, a pair of shaft bosses 3531a that serve as a pivot center of an entirety of the pivot link 353 may be provided at both opposing sides of the first end 3531 of the pivot link 353, respectively.

[0187] The pair of shaft bosses 3531a may be formed to protrude toward the first housing 3551 and the second housing 3552 so as to have a predetermined protrusion height from one side surface and the other side surface of the first end 3531 of the pivot link 353, respectively.

[0188] A bushing 356 or a bearing may be fitted around each of the pair of shaft bosses 3531a to reduce friction. The pair of shaft bosses 3531a may be connected to the first housing 3551 and the second housing 3552, respectively, while each bushing 356 is fitted around each of the pair of shaft bosses 3531a.

[0189] Each of the first housing 3551 and the second housing 3552 may be formed to have each of cylindrical bushing receiving portions 3551a and 3552a into which each bushing 356 may be inserted.

[0190] The pivot link 353 may be formed to have the guide groove 3533 into which the driving pin 3523 of the driving cam 352 as described above is inserted.

[0191] As illustrated, the guide groove 3533 may be formed between the first end 3531 and the second end 3532, and may be defined in a first extension 353a of the pivot link 353 as described below.

[0192] The guide groove 3533 may linearly extend along a length direction of the first extension 353a. Movement of the driving pin 3523 may be guided along the extension

direction of the guide groove 3533 so that the driving pin 3523 moves relative to the guide groove 3533 while being inserted into the guide groove 3533.

[0193] In one example, the second end 3532 of the pivot link 353 may be connected to the second handle body 312 of the pop-up handle 31 so as to be relatively pivotable with respect thereto, and may be configured to move the pop-up handle 31 forwards or backwards by pushing or pulling the second handle body 312 when the pivot link 353 pivots.

[0194] The second end 3532 of the pivot link 353 may be connected to the second handle body 312 via a connection pin 3534 so that the second end 3532 of the pivot link 353 may be pivotable relative to the second handle body 312.

[0195] In some examples, the link connector 354 may be further provided as a component for mutually connecting the second end 3532 of the pivot link 353 and the second handle body 312 to each other.

[0196] As illustrated, in one example, the link connector 354 may be configured to include a handle connection portion 3541 that is fastened to the second handle body 312 as described below, and a link connection portion 3542 that is indirectly connected to the second end 3532 via the connection pin 3534.

[0197] The handle connection portion 3541 may be formed in a flat shape so as to make surface contact with the second handle body 312 in order to secure a maximum contact area with the second handle body 312.

[0198] The handle connection portion 3541 may be formed to have a plurality of screw holes 3541h defined therein so that a connecting device such as a screw bolt may pass through each screw hole.

[0199] The link connection portion 3542 may be indirectly connected to the second end 3532 of the pivot link 353 via the connection pin 3534.

[0200] In some examples, a pin guide hole 3543 may be formed in the link connection portion 3542 and extend through the link connection portion along the left-right direction.

[0201] As illustrated, the pin guide hole 3543 may linearly extend along the vertical direction. The movement of the connection pin 3534 may be guided so that the connection pin moves relative to the pin guide hole 3543 in the vertical direction while being inserted into the pin guide hole 3543.

[0202] Therefore, when the pivot link 353 pivots, the connection pin 3534 coupled to the second end 3532 of the pivot link 353 moves along the pin guide hole 3543, thereby pushing the link connector 354 forwards or pulling the link connector backwards, thereby causing the pop-up handle 31 to move forwards or backwards.

[0203] In order to allow the connection pin 3534 to be connected in this way, left and right pin holes 3532h through which the connection pin 3534 passes may extend through the second end 3532 of the pivot link 353 along the left-right direction and may be arranged along the left-right direction.

[0204] Furthermore, the second end 3532 of the pivot link 353 may be formed in a branched form as illustrated in order to prevent interference with the link connection portion 3542 that moves relative to the second end 3532.

[0205] In one example, as described above, the pivot link 353 pivots around the first end 3531 to push or pull the link connector 354 and the second handle body 312 to generate the forward or backward movement stroke Ls of the pop-up handle 31.

[0206] In order to minimize a pivot amount of the pivot link 353 and maximize the frontward-backward movement stroke Ls of the pop-up handle 31, the second end 3532 of the pivot link 353 may extend in an inclined manner toward the second handle body 312 of the pop-up handle 31.

[0207] That is, as shown in FIG. 9, the pivot link 353 may include a first extension 353a that extends radially from the first end 3531, and a second extension 353b that extends in a bent manner toward the pop-up handle 31 and between the first extension 353a and the second end 3532.

[0208] In this way, the second extension 353b is formed to be bent or curved toward the pop-up handle 31, thereby greatly increasing a frontward-rearward stroke Ls by which the second handle body 312 of the pop-up handle 31 is pushed or pulled.

#### Movement of the Pop-up Handle Under Operation of Handle Driver

[0209] Referring to FIG. 10 to FIG. 13, a process in which the pop-up handle 31 moves forwards to the extended position Pd or moves backwards to the retracted position Pa under the operation of the handle driver 35 will be described below.

[0210] FIG. 10 illustrates a situation in which the pop-up handle 31 automatically moves forwards along the forward direction Dfw from the retracted position Pa toward the extended position Pd.

[0211] Referring to FIG. 10, when the pop-up handle 31 has been displaced to the retracted position Pa, the power is supplied to the driving motor 351, such that the operation of the driving motor 351 is initiated, and the driving motor 351 generates the forward direction rotation driving force.

[0212] Accordingly, the forward direction rotation of the output shaft 3512 of the driving motor 351 may be initiated, and the forward direction spin of the driving cam 352 forcibly connected to the output shaft 3512 may be initiated.

[0213] At this time, when the forward direction rotation is initiated, the output shaft 3512 and the driving cam 352 may start to rotate counterclockwise based on the illustrated state.

[0214] In one example, as the forward direction spin of the driving cam 352 is initiated, a forward direction revolve of the driving pin 3523 may be initiated.

[0215] As shown in FIG. 10, the driving pin 3523 which has been located at a lower end of the guide groove 3533 of the pivot link 353 may start to move to a top of the guide groove 3533.

[0216] As the driving pin 3523 revolves in the forward direction, the driving pin moves to the top from the bottom of the guide groove 3533, such that the driving pin 3523 presses the pivot link 353 such that the pivot link pivots forwards around the first end 3531. That is, based on the illustrated state, the pivot link 353 pivots counterclockwise around the first end 3531.

[0217] At this time, as the pivot link 353 pivots around the first end 3531, the second end 3532 of the pivot link 353 also pivots forwards, and the connection pin 3534 connected to the second end 3532 pivots forwards.

[0218] Accordingly, the driving pin 3523 which has been located at the bottom of the guide hole 3543 of the link connector 354 moves to the top of the guide hole 3543.

[0219] As the connection pin 3534 moves to the top from the bottom of the guide hole 3543, the connection pin 3534 presses the link connector 354 and the second handle body 312 to push forwards. That is, while the connection pin 3534

moves relative to the guide hole 3543 and along the guide hole 3543, a pressure force is applied to the link connector 354 to push the link connector 354 forwards.

[0220] In this way, the operation of the handle driver 35 is initiated, such that the driving cam 352 has completely rotated along a preset rotation range. Then, the power supply to the driving motor 351 may be cut off, and the forward movement of the pop-up handle 31 to the extended position Pd may be completed.

[0221] FIG. 11 shows the state in which the pop-up handle 31 has completed the forward movement to the extended position Pd.

[0222] When the forward movement of the pop-up handle 31 to the extended position Pd has been completed in this way, an entirety of the first handle body 311 may be exposed to the outside of the door 30, and thus, the user may easily perform the action of opening or closing the door 30 while holding the first handle body 311.

[0223] In some examples, as shown in FIG. 13, when the pop-up handle 31 has been displaced to the extended position Pd, the first extension 353a of the pivot link 353 has stood upright, and the driving pin 3523 of the driving cam 352 has been moved to the bottom of the guide groove 3533.

[0224] Therefore, as shown, a predetermined intersection angle  $\alpha$  may be defined between a virtual first extension line Lc1 connecting a center Cr of the driving pin 3523 and a rotation center Cc of the shaft hole 3522 as a rotation center of the cam body 3521 and a virtual second extension line Lc2 which is parallel to a moving direction Drw/Dfw of the pop-up handle 31 and passes through the rotation center Cc of the shaft hole 3522 of the cam body 3521. However, the intersection angle  $\alpha$  may be very small angle.

[0225] For example, the intersection angle  $\alpha$  may be in a range of 0 degrees inclusive to 5 degrees inclusive.

[0226] The very small intersection angle  $\alpha$  in a range of 5 degrees or smaller is defined in this way. Thus, a structure may be achieved in which the first handle body 311 is fixed at the extended position Pd without being removed from the extended position Pd even when a user's pressure to open or close the door 30 is applied to the first handle body 311 of the pop-up handle 31.

[0227] That is, a structure in which the pop-up handle 31 may be effectively fixed at the extended position Pd may be achieved by a position arrangement of the pivot link 353 and the driving cam 352 while a separate removal-prevention structure or fixing structure is not disposed at the pop-up handle 31 and the handle frame 30d as described below.

[0228] Thus, in the dish washer 1, a structure of a combination of the pop-up handle 31, the handle driver 35, and the handle frame 30d may be simplified, and a manufacturing cost thereof may be reduced.

[0229] FIG. 11 illustrates a situation in which the pop-up handle 31 automatically moves backwards along the backward direction Drw from the extended position Pd toward the retracted position Pa.

[0230] Referring to FIG. 11, the pop-up handle 31 has moved to the extended position Pd. Then, after a predetermined waiting time has elapsed, the power is supplied to the driving motor 351, the driving motor 351 starts operating, and the driving motor 351 generates the reverse rotation driving force. For example, the predetermined waiting time may be in a range of 2.5 seconds to 3.5 seconds.

[0231] Accordingly, the reverse rotation of the output shaft 3512 of the driving motor 351 starts, and the reverse spin of the driving cam 352 forcibly connected to the output shaft 3512 may start.

[0232] When the reverse rotation starts, the output shaft 3512 and the driving cam 352 may start to rotate clockwise based on the illustrated state.

[0233] Further, as the reverse spin of the driving cam 352 starts, the reverse revolution of the driving pin 3523 may start.

[0234] As shown in FIG. 11, the driving pin 3523 which has been positioned at the bottom of the guide groove 3533 of the pivot link 353 may start to move relative to the guide groove 3533 and to the top of the guide groove 3533.

[0235] As the driving pin 3523 revolves in the reverse direction, the driving pin moves relative to the guide groove 3533 and to the top from the bottom of the guide groove 3533, the driving pin 3523 presses the pivot link 353 to pivot in the rearward direction around the first end 3531. That is, based on the shown state, the pivot link 353 pivots clockwise around the first end 3531.

[0236] In some examples, as the pivot link 353 pivots around the first end 3531, the second end 3532 of the pivot link 353 also pivots in the rearward direction, and the connection pin 3534 connected to the second end 3532 pivots in the rearward direction.

[0237] Accordingly, the driving pin 3523 which has been located at the top of the guide hole 3543 of the link connector 354 moves relative to the guide hole 3543 and to the bottom of the guide hole 3543.

[0238] As the connection pin 3534 moves relative to the guide hole 3543 and from the top to the bottom of the guide hole 3543, the connection pin 3534 applies the pressure the link connector 354 to pull the link connector 354 in the rearward direction. That is, while the connection pin 3534 moves relative to and along the guide hole 3543, a pressure force is applied to the link connector 354 to pull the link connector 354 in the rearward direction.

[0239] In this way, the operation of the handle driver 35 has been initiated, and then, the driving cam 352 has completed the reverse pivot motion thereof along the preset rotation range. Then, the power supply to the driving motor 351 may be cut off, and the backward movement of the pop-up handle 31 to the retracted position Pa may have been completed.

#### Guide of Linear Movement of Pop-up Handle

[0240] As described above, the pop-up handle 31 is configured to move forwards or backwards under the forward direction driving force or the reverse direction driving force of the handle driver 35.

[0241] However, as described above, the pop-up handle 31 may be configured to move horizontally or linearly along the forward direction Dfw or the backward direction Drw.

[0242] A structure for implementing the horizontal or linear movement may be provided in the pop-up handle 31 and the handle frame 30d in which the pop-up handle 31 is accommodated.

[0243] As described above, the pop-up handle 31 may be configured to include the first handle body 311 that is exposed to the outside of the door 30 and can be gripped by the user when the handle has been moved to the extended position Pd, and the second handle body 312 that is con-

nected to a rear end of the first handle body 311 and is disposed inside the door 30 when the handle has been moved to the extended position Pd.

[0244] As illustrated in FIG. 14, the second handle body 312 may include a plate-shaped panel 3121 that serves to screen the opening 30e formed in the front panel 30a of the door 30 when the pop-up handle 31 has been moved to the extended position Pd, and an edge rib 3122 that extends along an edge of the panel 3121 and extends rearwardly so as to be away from the first handle body 311.

[0245] As described above, the link connector 354 of the handle driver 35 may be attached to a rear surface of the panel 3121 constituting the second handle body 312.

[0246] That is, the driving force of the handle driver 35 may be transmitted to the panel 3121 of the second handle body 312 via the link connector 354, and may be transmitted to the first handle body 311 via the panel 3121.

[0247] The edge rib 3122 extends along the edge of the panel 3121 and serves to reinforce rigidity of the panel 3121 and prevent the pop-up handle 31 from being removed from the door 30 when the handle is pulled by the user.

[0248] In order to perform the removal prevention function, the edge rib 3122 may be formed to have a width in the vertical direction and a width in the left-right direction larger than those of each of the opening 30e of the front panel 30a of the door 30 and an opening 30d2 of a handle frame 30d described later.

[0249] Due to the size of the edge rib 3122, when the first handle body 311 is pulled, a front surface of the edge rib 3122 may collide with an inner surface of the handle frame 30d, thereby preventing the first handle body 311 and the second handle body 312 from being removed from the door.

[0250] In one example, a vertical extension 3122b of the edge rib 3122 may have a guide protrusion 3123 that protrudes so as to be away from the edge rib 3122.

[0251] As shown in FIG. 14, the guide protrusion 3123 may have a shape having a constant thickness in the vertical direction and extending in an elongate manner along a direction parallel to the forward direction Dfw or the backward direction Drw of the pop-up handle 31.

[0252] The guide protrusion 3123 may be inserted into a rail groove 30d45 of the handle housing 30d4 described below. As the guide protrusion 3123 moves along the rail groove 30d45, the first handle body 311 and the second handle body 312 move horizontally or linearly.

[0253] Therefore, a combination of the guide protrusion 3123 of the second handle body 312 and the rail groove 30d45 of the handle housing 30d4 may act as a first structure for implementing the horizontal or linear movement of the pop-up handle 31.

[0254] FIG. 14 shows a configuration in which only a left portion of the edge rib 3122 is provided with the guide protrusion 3123. However, implementations of the present disclosure are not limited thereto. A right portion of the edge rib 3122 opposite to the left portion thereof may also be provided with the guide protrusion 3123.

[0255] Furthermore, as shown in FIG. 14, the horizontal extension 3122a of the second handle body 312 may have a notch 3122c defined therein whose a left-right width is maintained to be constant.

[0256] A protruding surface portion 30d46 of the handle housing 30d4 described later may be inserted into the notch 3122c.

[0257] A left-right width of the protruding surface portion 30d46 may be maintained to be constant in a corresponding manner to a shape of the notch 3122c.

[0258] When the first handle body 311 and the second handle body 312 have been accommodated in the handle housing 30d4, the protruding surface portion 30d46 may be inserted into the notch 3122c. Therefore, when the pop-up handle 31 moves, the notch 3122c moves along the protruding surface portion 30d46, such that the first handle body 311 and the second handle body 312 move horizontally or linearly.

[0259] Therefore, a combination of the notch 3122c of the second handle body 312 and the protruding surface portion 30d46 of the handle housing 30d4 may act as a second structure for implementing the horizontal or linear movement of the pop-up handle 31.

[0260] FIG. 15 illustrates the handle frame 30d including the handle housing 30d4 in which the first handle body 311 and the second handle body 312 are accommodated.

[0261] The handle frame 30d supports the aforementioned handle driver 35 attached thereto and receives therein and supports the pop-up handle 31 so as to be movable therein.

[0262] The handle frame 30d may include a panel portion 30d1 and an outer wall 30d3 that serve as a support surface or an attachment surface to support the handle driver 35.

[0263] The panel portion 30d1 and the outer wall 30d3 of the handle frame 30d may be attached to an inner surface of the front panel 30a of the door 30.

[0264] In one example, the handle frame 30d may further include the handle housing 30d4 to accommodate therein and support the pop-up handle 31 so as to be movable therein.

[0265] As illustrated, the handle housing 30d4 may be provided in a box shape with open front and rear surfaces so that the first handle body 311 and the second handle body 312 may be entirely accommodated in the handle housing in a state where the pop-up handle 31 has been moved to the retracted position Pa.

[0266] The open front surface of the handle housing 30d4 may act as the opening 30d2 through which the first handle body 311 extends or retracts.

[0267] The opening 30d2 of the handle housing 30d4 may be formed at a position corresponding to a position of the opening 30e of the front panel 30a of the door 30 and may have a corresponding size to a size of the opening 30e.

[0268] The handle housing 30d4 may be provided with the rail groove 30d45 and the protruding surface portion 30d46, each serving as the structure for implementing the horizontal or linear movement of the pop-up handle 31 as described above.

[0269] The rail groove 30d45 may be formed in each of a left side surface and a right side surface of the handle housing 30d4, and may be formed by partially protruding each of the left side and right side surfaces thereof toward the outer wall 30d3.

[0270] The protruding surface portion 30d46 may be formed on an upper surface of the handle housing 30d4, and may be formed by protruding a portion of the upper surface thereof downwards.

[0271] In one example, as illustrated, a cut-away 30d44 may be defined in a lower surface 30d42 of the handle housing 30d4 to provide a movement path of the pivot link 353 of the handle driver 35.

[0272] FIG. 16 illustrates a detailed structure of the pop-up handle 31 disposed in front of the first handle body 311 as described above.

[0273] Referring to FIG. 16, the pop-up handle 31 provided in the dish washer 1 may further include a handle substrate 313 that is disposed on a front surface of the first handle body 311 and has at least one light-source element 3131 mounted thereon, a light-guide plate 314 that is disposed in front of the handle substrate 313 and diffuses visible light generated from the light-source element 3131, and the decoration panel 315 that is disposed in front of the light-guide plate 314.

[0274] The light-source element 3131 generates visible light or another type of light when the pop-up handle 31 moves, thereby visually notifying the user that the pop-up handle 31 is operating normally.

[0275] The light-source element 3131 may be applied without limitation in terms of the type thereof as the light-source element 3131 may receive power and generate predetermined visible light. In one example, the light-source element 3131 may be an LED (light emitting diode) element.

[0276] The following description will be based on an example in which the LED element is applied as the light-source element 3131. However, implementations of the present disclosure are not limited thereto.

[0277] FIG. 16 illustrates a configuration in which a total of 7 LED elements are mounted on the handle substrate 313. However, implementations of the present disclosure are not limited thereto, and the number of LED elements may be increased or decreased depending on a size and a shape of the first handle body 311.

[0278] In one example, the light-guide plate 314 serves to diffuse the visible light generated from the light-source element 3131.

[0279] More specifically, the visible light generated from the light-source element 3131 may be introduced into the light-guide plate 314 through a rear surface of the light-guide plate 314. Then, the visible light received inside the light-guide plate 314 may be spread therein such that the visible light diffuses toward an edge of the light-guide plate 314.

[0280] In some examples, the decoration panel 315 disposed in front of the light-guide plate 314 may be surface-treated to have the same texture as that of the front panel 30a of the door 30 as described above.

[0281] Therefore, the visible light introduced into the light-guide plate 314 may not pass through the decoration panel 315 and may be projected to the outside through the edge of the light-guide plate 314.

[0282] In order to project the visible light, the edge of the light-guide plate 314 may be exposed to the outside, as shown in FIG. 17.

[0283] That is, the light-guide plate 314 may be positioned so as to be sandwiched between the decoration panel 315 and the front surface of the first handle body 311, while the edge of the light-guide plate 314 may not be covered with the decoration panel 315 and the front surface of the first handle body 311.

[0284] Therefore, as illustrated, the light generated from the light-source element 3131 may travel through the inside of the light-guide plate 314 and then through the edge of the light-guide plate 314 and then may be effectively projected to the outside. Thus, the user may effectively identify an operating state of the pop-up handle 31 based on the optical

light projected through the edge of the light-guide plate 314. In order that information indicating that the pop-up handle 31 is operating normally or that the operation of the pop-up handle will soon commence may be effectively conveyed to the user, the power may be supplied to the light-source element 3131 before the operation of the handle driver 35 commences or at the same time as a time when the operation of the handle driver 35 commences, so that the visible light may be irradiated to the outside out of the pop-up handle 31, as described below.

[0285] Furthermore, since the visible light is projected only through the edge of the light-guide plate 314, a lighting effect similar to indirect lighting may be achieved, thereby improving aesthetic sensibility for the user.

[0286] In one example, the pop-up handle 31 of the present disclosure is configured to automatically move forwards and automatically move backwards according to the operation of the handle driver 35.

[0287] Therefore, during the automatic backward movement of the pop-up handle 31, there is a possibility that the user's hand or an object may be caught into between the first handle body 311 and the door 30, and a device for warning and preventing such "hand being caught" to the user may be provided.

[0288] A vibration element 3132 as one of the devices for warning such "hand being caught" may be provided in the pop-up handle 31.

[0289] For example, the vibration element 3132 may be mounted on the handle substrate 313 and may be configured to generate a haptic vibration in the pop-up handle 31 when the "hand being caught" is detected.

[0290] As shown in FIG. 16, the vibration element 3132 may be mounted on the handle substrate 313.

[0291] In some examples, either a piezo element or a haptic motor may be selected as the vibration element 3132 that may generate the haptic vibration and may be effectively mounted on the handle substrate 313.

[0292] In one example, the pop-up handle 31 may further be provided with a device for detecting the "hand being caught."

[0293] The device for detecting the "hand being caught" may be referred to as a first safety sensor S\_sf1 and a second safety sensor S\_sf2.

[0294] The first safety sensor S\_sf1 detects whether the user's hand is caught with into between the first handle body 311 and the door 30.

[0295] In one example, the first safety sensor S\_sf1 may include either a touch sensor S\_t or an infrared sensor S\_if.

[0296] The touch sensor S\_t may be a capacitive touch sensor. In this case, a conductive sheet 316 constituting the capacitive touch sensor may be disposed on a rear surface of the first handle body 311 facing the door 30 so that contact of the user's finger therewith may be effectively detected by the sensor.

[0297] The infrared sensor S\_if may be configured to project infrared rays from a transmitter S\_if1 toward a receiver S\_if2 and identify presence of the user's finger between the transmitter S\_if1 and the receiver S\_if2 based on whether the infrared rays are received by the receiver S\_if2. In some examples, as illustrated in FIG. 16, the transmitter S\_if1 and the receiver S\_if2 may be separately and respectively disposed at both opposing ends of the first handle body 311.

[0298] However, the positions of the transmitter S\_if1 and receiver S\_if2 are only examples, and the transmitter S\_if1 and receiver S\_if2 may be installed in other positions than the positions on the first handle body 311.

[0299] The second safety sensor detects whether an object other than the user's hand is located between the pop-up handle 31 and the door 30.

[0300] For example, the second safety sensor S\_sf2 may include one of a strain sensor that detects whether the pop-up handle 31 or the handle driver 35 is deformed when the pop-up handle 31 moves backwards, or a current sensor that detects an overload of the driving motor 351 when the pop-up handle 31 moves backwards.

[0301] In some examples, the strain sensor may be attached to the first handle body 311 or the second handle body 312 constituting the pop-up handle 31, or may be attached to the pivot link 353 of the handle driver 35.

[0302] Furthermore, in some examples, the current sensor may be provided in a power supply 48 as described below and configured to detect a current value supplied to the driving motor 351 through the power supply 48.

[0303] As described above, the dish washer 1 may further include a device for detecting a user's intent to open the door 30.

[0304] For example, the device for detecting the user's intent to open the door 30 may be the proximity sensor S\_p and a knock-on sensor S\_n.

[0305] FIG. 18 illustrates a configuration for detecting the user's intent to open the door 30 using a single radar sensor as the proximity sensor S\_p.

[0306] In some implementations, the radar sensor may transmit the electromagnetic waves from a sensing surface thereof and may receive the electromagnetic waves reflected from the user or the object and may analyze the received electromagnetic waves and may perform a function of detecting the presence of the user or the object within a detection area as, a distance to the user or the object, and a moving speed of the user or the object based on the analysis result.

[0307] As illustrated, the detection area as of the radar sensor applied to the present disclosure may have an angular range of about 100 degrees along the frontward-backward direction and about 100 degrees along the left-right direction around the sensing surface S\_p1.

[0308] In some examples, as described above, the radar sensor functioning as the proximity sensor S\_p may be configured to be disposed at a position as close as possible to a center of a top surface of the front panel 30a of the door 30 defining the inside of the door 30 so as to easily identify whether the user is approaching an area in front of the door 30 and to distinguish between the user and a non-user such as a pet from each other.

[0309] At a position corresponding to the position where the radar sensor is disposed, a sensor hole 30a1 through which electromagnetic waves of the radar sensor may enter and exit may extend through the top surface of the front panel 30a. The sensor hole 30a1 may be closed with a glass panel 30a2.

[0310] In some examples, in order to minimize interference with the detection area as of the radar sensor, each of predetermined left and right second clearances D2 extending in the left-right direction should be secured between the radar sensor S\_p and the front panel 30a in an area of the sensor hole 30a1, as shown in FIG. 20. Further, each of

predetermined first left and right clearance D1 extending in the vertical direction should be secured between the sensor substrate 120 on which the radar sensor is mounted and the front panel 30a, as shown in FIG. 20.

[0311] For example, a size of each of the first clearance D1 and the second clearance D2 may be set to be 5 mm or greater.

[0312] In one example, as shown in FIG. 19, the radar sensor S\_p is disposed inside the door 30 and at a position closer to the top surface of the front panel 30a of the door 30, such that the sensing surface S\_p1 of the radar sensor may generally face upwardly of the door 30.

[0313] Furthermore, the sensing surface S\_p1 of the radar sensor may be oriented in a tilted manner at a predetermined angle in the frontward direction of door 30.

[0314] Therefore, the sensing surface S\_p1 of the radar sensor may be oriented in a state facing in the frontward and upward direction of the door 30.

[0315] In this way, the sensing surface S\_p1 of the radar sensor is oriented in a state facing in the frontward and upward direction of the door 30 rather than in the frontward and downward direction of door 30, the detection area as of the radar sensor may be formed in a tilted manner so as to face in the frontward and upward direction of the door 30.

[0316] More specifically, referring to FIG. 19, a substrate frame 30f to support the aforementioned control panel 32 and a main substrate 110 constituting the control panel 32 may be disposed between the front panel 30a and the rear panel 30b and in an upper end of an inner space of the door 30.

[0317] As illustrated, the substrate frame 30f may be disposed on top of the handle frame 30d and may be supported on the handle frame 30d.

[0318] In some examples, as illustrated, the substrate frame 30f may be provided as a combination of upper and lower portions stacked along the vertical direction, and may be composed of a first frame 30f1 constituting the upper portion and a second frame 30f2 constituting the lower portion.

[0319] As illustrated, a tilting holder 30/3 for supporting the radar sensor in the tilted state may be disposed on an inner bottom surface of the first frame 30f1 constituting the upper portion and may be integrally or separately formed with or from the first frame 30f1.

[0320] The radar sensor may be mounted on the main substrate 110, or may be mounted on the sensor substrate 120 provided separately from the main substrate 110 and adjacent to the main substrate 110, and may be supported on the tilting holder 30/3 as illustrated.

[0321] In this way, the sensing surface S\_p1 of the radar sensor is disposed on the tilting holder 30/3 in a tilted manner so that the sensing surface faces in the frontward and upward direction of the door 30. Thus, even when an object that may not be expected to use the dish washer 1, such as a pet or an infant with a height smaller than at least a height of the dish washer 1, approaches the area in front of the door 30, the radar sensor may be configured not to detect the object such as the pet or the infant. Accordingly, the pop-up handle 31 may be prevented from operating meaninglessly upon detecting the pet or the infant, and thus power loss may be minimized.

[0322] In some implementations, the tilting angle at of the sensing surface S\_p1 of the radar sensor with respect to the horizontal direction may be, for example, in a range of 25



degrees inclusive to 35 degrees inclusive, for example, 30 degrees. For instance, the tilting angle may range from 25 degrees to 35 degrees with respect to the top surface of the door where the sensor hole **30a1** is defined.

**[0323]** However, the tilting angle at of the sensing surface **S\_p1** of the radar sensor provided in the present disclosure with respect to the horizontal direction may be adjusted according to the physical condition of the user who is expected to use the dish washer **1**.

**[0324]** For example, when the tilting angle at of the sensing surface **S\_p1** of the radar sensor with respect to the horizontal direction is set to 30 degrees, a minimum vertical detection height **H\_min** of the radar sensor may be in a range of 100 cm inclusive to 110 cm inclusive, for example, 105 cm, and a maximum detection distance **L\_max** based on the horizontal direction may be in a range of 75 cm inclusive to 85 cm inclusive, for example, 80 cm.

**[0325]** That is, when the tilting angle at is set to 30 degrees, a user with a height of 105 cm or larger may be recognized as approaching the door when he or she enters the detection range within 80 cm from the radar sensor based on the horizontal direction.

**[0326]** Alternatively, for example, when the tilt angle at is set to 15 degrees, a user with a height of 127 cm or more may be recognized as approaching to the door when he or she enters the detection range within 50 cm of the radar sensor in the horizontal direction.

**[0327]** In some examples, the tilting angle at may be changed by adjusting the inclination angle of the aforementioned tilting holder **30/3**.

**[0328]** In this way, the dish washer **1** is configured so that the tilting angle at of the sensing surface **S\_p1** of the radar sensor may be adjusted. Thus, the vertical minimum detection height **H\_min** of the detection range and the horizontal maximum detection distance **L\_max** of the detection range that can be detected by a single radar sensor and may be easily changed and set.

**[0329]** In some examples, the dish washer **1** may not be configured to immediately move the pop-up handle **31** even when the radar sensor recognizes that the user is located within a predetermined distance range from the door **30**.

**[0330]** This is because, for example, a situation in which while the user simply passes by the dish washer **1** without the intention of opening the door **30**, the user approaching the door is detected by the proximity sensor **S\_p** may occur.

**[0331]** Therefore, the dish washer **1** may be further configured to add a time condition to identify absence or presence of the intention to open the door **30** using the proximity sensor **S\_p** such as the radar sensor.

**[0332]** In some examples, when the dish washer **1** identifies that the user is present within a set distance range from the door **30** using the radar sensor and continues to stay within the set distance range for a set time condition, the dish washer **1** may determine that the user has the intention to open the door **30**.

**[0333]** In some examples, the set time condition may be in a range of 0.9 seconds inclusive to 1.1 seconds inclusive, for example, 1 second.

**[0334]** When the detection range condition and the time condition set in this way are satisfied, as described below, the controller **100** may be configured to initiate the operation of the handle driver **35** to move the pop-up handle **31** forwards from the retracted position **Pa** to the extended

position **Pd** before the washing course starts or after the washing course has been completed.

**[0335]** However, when the door **30** is opened while the dish washer **1** is performing the washing course, there is a very high possibility that the washing water will leak from the tub **20** or the user will be burned by the high-temperature washing water or the high-temperature airflow.

**[0336]** That is, while the washing cycle **S2** is in progress using high-temperature washing water inside the tub **20**, or the heating and rinsing cycle **S4** is in progress using high-temperature washing water inside the tub **20**, or the drying cycle **S5** of drying the dishes is in progress using high-temperature airflow inside the tub **20**, the door **30** may be opened momentarily, such that there is a very high possibility that the user will be burned by the high-temperature washing water or high-temperature airflow.

**[0337]** However, in some cases, even when the washing course is in progress, a situation may arise where the washing course in progress should be temporarily stopped and the dishes should be added to the inside of the tub **20** or some of the dishes should be withdrawn from the inside of the tub **20**.

**[0338]** For example, a knock-on sensor **S\_n** may be provided as an additional device for detecting absence or presence of the user's intention to open the door **30** while the washing course is in progress. That is, the knock-on sensor **S** can detect a motion of the user to thereby determine the user's intention.

**[0339]** When the user knocks on the door **30** with the intention of opening the door **30**, the knock-on sensor **S\_n** detects the knock-on, and transmits an output signal corresponding to the detected knock-on to the controller **100** described below.

**[0340]** As described below, the controller **100** may be configured to determine absence or presence of the user's intention to open the door based on a vibration signal received as the output signal from the knock-on sensor **S\_n**.

**[0341]** The knock-on sensor **S\_n** may be a vibration sensor to effectively detect the user's knock-on input, and may be configured to include a first vibration sensor **S\_n1** and a second vibration sensor **S\_n2** which are positioned at different locations.

**[0342]** For example, a combination of the first vibration sensor **S\_n1** and the second vibration sensor **S\_n2** may act as a single-axis directional vibration detection sensor that may detect a single-axis directional vibration component among three-axes directional vibration components. the first vibration sensor **S\_n1** and the second vibration sensor **S\_n2** may be configured to have the same appearance and size. The knock-on sensor **S\_n** may be composed of the two vibration sensors having the same appearance and size, the manufacturing cost and assembly cost may be reduced.

**[0343]** In some examples, the positions at which the first vibration sensor **S\_n1** and the second vibration sensor **S\_n2** are respectively positioned, and a direction in which the first vibration sensor **S\_n1** and the second vibration sensor **S\_n2** are arranged may vary according to implementations.

**[0344]** More specifically, as illustrated in FIG. **21**, the first vibration sensor **S\_n1** may be attached to an inner surface of a front portion **30/21** of the second frame **30/2** of the substrate frame **30/** having a cross-section shape of a turned-upside down U shape.

[0345] As illustrated, the front portion 30/21 of the second frame 30/2 may be in direct contact with the front panel 30a constituting the front portion of the door 30.

[0346] Therefore, the first vibration sensor S<sub>n1</sub> may be configured to directly receive the user's knock-on input from the front panel 30a.

[0347] A rear portion 30/22 of the second frame 30/2 may directly contact the rear panel 30b of the door 30.

[0348] In one example, the second vibration sensor S<sub>n2</sub> may be mounted on the main substrate 110 which is received in a space formed between an upper portion 30/13 of the first frame 30/1 and an upper portion 30/23 of the second frame 30/2.

[0349] As shown, the main substrate 110 may be supported on the first frame 30/1 and the second frame 30/2 in a state where a contact area thereof with the first frame 30/1 and the second frame 30/2 is minimized to prevent a short circuit.

[0350] Therefore, the vibration generated by the user's knock-on input may be indirectly attenuated through the first frame 30/1, the second frame 30/2, and the main substrate 110 and then transmitted to the second vibration sensor S<sub>n2</sub>.

[0351] Like the second frame 30/2, the front portion 30/11 of the first frame 30/1 may directly contact the front panel 30a of the door 30, and the rear portion 30/22 of the second frame 30/2 may directly contact the rear panel 30b of the door 30.

[0352] In one example, as described above, each of the first vibration sensor S<sub>n1</sub> and the second vibration sensor S<sub>n2</sub> may act as a single-axis directional vibration sensor, such that directions in which the first vibration sensor S<sub>n1</sub> and the second vibration sensor S<sub>n2</sub> are oriented may be different from each other.

[0353] In an example, as shown in FIG. 21, the first vibration sensor S<sub>n1</sub> may be disposed on the second frame 30/2 so as to detect front-rear directional vibration V1, and the second vibration sensor S<sub>n2</sub> may be disposed on the main substrate 110 so as to detect vertical vibration V2. That is, the first vibration sensor S<sub>n1</sub> and the second vibration sensor S<sub>n2</sub> may be configured to detect vibrations in directions orthogonal to each other, respectively.

[0354] In this way, the positions where the first vibration sensor S<sub>n1</sub> and the second vibration sensor S<sub>n2</sub> are positioned from each other and the directions of the vibrations which may be detected thereby are different from each other. Thus, using the first vibration sensor S<sub>n1</sub> and the second vibration sensor S<sub>n2</sub>, the dish washer may be configured to easily distinguish the vibration that occurs during the operation of the dish washer 1 from the vibration caused by the user's knock-on input.

[0355] That is, the user's knock-on input is generally made through the front panel 30a that constitutes the front portion of the door 30.

[0356] Furthermore, the front panel 30a has the vertical length and the left-right directional width much larger than a thickness thereof.

[0357] Therefore, the vibration generated in the front panel 30a of the door 30 due to the knock-on input may be generated so that a front-rear directional amplitude thereof is much larger than each of a left-right directional amplitude and a vertical amplitude thereof.

[0358] Therefore, when the user's knock-on is input to the door, the amplitude of the vibration detected by the first

vibration sensor S<sub>n1</sub> may be much larger than the amplitude detected by the second vibration sensor S<sub>n2</sub>. However, when the vibration is simply generated during the washing course of the dish washer 1, there is no significant difference between the amplitude detected by the first vibration sensor S<sub>n1</sub> and the amplitude detected by the second vibration sensor S<sub>n2</sub>.

[0359] As described below, when there is a significant difference between an amplitude of a first vibration signal output from the first vibration sensor S<sub>n1</sub> and an amplitude of a second vibration signal output from the second vibration sensor S<sub>n2</sub>, the controller 100 may be configured to determine that the user's knock-on is input to the door. However, when there is substantially no difference between an amplitude of a first vibration signal output from the first vibration sensor S<sub>n1</sub> and an amplitude of a second vibration signal output from the second vibration sensor S<sub>n2</sub>, the controller 100 may be configured to easily determine that the vibration is not a vibration caused by the user's knock-on.

[0360] Hereinafter, referring to FIG. 22, the configuration of the controller 100 included in the dish washer 1 will be described.

[0361] As shown in FIG. 22, the dish washer 1 may include the controller 100 for controlling each of the functional modules of the dish washer.

[0362] For example, the controller 100 may be configured to be implemented in various forms such as an electric circuit, a computer, a microcontroller, a microcomputer, or a microprocessor that may be mounted on the aforementioned main substrate 110.

[0363] In some implementations, the controller 100 may be configured to be electrically connected to the driving motor 351 of the handle driver 35. The controller 100 may be configured to start or stop the operation of the driving motor 351 by controlling the power supplied to the driving motor 351 from the power supply 48 as described below. The controller 100 may be configured to supply the power to the driving motor 351 to rotate in a forward direction to move the pop-up handle 31 in the frontward direction, or supply the power to the driving motor 351 to rotate in a reverse direction to move the pop-up handle 31 in the backward direction.

[0364] When the user's intention to open the door 30 is identified as being present using the proximity sensor S<sub>p</sub> and the knock-on sensor S<sub>n</sub>, the controller 100 may be configured to supply the power to the driving motor 351 of the handle driver 35 through the power supply 48 to drive the driving motor 351 in the forward direction to move the pop-up handle 31 in the frontward direction to the extended position Pd.

[0365] Furthermore, when a predetermined waiting time has elapsed after the pop-up handle 31 has moved to the extended position Pd, the controller 100 may be configured to supply the power to the driving motor 351 to drive the driving motor 351 in the reverse direction to move the pop-up handle 31 backward to the retracted position.

[0366] Furthermore, the controller 100 may be configured to be electrically connected to the button unit 34 for inputting a user's manipulation command. When the user's power on-off manipulation input, washing course selection manipulation, or option selection manipulation is input through the button unit 34, the button unit 34 may transmit a corresponding electrical signal thereto to the controller 100.

[0367] When the electrical signal has been transmitted from the button unit 34 to the controller, the controller 100 may be configured to turn on/off the power of the dish washer 1 or to control the dish washer 1 to perform an individual cycle of the dish washer 1 according to the selected washing course and the selected operation mode.

[0368] In some examples, the user's manipulation command may be input through other input devices such as a user's wireless terminal, etc. in addition to the button unit 34.

[0369] Furthermore, the controller 100 may be configured to be electrically connected to the door position sensor S<sub>d</sub>. The controller 100 may be configured to determine whether the door 30 is currently closed or opened based on the signal received from the door position sensor S<sub>d</sub>, and to identify absence or presence of the user's intention to open the door 30 in a state in which the door 30 is closed, and to operate the handle driver 35 to move the pop-up handle 31 in the forward direction to the extended position Pd when the door 30 needs to be opened.

[0370] Furthermore, the controller 100 may be configured to be electrically connected to the proximity sensor S<sub>p</sub>. The controller 100 may be configured to determine whether the user is approaching a position within a specific detection range from door 30 based on the signal received from the proximity sensor S<sub>p</sub>.

[0371] As described above, the proximity sensor S<sub>p</sub> may include one of a radar sensor, an image sensor, or an infrared sensor.

[0372] Furthermore, the controller 100 may be configured to be electrically connected to the first vibration sensor S<sub>n1</sub> and the second vibration sensor S<sub>n2</sub> constituting the knock-on sensor S<sub>n</sub>. As described above, the first vibration sensor S<sub>n1</sub> and the second vibration sensor S<sub>n2</sub> detect the vibrations generated from the dish washer 1. The controller 100 may be configured to determine whether the user's intention to open the door 30 is input during the washing course based on a comparing result between the amplitude of the first vibration signal and the amplitude of the second vibration signal respectively received from the first vibration sensor S<sub>n1</sub> and the second vibration sensor S<sub>n2</sub>. In some examples, the controller 100 may be configured to further include a device (e.g., amplifier) for amplifying each of the amplitude of the first vibration signal and the amplitude of the second vibration signal in order to clearly detect the user's knock-on input.

[0373] Furthermore, the controller 100 may be configured to be electrically connected to the light-source element 3131 and the vibration element 3132 mounted on the handle substrate 313.

[0374] The controller 100 may be configured to provide the power to the light-source element 3131 to generate the visible light or other types of light at the same time as a time when the forward movement of the pop-up handle 31 is initiated or before the forward movement of the pop-up handle 31 is initiated, thereby visually indicating to the user that the pop-up handle 31 is being operating normally and that the pop-up handle 31 will be moved forwards toward the extended position Pd.

[0375] As described above, the light-source element 3131 may be implemented as the LED element that may receive the power to emit predetermined visible light.

[0376] Furthermore, the controller 100 may be configured to be electrically connected to an audio output unit that generates voice output or sound output.

[0377] When the controller 100 has identified that the user's intention to open the door 30 is present using the proximity sensor S<sub>p</sub> and the knock-on sensor S<sub>n</sub>, the controller 100 may be configured to generate a voice alarm or a sound alarm through the audio output unit to preliminarily notify that the pop-up handle 31 will move forwards.

[0378] For example, the voice alarm may include guidance information such as "I will extend the handle."

[0379] In one example, the controller 100 may be configured to be electrically connected to a memory and a timer. The controller 100 may be configured to retrieve an operation condition and a time condition related to each of the cycles that are pre-stored in the memory for each washing course and to generate a control signal for controlling a progress and an end of the cycle according to the washing course based on the operation condition and the time condition.

[0380] In addition, as described later, information about a set time that serves as a reference time used to determine absence or presence of the user's intention to open the door 30 may be further stored in the memory.

[0381] Furthermore, the controller 100 may be configured to measure an elapsed time of each of the cycles using the timer and determine whether each of the cycles has been completed based on a comparing result of the measured time with the pre-stored time condition related to each of the cycles.

[0382] In some examples, the cycles may include a pre-washing cycle S1, a washing cycle S2, a rinsing cycle S3, a heating and rinsing cycle S4, and a drying cycle S5 as shown in FIG. 23. The controller 100 may be configured to control the dish washer 1 so that the washing course including a combination of at least one of the above listed cycles according to the user's selection is performed.

[0383] Hereinafter, a method for controlling the dish washer 1 will be described with reference to FIG. 23 to FIG. 26.

[0384] As illustrated in FIG. 23, the controller 100 may be configured to generally control progress of the washing course of the dish washer 1 including, for example, at least one of the pre-washing cycle S1, the washing cycle S2, the rinsing cycle S3, the heating and rinsing cycle S4, and the drying cycle S5.

[0385] The pre-washing cycle S1 refers to a cycle in which the washing water is circulated under an operation of the washing pump 45 without injecting the detergent through the detergent supply device and an amount of contamination is measured using a turbidity sensor provided in the sump 41. The washing cycle S2 refers to a cycle in which dishes are washed by circulating the washing water while injecting the detergent through the detergent supply device.

[0386] Each of the rinsing cycle S3 and the heating and rinsing cycle S4 refers to a cycle in which rinse is injected from the detergent supply device and the washing water is circulated to remove the detergent remaining on the dishes.

[0387] During the heating and rinsing cycle S4, the heated washing water is supplied so that the dishes may be heated to a predetermined temperature. Thus, the drying efficiency of the dishes may be improved and the drying time may be

shortened in the drying cycle S5 that is performed after the completion of the rinsing cycle S3 and heating and rinsing cycle S4.

[0388] The above detailed cycles may be controlled to be omitted or to be combined with each other so as to be performed repeatedly depending on the selected washing course settings and options.

[0389] In some examples, a water discharge cycle of the washing water used in each of the cycles and a water supply cycle that supplies new washing water may be included between temporally adjacent ones of the cycles.

[0390] The water supply cycle may be included before the pre-washing cycle S1.

[0391] The water discharge cycle and the water supply cycle may be performed between the pre-washing cycle S1 and the washing cycle S2, between the washing cycle S2 and the rinsing cycle S3, and between the heating and rinsing cycle S4 and the rinsing cycle S3. The water discharge cycle may be performed between the heating and rinsing cycle S4 and the drying cycle S5.

[0392] The water supply cycle may be performed by controlling an aqua stop device included in the water supply 43 to supply the washing water to the sump 41 through a water supply path. The water discharge cycle may be performed by controlling the water discharger 44 connected to the sump 41 to discharge the washing water to the outside out of the dish washer 1 through a water discharge path.

[0393] In some examples, when the user's intention to open the door 30 is identified as being present using the proximity sensor S<sub>p</sub> before the washing course that is performed in the above order of the cycles is started or after the washing course has been completed, the controller 100 may be configured to drive the handle driver 35 in the forward direction to drive the pop-up handle 31 to automatically move forwards from the retracted position Pa to the extended position Pd.

[0394] Furthermore, after a predetermined waiting time has elapsed after the pop-up handle 31 has moved to the extended position Pd, the controller 100 may be configured to drive the handle driver 35 in the reverse direction, so that the pop-up handle 31 automatically moves backwards from the extended position Pd to the retracted position Pa.

[0395] Furthermore, when the user's intention to open the door 30 is additionally identified as being present using the aforementioned knock-on sensor S<sub>n</sub>, the controller 100 may be configured to control the pop-up handle 31 to move forwards from the retracted position Pa toward the extended position Pd even during the washing cycle.

[0396] This is to deal with a case where the door 30 is opened while the washing cycle is in progress, for example, in order to add the dishes to be washed into the washing space in the tub

[0397] When the forward movement of the pop-up handle 31 is initiated during the progress of the washing course, the controller 100 may be configured to temporarily stop the progress of the washing course in consideration of water leakage prevention and user safety.

[0398] FIG. 24 illustrates an example of a control method of the dish washer 1, in which the method includes operations S10 and S20 of moving the pop-up handle 31 in the frontward direction from the retracted position to the extended position, based on a combination of a determination result of whether the washing course of the dish washer

1 is in progress, and a determination result of whether the user intends to open the door 30.

[0399] FIG. 25 illustrates detailed operations of operation S10.

[0400] Referring to FIG. 25, the controller 100 may be configured to receive an output signal from the proximity sensor S<sub>p</sub> before the start of the selected washing course and after the completion of the selected washing course in S101.

[0401] When the output signal has been received from the proximity sensor S<sub>p</sub> in operation S101, the controller 100 is configured to identify whether a user's approaching a position within the detection range of the proximity sensor S<sub>p</sub> is detected in S102.

[0402] In some examples, as described above, the vertical minimum detection height H<sub>min</sub> of the proximity sensor S<sub>p</sub> may be in a range of 100 cm inclusive to 110 cm inclusive, for example, 105 cm.

[0403] Furthermore, the maximum horizontal detection distance L<sub>max</sub> of the proximity sensor S<sub>p</sub> may be in a range of 75 cm inclusive to 85 cm inclusive, for example, 80 cm.

[0404] When it is determined that the proximity of the user to the position within the detection range of the proximity sensor S<sub>p</sub> has been detected in operation S102, the controller 100 may be configured to determine whether the proximity state of the user to the position in the detection range lasts for a predetermined set time duration after the proximity of the user to the position has been detected in S103.

[0405] In some examples, the set time duration may be in a range of 0.9 seconds inclusive to 1.1 seconds inclusive, for example, 1 second.

[0406] Upon determination that the proximity state of the user to the position in the detection range has lasted for the predetermined set time duration in operation S103, the controller 100 may be configured to determine that the user has the intention to open the door 30.

[0407] When the user's intention to open the door 30 has been identified as being present before the start of the washing course or after the completion of the washing course, the controller 100 may be configured to supply the power to the handle driver 35 to drive the handle driver 35 in the forward direction, thereby automatically moving the pop-up handle 31 in the frontward direction from the retracted position Pa to the extended position Pd in S105.

[0408] In one example, when the user's intention to open the door 30 has been identified as being present, the controller 100 may be configured to supply the power to the light-source element 3131 disposed inside the pop-up handle 31 to turn on the light-source element 3131 in S104.

[0409] In some examples, the controller 100 may be configured to turn on the light-source element 3131 before the operation of the handle driver 35 is initiated or simultaneously with the start of the operation of the handle driver 35. Thus, the user may intuitively and visually recognize that the pop-up handle 31 will begin moving forwards before or simultaneously with the start of the movement of the handle.

[0410] In some examples, the controller 100 may be configured to control the sound output unit to generate an audio alarm or an acoustic alarm including information indicating that the forward movement of the pop-up handle

**31** will be initiated, before the operation of the handle driver **35** is initiated or simultaneously with the start of the operation of the handle driver **35**.

[0411] In one example, when the pop-up handle **31** has completed the forward movement to the extended position Pd after the operation of the handle driver **35** has been initiated in operation S105, the controller **100** may be configured to cut off the power supply to the handle driver **35** to stop the position of the pop-up handle **31** at the extended position Pd in S106.

[0412] Furthermore, in some examples, when the forward movement of the pop-up handle **31** has been completed, the controller **100** may be configured to turn off the light-source element **3131** by cutting off the power supply to the light-source element **3131** or to keep the light-source element **3131** in the turned-on state by maintaining the power supply thereto.

[0413] When the forward movement of the pop-up handle **31** to the extended position Pd has been completed, the user may easily open the door **30** while holding the pop-up handle **31**. FIG. 26 shows detailed operations of operation S20.

[0414] Referring to FIG. 26, the controller **100** may be configured to receive the output signal from the proximity sensor S<sub>p</sub> during the progress of the selected washing course in S201.

[0415] When the output signal has been received from the proximity sensor S<sub>p</sub> in operation S201, the controller **100** may be configured to determine whether the user's approaching the position within the detection range of the proximity sensor S<sub>p</sub> is detected S202.

[0416] In some examples, as described above, the vertical minimum detection height H<sub>min</sub> of the proximity sensor S<sub>p</sub> may be in a range of 100 cm inclusive to 110 cm inclusive, for example, 105 cm.

[0417] Furthermore, the maximum horizontal detection distance L<sub>max</sub> of the proximity sensor S<sub>p</sub> may be in a range of 75 cm inclusive to 85 cm inclusive, for example, 80 cm.

[0418] When it is determined that the proximity of the user to the position within the detection range of the proximity sensor S<sub>p</sub> has been detected in operation S202, the controller **100** may be configured to determine whether the proximity state of the user to the position in the detection range lasts for a predetermined set time duration after the proximity of the user to the position has been detected in S203.

[0419] In some examples, the set time duration may be in a range of 0.9 seconds inclusive to 1.1 seconds inclusive, for example, 1 second.

[0420] Upon determination that the proximity state of the user to the position in the detection range has lasted for the predetermined set time duration in operation S203, the controller **100** may be configured to receive the output signals from the first vibration sensor S<sub>n1</sub> and the second vibration sensor S<sub>n2</sub> constituting the knock-on sensor S<sub>n</sub> in S204.

[0421] In some examples, the output signal of the first vibration sensor S<sub>n1</sub> may be the first vibration signal, and the output signal of the second vibration sensor S<sub>n2</sub> may be the second vibration signal.

[0422] When the first vibration signal has been received from the first vibration sensor S<sub>n1</sub> and the second vibration signal has been received from the second vibration sensor

S<sub>n2</sub> in operation S204, the controller **100** may be configured to calculate a maximum amplitude of the first vibration signal and a maximum amplitude of the second vibration signal in S205.

[0423] In some examples, in order to facilitate the calculation of and the comparison between the maximum amplitudes thereof, each of the first vibration signal and the second vibration signal may be amplified at a predetermined ratio after having been received by the controller **100**.

[0424] When the maximum amplitude of the first vibration signal and the maximum amplitude of the second vibration signal have been calculated in operation S205, the controller **100** may be configured to compare the maximum amplitude of the first vibration signal with the maximum amplitude of the second vibration signal in S206.

[0425] When the controller **100** determines that the maximum amplitude of the first vibration signal is greater than the maximum amplitude of the second vibration signal based on a result of the comparison in operation S206, the controller **100** may be configured to determine that the user's knock-on input is input into the door **30** and to determine that the user has the intention to open the door **30**.

[0426] In some examples, when the controller **100** determines that the maximum amplitude of the first vibration signal is smaller than or equal to the maximum amplitude of the second vibration signal based on a result of the comparison in operation S206, the controller **100** may be configured to determine that the received first vibration signal and second vibration signal are not generated due to the user's knock-on input. Thus, the process returns to the aforementioned operation S201 and following operations are repeated.

[0427] In one example, when it is determined that the user intends to open the door **30** during the progress of the washing cycle, the controller **100** may be configured to supply the power to the handle driver **35** to drive the handle driver **35** in the forward direction, thereby automatically moving the pop-up handle **31** in the frontward direction from the retracted position Pa to the extended position Pd in S208.

[0428] In one example, when the user's intention to open the door **30** has been identified as being present, the controller **100** may be configured to supply the power to the light-source element **3131** disposed inside the pop-up handle **31** to turn on the light-source element **3131** in S207.

[0429] In some examples, the controller **100** may be configured to turn on the light-source element **3131** before the operation of the handle driver **35** is initiated or simultaneously with the start of the operation of the handle driver **35**. Thus, the user may intuitively and visually recognize that the pop-up handle **31** will begin moving forwards before or simultaneously with the start of the forward movement of the handle.

[0430] In some examples, the controller **100** may be configured to control the sound output unit to generate an audio alarm or an acoustic alarm including information indicating that the forward movement of the pop-up handle **31** will be initiated before the operation of the handle driver **35** is initiated or simultaneously with the start of the operation of the handle driver **35**.

[0431] In one example, when the pop-up handle **31** has completed the forward movement to the extended position Pd after the operation of the handle driver **35** has been initiated in operation S206, the controller **100** may be

configured to cut off the power supply to the handle driver **35** to stop the position of the pop-up handle **31** at the extended position Pd in **S209**.

[0432] Furthermore, in some examples, when the forward movement of the pop-up handle **31** has been completed, the controller **100** may be configured to turn off the light-source element **3131** by cutting off the power supply to the light-source element **3131** or to keep the light-source element **3131** in the turned-on state by maintaining the power supply thereto.

[0433] When the forward movement of the pop-up handle **31** to the extended position Pd has been completed, the user may open the door **30** while holding the pop-up handle **31**. However, since the dish washer **1** is currently in the washing process, it can be necessary to stop the washing process for the safety reason as described above.

[0434] Therefore, the controller **100** may be configured to control the dish washer **1** so that after the forward movement of the pop-up handle **31** is initiated by starting to operate the handle driver **35** in operation **S208**, the washing course currently in progress in the dish washer **1** is temporarily stopped in **S210**.

[0435] In some examples, the controller **100** may be configured to control the washing course so as to be temporarily stopped at least before the operation of the handle driver **35** is stopped in operation **S209** or at the same time as a time when the operation of the handle driver **35** is stopped in operation **S209**.

[0436] Thus, the user may be effectively prevented from being burned by high-temperature washing water or high-temperature airflow flowing out from the tub **20** due to the door **30** being opened while the washing course is in progress.

[0437] Although the implementations of the present disclosure have been described in more detail with reference to the accompanying drawings, the present disclosure is not necessarily limited to these implementations, and may be modified in a various manner within the scope of the technical spirit of the present disclosure. Accordingly, the implementations as disclosed in the present disclosure are intended to describe rather than limit the technical idea of the present disclosure, and the scope of the technical idea of the present disclosure is not limited by these implementations. Therefore, it should be understood that the implementations described above are not restrictive but illustrative in all respects. In addition, even though an effect of a configuration of the present disclosure is not explicitly described in describing the implementation of the present disclosure above, it is obvious that the predictable effect from the configuration should be recognized.

What is claimed is:

1. A dish washer comprising:

a tub that defines a washing space configured to accommodate one or more objects to be washed therein, the tub having an open front surface in fluid communication with the washing space;

a door configured to open and close the open front surface of the tub;

a handle configured to reciprocate between (i) an extended position in which the handle protrudes forward from the door and (ii) a retracted position in which the handle is at least partially accommodated within the door;

a handle driver disposed within the door and configured to move the handle from the retracted position toward the extended position or from the extended position toward the retracted position; and

a controller configured to determine whether to operate the handle driver and to control power to be supplied to the handle driver,

wherein the controller is configured to, based on a position or a motion of a user, control the handle driver to move the handle forward from the retracted position toward the extended position.

2. The dish washer of claim 1, wherein the controller is further configured to:

control the handle driver to move the handle forward from the retracted position toward the extended position (i) before a washing course starts or (ii) after the washing course has been completed.

3. The dish washer of claim 2, wherein the controller is further configured to:

based on the position or the motion of the user, determine whether the user intends to open the door before the washing course starts or after the washing course has been completed; and

based on a determination that the user intends to open the door, supply power to the handle driver to operate the handle driver to cause the handle to move forward from the retracted position toward the extended position.

4. The dish washer of claim 3, further comprising a proximity sensor configured to detect whether the user is located at a position within a predetermined detection range from the door,

wherein the controller is further configured to:

receive an output signal from the proximity sensor;

determine whether the user is disposed at the position within the predetermined detection range based on the output signal received from the proximity sensor;

based on a determination that the user is disposed at the position within the predetermined detection range, determine whether the user has stayed at the position for a predetermined set time duration; and

based on a determination that the user has stayed at the position for the predetermined set time duration, determine that the user intends to open the door.

5. The dish washer of claim 4, wherein the door has a sensor hole defined at a top surface of the door,

wherein the proximity sensor comprises a radar sensor disposed inside the door and configured to detect, through the sensor hole, whether the user is disposed within the predetermined detection range, and

wherein the radar sensor has a sensing surface that is tilted and faces the top surface of the door in a frontward and upward direction.

6. The dish washer of claim 5, wherein a tilting angle of the sensing surface of the radar sensor is in a range from 25 degrees to 35 degrees with respect to the top surface of the door.

7. The dish washer of claim 4, wherein the controller is further configured to:

based on determining (i) that the user has a height greater than or equal to a minimum detection height of the proximity sensor in a vertical direction and (ii) that the user is disposed in a distance less than or equal to a maximum detection distance from the proximity sensor

in a horizontal direction, determine that the user is disposed at the position within the predetermined detection range.

8. The dish washer of claim 7, wherein the minimum detection height is in a range from 100 cm to 110 cm.

9. The dish washer of claim 7, wherein the maximum detection distance is in a range from 75 cm to 85 cm.

10. The dish washer of claim 4, wherein the predetermined set time duration is in a range from 0.9 seconds to 1.1 seconds.

11. The dish washer of claim 3, further comprising a light-source disposed inside the handle and configured to receive power to generate visible light, the light-source being configured to irradiate the visible light to an outside of the handle, and

wherein the controller is further configured to, based on determining that the user intends to open the door, supply power to the light-source to thereby turn on the light-source before an operation of the handle driver is started or simultaneously with a start of the operation of the handle driver.

12. The dish washer of claim 1, wherein the controller is further configured to control the handle driver to move the handle forward from the retracted position toward the extended position while a washing course is in progress.

13. The dish washer of claim 12, wherein the controller is further configured to:

based on the position or the motion of the user, determine whether the user intends to open the door while the washing course is in progress; and

based on a determination that the user intends to open the door while the washing course is in progress, supply power to the handle driver to operate the handle driver to cause the handle to move forward from the retracted position toward the extended position.

14. The dish washer of claim 13, further comprising:

a proximity sensor configured to detect whether the user is disposed at a position within a predetermined detection range from the door; and

a first vibration sensor and a second vibration sensor that are respectively positioned at different locations inside the door and configured to detect a knock-on input of the user through the door,

wherein the controller is further configured to:

receive an output signal from the proximity sensor, determine whether the user is disposed at the position within the predetermined detection range based on the output signal received from the proximity sensor,

based on a determination that the user is disposed at the position within the predetermined detection range, determine whether the user has stayed at the position for a predetermined set time duration,

based on a determination that the user has stayed at the position for the predetermined set time duration, receive (i) a first vibration signal from the first

vibration sensor and (ii) a second vibration signal from the second vibration sensor,

determine (i) a maximum amplitude of the first vibration signal received from the first vibration sensor and (ii) a maximum amplitude of the second vibration signal received from the second vibration sensor,

compare the maximum amplitude of the first vibration signal with the maximum amplitude of the second vibration signal, and

based on a determination that the maximum amplitude of the first vibration signal is greater than the maximum amplitude of the second vibration signal, determine that the user intends to open the door.

15. The dish washer of claim 14, wherein the first vibration sensor is located closer to a front surface of the door than the second vibration sensor is.

16. The dish washer of claim 14, wherein the first vibration sensor is configured to detect vibration in a first axial direction, and the second vibration sensor is configured to detect vibration in a second axial direction orthogonal to the first axial direction.

17. The dish washer of claim 14, wherein the first vibration signal corresponds to vibration in a horizontal direction, and the second vibration signal corresponds to vibration in a vertical direction orthogonal to the horizontal direction.

18. The dish washer of claim 14, further comprising a light-source disposed inside the handle and configured to receive power to generate visible light, the light-source being configured to irradiate the visible light to an outside of the handle,

wherein the controller is further configured to:

based on a determination that the maximum amplitude of the first vibration signal is greater than the maximum amplitude of the second vibration signal, supply power to the light-source to thereby turn on the light-source before or simultaneously with a start of an operation of the handle driver.

19. The dish washer of claim 13, wherein the controller is further configured to:

after the handle driver starts to operate, pause the washing course in progress; and

based on a forward movement of the handle to the extended position having been completed after operating the handle driver, stop an operation of the handle driver.

20. The dish washer of claim 19, wherein the controller is further configured to pause the washing course in progress before the operation of the handle driver is stopped or simultaneously with a stop of the operation of the handle driver.

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