



(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
24.07.2019 Bulletin 2019/30

(51) Int Cl.:
F25D 23/02 (2006.01) F25D 29/00 (2006.01)

(21) Application number: **17850865.1**

(86) International application number:
PCT/JP2017/032766

(22) Date of filing: **12.09.2017**

(87) International publication number:
WO 2018/051963 (22.03.2018 Gazette 2018/12)

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA ME
Designated Validation States:
MA MD

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(30) Priority: **16.09.2016 JP 2016181079**

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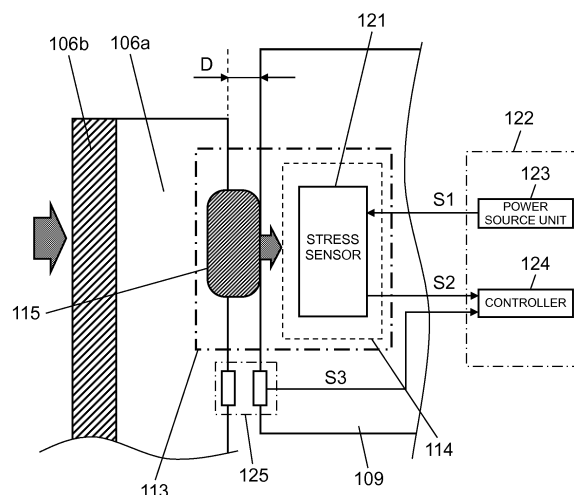
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(54) **REFRIGERATOR**

(57) Provided is a refrigerator in which operation transmission part (115) is disposed on an inner wall of drawable vegetable compartment door (106a) adjacent to a housing, and detector (114) is disposed at a portion of heat insulating partition plate (109) that faces operation transmission part (115). Further pushing vegetable compartment door (106a) in a normal closed state is determined to be a door opening operation by stress sensor (121).

FIG. 3



Description

TECHNICAL FIELD

[0001] The present disclosure relates to a refrigerator provided with a drawable door as a storage compartment door.

BACKGROUND ART

[0002] Recently, due to dietary changes and increase of suburban large supermarkets, daily shopping habits have been reduced, and people tend to buy groceries for one week in bulk and store the groceries into a refrigerator, for example. In addition, older people using a relatively large refrigerator have been increasing. For such a user, the total weight of groceries purchased in bulk and to be stored in such a large refrigerator and a door of the refrigerator is heavy, and thus, it is becoming a burden for the user to manually open and close a storage compartment configured to be opened and closed via a drawable door.

[0003] To address such a problem of manual door opening, there has been proposed a refrigerator for reducing a burden of opening of a drawable door of a storage compartment in which the door is automatically opened by an actuator, and an operation unit for the actuator is provided on a front surface of the door to be opened (for example, see PTL 1).

[0004] FIG. 11 is a longitudinal sectional view of a freezing compartment whose door is closed of a conventional refrigerator described in PTL 1, the freezing compartment being configured to be opened and closed via a drawable door. FIG. 12A and FIG. 12B are diagrams illustrating a detailed configuration of an opening switch in portion A of FIG. 11. In FIG. 11, FIG. 12A, and FIG. 12B, at an upper end of freezing compartment door 1a on a front surface of freezing compartment 1, push button 2 is provided. On a bottom side of push button 2 (on a rear side of freezing compartment 1), output lever 3 is provided. Return spring 4 is interposed between push button 2 and output lever 3. Return spring 4 is slidably supported by output lever 3. Return force generated by return spring 4 is transmitted to push button 2 and output lever 3. On a side of frame 5 of freezing compartment 1 that comes into contact with freezing compartment door 1a, switch body 6 of a microswitch is provided. Further, in frame 5, wire 7 is provided extending from switch body 6 provided in frame 5 to a control microcomputer of a refrigerator body.

[0005] When the user presses push button 2 with his or her hand, as illustrated in FIG. 12B, push button 2 moves rightward in FIG. 12B by a stroke when push button 2 is pressed (pressing amount 8). The movement of push button 2 causes output lever 3 to move via return spring 4. This causes output lever 3 to push plunger 9 provided in switch body 6 to close contacts provided in switch body 6, transmitting a signal indicating that push button 2 has been pressed by the user to the control microcomputer. When the user takes his or her hand off push button 2, force generated by return spring 4 causes, as illustrated in FIG. 12A, push button 2 and output lever 3 to return to a state before push button 2 is pressed. As a result, plunger 9 returns to an original state, and the contacts in switch body 6 return to an open state.

[0006] In the conventional refrigerator configured as described above, the control microcomputer controls energization such that door drive device 10 is not energized when the user presses push button 2, and door drive device 10 is energized when the user presses push button 2 and then takes his or her hand off push button 2. When door drive device 10 is energized, storage case 11 is pushed out, and slide rail 12 holding storage case 11 moves accordingly, thereby opening freezing compartment door 1a in opening direction 13 illustrated in FIG. 12B.

[0007] However, in the conventional configuration described above, since push button 2 to be actuated by the user is fixed to a portion of freezing compartment door 1a (the upper end of freezing compartment door 1a in the above-described conventional example), it is difficult for the user to press the portion to which push button 2 is fixed, particularly when both hands of the user are full. Further, a refrigerator having a flat door made of a glass surface member that is recently in vogue has problems that an uneven portion of push button 2 makes cleaning of the door difficult and luxury appearance in design is impaired.

Citation List

Patent Literature

[0008] PTL 1: Japanese Patent No. 4477646

SUMMARY OF THE INVENTION

[0009] The present disclosure has been made in view of the above-described problems and provides a refrigerator with a sophisticated design including an easy-to-use operation unit actuated by a user as a trigger for door opening and a door having a glass surface member that does not impair luxury appearance of a flat appearance design.

[0010] Specifically, the refrigerator according to one example of the present disclosure includes a housing having a

heat insulating wall, a plurality of storage compartments provided in the housing, a plurality of doors that open and close the plurality of storage compartments, and an automatic door opening unit that automatically opens at least one of the plurality of doors. The at least one of the plurality of doors is a drawable door. A detector of a door opening trigger device of the automatic door opening unit is disposed in the housing. An operation transmission part of the door opening trigger device is disposed on a surface of an inner wall of the drawable door, the surface being adjacent to the housing.

[0011] More specifically, in the refrigerator according to the one example of the present disclosure, the operation transmission part is disposed on a back side of the drawable door. Further, in the refrigerator according to the one example of the present disclosure, the operation transmission part and the detector facing the operation transmission part constitute the door opening trigger device.

[0012] Such a configuration allows a flat shape of a surface of the drawable door visible to the user to be secured because no operation unit for operation such as door opening is not disposed on the surface. Accordingly, the configuration allows a design having luxury appearance achieved by a flat shape such as a glass surface member on the surface of the door to be maintained.

[0013] Further, in the refrigerator according to the one example of the present disclosure, the detector may be a stress sensor. Further, in the refrigerator according to the one example of the present disclosure, the operation transmission part may be an elastic body that transmits stress to the detector. In this case, the refrigerator according to the one example of the present disclosure may be configured such that, when the drawable door in a closed state is pushed, the operation transmission part transmits the stress to the detector.

[0014] Such a configuration allows the operation transmission part that is an elastic body to transmit, when the drawable door is pushed by the user, the pressure to the detector as stress and allows determination whether a door opening operation is performed to be made based on a variation in output from the stress sensor. The configuration allows the user to push anywhere in a wide area on the door to perform the door opening operation, which eliminates a bothersome operation on a fixed position. Accordingly, the configuration facilitates operations such as the door opening operation and allows a refrigerator with improved usability to be provided.

[0015] Further, in the refrigerator according to the one example of the present disclosure, the detector of the door opening trigger device may be an inductive sensor that detects an inductance value of a torsion spring. Further, in the refrigerator according to the one example of the present disclosure, the operation transmission part may be a rigid body. In this case, the refrigerator according to the one example of the present disclosure may be configured such that, when the drawable door in the closed state is pushed, the operation transmission part transmits pressing stress to the detector to compress the torsion spring.

[0016] Such a configuration allows pressure generated when the drawable door is pushed by the user to compress the torsion spring through the operation transmission part and allows determination whether the door opening operation is performed to be made based on a variation in the inductance value. Accordingly, the configuration allows a variation in distance by which the door is pushed to be checked based on reliable values, which suppresses variations in operation feeling of the user during stress detection.

[0017] Further, in the refrigerator according to the one example of the present disclosure, the detector of the door opening trigger device may be an inductive sensor that detects an inductance value of a coil-shaped conductive pattern. Further, in the refrigerator according to the one example of the present disclosure, the operation transmission part may be a metal plate. Further, the refrigerator according to the one example of the present disclosure may be configured such that, when the drawable door is pushed in the closed state, a variation in distance (gap) between the detector and the operation transmission part is detected as a variation in the inductance value.

[0018] With such a configuration, pressure generated when the drawable door is pushed by the user makes the distance between the operation transmission part having a metal plate and the coil-shaped conductive pattern shorter, thereby making inductive coupling between the operation transmission part and the coil-shaped conductive pattern stronger. This allows determination whether the door opening operation is performed to be made based on a variation in the inductance value of the coil-shaped conductive pattern. Specifically, the configuration eliminates influence from a contact and movable structure for stress detection or variation detection, which makes it possible to provide a door opening trigger device with high detection accuracy and reliability.

[0019] The refrigerator according to the one example of the present disclosure is configured such that, as described above, an operation for activating an automatic door opening device can be achieved by an operation where any position in the wide area on the drawable door is pushed. According to the present disclosure, it is possible to provide a refrigerator with improved usability. Further, the automatic door opening device is not disposed on the front surface of the drawable door, preventing cleaning efficiency from decreasing due to an uneven shape of the operation unit and preventing the design of the flat glass surface member from deteriorating, which makes it possible to provide a refrigerator that can maintain a design having luxury appearance.

BRIEF DESCRIPTION OF DRAWINGS

[0020]

FIG. 1 is a front view of a refrigerator according to a first exemplary embodiment of the present disclosure.
 FIG. 2 is a sectional view, taken along line 2-2 in FIG. 1, of a vegetable compartment of the refrigerator according to the first exemplary embodiment of the present disclosure.
 FIG. 3 is a diagram illustrating a detailed configuration of main part C, in FIG. 2, of the refrigerator according to the first exemplary embodiment of the present disclosure.
 FIG. 4 is a diagram illustrating an arrangement example of detectors with a vegetable compartment door of the refrigerator according to the first exemplary embodiment of the present disclosure removed.
 FIG. 5 is a graph illustrating time-series variations in output from a stress sensor of the refrigerator according to the first exemplary embodiment of the present disclosure.
 FIG. 6 is a flowchart illustrating an operation of the refrigerator according to the first exemplary embodiment of the present disclosure.
 FIG. 7 is a diagram for describing a configuration and function of a main part of a vegetable compartment in a closed state of a refrigerator according to a second exemplary embodiment of the present disclosure.
 FIG. 8 is a graph illustrating time-series variations in output from an inductive sensor of the refrigerator according to the second exemplary embodiment of the present disclosure.
 FIG. 9 is a flowchart illustrating an operation of the refrigerator according to the second exemplary embodiment of the present disclosure.
 FIG. 10 is a diagram for describing a configuration and function of a main part of a vegetable compartment in a closed state of a refrigerator according to a third exemplary embodiment of the present disclosure.
 FIG. 11 is a longitudinal sectional view of a drawable freezing compartment in a closed state of a conventional refrigerator.
 FIG. 12A is a diagram illustrating a detailed configuration of an opening switch, in portion A of FIG. 11, of the conventional refrigerator.
 FIG. 12B is another diagram illustrating the detailed configuration of the opening switch, in portion A of FIG. 11, of the conventional refrigerator.

DESCRIPTION OF EMBODIMENTS

[0021] Exemplary embodiments of the present disclosure are described below with reference to the drawings. Note that the present invention is not limited to the following exemplary embodiments.

(First exemplary embodiment)

[0022] FIG. 1 is a front view of a refrigerator according to a first exemplary embodiment of the present disclosure, FIG. 2 is a sectional view, taken along line 2-2 in FIG. 1, of a vegetable compartment of the refrigerator according to the first exemplary embodiment of the present disclosure, and FIG. 3 is a diagram illustrating a detailed configuration of main part C, in FIG. 2, of the refrigerator according to the first exemplary embodiment of the present disclosure. FIG. 4 is a diagram illustrating an arrangement example of detectors with a vegetable compartment door of the refrigerator according to the first exemplary embodiment of the present disclosure removed, FIG. 5 is a graph illustrating time-series variations in output from a stress sensor of the refrigerator according to the first exemplary embodiment of the present disclosure, and FIG. 6 is a flowchart illustrating an operation of the refrigerator according to the first exemplary embodiment of the present disclosure.

[0023] Housing 101 in FIG. 1 to FIG. 3 is a heat insulating box. Housing 101 includes an outer box made primarily of a steel plate, an inner box that results from molding resin such as acrylonitrile-butadiene-styrene (ABS) resin, and a heat insulating material with which a space between the outer box and the inner box is filled.

[0024] Housing 101 is partitioned into a plurality of storage compartments, each of which is heat-insulated. Provided as an uppermost compartment in housing 101 is refrigerating compartment 102, and, below refrigerating compartment 102, ice-making compartment 103 and switching compartment 104 are provided side by side. Further, in housing 101, freezing compartment 105 is provided below ice-making compartment 103 and switching compartment 104, and vegetable compartment 106 is disposed as a lowermost compartment. Provided on a front surface of each of the storage compartments along a front surface opening of housing 101 is a heat insulating door that insulates a corresponding storage compartment from outside air. Refrigerating compartment door 102a serving as a heat insulating door of refrigerating compartment 102 is a double door. Display operation unit 108 is provided near a center of refrigerating compartment door 102a, and a user can use display operation unit 108 to make various settings, such as a setting of respective

inside temperatures of the storage compartments and a setting for ice-making and quick cooling.

[0025] In a machine compartment provided in a rear area of an uppermost portion of refrigerating compartment 102, components, such as a compressor and a dryer that removes moisture, constituting a refrigeration cycle are stored. Provided on a back surface of freezing compartment 105 is a cooling compartment that generates cool air. Disposed in the cooling compartment are a cooler and a cooling fan that blows cool air that is a cooling unit cooled by the cooler, through an air duct provided on a back surface side of refrigerator 102, to refrigerating compartment 102, ice-making compartment 103, switching compartment 104, freezing compartment 105, and vegetable compartment 106. Furthermore, an airflow rate control damper that controls a flow rate of air sent from the cooling fan is provided in the air duct. Further, in the cooling compartment, a radiant heater, a drain pan, a drain tube, an evaporating dish, and the like are provided. The radiant heater is provided below the cooler for removing frost and ice attached to the cooler and an area around the cooler. Provided below the radiant heater is the drain pan that receives water that results from defrosting. The drain tube is provided passing through a deepest portion of the drain pan to the outside of the compartment. The evaporating dish is provided downstream of the drain tube.

[0026] Refrigerating compartment 102 is normally set to 1°C to 5°C in which the lowest temperature is an unfreezing temperature for preservation by refrigeration. Vegetable compartment 106 that is the lowermost compartment is set to 2°C to 7°C that is equal to or slightly higher than a temperature of refrigerating compartment 102. Further, freezing compartment 105 is set to a freezing temperature range and is normally set to -22°C to -15°C for preservation by freezing. Note that, freezing compartment 105 may be set to a lower temperature such as -30°C or -25°C to enhance preservation by freezing.

[0027] Ice-making compartment 103 causes an automatic icemaker provided at an upper portion of ice-making compartment 103 to produce ice from water fed from a water tank in refrigerating compartment 102, and stores the ice in an ice container disposed at a lower portion of ice-making compartment 103.

[0028] Switching compartment 104 is capable of switching a temperature range to a preset temperature range between a refrigerating temperature range and the freezing temperature range, in addition to the refrigerating temperature range from 1°C to 5°C, a vegetable temperature range from 2°C to 7°C, and the freezing temperature range normally from -22°C to -15°C. Switching compartment 104 is a storage compartment disposed adjacent to ice-making compartment 103 and provided with an independent door, and is often provided with a drawable door.

[0029] Note that, in the present exemplary embodiment, switching compartment 104 serves as a storage compartment capable of switching a set temperature to one of temperature ranges from the refrigerating temperature range to the freezing temperature range. However, switching compartment 104 is not limited to such a configuration, but another configuration may be employed where refrigerating compartment 102 and vegetable compartment 106 are responsible for the refrigerating function, freezing compartment 105 is responsible for the freezing function, and switching compartment 104 serves as a storage compartment that switches the temperature range only to temperature ranges between the refrigerating temperature range and the freezing temperature range. Further, switching compartment 104 may be configured as a storage compartment whose temperature range is fixed to a specific temperature range, for example, the freezing temperature range, considering that there is increased demand for frozen food in recent years.

[0030] Vegetable compartment door 106a includes, as illustrated in FIG. 2, glass surface member 106b having a flat shape on a front surface of vegetable compartment door 106a. Storage case 111 supported by frame 110 is attached to vegetable compartment door 106a. Drawer rail 112 is fixed to an inner wall of vegetable compartment 106. Frame 110 is configured to slide on drawer rail 112. Further, frame 110 and vegetable compartment door 106a are formed in a monolithic structure, so that frame 110 and storage case 111 move together when vegetable compartment door 106a is opened or closed.

[0031] Further, door opening and closing unit 116 is provided on the inner wall of vegetable compartment 106 near drawer rail 112. Door opening and closing unit 116 includes a motor and a gear mechanism and transmits power from the motor to link 117. Link 117 has a recessed shape and moves along guide 118 in door opening and closing unit 116. On frame 110, protrusion 119 is provided. When link 117 moves with protrusion 119 engaged with a recess of link 117, frame 110 moves in conjunction with link 117.

[0032] Note that guide 118 has a shape that is not a simple linear shape, but a shape where, as illustrated in FIG. 2, a rear end portion of guide 118 adjacent to a back surface of vegetable compartment 106 slightly bends toward lower right in FIG. 2 (toward the back surface and bottom of vegetable compartment 106) such that, with vegetable compartment door 106a closed, link 117 and protrusion 119 disengage from each other. The reason why the rear end portion of guide 118 adjacent to the back surface of vegetable compartment 106 bends as described above is to prevent a burden due to which force stronger than usual is required to open vegetable compartment door 106a from being imposed on the user, the burden being caused by the gear mechanism and the motor in door opening and closing unit 116 when the user opens vegetable compartment door 106a not automatically but manually with link 117 and protrusion 119 constantly engaged with each other.

[0033] First, after a door opening operation on vegetable compartment door 106a is started, link 117 and protrusion 119 engage with each other in a linear section of guide 118, and as link 117 further moves, vegetable compartment door

106a gradually opens. As vegetable compartment door 106a is opened by a certain distance, link 117 and protrusion 119 move to a front end portion of guide 118 that slightly bends toward lower left in FIG. 2 (toward a front surface and bottom of vegetable compartment 106) and disengage from each other, and vegetable compartment door 106a further moves by inertia and then stops.

5 **[0034]** Next, in a door closing operation, an operation reverse to the automatic door opening operation described above is performed. That is, automatic door closing is started when the user closes vegetable compartment door 106a to a position where protrusion 119 can engage with link 117. Specifically, link 117 and protrusion 119 engage with each other, and vegetable compartment door 106a is moved in a direction toward a closed position. When the door is closed, link 117 and protrusion 119 disengage from each other, as illustrated in FIG. 2, and door opening and closing unit 116
10 waits in a state where door opening and closing unit 116 is ready to accept either the automatic door opening or the automatic door closing.

[0035] To enhance airtightness of vegetable compartment 106 with vegetable compartment door 106a closed, provided on the inner wall of vegetable compartment 106 is airtightness holding mechanism 120 that uses a spring, an inclination of the rail, or the like. Airtightness holding mechanism 120 pulls frame 110 in a closing direction by force that does not
15 interfere the opening of vegetable compartment door 106a. Note that airtightness holding mechanism 120 may be provided inside door opening and closing unit 116.

[0036] Such a mechanism causes frame 110, vegetable compartment door 106a, and storage case 111 to be connected to one another and move in conjunction with one another, enabling vegetable compartment door 106a to be automatically opened and closed by door opening and closing unit 116.

20 **[0037]** Further, as illustrated in FIG. 2, on a portion of heat insulating partition plate 109 disposed between vegetable compartment 106 and freezing compartment 105, the portion facing the inner wall of vegetable compartment door 106a, detector 114 is provided. On the other hand, provided on a portion of the inner wall of vegetable compartment door 106a that faces heat insulating partition plate 109 is operation transmission part 115 that faces detector 114 (that is positioned to face detector 114 or the like). Detector 114 and operation transmission 115 constitute door opening trigger device 113.

25 **[0038]** Next, with reference to FIG. 3, a description will be given of door opening trigger device 113 and a configuration around door opening trigger device 113.

[0039] Heat insulating partition plate 109 and vegetable compartment door 106a maintain the state where vegetable compartment door 106a is closed via a gasket (not illustrated) with distance D in order to secure airtightness and absorb impact upon closing vegetable compartment door 106a. Operation transmission part 115 is an elastic body member and is brought into close contact with detector 114 facing operation transmission part 115 by stress from the gasket provided for securing airtightness.

30 **[0040]** Further, door opened and closed state detector 125 detects an opened and closed state of vegetable compartment door 106a. For door opened and closed state detector 125, electronic detection is typically employed in which a magnetic sensor such as a Hall IC disposed on heat insulating partition plate 109 and a magnetic body such as a magnet
35 disposed on vegetable compartment door 106a are paired with each other. However, door opened and closed state detector 125 is not limited to such a configuration, but may be configured as a mechanical switch that breaks a connection between contacts when the distance between heat insulating partition plate 109 and vegetable compartment door 106a is equal to or greater than distance D, and makes the connection between the contacts when the distance is equal to distance D.

40 **[0041]** In the present exemplary embodiment, stress sensor 121 is used as detector 114. Stress sensor 121 detects stress from operation transmission part 115. As detector 114, a sensor including a strain resistance element whose resistance varies by stress and a conductive rubber, or a pressure sensor whose capacitance varies may be employed.

[0042] Control circuit board 122 includes power source unit 123 and controller 124. Power S1 is supplied from power source unit 123 to stress sensor 121. Signal S2 detected by stress sensor 121 is transmitted to controller 124. Further,
45 controller 124 receives signal S3 indicating door opened and closed state detected by door opened and closed state detector 125.

[0043] Further, as illustrated in FIG. 4, a plurality of detectors 114 are arranged on heat insulating partition plate 109, a plurality of operation transmission parts 115 are provided, each of which faces corresponding detector 114, and detection results are averaged based on pieces of information from a plurality of door opening trigger devices 113, which
50 enables detection with high accuracy.

[0044] Hereinafter, the manner of operation and effects of refrigerator 100 having the above-mentioned configuration will be described with reference to the graph illustrating time-series variations in output from the stress sensor in FIG. 5 and the flowchart of the operation in FIG. 6.

55 **[0045]** First, in step 1, when power is supplied to refrigerator 100 with vegetable compartment door 106a closed, control circuit board 122 is activated, and power S1 is supplied from power source unit 123 to stress sensor 121 (time a in FIG. 5).

[0046] Next, in step 2, door opened and closed state detector 125 detects the opened and closed state of vegetable compartment door 106a and determines whether vegetable compartment door 106a is closed. When determining that

vegetable compartment door 106a is closed, door opened and closed state detector 125 outputs signal S3 to controller 124 and causes the process to proceed to step 3. When determining that vegetable compartment door 106a is opened, door opened and closed state detector 125 outputs signal S3 to controller 124 and puts the process on standby at step 2. At this time, when vegetable compartment door 106a is closed, stress sensor 121 is pushed by stress from the gasket, which causes an output value from stress sensor 121 to be P2 (time b in FIG. 5).

[0047] In step 3, controller 124 determines that vegetable compartment door 106a is closed, receives signal S2 from stress sensor 121, stores output value P2, and causes the process to proceed to step 4 (time b to time c in FIG. 5).

[0048] Next, in step 4, controller 124 measures output value P3 from stress sensor 121 and causes the process to proceed to step 5.

[0049] In step 5, when controller 124 determines whether a difference between output value P3 and output value P2 has reached predetermined ΔP and determines that the difference has reached ΔP , controller 124 determines that vegetable compartment door 106a has been further pushed by the user in a normal closed state and causes the process to proceed to step 6. Otherwise, controller 124 returns a logic to step 4 and waits until a door opening operation is performed (time c to time f in FIG. 5).

[0050] Note that, in FIG. 5, the output value exceeds P3 (ΔP as a variation) at time e due to a time lag until the user fully pushes vegetable compartment door 106a. Further, after the door opening operation, the output value does not return to P2 and becomes P1 with a slight variation at time f when the user takes his or her hand off vegetable compartment door 106a because of a hysteresis effect of each of the elastic bodies of operation transmission part 115 and the gasket. Therefore, refrigerator 100 of the present exemplary embodiment is configured to update output value P2 corresponding to the normal closed state in the next or later door opening operation.

[0051] Then, in step 6, controller 124 receives signal S2 from stress sensor 121 and signal S3 from the door opened and closed state detector, checks the door opened and closed state and determines that the door opening operation has been performed, and then causes the process to proceed to step 7 (time f in FIG. 5).

[0052] Here, the reason why the determination that the door opening operation has been performed is made based on a period from time e when the user takes his or her hand off vegetable compartment door 106a to time f corresponding to step 7 (when controller 124 determines that the door opening operation has been performed) rather than a time when the user pushes vegetable compartment door 106a is to prevent unusual operation feeling from being given.

[0053] Next, in step 7, control circuit board 122 determines that the door opening operation has been started, activates door opening and closing unit 116, and causes the process to proceed to step 8 (time f in FIG. 5).

[0054] In step 8, door opened and closed state detector 125 confirms that vegetable compartment door 106a is opened and returns the logic to step 2 (time g in FIG. 5).

[0055] As described above, refrigerator 100 of the present exemplary embodiment includes housing 101 having a heat insulating wall, the plurality of storage compartments including vegetable compartment 106 provided in housing 101, and a plurality of doors, each of which opens and closes a corresponding one of the plurality of storage compartments including vegetable compartment 106. At least one of the plurality of doors, that is, vegetable compartment door 106a, is a drawable door. Further, in refrigerator 100 of the present exemplary embodiment, detector 114 of door opening trigger device 113 is disposed on housing 101. Detector 114 of door opening trigger device 113 is preferably disposed on heat insulating partition plate 109 of housing 101. Further, in refrigerator 100 of the present exemplary embodiment, operation transmission part 115 of door opening trigger device 113 is disposed on a portion of a surface, adjacent to housing 101, of the inner wall of vegetable compartment door 106a that is drawable, the portion facing detector 114.

[0056] Such a configuration allows a flat shape having luxury appearance to be secured because a mechanism having an uneven shape such as a mechanical switch is not provided as a door opening operation unit on glass surface member 106b provided on the front surface of vegetable compartment door 106a. Note that it is conceivable that a configuration where an operation unit including a capacitive touch sensor, a microwave sensor, and the like is provided without a design change of the surface of a door is employed, but there are problems that such a configuration requires power supply to a drawable door, and increases costs and requires a mounting space when wireless power supply is used. The configuration of the present exemplary embodiment can solve such a problem.

[0057] Note that, in the present exemplary embodiment, a description has been given of vegetable compartment door 106a as an example, but the configuration is applicable to a drawable door such as freezing compartment door 105a provided with glass surface member 105b on a front surface, and any storage compartment provided with a drawable door can have the same configuration as the configuration of the present exemplary embodiment.

[0058] Further, in refrigerator 100 of the present exemplary embodiment, detector 114 of door opening trigger device 113 is stress sensor 121, and operation transmission part 115 is an elastic body. When vegetable compartment door 106a in the closed state is pushed, operation transmission part 115 transmits the stress to detector 114. Such a configuration makes it possible to extract the stress generated when vegetable compartment door 106a is pushed by the user from stress sensor 121 as a variation in physical quantity output such as a voltage or a resistance value. Accordingly, the configuration allows door opening trigger device 113 to make accurate determination on the door opening operation.

[0059] Further, in the present exemplary embodiment, operation transmission part 115 is the elastic body. Such a

configuration allows airtightness between heat insulating partition plate 109 and vegetable compartment door 106a to be secured. Note that employing a configuration where the gasket pushes detector 114 in order to secure airtightness between heat insulating partition plate 109 and vegetable compartment door 106a and absorb impact upon closing vegetable compartment door 106a eliminates the need of operation transmission part 115.

[0060] Furthermore, refrigerator 100 of the present exemplary embodiment is configured to update output value P2 from stress sensor 121 each time when vegetable compartment door 106a is closed. Accordingly, even when distance D between heat insulating partition plate 109 and vegetable compartment door 106a varies due to aging deterioration of the gasket or operation transmission part 115, it is possible to keep operation reliability and accuracy constant.

[0061] Further, in the description of the operation of the present exemplary embodiment, when a variation in the output value from stress sensor 121 is equal to or greater than variation ΔP , a determination is made that the door opening operation has been performed, but, including a period during which the operation is performed (a period from time c to time d in FIG. 5) in a determination criteria allows a determination whether it is an unintended impact force generated by, for example, a collision to be made and makes door opening trigger device 113 more suitable for use.

(Second exemplary embodiment)

[0062] A description will be given below of refrigerator 200 of a second exemplary embodiment of the present disclosure with reference to FIG. 7 to FIG. 9. Refrigerator 200 of the second exemplary embodiment of the present disclosure is different from refrigerator 100 of the first exemplary embodiment in that inductive sensor 131 is used as detector 114, and operation transmission part 115 has a protruded shape and is a rigid member such as a resin molded product.

[0063] FIG. 7 is a diagram for describing a configuration and function of a main part of a vegetable compartment, in a closed state, of the refrigerator according to the second exemplary embodiment of the present disclosure, FIG. 8 is a graph illustrating time-series variations in output from the inductive sensor of the refrigerator according to the second exemplary embodiment of the present disclosure, and FIG. 9 is a flowchart illustrating an operation of the refrigerator according to the second exemplary embodiment of the present disclosure. Note that components of the present exemplary embodiment identical to the components of the first exemplary embodiment are denoted by the identical reference marks and will not be described in detail, and only different configurations will be mainly described.

[0064] First, with reference to FIG. 7, a description will be given of door opening trigger device 113 and a configuration around door opening trigger device 113. Heat insulating partition plate 109 and vegetable compartment door 106a maintain the state where vegetable compartment door 106a is closed via a gasket (not illustrated) with distance E in order to secure airtightness and absorb impact upon closing vegetable compartment door 106a. In the present exemplary embodiment, operation transmission part 115 has a protrusion. Further, a rigid member such as a resin molded product is used as operation transmission part 115. Further, in the present exemplary embodiment, operation transmission part 115 is brought into close contact with first electrode 127 of detector 114 (to be described later) by stress from the gasket provided for securing airtightness, first electrode 127 being provided at a position facing operation transmission part 115.

[0065] Further, door opened and closed state detector 125 detects that vegetable compartment door 106a is closed. For door opened and closed state detector 125, electronic detection is typically employed in which a magnetic sensor such as a Hall IC on heat insulating partition plate 109 and a magnetic body such as a magnet on vegetable compartment door 106a are paired with each other. However, door opened and closed state detector 125 is not limited to such a configuration, but may be configured as a mechanical switch that breaks a connection between contacts when the distance between heat insulating partition plate 109 and vegetable compartment door 106a is equal to or greater than distance E, and makes the connection between the contacts when the distance is equal to distance E.

[0066] Further, in the present exemplary embodiment, inductive sensor 131 is used as detector 114. Detector 114 is configured to detect stress from operation transmission part 115. In inductive sensor 131, first electrode 127 and second electrode 128 are movably connected with each other via torsion spring 126 made of metal. First electrode 127 and second electrode 128 individually have an electrical connection to frequency detector 130. Further, first electrode 127, torsion spring 126, and second electrode 128 are connected in series, and capacitor 129 is electrically connected between an end of first electrode 127 that is not connected to torsion spring 126 and an end of second electrode 128 that is not connected to torsion spring 126. When the protrusion of operation transmission part 115 is pushed by stress, first electrode 127 moves to compress torsion spring 126 provided between first electrode 127 and second electrode 128 that is fixed, making a total length of torsion spring 126 shorter, which in turn makes the inductance value of torsion spring 126 greater.

[0067] Control circuit board 122 includes power source unit 123 and controller 124. Power S4 is supplied from power source unit 123 of control circuit board 122 to frequency detector 130. Further, signal S5 detected by frequency detector 130 is transmitted to controller 124 of control circuit board 122. Further, controller 124 receives, from door opened and closed state detector 125, signal S6 indicating the door opened and closed state detected by door opened and closed state detector 125.

[0068] Hereinafter, the manner of operation and effects of refrigerator 200 having the above-mentioned configuration

will be described with reference to the graph illustrating time-series variations in output from the inductive sensor in FIG. 8 and the flowchart of the operation in FIG. 9.

[0069] First, in step 9, when power is supplied to refrigerator 200 with vegetable compartment door 106a closed, control circuit board 122 is activated, and power S4 is supplied from power source unit 123 to frequency detector 130 of inductive sensor 131. At this time, in inductive sensor 131, a resonant circuit is formed with inductance of torsion spring 126 and capacitance of capacitor 129, and resonance frequency f of the resonant circuit is represented by equation (1).

$$f = \frac{1}{2\pi\sqrt{L \times C}} \quad (1)$$

[0070] In equation (1), L denotes an inductance value of torsion spring 126, C denotes a capacitance value of capacitor 129, and both of the values are fixed values.

[0071] In frequency detector 130, resonance frequency f is converted to value L using equation (1), and frequency detector 130 outputs value L as signal S5 to controller 124, and causes the process to proceed to step 10 (time h in FIG. 8).

[0072] Next, in step 10, door opened and closed state detector 125 detects the opened and closed state of vegetable compartment door 106a, and determines whether vegetable compartment door 106a is closed. When determining that vegetable compartment door 106a is closed, door opened and closed state detector 125 outputs signal S6 to controller 124, and causes the process to proceed to step 11. When determining that vegetable compartment door 106a is opened, door opened and closed state detector 125 outputs signal S6 to controller 124, and puts the process on standby at step 10. Note that, when vegetable compartment door 106a is closed, torsion spring 126 of inductive sensor 131 is pressed by stress from the gasket via the protrusion of operation transmission part 115, making the total length of torsion spring 126 shorter, which in turn makes the inductance value greater than an initial value and causes the output to be L_2 (see FIG. 8). This is because a coil spring generally has a characteristic represented by a relational expression corresponding to equation (2), and as long as a number of turns is the same, the shorter the total length is, the greater the inductance value becomes (time i in FIG. 8).

$$L = \frac{\mu \times N^2 \times d}{l} \quad (2)$$

[0073] In equation (2), μ denotes magnetic permeability, N denotes the number of turns, d denotes a diameter of a coil, and l denotes a total length of the coil.

[0074] In step 11, controller 124 determines that vegetable compartment door 106a is closed, receives signal S5 from frequency detector 130, stores output value L_2 , and causes the process to proceed to step 12 (time i to time j in FIG. 8).

[0075] Next, in step 12, controller 124 measures output value P3 from inductive sensor 131 and causes the process to proceed to step 13.

[0076] In step 13, controller 124 determines whether a difference between output value L_3 and output value L_2 has reached predetermined output value difference ΔL . When the difference has reached output value difference ΔL , controller 124 determines that vegetable compartment door 106a in the normal closed state has been further pushed by the user and causes the process to proceed to step 14. Otherwise, controller 124 returns the process to step 12 and waits until the door opening operation is performed (time j to time m in FIG. 8).

[0077] Here, in FIG. 8, the output value from inductive sensor 131 exceeds L_3 (ΔL as a variation) at time l due to a time lag until the user fully pushes vegetable compartment door 106a. Further, after the operation, the output value does not return to L_2 and becomes L_1 with a slight variation at time m when the user takes his or her hand off vegetable compartment door 106a because of a spring constant of torsion spring 126 and a hysteresis effect of the elastic body of the gasket. Therefore, refrigerator 200 of the present exemplary embodiment is configured to update output value L_2 corresponding to the normal closed state in the next or later door opening operation.

[0078] Then, in step 14, controller 124 receives signal S5 from inductive sensor 131 and signal S6 from the door opened and closed state detector, checks the door opened and closed state and determines that the door opening operation has been performed, and then causes the process to proceed to step 15 (time m in FIG. 8).

[0079] Here, the reason why the determination that the door opening operation has been performed is made based on a period from time l when the user takes his or her hand off vegetable compartment door 106a to time m corresponding to step 14 (when controller 124 determines that the door opening operation has been performed) rather than a time when the user pushes vegetable compartment door 106a is to prevent unusual operation feeling from being given.

[0080] Next, in step 15, controller 124 of control circuit board 122 determines that the door opening operation has

been started, activates door opening and closing unit 116 (time f in FIG. 8), confirms that vegetable compartment door 106a is opened with door opened and closed state detector 125, and returns the process to step 10 (time n in FIG. 8).

[0081] As described above, refrigerator 200 of the present exemplary embodiment includes the inductive sensor that detects the inductance value of torsion spring 126 disposed in detector 114 of door opening trigger device 113. Further, refrigerator 200 of the present exemplary embodiment includes operation transmission part 115 having the protrusion. A rigid member is used as operation transmission part 115.

[0082] Further, refrigerator 200 of the present exemplary embodiment is configured to cause operation transmission part 115 to transmit, when vegetable compartment door 106a that is drawable is pushed in the closed state, the stress to detector 114 to compress torsion spring 126. Such a configuration allows the fact that vegetable compartment door 106a has been pushed by the user to be detected based on a variation in the inductance value of torsion spring 126 and allows the determination of whether the door opening operation has been performed to be made. Further, the configuration allows a variation in distance by which the door is pushed to be checked based on reliable values. Accordingly, the configuration can suppress variations caused by force dispersion in, for example, stress detection, which prevents unusual operation feeling from being given to the user.

(Third exemplary embodiment)

[0083] A description will be given below of refrigerator 300 of a third exemplary embodiment of the present disclosure with reference to FIG. 10. Note that, in the present exemplary embodiment, components identical to the components of the first exemplary embodiment or the second exemplary embodiment are denoted by the identical reference marks and will not be described in detail, and only different configurations will be mainly described.

[0084] Refrigerator 300 of the third exemplary embodiment of the present disclosure is different from refrigerator 200 of the second exemplary embodiment, particularly, in the configuration of the inductive sensor. Therefore, in the present exemplary embodiment, a description will be mainly given of differences from the inductive sensor of refrigerator 200 of the second exemplary embodiment.

[0085] FIG. 10 is a diagram for describing a configuration and function of a main part of a vegetable compartment, in a closed state, of the refrigerator according to the third exemplary embodiment of the present disclosure.

[0086] In FIG. 10, heat insulating partition plate 109 and vegetable compartment door 106a maintain a state where vegetable compartment door 106a is closed via a gasket (not illustrated) with distance F in order to secure airtightness and absorb impact upon closing vegetable compartment door 106a. In refrigerator 300 of the present exemplary embodiment, operation transmission part 115 is a flat metal plate. Further, inductive sensor 131 is used as detector 114. Detector 114 is configured to detect stress from operation transmission part 115. Detector 114 includes coil-shaped conductive pattern 132 in inductive sensor 131. Operation transmission part 115 is disposed close to coil-shaped conductive pattern 132 of detector 114 with distance F by stress from the gasket for securing airtightness, coil-shaped conductive pattern 132 being disposed facing operation transmission part 115. Coil-shaped conductive pattern 132 is preferably disposed as close as possible to a surface of heat insulating partition plate 109. Note that, examples of a specific configuration of coil-shaped conductive pattern 132 include a configuration where a copper foil having a loop-antenna shape formed on a printed wiring board and a configuration where a copper wire formed into a spiral shape is fixed onto a printed wiring board.

[0087] Both ends of coil-shaped conductive pattern 132 in inductive sensor 131 are electrically connected to frequency detector 130. Capacitor 129 is electrically connected between coil-shaped conductive pattern 132 and frequency detector 130. When vegetable compartment door 106a is pushed, a distance between operation transmission part 115 and coil-shaped conductive pattern 132 becomes shorter than initial distance F.

[0088] Hereinafter, the manner of operation of refrigerator 300 having the above-mentioned configuration will be described.

[0089] In the initial closed state of vegetable compartment door 106a where distance F is maintained, inductance of coil-shaped conductive pattern 132 includes self-inductance and mutual inductance due to metal interference of operation transmission part 115. The shorter distance F is, that is, the more vegetable compartment door 106a is pushed, the greater a mutual inductance value becomes inversely. Accordingly, when such a varying inductance value is used for the operation from step 9 to step 15 described in the second exemplary embodiment, the fact that vegetable compartment door 106a has been pushed can be a trigger for door opening and closing unit 116 (determination of a door opening operation).

[0090] As described above, refrigerator 300 of the present exemplary embodiment includes inductive sensor 131 that is disposed in detector 114 of door opening trigger device 113 and detects the inductance value of coil-shaped conductive pattern 132. Further, in refrigerator 300 of the present exemplary embodiment, a metal plate is used as operation transmission part 115. Further, in refrigerator 300 of the present exemplary embodiment, detecting a variation in the distance between detector 114 and operation transmission part 115 as a variation in the inductance value when vegetable compartment door 106a that is drawable is pushed in the closed state eliminates an error factor of the contact and

movable structure from door opening trigger device 113, which produces a refrigerator with high reliability. Note that the configuration where operation transmission part 115 is a magnetic body is greater in variation in the mutual inductance value than the configuration where operation transmission part 115 is a metal plate. Such a configuration enables implementation of door opening trigger device 113 with higher accuracy.

INDUSTRIAL APPLICABILITY

[0091] As described above, the present disclosure provides a refrigerator that eliminates the need for disposing an operation unit for activating an automatic door opening device on a front surface of a drawable door, has improved operability, and does not impair the design of a flat door. Accordingly, the present disclosure is applicable to home-use and business-use refrigerators, refrigerating and freezing show cases, storage that does not need temperature control, and the like, each of which having a drawable door.

REFERENCE MARKS IN THE DRAWINGS

[0092]

100, 200, 300:	refrigerator
101:	housing
102:	refrigerating compartment
102a:	refrigerating compartment door
103:	ice-making compartment
104:	switching compartment
105:	freezing compartment
105a:	freezing compartment door
105b:	glass surface member
106:	vegetable compartment
106a:	vegetable compartment door
106b:	glass surface member
108:	display operation unit
109:	heat insulating partition plate
110:	frame
111:	storage case
112:	drawer rail
113:	door opening trigger device
114:	detector
115:	operation transmission part
116:	door opening and closing unit
117:	link
118:	guide
119:	protrusion
120:	airtightness holding mechanism
121:	stress sensor
122:	control circuit board
123:	power source unit
124:	controller
125:	door opened and closed state detector
126:	torsion spring
127:	first electrode
128:	second electrode
129:	capacitor
130:	frequency detector
131:	inductive sensor
132:	coil-shaped conductive pattern

Claims**1.** A refrigerator comprising:

5 a housing having a heat insulating wall;
a plurality of storage compartments provided in the housing;
a plurality of doors that open and close the plurality of storage compartments; and
an automatic door opening unit that automatically opens the plurality of doors,
wherein
10 at least one of the plurality of doors is a drawable door,
the automatic door opening unit includes a door opening trigger device having a detector disposed in the housing,
and
the door opening trigger device includes an operation transmission part disposed on a surface of an inner wall
of the drawable door, the surface being adjacent to the housing.

15 **2.** The refrigerator according to claim 1, wherein
the detector of the door opening trigger device is a stress sensor, and
the operation transmission part is an elastic body and transmits stress to the detector when the drawable door in a
closed state is pushed.

20 **3.** The refrigerator according to claim 1, wherein
the detector of the door opening trigger device is an inductive sensor that detects an inductance value of a torsion
spring, and
the operation transmission part is a rigid body and configured to transmit pressing stress to the detector to compress
25 the torsion spring when the drawable door in a closed state is pushed.

4. The refrigerator according to claim 1, wherein
the detector of the door opening trigger device is an inductive sensor that detects an inductance value of a coil-
shaped conductive pattern, and
30 the operation transmission part is a metal plate and detects a variation in a gap between the detector and the
operation transmission part as a variation in the inductance value when the drawable door in a closed state is pushed.

FIG. 1

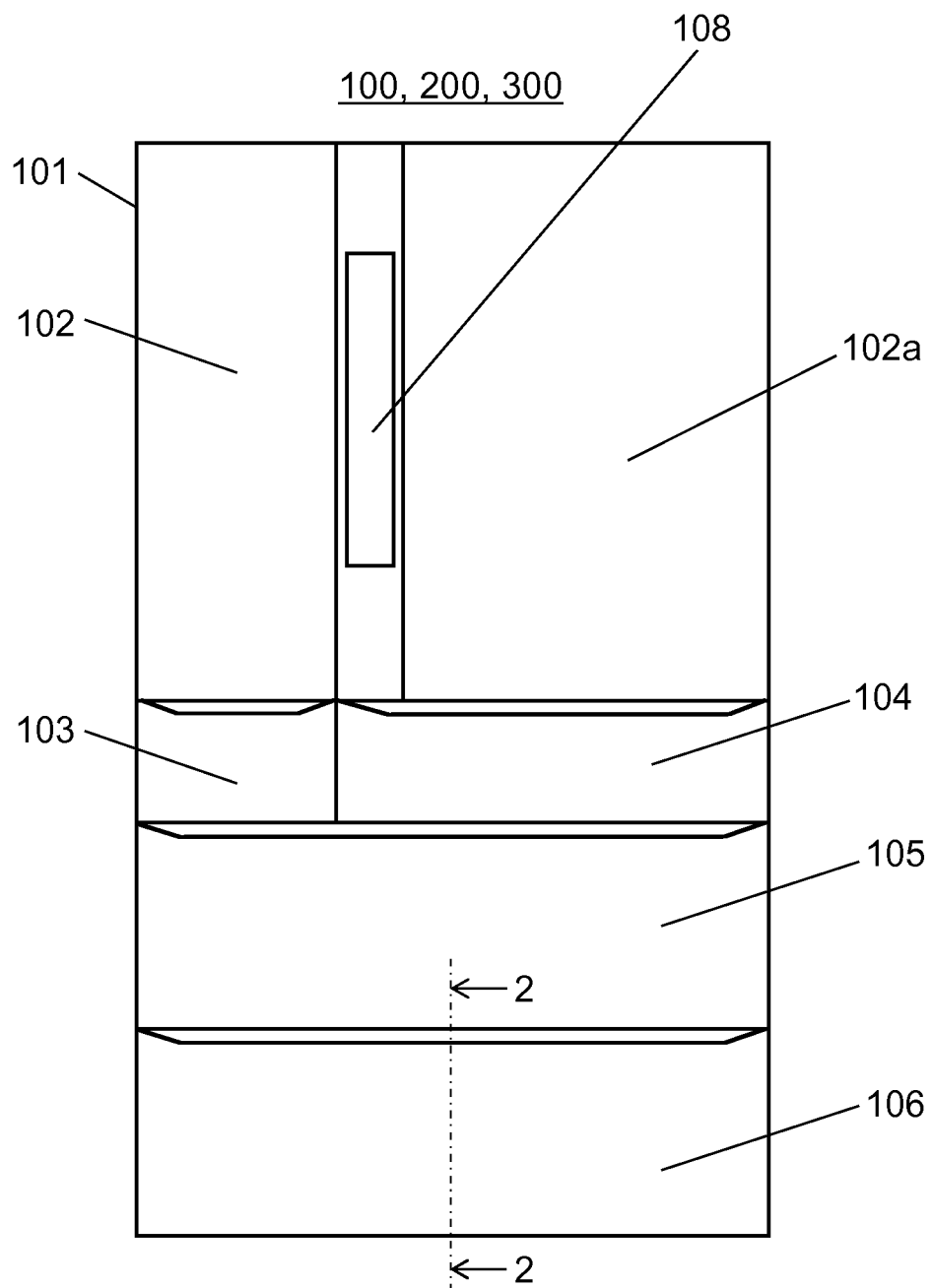


FIG. 2

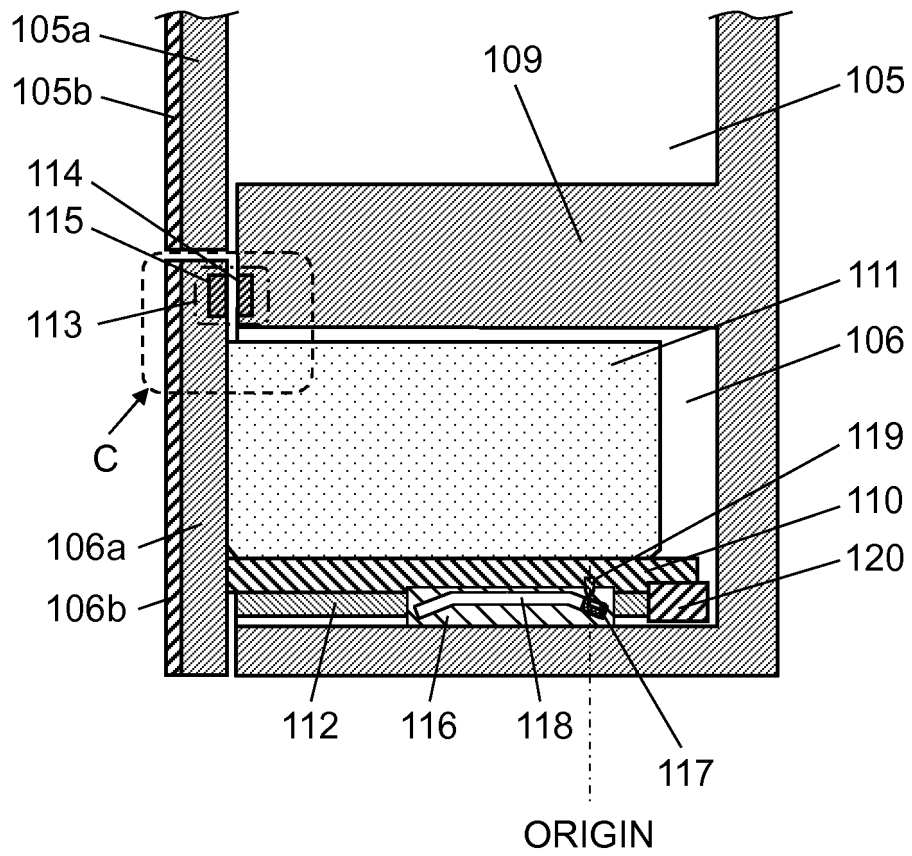


FIG. 3

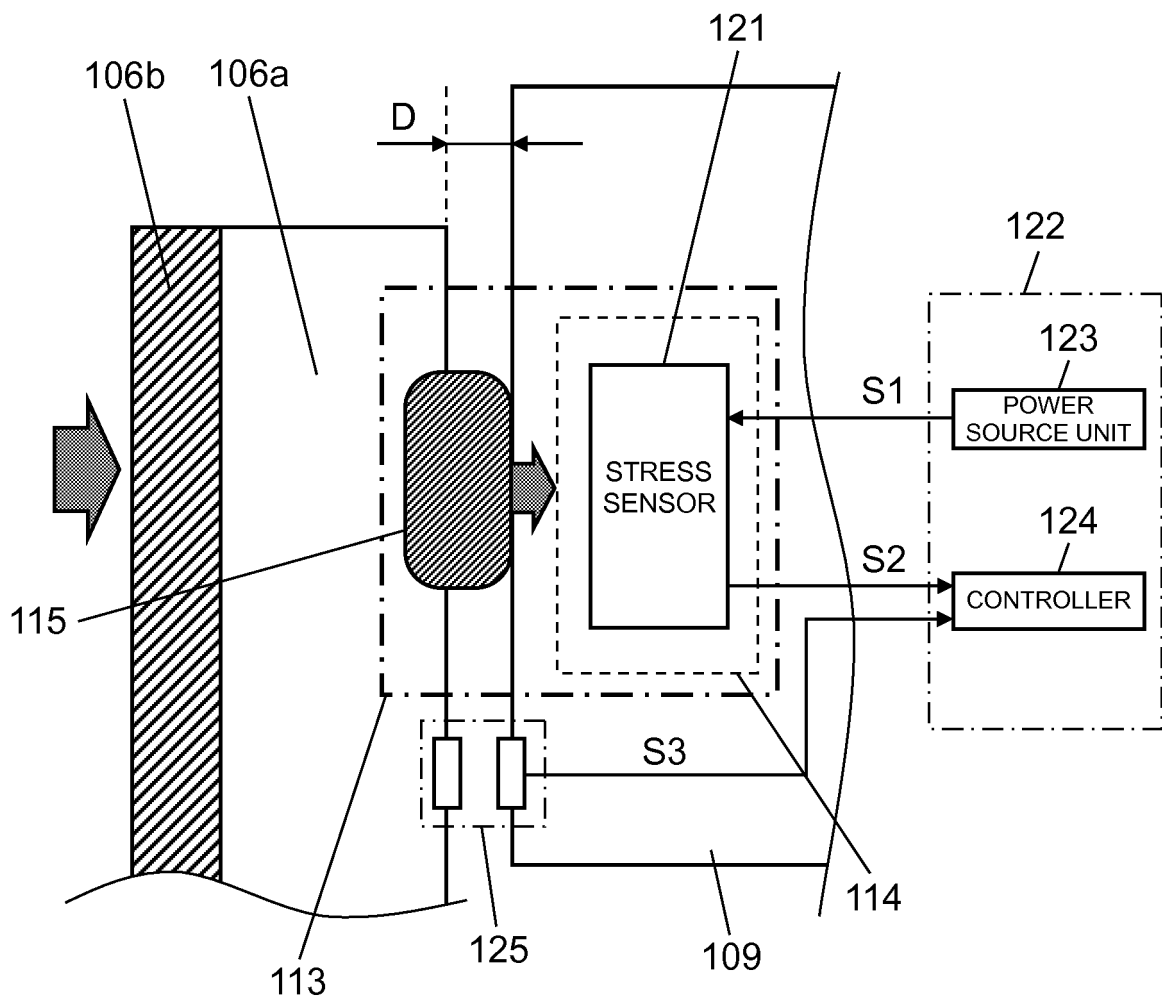


FIG. 4

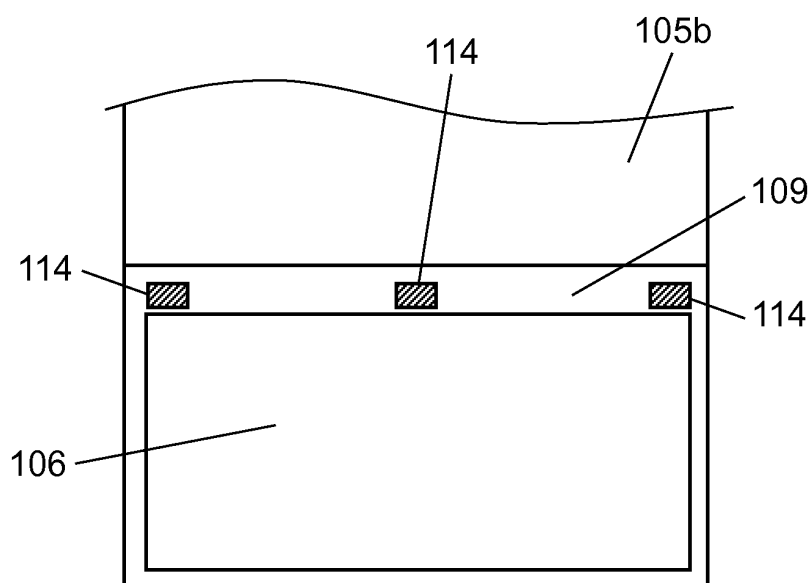


FIG. 5

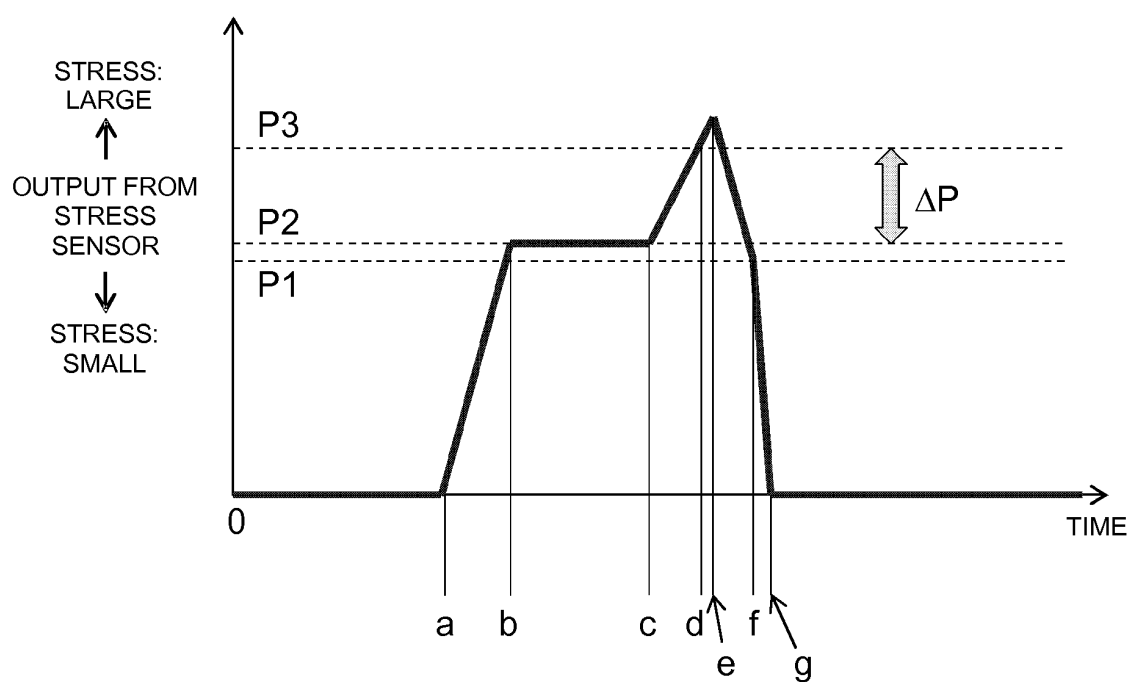


FIG. 6

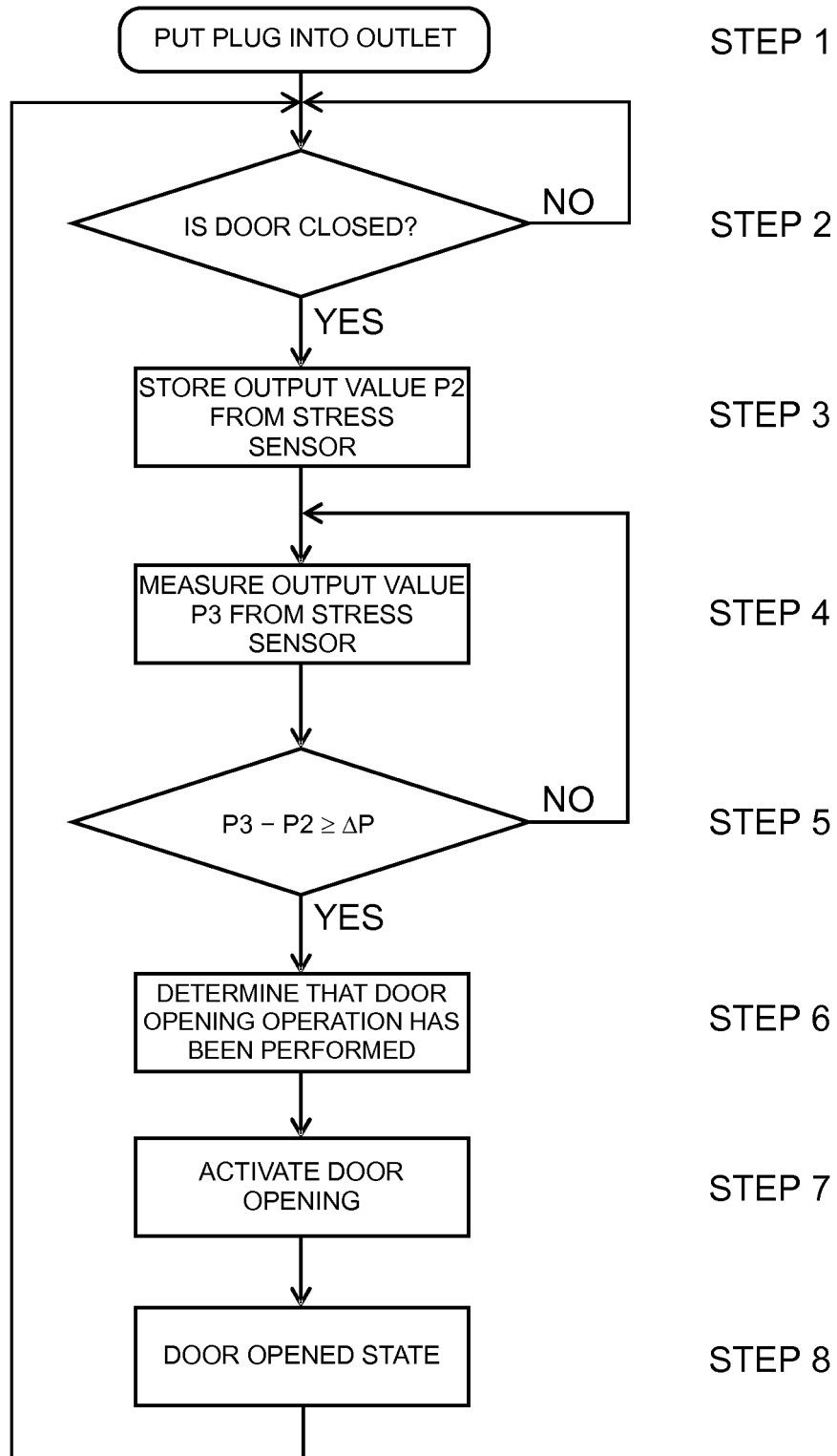


FIG. 7

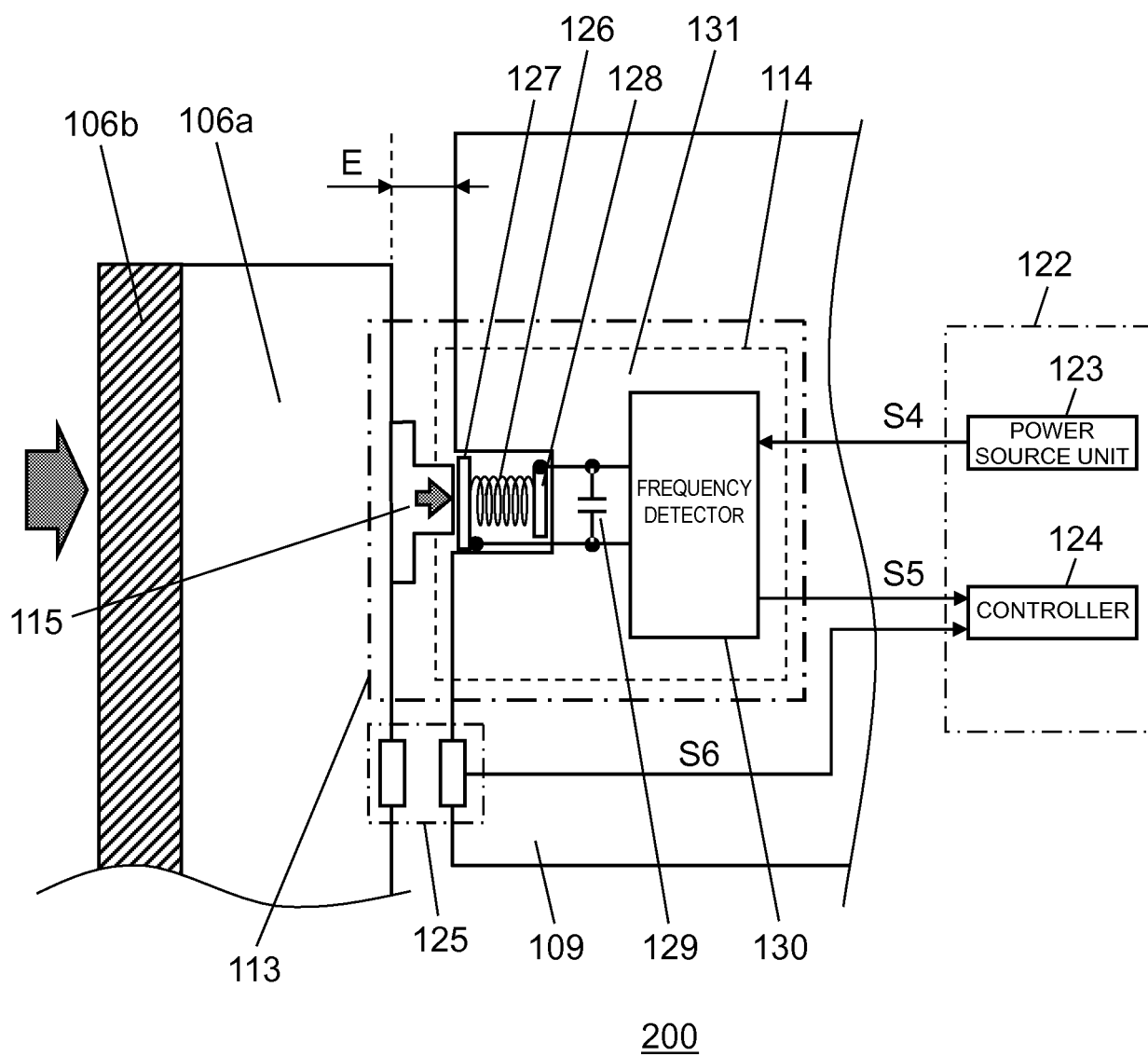


FIG. 8

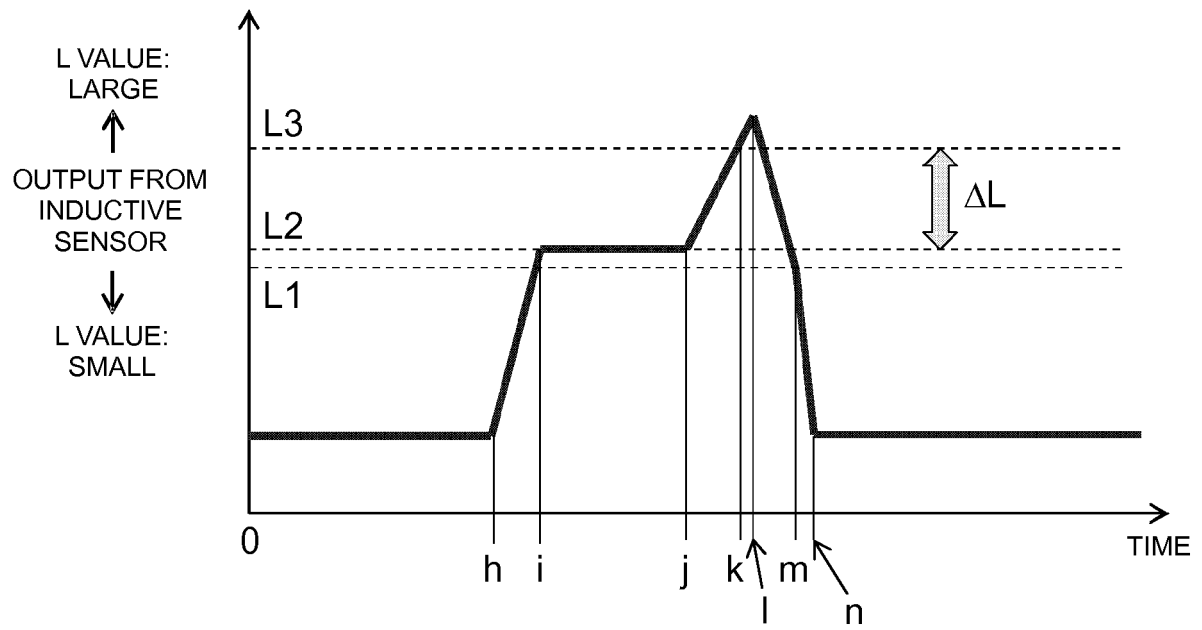


FIG. 9

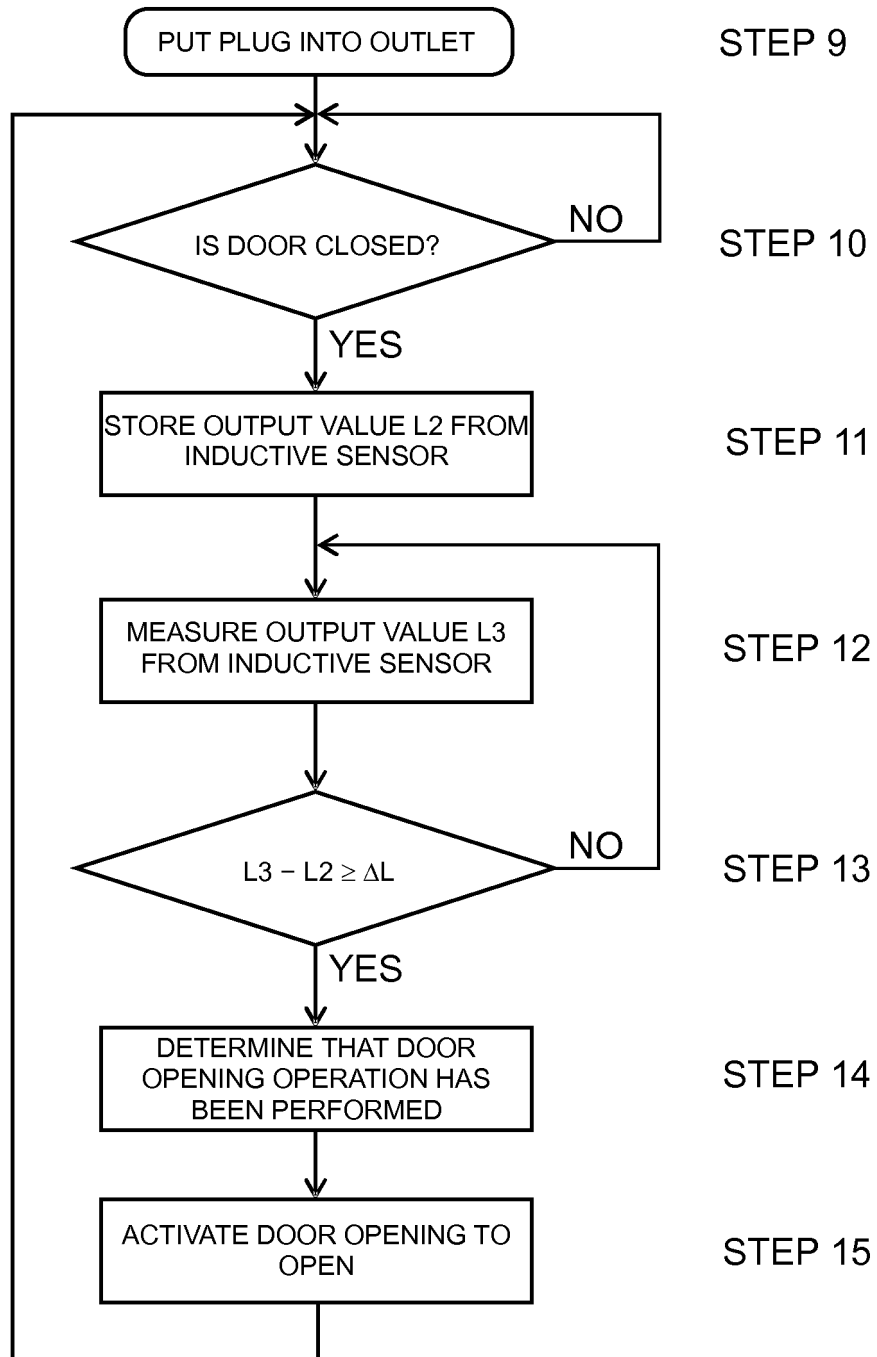


FIG. 10

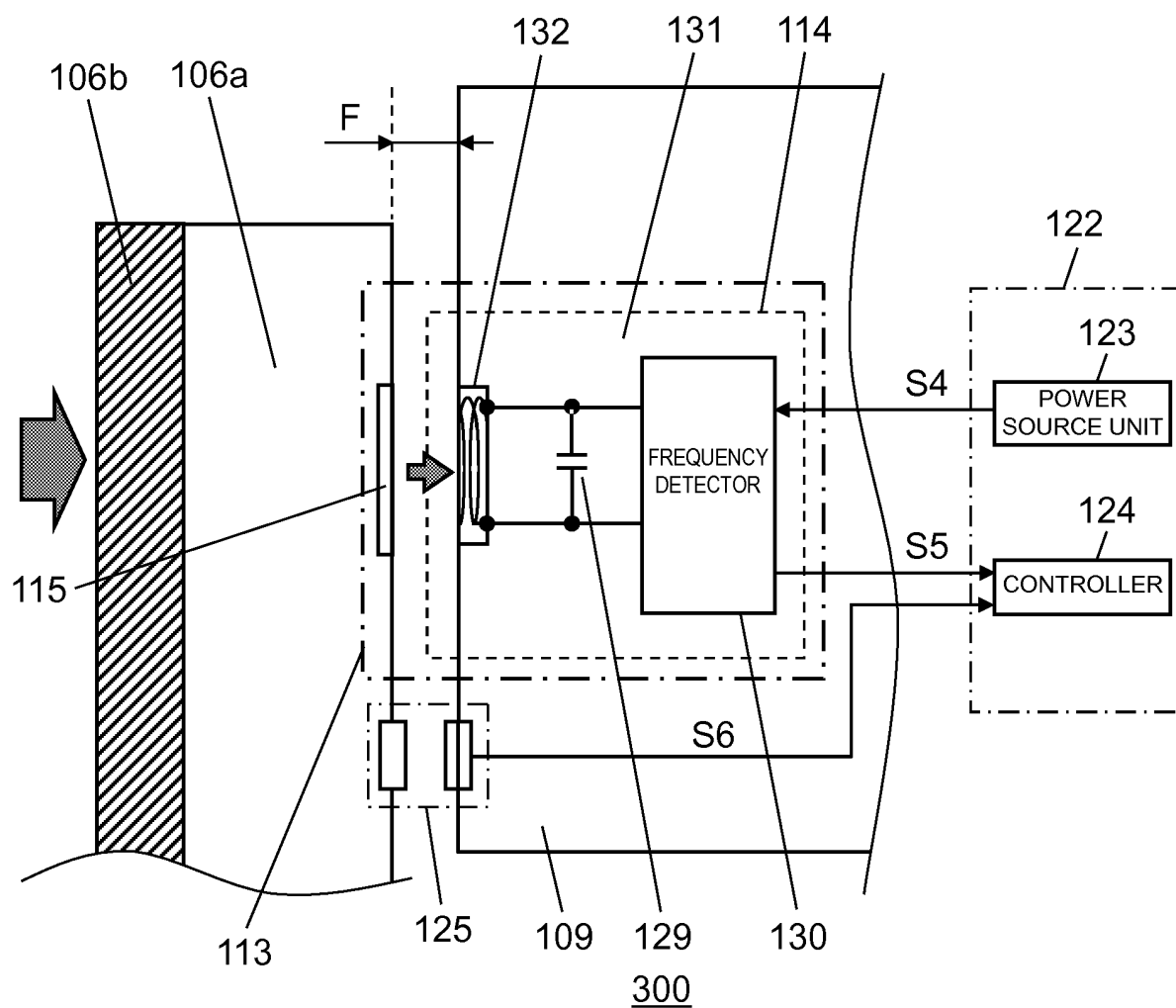


FIG. 11

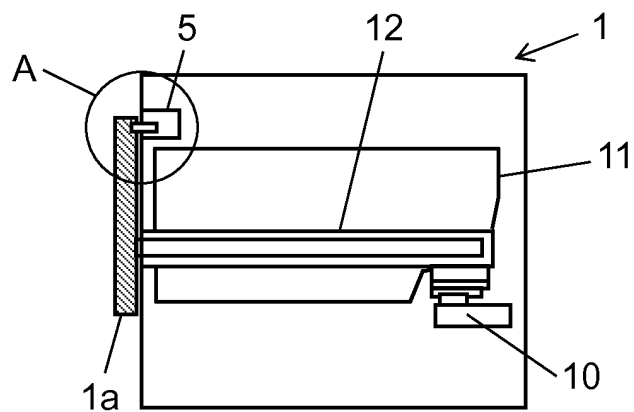


FIG. 12A

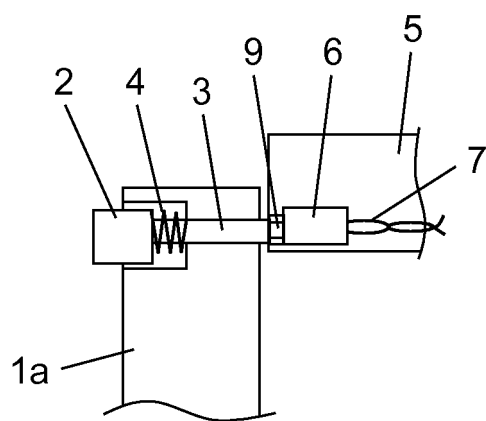
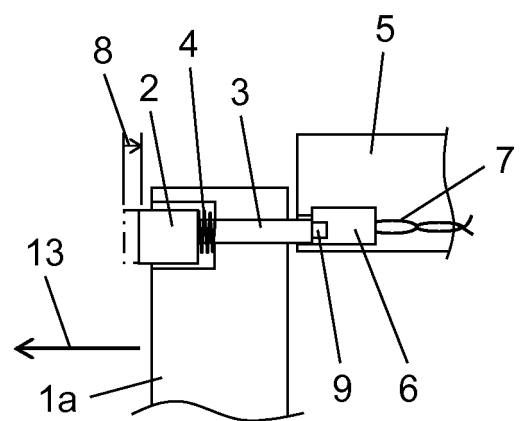


FIG. 12B



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2017/032766

A. CLASSIFICATION OF SUBJECT MATTER

F25D23/02(2006.01)i, F25D29/00(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

A47B88/00, F25D23/00, F25D29/00, E05B17/00, E05F15/00-15/79

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2017

Kokai Jitsuyo Shinan Koho 1971-2017 Toroku Jitsuyo Shinan Koho 1994-2017

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y A	US 2010/0307189 A1 (KELLER), 09 December 2010 (09.12.2010), paragraphs [0039] to [0041]; fig. 6 & WO 2008/077703 A2 & EP 2126491 A2 & DE 102006061083 A1 & CN 101600921 A	1-2, 4 3
Y A	JP 2006-308168 A (Toshiba Corp.), 09 November 2006 (09.11.2006), paragraphs [0008] to [0043]; fig. 1 to 10 & KR 10-2006-0113435 A & CN 1854650 A & TW 200710360 A	1-2, 4 3



Further documents are listed in the continuation of Box C.



See patent family annex.

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"&" document member of the same patent family

Date of the actual completion of the international search
02 November 2017 (02.11.17)Date of mailing of the international search report
14 November 2017 (14.11.17)Name and mailing address of the ISA/
Japan Patent Office
3-4-3, Kasumigaseki, Chiyoda-ku,
Tokyo 100-8915, Japan

Authorized officer

Telephone No.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2017/032766

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	JP 2007-502680 A (Julius Blum GmbH), 15 February 2007 (15.02.2007), paragraphs [0015] to [0030]; fig. 1 to 3 & WO 2004/100718 A1 & EP 1624773 A1 & AT 502574 A & CN 1787765 A & MY 140771 A	2, 4
Y	JP 2008-248581 A (Aisin Seiki Co., Ltd.), 16 October 2008 (16.10.2008), paragraph [0018]; fig. 2 (Family: none)	2
Y	JP 2012-76567 A (East Japan Railway Co.), 19 April 2012 (19.04.2012), paragraphs [0017] to [0020]; fig. 1 (Family: none)	2

Form PCT/ISA/210 (continuation of second sheet) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 4477646 B [0008]