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(54) **REFRIGERATOR**

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(57) **ABSTRACT**

A refrigerator includes: a heat-insulating main body composing a storage compartment; and a main door at an opening of the storage compartment, in which the main door includes: an opening provided at a front face of the main door; a sub door which freely opens and closes at the opening through rotation; an axis member for rotatably holding the sub door; a fixing member provided across a sub door side face and an opening inner side face, the sub door side face being a side face of the sub door in an axial direction of the axis member, and the opening inner side face being an inner side face of the opening opposite to the sub door side face; and a regulating member for regulating a rotational angle of the sub door at a predetermined angle by contacting the fixing member when the sub door is open.

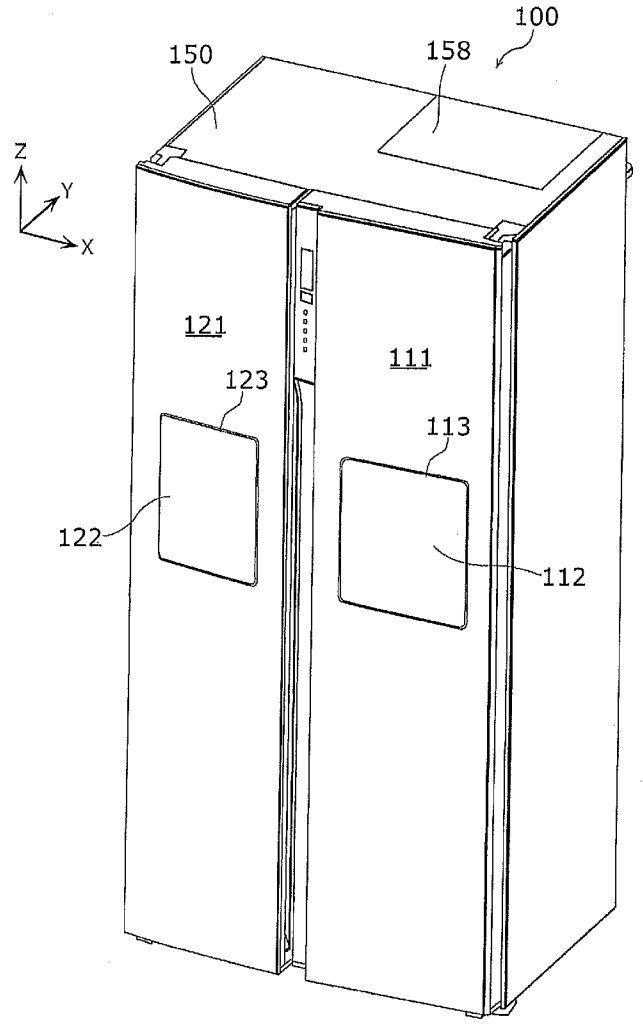


FIG. 1

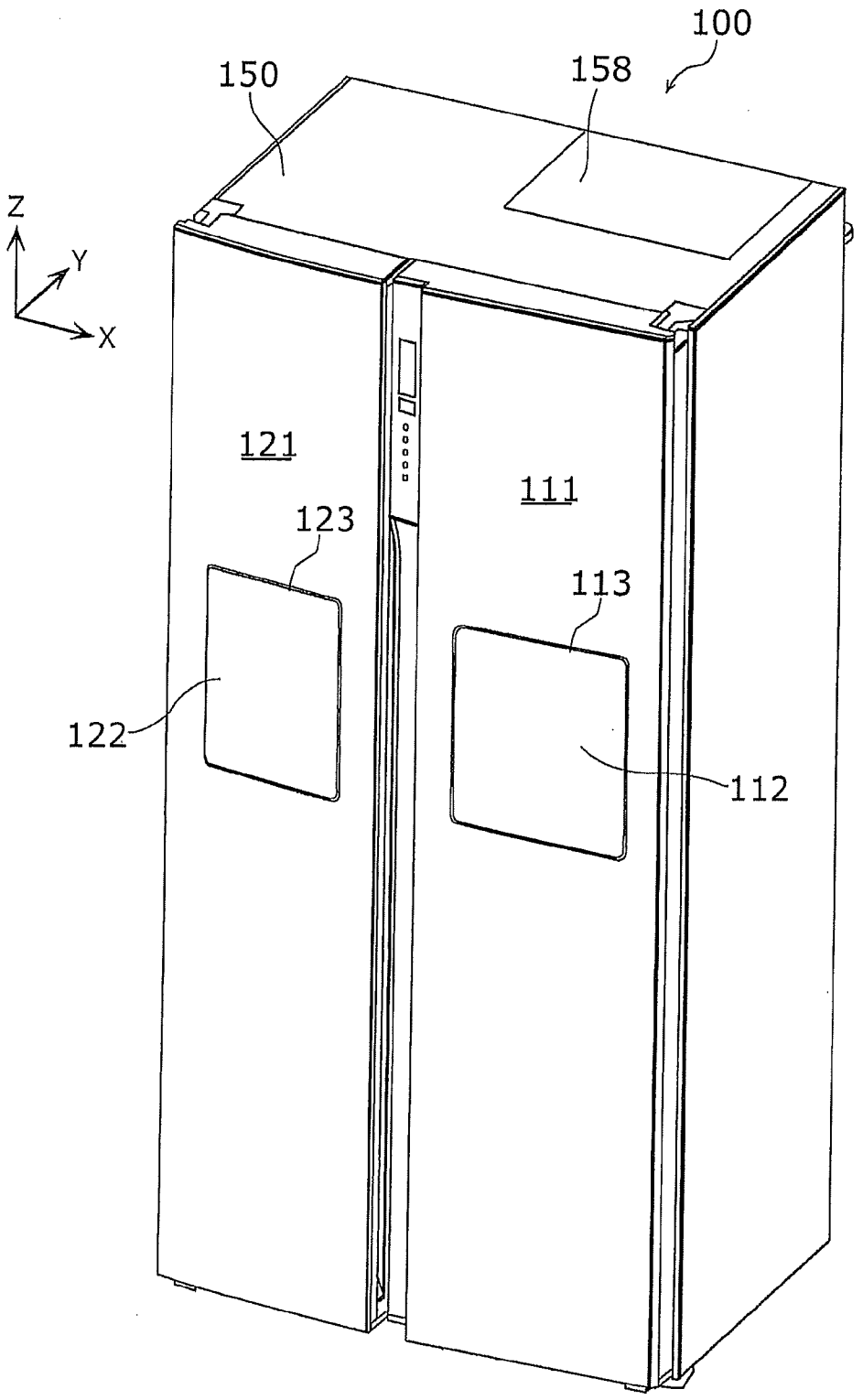


FIG. 2

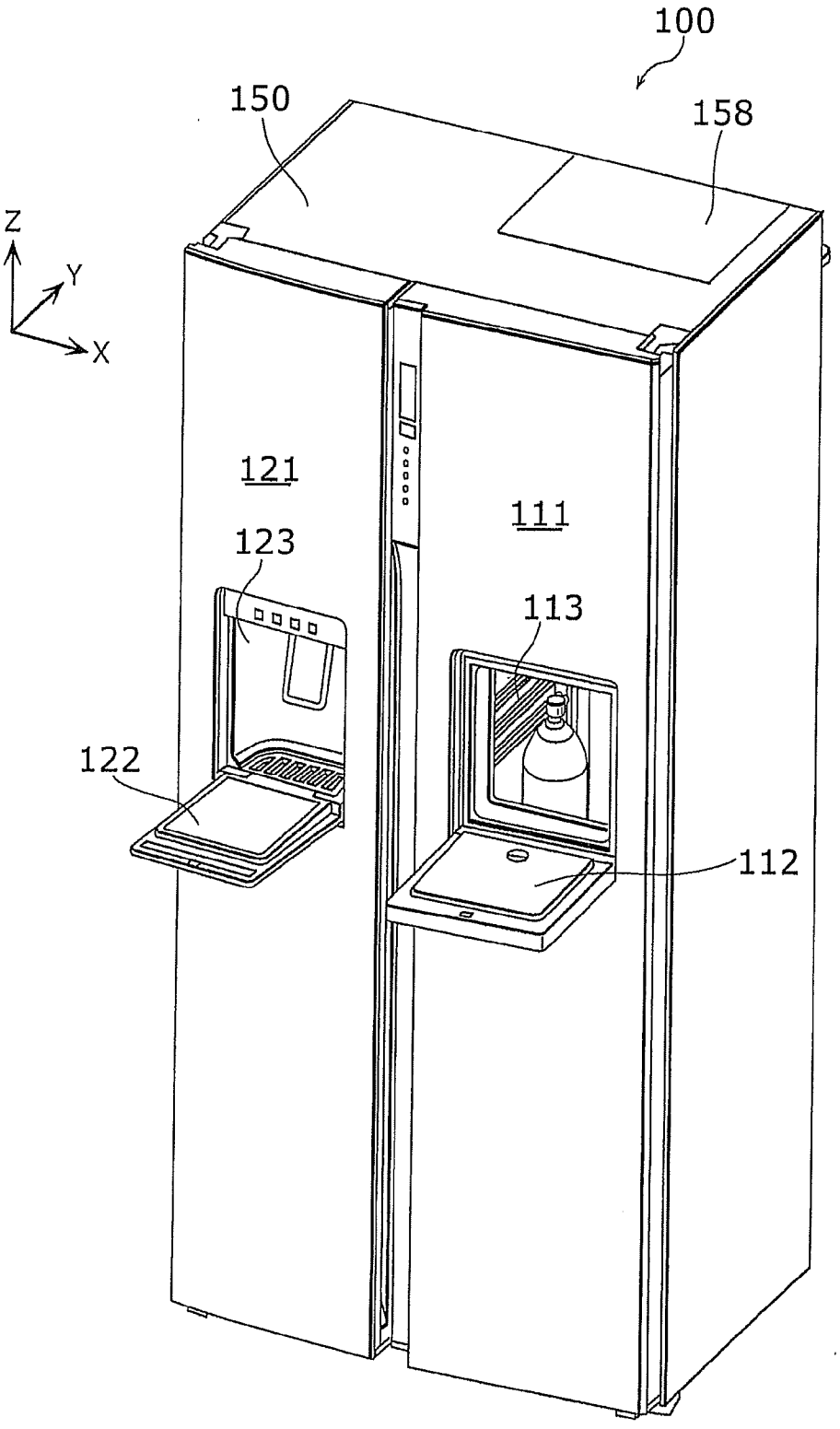


FIG. 3

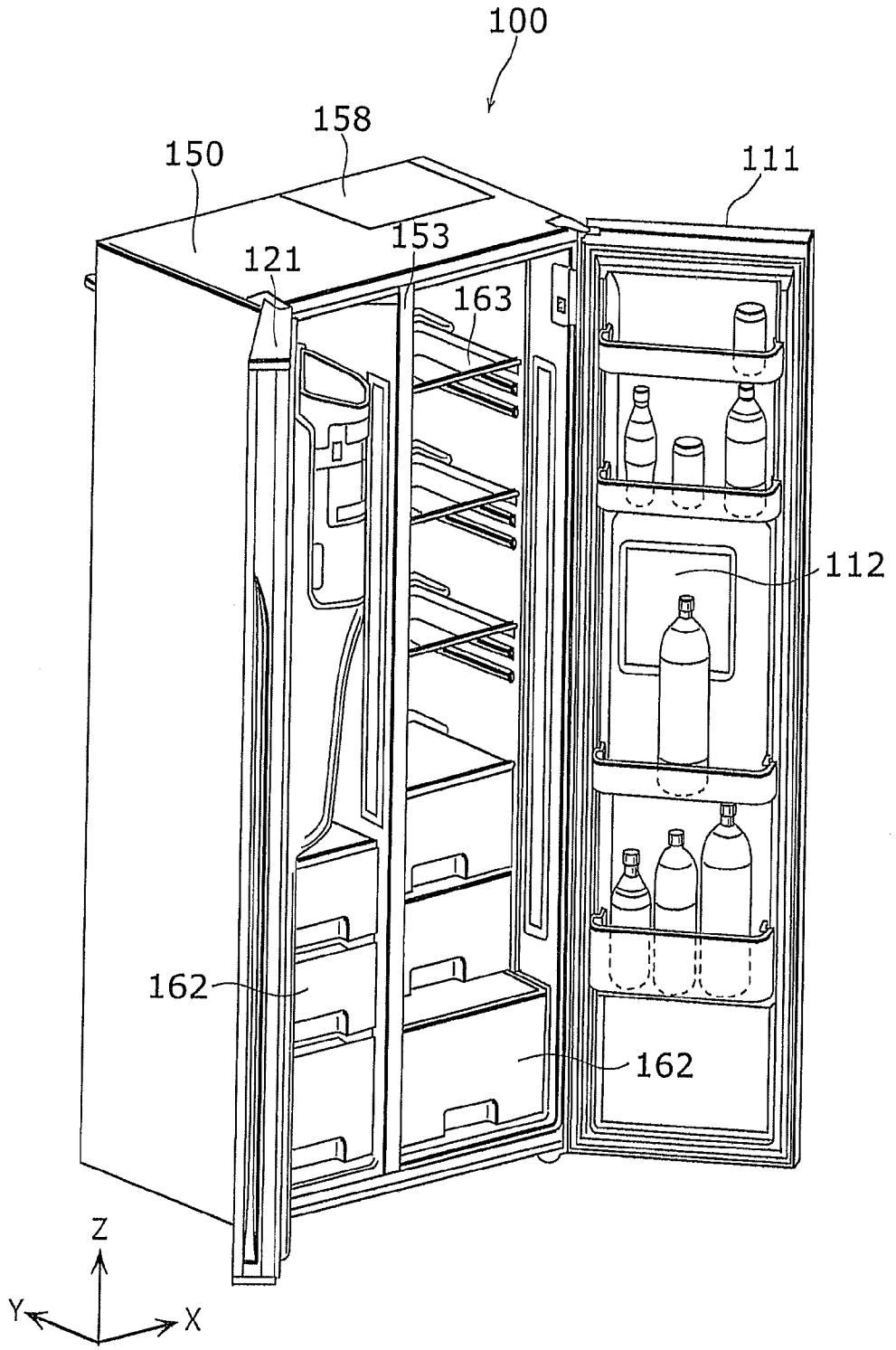


FIG. 4

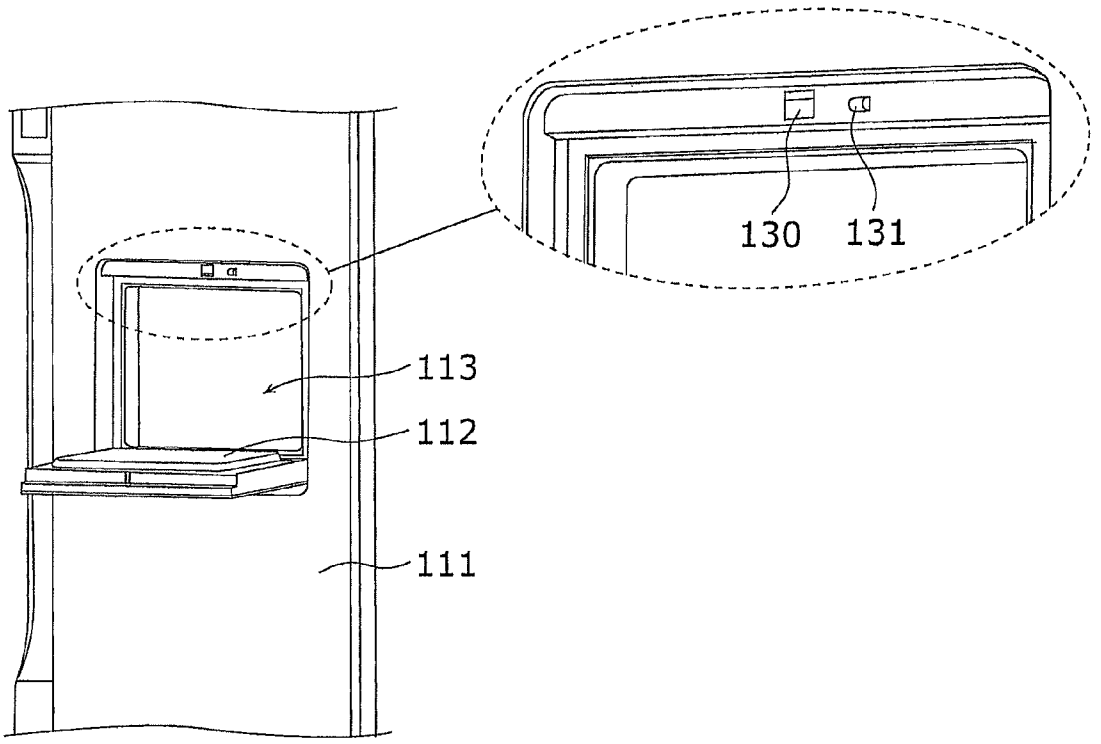


FIG. 5

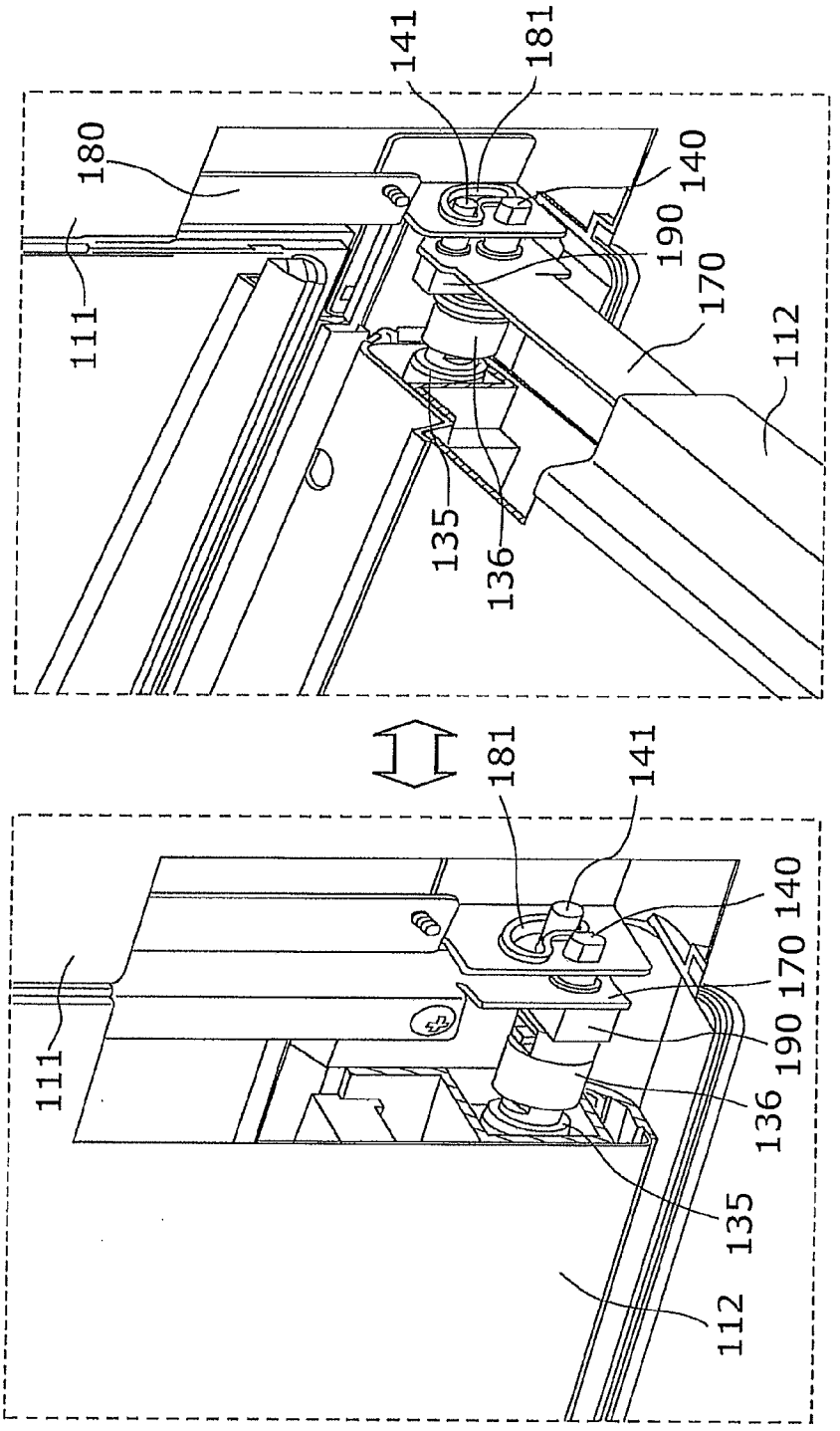

141
181
180
140
190
170
111
112
135
136
181
141
140
170
190
111
136
135
112

FIG. 6

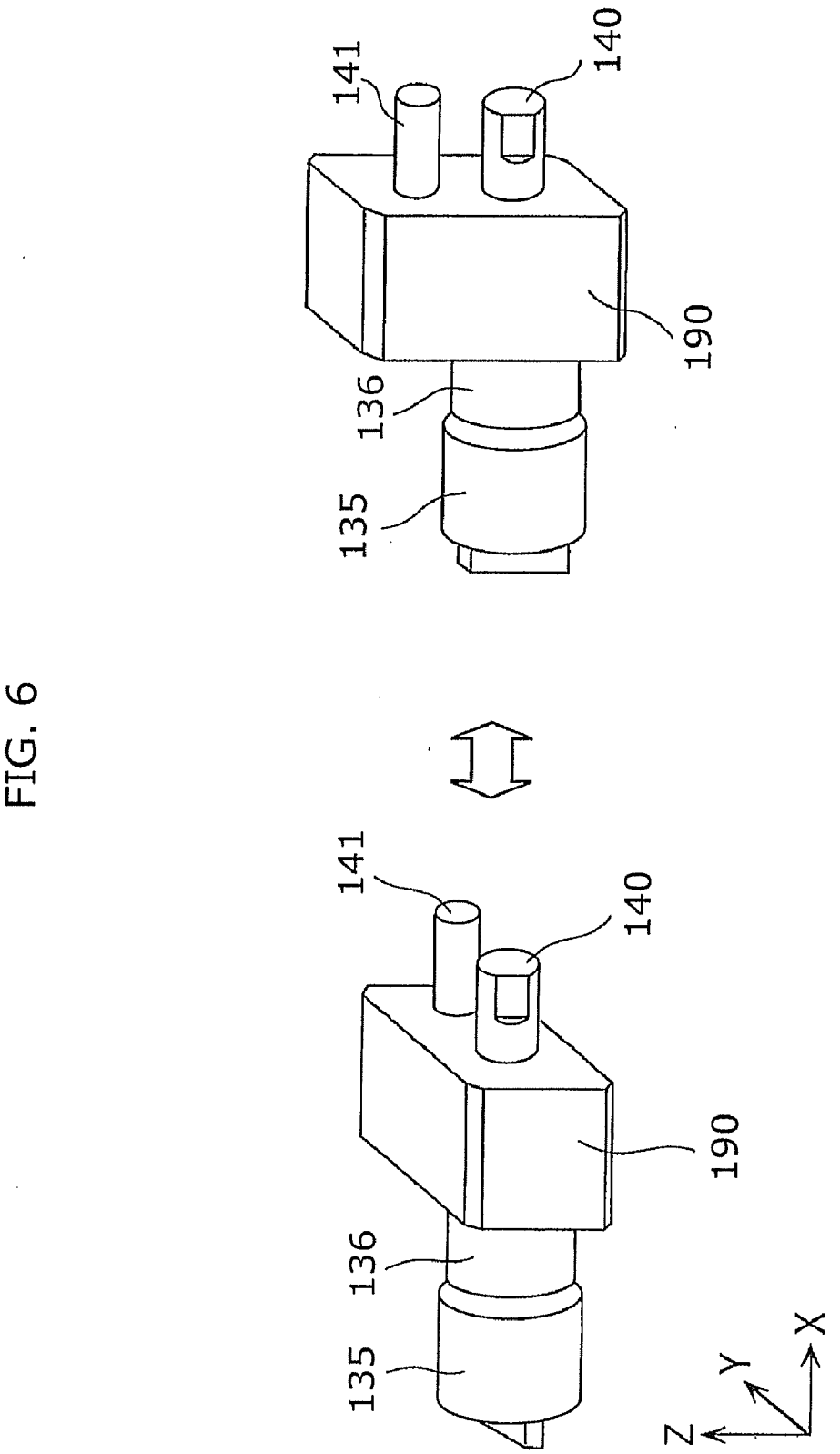


FIG. 7

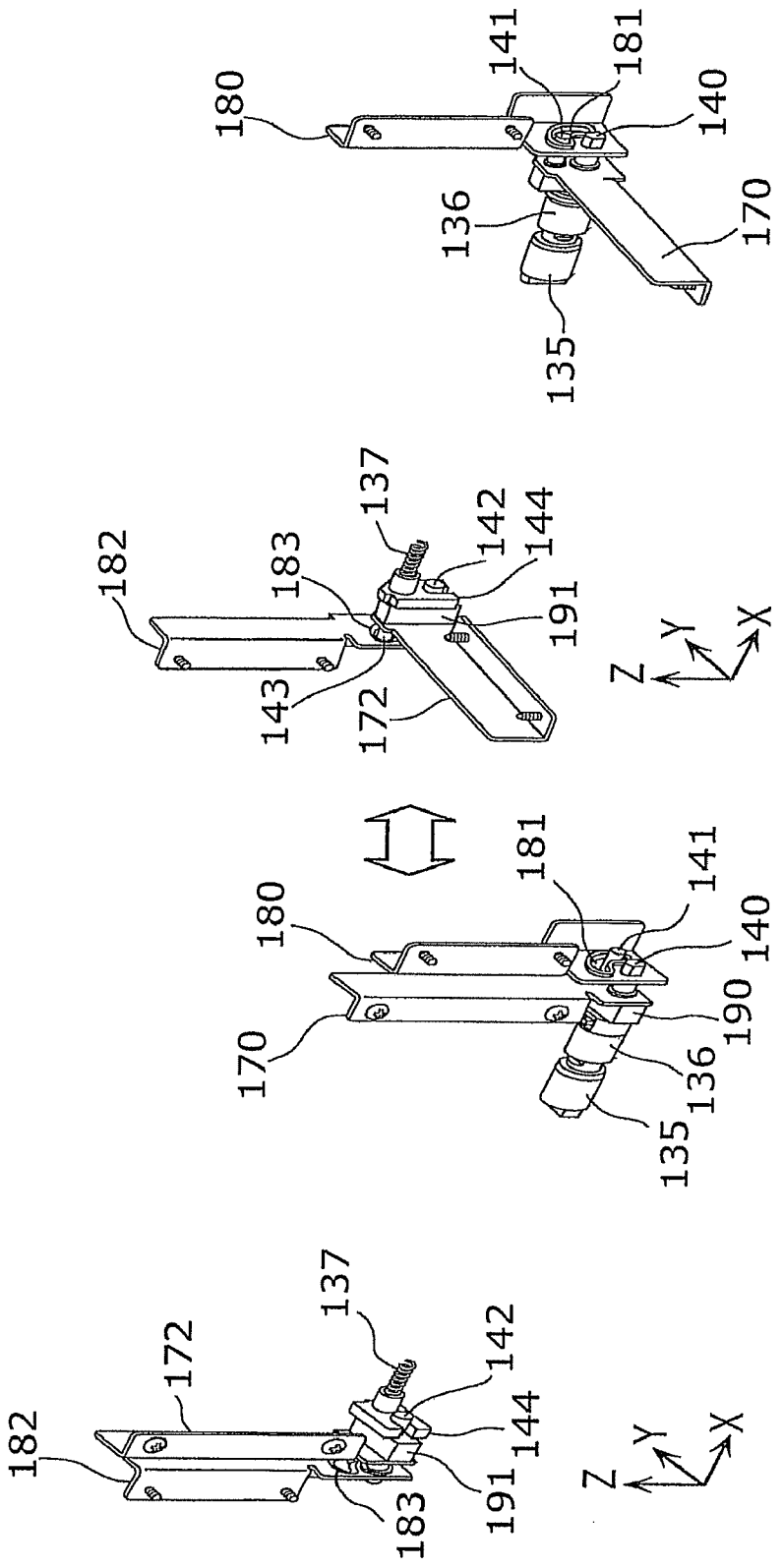

180
141
181
140
136
170
135
182
183
137
142
144
191
143
172
Z
Y
X
180
181
141
140
170
190
136
135
182
172
137
142
144
191
183
Z
Y
X

FIG. 8

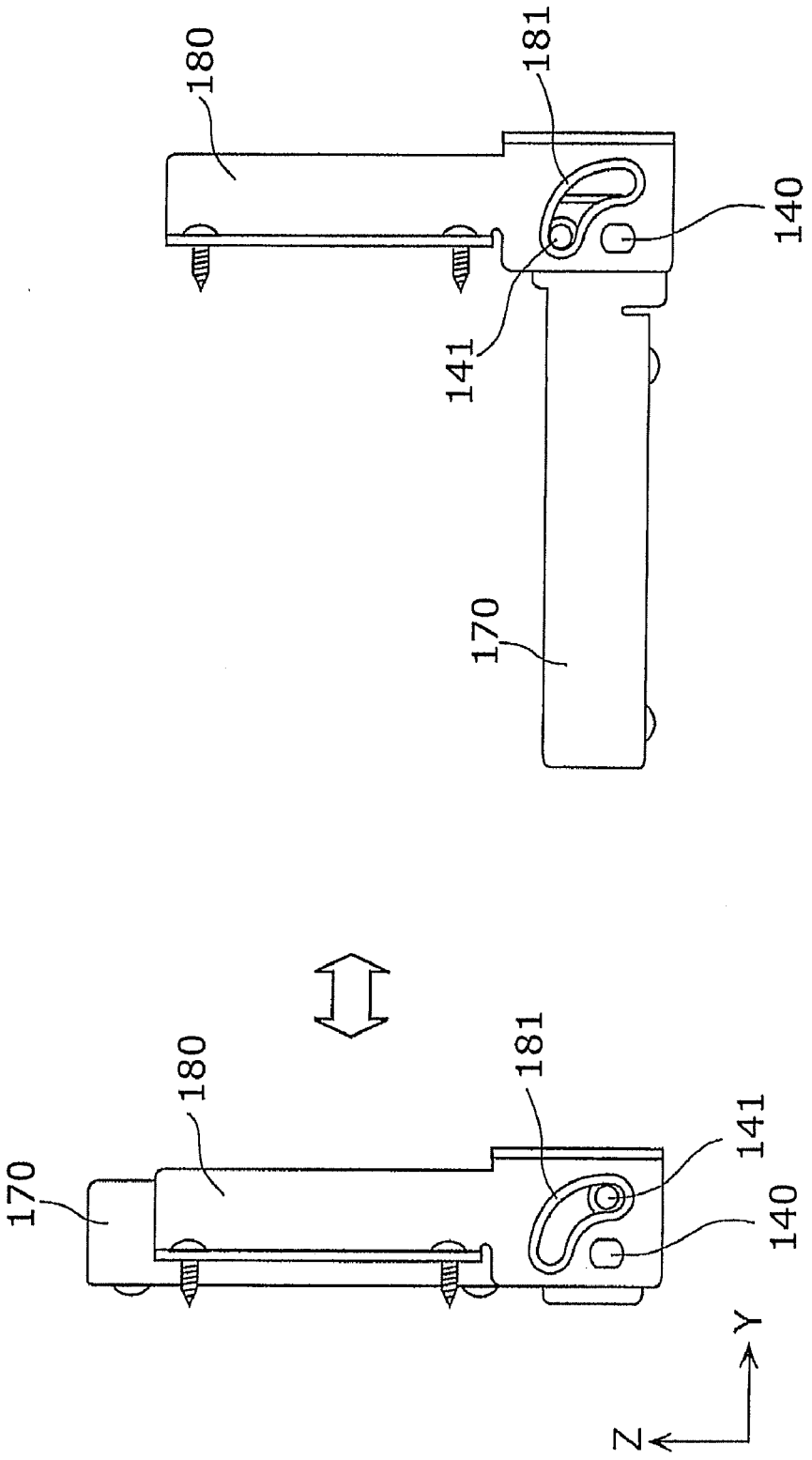


FIG. 9

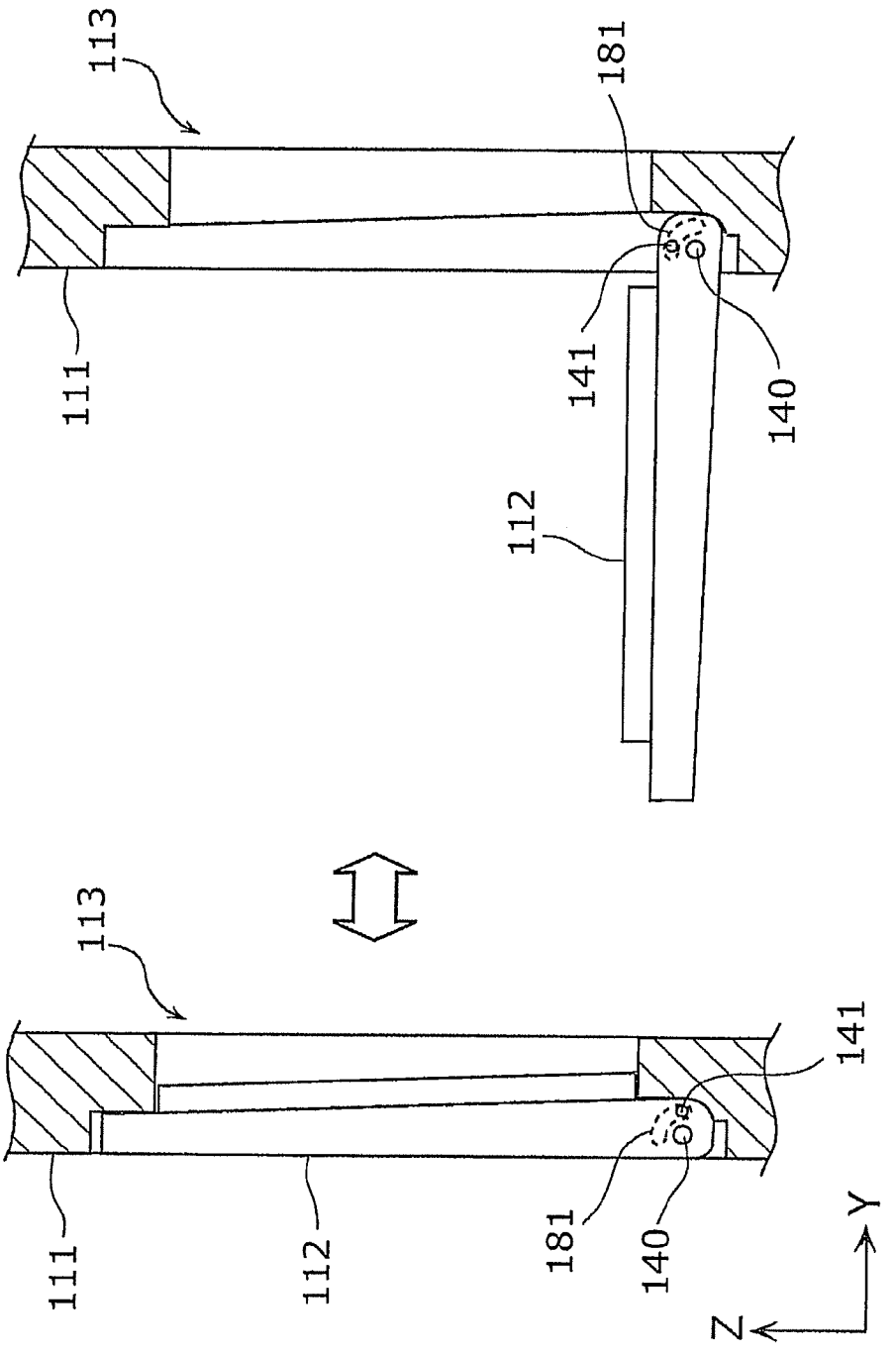


FIG. 10

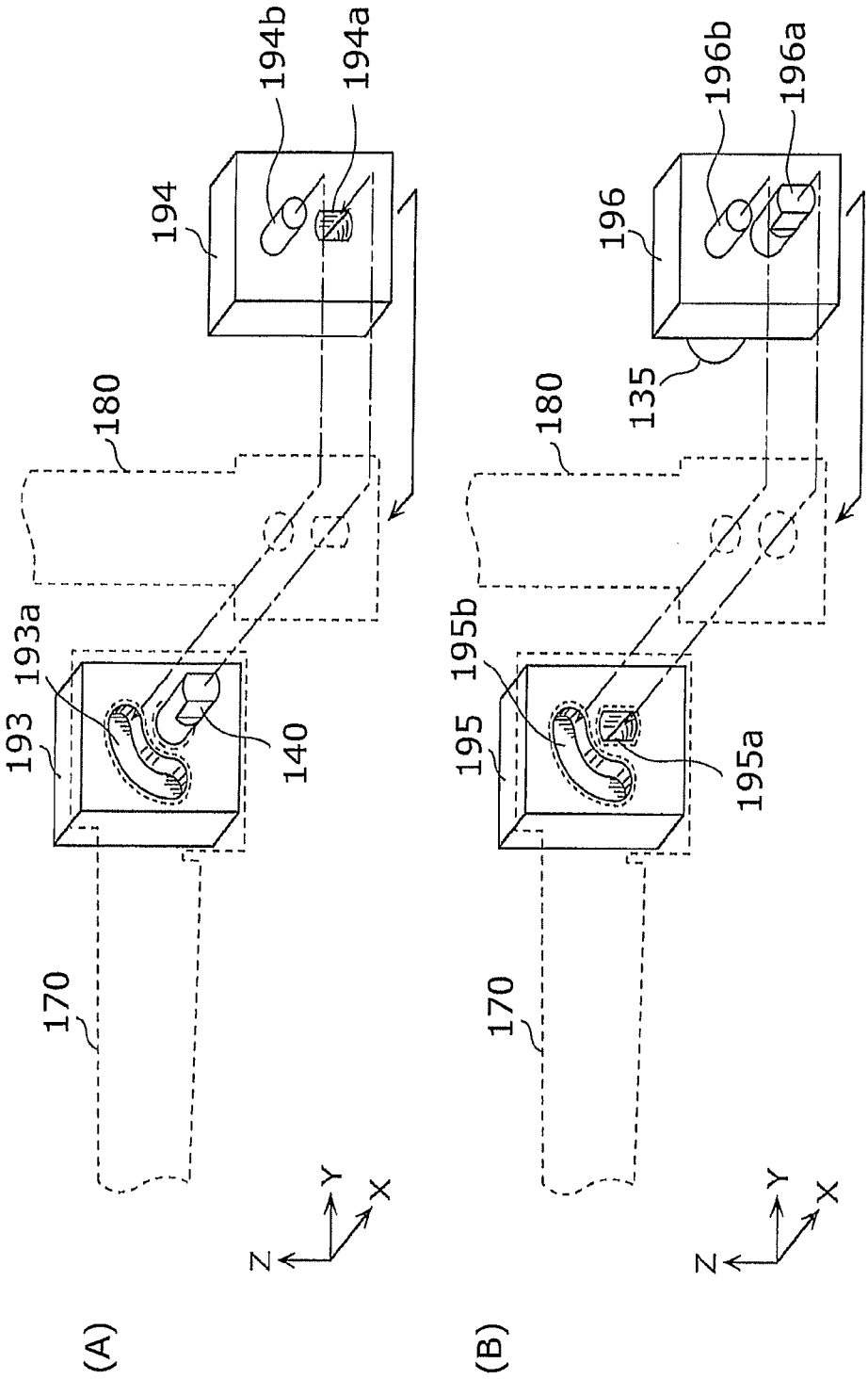

194b
194a
194
180
193a
193
140
170
Y
X
Z
(A)
196b
196a
196
135
180
195b
195
195a
170
Y
X
Z
(B)

FIG. 11

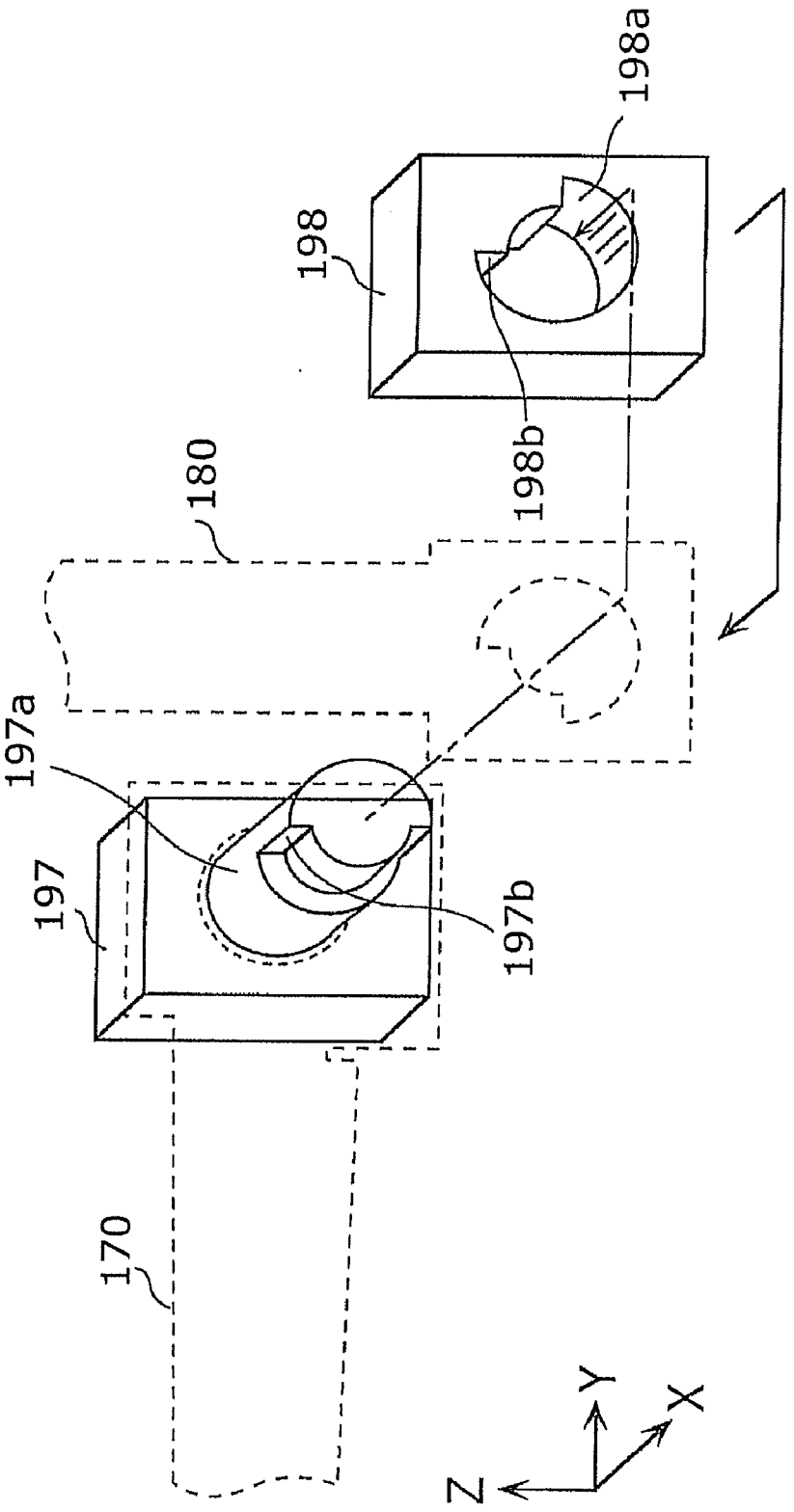
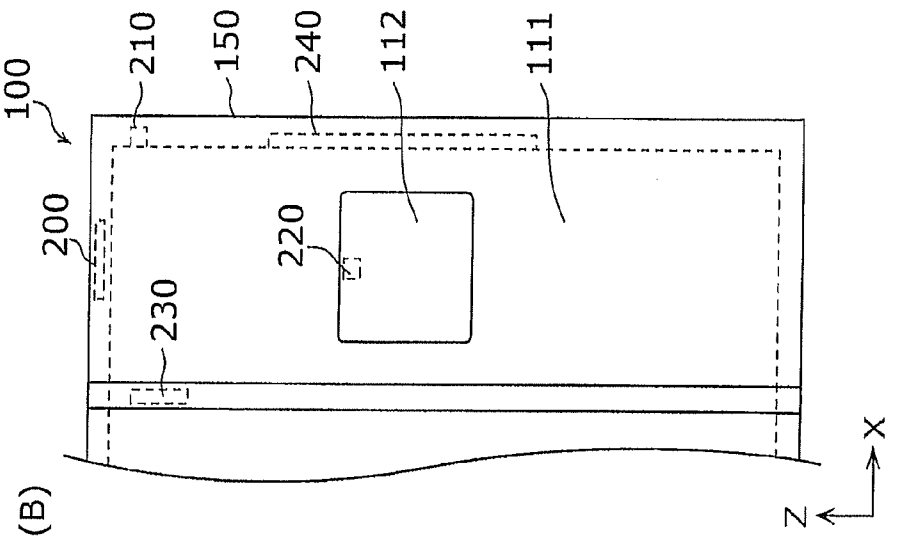


FIG. 12


(B)
100
210
150
240
112
111
200
220
230
X
Z

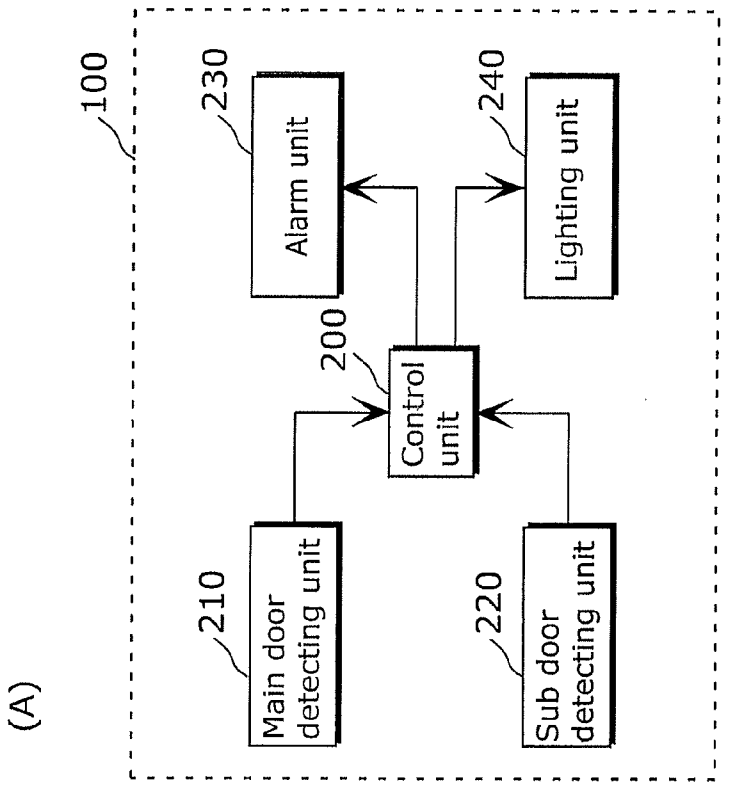

(A)
100
230
Alarm unit
240
Lighting unit
200
Control unit
210
Main door detecting unit
220
Sub door detecting unit

FIG. 13

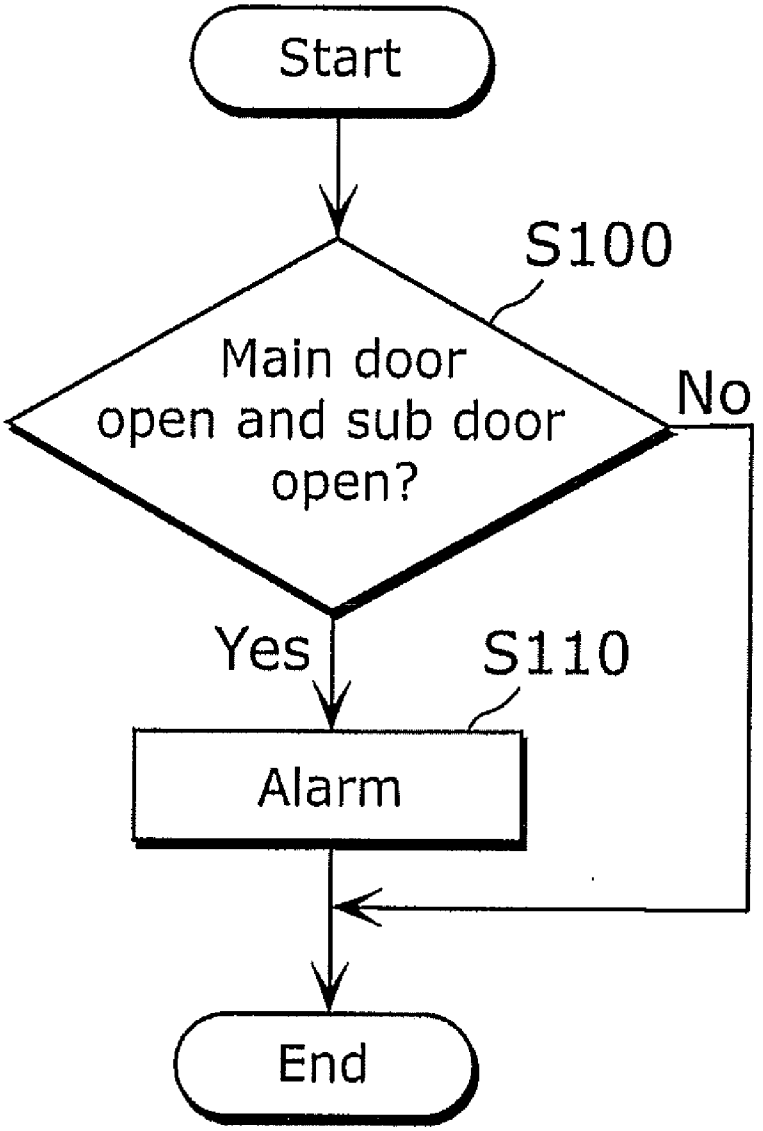
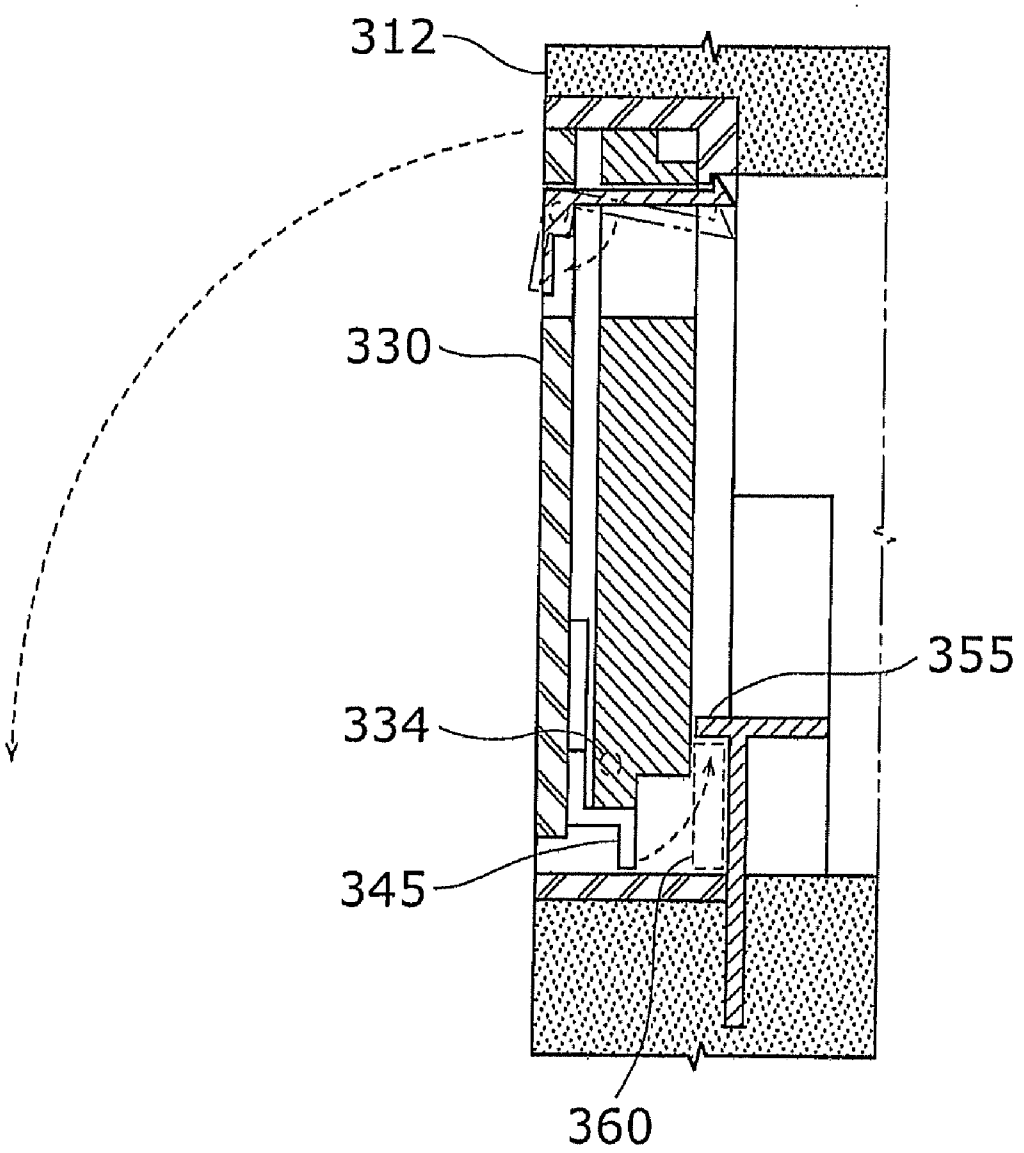

Start
S100
Main door open and sub door open?
No
Yes
S110
Alarm
End

FIG. 14



REFRIGERATOR

TECHNICAL FIELD

[0001] The present invention relates to a refrigerator, and particularly relates to a structure of a door which freely opens and closes at a storage compartment.

BACKGROUND ART

[0002] Conventionally, there is a refrigerator having a door (hereafter referred to as "main door") which freely opens and closes at a storage compartment with an opening for easily taking items such s food in and out of the storage compartment.

[0003] Such a refrigerator includes a door which freely opens and closes at the opening (hereafter referred to as "sub door") at the main door. A user of the refrigerator can open the sub door to take out items such as food stored behind of the main door. Items such as food can be stored behind the main door.

[0004] With such a refrigerator, the user can take food in and out of the storage compartment by opening the sub door, without opening the main door.

[0005] The sub door includes an axis extending laterally at a lower end portion, and is opened by turning toward the user, with the axis rotating as the center, for example.

[0006] When the sub door is opened as described above, it is preferable that the sub door is held to have an inner face (a face toward the storage compartment when closed) substantially horizontal.

[0007] This is because the inner face of the sub door is used as a table for temporally placing food taken out of the storage compartment, for example.

[0008] Thus, there is a refrigerator with arms at the lateral sides of the sub door for regulating a rotational angle of the sub door.

[0009] There is another refrigerator which regulates the rotational angle of the sub door when opened by modifying the structure of the sub door and the opening, without providing the arms (for example, see Patent Literature 1).

[0010] FIG. **14** is a cross-sectional view of an example of conventional structure for regulating the rotational angle of the sub door.

[0011] As illustrated in FIG. **14**, a main door **312** includes a sub door **330**. The sub door **330** rotates with an axis member **334** composing the rotational axis as the center.

[0012] Furthermore, a first stopper **345** is provided at the lower end of the sub door **330**, and a second stopper **355** is provided a the lower part of the opening of the main door **312**.

[0013] When the sub door **330** is opened, the first stopper **345** comes into contact with the second stopper **355**. With this, the rotational angle of the sub door **330** is regulated at approximately 90 degrees.

[0014] As such, the first stopper **345** is provided in a direction vertical to the rotational axis of the sub door **330**, and the second stopper **355** is provided at the lower part of the opening of the main door **312** to come into contact with the first stopper **345**. With this, it is possible to regulate the rotational angle when the sub door **330** is open, without using the lateral regions of the sub door **330**.

CITATION LIST

Patent Literature

[0015] [Patent Literature 1] Japanese Unexamined Patent Application Publication 2003-207263

SUMMARY OF INVENTION

Technical Problem

[0016] However, in the case of the conventional refrigerator, the rotational trajectory of the sub door **330** including the first stopper **345** is larger than the rotational trajectory when there is no the first stopper **345**. Thus, a space **360** is always necessary behind the rotational axis of the sub door **330** for the first stopper **345** to rotate.

[0017] When the sub door **330** is closed, air barely flows in the space **360**. As a result, the air tends to stagnate, easily causing condensation.

[0018] In this case, for example, a heating element such as a radiation pipe may be arranged near the space **360** to prevent the condensation. However, the space **360** is close to the storage compartment, and thus arranging the heating element is impractical in terms of the efficiency for cooling the storage compartment.

[0019] In view of the conventional problems, it is an object of the present invention to provide a refrigerator having a main door with a sub door, and regulates the rotational angle of the sub door without affecting the cooling efficiency.

Solution to Problem

[0020] In order to solve the abovementioned problem, the refrigerator according to the present invention is a refrigerator including: a heat-insulating main body composing a storage compartment having an opening at a front face; and a main door which freely opens and closes at the opening of the storage compartment, in which the main door includes: an opening provided at a front face of the main door; a sub door which freely opens and closes at the opening through rotation; an axis member for rotatably holding the sub door; a fixing member provided across a sub door side face and an opening inner side face, the sub door side face being a side face of the sub door in an axial direction of the axis member, and the opening inner side face being an inner side face of the opening opposite to the sub door side face; and a regulating member for regulating a rotational angle of the sub door at a predetermined angle by contacting the fixing member when the sub door is open.

[0021] With this structure, the fixing member regulating the rotational angle of the sub door is provided across the side face of the sub door and the inner side face of the opening which are next to each other. More specifically, the fixing member is provided in parallel with the axial direction of the axis member, for example. Accordingly, the rotational trajectory of the sub door does not increase due to the fixing member, as in the conventional refrigerator.

[0022] As a result, a space for rotating the fixing member is not necessary behind the rotational axis. In other words, in the refrigerator according to the present invention, a space susceptible to condensation is not necessary around the sub door, and the rotational angle of the sub door can be regulated reliably.

[0023] Furthermore, the fixing member may protrudes from the sub door side face, and rotates along with the rotation of the sub door, and the regulating member may be provided at the opening inner side face.

[0024] Furthermore, the fixing member may protrude from the opening inner side face, and the regulating member may be provided at the sub door side face, and may rotate along with the rotation of the sub door.

[0025] As such, one of the fixing member and the regulating member may be arranged on the sub door, and the other may be arranged on the opening inner side face. More specifically, the arrangement positions of the fixing member and the regulating member may be a position allowing a regulation on the rotational angle of the sub door by the contact of the fixing member and the regulating member.

[0026] Furthermore, the main door may further include a reinforcing member for suppressing a change in an attitude of the fixing member with respect to the axis member by holding the fixing member and the axis member.

[0027] With this structure, the change in a relative positional relationship between the fixing member and the axis member can be prevented, securing stability when opening and closing the sub door.

[0028] Furthermore, the main door may further include a damper apparatus for suppressing a rotation speed of the sub door.

[0029] With this structure, it is possible to prevent the sub door from rapidly opening, and to prevent an excessive force on the fixing member and the axis member when the sub door is open, and thereby enhancing safety for opening and closing the sub door, and increasing the product life of the open-close structure.

[0030] Furthermore, the main door may further include an elastic member for biasing the axis member and the fixing member that are movable in the axial direction toward the opening inner side face or toward the sub door, and the axis member and the fixing member are removed from the sub door or the opening inner side face by being moved against a biasing force of the elastic member.

[0031] This structure allows a user to remove the sub door from the refrigerator easily, and to attach the sub door to the refrigerator easily. In other words, for the user of the refrigerator, it is easy to clean the sub door and the part around the opening of the main door.

Advantageous Effects of Invention

[0032] The present invention provides a refrigerator having a main door with a sub-door, and which regulates the rotational angle of the sub-door without affecting the cooling efficiency.

BRIEF DESCRIPTION OF DRAWINGS

[0033] FIG. **1** is a perspective view illustrating the external appearance of the refrigerator according to Embodiment of the present invention.

[0034] FIG. **2** is a perspective view illustrating the external appearance of the refrigerator with a first sub door and a second sub door open.

[0035] FIG. **3** is a perspective view illustrating the external appearance of the refrigerator with a first main door and a second main door open.

[0036] FIG. **4** is a partial perspective view illustrating a state in which the first sub door is open.

[0037] FIG. **5** is a perspective view illustrating the structure around the axis member of the refrigerator according to Embodiment.

[0038] FIG. **6** illustrates rotation of a reinforcing member for holding the axis member and a fixing member.

[0039] FIG. **7** is a perspective view illustrating structure for opening and closing the first sub door.

[0040] FIG. **8** is a right-side view illustrating structure for opening and closing the first sub door.

[0041] FIG. **9** is a cross-sectional view illustrating an open state and a closed state of the first sub door in Embodiment.

[0042] FIG. **10** (A) illustrates another example of positions for arranging the fixing member and a regulating groove, and FIG. **10** (B) illustrates another example of positions for arranging the fixing member and the axis member.

[0043] FIG. **11** illustrates an example of a member functioning both as the axis member and the fixing member.

[0044] FIG. **12** (A) is a block diagram illustrating a control system of a lighting unit in the refrigerator according to Embodiment. FIG. **12** (B) is a schematic diagram illustrating arrangement positions of components in FIG. **12** (A) in the refrigerator.

[0045] FIG. **13** is a flowchart illustrating the flow of process for alarm by refrigerator according to Embodiment.

[0046] FIG. **14** is a cross-sectional view of an example of conventional structure for regulating the rotational angle of the sub door.

DESCRIPTION OF EMBODIMENTS

[0047] The following shall describe Embodiment of the refrigerator according to the present invention with reference to the drawings.

[0048] First, with reference to FIGS. **1** to **3**, the basic structure of the refrigerator **100** according to Embodiment of the present invention shall be described.

[0049] FIG. **1** is a perspective view illustrating the external appearance of the refrigerator **100** according to Embodiment of the present invention.

[0050] FIG. **2** is a perspective view illustrating the external appearance of the refrigerator **100** with the first sub door **112** and the second sub door **122** open.

[0051] FIG. **3** is a perspective view illustrating the external appearance of the refrigerator **100** with the first main door **111** and the second main door **121** open.

[0052] The refrigerator **100** according to this embodiment is an apparatus for preserving storage items stored inside by refrigeration or freezing. The refrigerator **100** has a wall partitioning the body at an intermediate portion in the width direction, and has storage compartments of different types on the right and left. Such a refrigerator is referred to as a side-by-side (SBS) refrigerator, for example.

[0053] The refrigerator **100** includes a heat-insulating main body **150**, a first main door **111**, and a second main door **121**, as illustrated in the drawings.

[0054] The first main door **111** also has an opening **113** at the front face, and the first sub door **112** which freely opens and closes at the opening **113**. The second main door **121** includes an opening **123** provided at the front and the second sub door **122** which freely opens and closes at the opening **123**.

[0055] The first main door **111** freely opens and closes at the opening of the refrigerator compartment arranged on the user's right side when facing the heat-insulating main body **150**. In the case of Embodiment, the first main door **111** is

attached to the heat-insulating main body **150** by a hinge (not illustrated) such that the first main door **111** rotates with the axis extending in the vertical direction in front of the right side wall of the heat-insulating main body **150** as the center. The first main door **111** is a vertically long rectangle arranged from the top to the bottom of the refrigerator **100**, and has the axis passing through the right end portion of the first main door **111**.

[0056] The second main door **121** freely opens and closes at the opening of the freezer compartment arranged on the left of the user when facing the heat-insulating main body **150**. In the case of Embodiment, the second main door **121** is attached to the heat-insulating main body **150** by a hinge (not illustrated) such that the second main door **121** rotates around the axis extending in the vertical direction in front of the left side wall of the heat-insulating main body **150** as the center. The second main door **121** is a vertically long rectangle arranged from the top to the bottom of the refrigerator **100**, and has the axis passing through the left end portion of the second main door **121**.

[0057] The opening **113** forms a through hole in the thickness direction of the first main door **111**. The user of the refrigerator **100** can take out storage items stored behind the first main door **111** through the opening **113**, and can store items behind the first main door **111**.

[0058] The first sub door **112** freely opens and closes at the opening **113**. In the case of Embodiment, the first sub door **112** is attached to the first main door **111** by the axis member such that the first sub door **112** rotates around the axis laterally extending at the lower end portion of the opening **113**. The axis passes through the lower end portion of the first sub door **112**. The axis member shall be described in detail later with reference to FIG. **5** and others.

[0059] The second sub door **122** freely opens and closes at the opening **123** for receiving receives ice supplied from the inside of the refrigerator **100**.

[0060] A control board for controlling operations of the refrigerator **100** is stored at the top portion of the heat-insulating body **150**, and a board cover **158** covering the storage space is attached.

[0061] The space inside of the heat-insulating main body **150** is partitioned into the left part and the right part by a partition **153**, forming a refrigerator compartment on the right and the freezer compartment on the left.

[0062] Containers **162** for storing items such as food and shelves **163** for placing the items are attached to the refrigerator compartment and the freezer compartment.

[0063] With reference to FIGS. **4** to **9**, a mechanical structure for opening and closing the first sub door **112** in the refrigerator **100** (hereafter referred to as "open-close structure") shall be described.

[0064] Note that, the open-close structure of the first sub door **112** and the open-close structure of the second sub door **122** are basically identical. Thus, the description shall be made focusing on the first sub door **112**, and the description of the second sub door **122** shall be omitted.

[0065] FIG. **4** is a partial perspective view illustrating the state in which the first sub door **112** is open.

[0066] As illustrated in FIG. **4**, the first sub door **112** rotates until the inner face (the top face in FIG. **4**) is substantially horizontal, and is held at that angle.

[0067] A push latch **130** is provided at the top portion of the opening **113**. A closed state of the first sub door **112** is maintained by the protrusion provided at the top portion of the inner face of the first sub door **112** and the push latch **130** latched together. The protrusion and the push latch **130** are released from the latched state by pressing the top portion of the first sub door **112**, opening the first sub door **112**

[0068] Furthermore, a sub door switch **131** is provided next to the push latch **130**. Whether or not the first sub door **112** is closed is determined by detecting whether or not the sub door switch **131** is pressed. A sub door detecting unit for the detection shall be described later with reference to FIG. **12** (A).

[0069] FIG. **5** is a perspective view illustrating the structure around the axis member **140** in the refrigerator **100** according to Embodiment.

[0070] Note that, in FIG. **5**, part of the first sub door **112** and the first main door **111** are cut away to show the structure around the axis member **140**.

[0071] As illustrated in FIG. **5**, a rotation frame **170** which is a component of the first sub door **112** and a fixing frame **180** fixed with the first main door **111** are connected by the axis member **140**.

[0072] Note that, in Embodiment, the rotation frame **170** and the fixing frame **180** are both made of metal. The axis member **140** is fixed such that the axis member **140** does not rotate with respect to the fixing frame **180**.

[0073] The axis member **140** is connected to a damper apparatus **135** for suppressing a rotation speed of the first sub door **112** through a joint member **136**. The main body of the damper apparatus **135** is fixed with the first sub door **112**.

[0074] To put it differently, when opening the first sub door **112**, the damper apparatus **135** and the axis member **140** rotate with respect to each other, and the damper apparatus **135** provides the first sub door **112** with a force in a direction suppressing the rotation speed of the first sub door **112**.

[0075] The first main door **111** also includes a fixing member **141**. The fixing member **141** is provided across a sub door side face which is a side face of the first sub door **112** in the axis direction of the axis member **140** and an opening inner side face which is an inner side face of the opening **113** facing the sub door side face.

[0076] In the Embodiment, the fixing member **141** protrudes from the side face of the first sub door **112** as illustrated in FIG. **5**, and rotates as the first sub door **112** rotates.

[0077] The end portion of the fixing member **141** opposite to the first sub door **112** is inserted into a regulating groove **181** of the fixing frame **180**.

[0078] When the first sub door **112** is opened, the fixing member **141** attached to the first sub door **112** rotates up to the front end of the regulating groove **181** when facing the user, and the movement is regulated by the contact to the front end.

[0079] In other words, the rotation angle of the first sub door **112** is regulated to a predetermined angle (approximately 90 degrees in this Embodiment) by the fixing frame **180**. Note that, the fixing frame **180** is an example of a regulating member in the refrigerator according to the present invention.

[0080] The axis member **140** and the fixing member **141** are held by a reinforcing member **190** which is a block made of metal.

[0081] FIG. **6** illustrates the rotation of the reinforcing member **190** holding the axis member **140** and the fixing member **141**.

[0082] Note that, in FIG. **6**, illustration of the rotation frame **170**, the fixing frame **180**, and others are omitted to clearly illustrate the reinforcing member **190**.

[0083] In this Embodiment, the reinforcing member **190** includes a hole for holding the axis member **140**, and a hole for holding the fixing member **141**. The axis member **140** and the fixing member **141** are held by the reinforcing member **190** through the insertion to the holes. With this, the change in the attitude of the fixing member **141** with respect to the axis member **140** is suppressed.

[0084] More specifically, the fixing member **141** is a metal rod, and the fixing member **141** is held substantially in parallel with the axis member **140** by the reinforcing member **190**, as illustrated in FIG. **6**.

[0085] When the first sub door **112** is opened in this state and the fixing member **141** comes into contact with the end of the regulating groove **181**, force tilting the fixing member **141** with respect to the axis member **140** is given to the fixing member **141** and the axis member **140**. More specifically, the force twisting the fixing member **141** and the axis member **140** is given to the fixing member **141** and the axis member **140**.

[0086] However, both the axis member **140** and the fixing member **141** are held by the reinforcing member **190**. Thus, the twist is prevented; allowing opening and closing the first sub door **112** stably.

[0087] Note that, both or one of the axis member **140** and the fixing member **141** may be formed integrally with the reinforcing member **190**. In other words, the reinforcing member **190** may non-detachably hold one of, or both of the axis member **140** and the fixing member **141**.

[0088] When the reinforcing member **190** and the axis member **140** are integrally formed, the axis member **140** is incapable of rotating with respect to the first sub door **112**. In this case, the fixing frame **180** may hold the axis member **140** such that the axis member **140** rotates with respect to the first main door **111**.

[0089] More specifically, the fixing frame **180** may be provided with a hole supporting the axis member **140** to allow free rotation, and the damper apparatus **135** may be provided at the outer side of the hole (opposite side from the first sub door **112** interposing the fixing frame **180**), connecting the top of the axis member **140** and the damper apparatus **135**.

[0090] In FIG. **5**, the open-close structure at the right end portion of the first sub door **112** is illustrated. However, the axis member and other components are arranged in the same manner on the left side of the first sub door **112**.

[0091] FIG. **7** is a perspective view illustrating the open-close structure of the first sub door **112**.

[0092] FIG. **8** is a right side view illustrating the open-close structure of the first sub door **112**.

[0093] Note that, in these diagrams, in order to clearly indicate the open-close structure of the first sub door **112**, only the components related to opening and closing of the first sub door **112** are illustrated, and boards forming the surface of the first sub door **112** and the first main door **111** are omitted from the illustration.

[0094] The rotation frame **172** illustrated in FIG. **7** arranged at the left end portion of the first sub door **112** is connected to the fixing frame **182** on the left by the axis member **142**.

[0095] Furthermore, the fixing member **143** is attached to the rotation frame **172**, and the left end portion of the rotation frame **172** is inserted into the regulating groove **183** in the fixing frame **182**.

[0096] Both the fixing member **143** and the axis member **142** are held by the reinforcing member **191** which is a metal block.

[0097] As described above, the left end portion of the first sub door **112** has the structure identical to the structure of the right end portion.

[0098] With this, as illustrated in FIGS. **7** and **8**, the rotation angles of the rotation frames **170** and **172** are regulated to approximately 90 degrees. More specifically, the rotation angle of the first sub door **112** is regulated at approximately 90 degrees.

[0099] Note that, as illustrated in FIG. **7**, the fixing member **143** and the axis member **142** are biased by an elastic member **137** through a moving member **144**. The elastic member **137** in this Embodiment is a compression spring.

[0100] In other words, the axis member **142** and the fixing member **143** are movable toward the axial direction of the axis member **142**, and are biased toward the opening inner side face.

[0101] With this, the left end portion of the fixing member **143** is inserted into the regulating groove **183** at the opening inner side face, and the left end portion of the axis member **142** is inserted into the hole in the fixing frame **182**.

[0102] With this state, for example, when the user presses the moving member **144** to right, the left end portions of the fixing member **143** and the axis member **142** are removed from the opening inner side face. With this, the first sub door **112** is removable from the first main door **111**, and is attachable to the first main door **111**.

[0103] Note that, the elastic member **137** may be arranged farther on the left of the opening inner side face such that the elastic member **137** biases the axis member **142** and the fixing member **143** toward the first sub door **112**. In this case, the right end portions of the fixing member **143** and the axis member **142** can be removed from the first sub door **112** by moving the fixing member **143** and the axis member **142** to the left against the biased force. In other words, the first sub door **112** can be freely attached to and detached from the first main door **111**.

[0104] As described above, the first sub door **112** is detachably attached to the first main door **111** to be freely opened and closed. In addition, the rotation angle when opening the first sub door **112** is regulated.

[0105] In this Embodiment, as illustrated in FIG. **8**, the fixing member **141** attached to the rotation frame **170** coming into contact with the end of the regulating groove **181** in the fixing frame **180** regulates the rotation angle of the first sub door **112** at approximately 90 degrees.

[0106] Here, as illustrated in FIG. **7**, on the left of the first sub door **112**, the fixing member **143** comes into contact with the end of the regulating groove **183** in the fixing frame **182**. This also regulates the rotation angle of the first sub door **112** at approximately 90 degrees.

[0107] In other words, in the refrigerator **100** in this Embodiment, the fixing member **141** (**143**) extending in a direction identical to the axial direction of the first sub door **112**, and the regulating groove **181** (**183**) provided in the fixing frame **180** (**182**) regulate the rotation angle of the first sub door **112**.

[0108] In other words, the member for regulating the rotation angle of the first sub door **112** (the fixing member **141** in this Embodiment) does not affect a rotational trajectory of the first sub door **112** on a plane vertical to the axis.

[0109] With this, it is possible to eliminate or significantly reduce the space behind the axis of the sub door provided for the rotation of the sub door with usually almost no air flow (for example, the space **360** in FIG. **14**).

[0110] FIG. **9** is a cross-sectional view illustrating the open state and the closed state of the first sub door **112** according to Embodiment.

[0111] As illustrated in FIG. **9**, the space for making the first sub door **112** rotatable is not necessary behind the axis member **140**. In other words, it is not necessary for proving a space with stagnated air such as the space **360** in FIG. **14**.

[0112] As such, the condensation at the lower part of the opening **113** is prevented, and it is not necessary to provide a heating element for preventing the condensation. Furthermore, it is possible to reliably regulate the rotational angle of the first sub door **112** when opened.

[0113] More specifically, the refrigerator **100** according to Embodiment can regulate the rotational angle of the first sub door **112** when opened to an angle with the inner face of the first sub door **112** substantially horizontal, without affecting the cooling efficiency.

[0114] Note that, in this Embodiment, the reinforcing member **190** is provided in the first sub door **112**, holding the axis member **140** and the fixing member **141**.

[0115] In other words, the fixing member **141** rotates as the first sub door **112** rotates. However, the fixing member may be fixed at the inner side face of the opening **113**, and a regulating groove that comes in contact with the fixing member may be provided in the first sub door **112**.

[0116] FIG. **10** (A) illustrates another example of the arrangement positions of the fixing member and the regulating groove.

[0117] As illustrated in FIG. **10** (A), the reinforcing member **193** holding the axis member **140** and having the regulating groove **193***a* is arranged in the rotation frame **170** of the first sub door **112**.

[0118] In addition, on a side opposite to the first sub door **112** interposing the fixing frame **180**, a reinforcing member **194** having an axial hole **194***a* for holding the axis member **140** so as to prevent the rotation of the axis member **140**, and the fixing member **194***b*.

[0119] In this case, the regulating groove **193***a* rotates as the first sub door **112** rotates. The back end of the regulating groove **193***a* comes into contact with the fixing member **194***b* fixed with the first main door **111**. With this, the rotational angle of the first sub door **112** is regulated.

[0120] Alternatively, the fixing member may be fixed with the first main door **111**, the regulating groove may be provided in the first sub door **112**, and the axis member **140** may be positioned not to rotate with respect to the first sub door **112**.

[0121] FIG. **10** (B) illustrates another example of the arrangement positions of the fixing member and the regulating groove.

[0122] As illustrated in FIG. **10** (B), a reinforcing member **195** having an axial hole **195***a* for holding the axis member **140** so as to prevent from the rotation, and a regulating groove **195***b* is arranged on the rotation frame **170** of the first sub door **112**.

[0123] Furthermore, on a side opposite to the first sub door **112** interposing the fixing frame **180**, a reinforcing member **196** having a fixing member **196***b* and a hole for rotatably holding the axis member **196***a* are arranged.

[0124] Furthermore, the damper apparatus **135** is arranged behind the reinforcing member **194** and is connected to the back end of the axis member **196***a*.

[0125] In this case, the regulating groove **195***b* rotates as the first sub door **112** rotates, and the back end of the regulating groove **195***b* comes into contact with the fixing member **196***b* fixed to the first main door **111**. With this, the rotational angle of the first sub door **112** is regulated.

[0126] As the first sub door **112** rotates, the axis member **196***a* rotatably held by the reinforcing member **196** rotates. The damper apparatus **135** gives a force in a direction suppressing the rotation speed of the axis member **196***a* as the axis member **196***a* rotates. Consequently, the rotation speed of the first sub door **112** is suppressed.

[0127] Note that, the reinforcing member **195** includes the regulating groove **195***b* and the axial hole **195***a* for holding the axis member **140** while preventing its rotation. Accordingly, as illustrated in FIG. **7** and others, when the fixing member **141** rotates with the first sub door **112**, the reinforcing member **195** may be used as a member for reinforcing the regulating groove **181** in the fixing frame **180** and the hole for holding the axis member **140**. In other words, the reinforcing member **195** may be used for reinforcing the regulating member.

[0128] Furthermore, although the axis member **140** and the fixing member **141** are formed separately in this Embodiment, the functions of these components may be implemented by one component.

[0129] FIG. **11** illustrates an example of member functioning both as the axis member and the fixing member.

[0130] As illustrated in FIG. **11**, a reinforcing member **197** having an axis member **197***a* is arranged on a rotation frame **170** of the first sub door **112**. The axis member **197***a* has a part of the circumference cut away, as illustrated in FIG. **11**. With this, the fixing face **197***b* vertical to the axial direction is formed.

[0131] Furthermore, on a side opposite to the first sub door **112** interposing the fixing frame **180**, the reinforcing member **198** having an axial hole **198***a* which rotatably holds the axis member **197***a*, and regulates the rotation exceeding the predetermined rotation angle is arranged.

[0132] In this case, the axis member **197***a* rotates as the first sub door **112** rotates. Furthermore, the fixing face **197***b* comes into contact with a contact face **198***b* which is a part of the inner surface of the axial hole **198***a*. With this, the rotational angle of the first sub door **112** is regulated.

[0133] Note that, although not illustrated in FIG. **11**, the damper apparatus **135** is placed behind the reinforcing member **198**, and the damper apparatus **135** is connected to the top of the axis member **197***a*. With this, the rotational speed when opening the first sub door is suppressed.

[0134] As described above with reference to FIGS. **10** (A) to **11**, the mechanism for rotating the first sub door **112** with respect to the first main door **111**, and the mechanism for regulating the rotation may be other than the mechanism illustrated in FIGS. **5** to **9**.

[0135] Furthermore, although all of the fixing members **141**, **143**, **194***b*, and **196***b* are rod-shaped, the fixing member may not be shaped like a rod. The fixing member may be provided across the gap between at least one of the side faces of the first sub door **112** in the direction of the rotational axis (lateral side faces in this Embodiment) of the first sub door **112** and an opening inner side face opposite to the side face, and its shape is not particularly limited.

[0136] Furthermore, the fixing frame **180** which is an example of the regulating member in the refrigerator according to the present invention specifically regulates the movement of the fixing member **141** by the contact of the end of the

regulating groove **181** with the fixing member **141**. With this, the rotational angle of the first sub door **112** is regulated.

[0137] The shape may not be limited to a groove as long as the movement of the fixing member **141** is regulated. For example, the hole may be circular or rectangular. Alternatively, a wall blocking the movement of the fixing member **141** may be simply provided to the fixing frame **180** to regulate the movement of the fixing member **141**.

[0138] In short, the first main door **111** have to include only the fixing member provided across the gap between the side face of the first sub door **112** and the opening inner side face which is an inner side face of the opening **113** opposite to the side face, and the regulating member regulating the rotational angle of the first sub door **112** at a predetermined angle by the contact with the fixing member.

[0139] With this, it is possible to regulate the rotational angle of the first sub door **112** without the space behind the rotational axis of the first sub door **112** for rotating the fixing member.

[0140] Note that, as described above, the first main door **111** is provided with a sub door switch **131**, and a sub door detecting unit can detect whether or not the first sub door **112** is closed, based on the state of the sub door switch **131**.

[0141] ON and OFF of the lighting unit in the refrigerator is controlled based on whether or not the first sub door **112** is closed, and whether or not the first main door **111** is closed.

[0142] FIG. **12** (A) is a block diagram illustrating the control system of the lighting unit **240** in the refrigerator **100** according to Embodiment.

[0143] FIG. **12** (B) is a schematic diagram illustrating an example of positions of the components in the refrigerator **100** illustrated in FIG. **12** (A).

[0144] As illustrated in FIG. **12** (A), the refrigerator **100** includes a control unit **200**, a main door detecting unit **210**, a sub door detecting unit **220**, an alarm unit **230**, and a lighting unit **240**.

[0145] For example, when the first sub door **112** is open, the pressed sub door switch **131** (see FIG. **4**) is protruded. With this, the sub door detecting unit **220** detects that the first sub door **112** is not closed, or the first sub door **112** is open.

[0146] When the detection result is obtained, the control unit **200** turns ON the lighting unit **240** from OFF-state. With this, when the first sub door **112** is open, the lighting unit **240** lights up inside of the refrigerator compartment, helping the user to take food out of or into the refrigerator compartment.

[0147] Note that, when the first main door **111** is open, the main door detecting unit **210** detects that the first main door **111** is not closed, or that the first main door **111** is open. The control unit **200** which received the detection result turns ON the lighting unit **240** from OFF-state.

[0148] Here, it is assumed that the first main door **111** is opened and closed with both the first main door **111** and the first sub door **112** open. In this case, the rotational trajectory of the first sub door **112** is large. Thus, for example, it is possible for the first sub door **112** to contact objects around the refrigerator **100**. Accordingly, there is a problem in terms of safety.

[0149] Thus, in the refrigerator **100** according to this Embodiment, an alarm is sent when a state in which both the first main door **111** and the first sub door **112** are open, that is, a state in which neither the first main door or the first sub door **112** is not closed.

[0150] FIG. **13** is a flowchart illustrating the process flow for notifying alarm performed by the refrigerator **100** in Embodiment.

[0151] When the control unit **200** determines, based on the detection results by the main door detecting unit **210** and the sub door detecting unit **220**, that the first main door **111** is open, that is, not closed, and that the first sub door **112** is open, that is, not closed (Yes in **S100**), the control unit **200** instructs the alarm unit **230** to send an alarm.

[0152] Upon receiving instruction from the control unit **200** for sending the alarm, the alarm unit **230** outputs audio indicating that both the first main door **111** and the first sub door **112** are open, and an instruction for closing the first main door **111** (**S110**).

[0153] Furthermore, using a display panel provided between the first main door **111** and the second main door **121**, the alarm unit **230** displays content which is equivalent to the audio output, by using characters, flickering lights, and others, together with or instead of the audio output.

[0154] Thus, it is possible to prevent the first main door **111** from opening wide with the first sub door **112** open, improving the safety of the refrigerator **100**.

[0155] With reference to FIGS. **12**(A) to **13**, the relationship between opening and closing the first main door **111** and the first sub door **112**, and operations by the lighting unit **240** and the alarm unit **230** have been described. The same operation control is performed on the freezer compartment side. More specifically, when one of the second main door **121** and the second sub door **122** is open, the lighting unit in the freezer compartment is turned ON. Furthermore, when the state in which both the second main door **121** and the second sub door **122** are open, or the state in which both of the doors are not closed, an alarm is sent.

[0156] Although the description above describes Embodiments of the present invention, the technical features of the present invention is effective to a refrigerator including a main door with a sub door.

[0157] Accordingly, the present invention is applicable not only to a SBS-type refrigerator such as the refrigerator **100** in Embodiment, but also to various types of refrigerators with a main door having a sub door.

INDUSTRIAL APPLICABILITY

[0158] The present invention provides a refrigerator having a main door with a sub door, and which regulates the rotational angle of the sub door without affecting the cooling efficiency. Accordingly, the present invention is useful as a refrigerator and others with a various types and size for household use and professional use.

REFERENCE SIGNS LIST

[0159] **100** Refrigerator
[0160] **111** First main door
[0161] **112** First sub door
[0162] **113** Opening
[0163] **121** Second main door
[0164] **122** Second sub door
[0165] **123** Opening
[0166] **130** Push latch
[0167] **131** Sub door switch
[0168] **135** Damper apparatus
[0169] **136** Joint member
[0170] **137** Elastic member

[0171] **14**Q, **142**, **196***a*, **197***a* Axis member
[0172] **141**, **143**, **194***b*, **196***b* Fixing member
[0173] **144** Moving member
[0174] **150** Heat-insulating main body
[0175] **153** Partition
[0176] **158** Board cover
[0177] **162** Container
[0178] **163** Shelf
[0179] **170**, **172** Rotation frame
[0180] **180**, **182** Fixing frame
[0181] **181**, **183**, **193***a*, **195***b* Regulating groove
[0182] **190**, **191**, **193**, **194**, **195**, **196**, **197**, **198** Reinforcing member
[0183] **194***a*, **195***a*, **198***a* Axial hole
[0184] **197***b* Fixing face
[0185] **198***b* Contact face
[0186] **200** Control unit
[0187] **210** Main door detecting unit
[0188] **220** Sub door detecting unit
[0189] **230** Alarm unit
[0190] **240** Lighting unit

1. A refrigerator comprising:
a heat-insulating main body composing a storage compartment having an opening at a front face; and
a main door which freely opens and closes at the opening of the storage compartment,
wherein said main door includes:
an opening provided at a front face of said main door;
a sub door which freely opens and closes at the opening through rotation;
an axis member for rotatably holding said sub door;
a fixing member provided across a sub door side face and an opening inner side face, the sub door side face being a side face of said sub door in an axial direction of said axis member, and the opening inner side face being an inner side face of said opening opposite to the sub door side face; and
a regulating member for regulating a rotational angle of said sub door at a predetermined angle by contacting said fixing member when said sub door is open.

2. The refrigerator according to claim **1**,
wherein said fixing member protrudes from the sub door side face, and rotates along with the rotation of said sub door, and
said regulating member is provided at the opening inner side face.

3. The refrigerator according to claim **1**,
wherein said fixing member protrudes from the opening inner side face, and
said regulating member is provided at the sub door side face, and rotates along with the rotation of said sub door.

4. The refrigerator according to claim **1**,
wherein said main door further includes
a reinforcing member for suppressing a change in an attitude of said fixing member with respect to said axis member by holding said fixing member and said axis member.

5. The refrigerator according to claim **1**,
wherein said main door further includes a damper apparatus for suppressing a rotation speed of said sub door.

6. The refrigerator according to claim **1**,
wherein said main door further includes
an elastic member for biasing said axis member and said fixing member that are movable in the axial direction toward the opening inner side face or toward said sub door, and
said axis member and said fixing member are removed from said sub door or the opening inner side face by being moved against a biasing force of said elastic member.

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