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Oh et al.

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(54) **REFRIGERATOR INCLUDING MULTIPLE STORAGE COMPARTMENTS**

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(73) Assignee: **LG Electronics Inc.**, Seoul (KR)

(*) Notice: This patent is subject to a terminal disclaimer.

(21) Appl. No.: **17/465,454**

(22) Filed: **Sep. 2, 2021**

Related U.S. Patent Documents

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Issued: **Apr. 26, 2016**
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U.S. Applications:

(60) Continuation of application No. 16/700,781, filed on Dec. 2, 2019, now Pat. No. Re. 48,724, which is an (Continued)

(30) **Foreign Application Priority Data**

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(51) **Int. Cl.**
A47B 96/04 (2006.01)
F25D 23/02 (2006.01)
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CPC **F25D 23/028** (2013.01); **E05B 65/0042** (2013.01); **E05D 7/00** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC F25D 23/038; F25D 23/025; F25D 23/04; F25D 11/02; Y10T 292/1043; Y10T 292/2075; Y10T 292/1083
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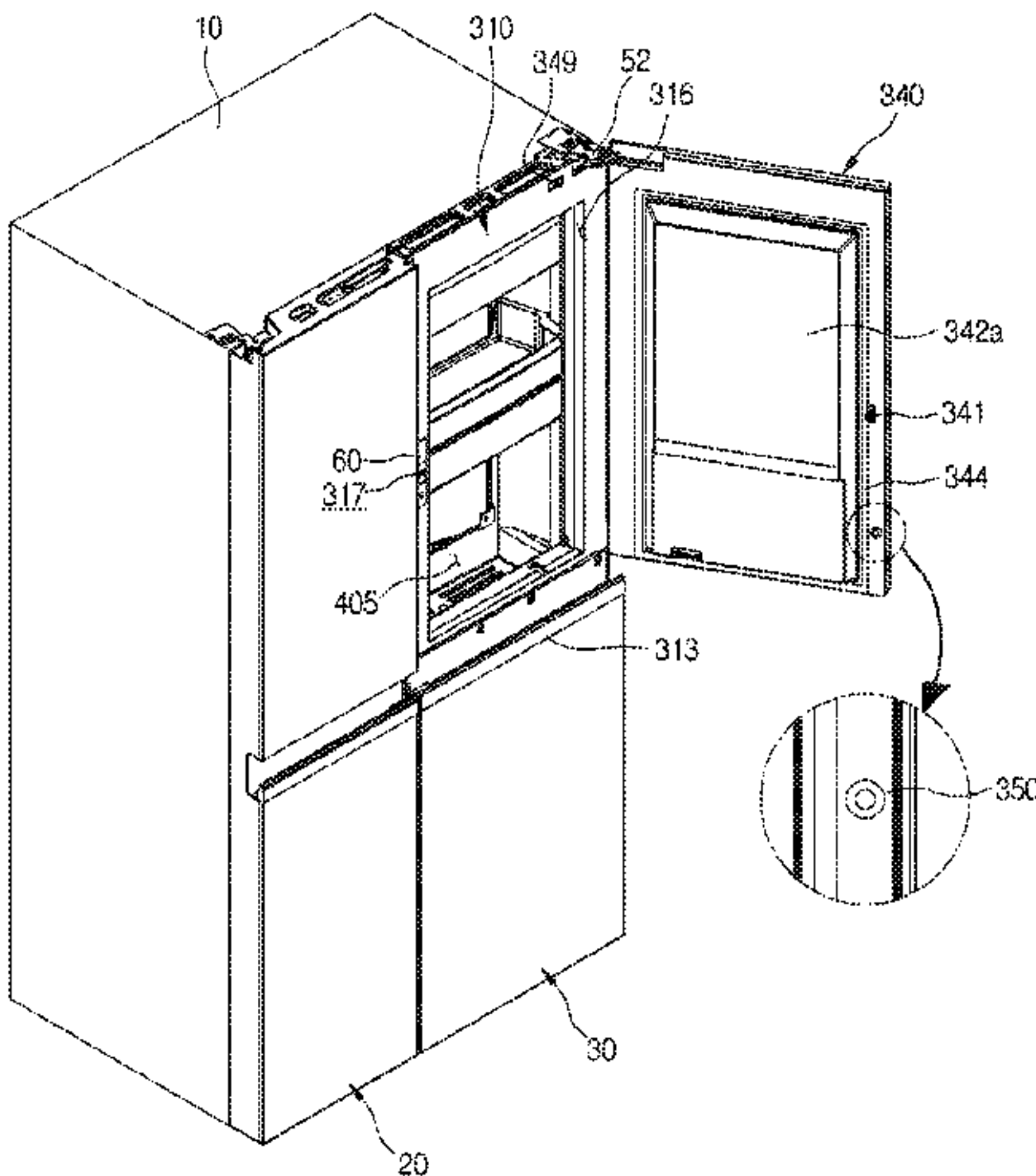
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(57) **ABSTRACT**
A refrigerator includes a cabinet that defines a first storage compartment; a first door that is opened or closed to allow or prevent access to an interior of the first storage compartment; a storing device coupled to the first door to define a second storage compartment, wherein, when the first door is closed, the second storage compartment is disposed in the first storage compartment; and a second door connected to the first door and configured to be opened or closed to allow or prevent access to an interior of the second storage compartment, wherein the interior of the second storage compartment is accessible when the first door is closed and the second door is opened, wherein the first door includes a plurality of first coupling parts to which the storing device is coupled, wherein the storing device includes: a frame; and a basket installed on the frame, wherein each of the frame (Continued)



and the basket includes at least one second coupling part interacting with at least one of the plurality of first coupling parts, wherein a front surface of the second door is positioned to be generally coplanar with at least a portion of a front surface of the first door.

27 Claims, 66 Drawing Sheets

Related U.S. Application Data

application for the reissue of Pat. No. 9,322,591, and a continuation of application No. 15/963,465, filed on Apr. 26, 2018, now Pat. No. Re. 47,753, which is an application for the reissue of Pat. No. 9,322,591, which is a division of application No. 13/500,980, filed as application No. PCT/KR2010/006297 on Sep. 15, 2010, now abandoned.

(51) Int. Cl.

E05B 65/00 (2006.01)
E05D 7/00 (2006.01)
E05D 7/081 (2006.01)
E05D 11/00 (2006.01)
E05D 11/06 (2006.01)
E05D 11/10 (2006.01)
E05F 5/00 (2017.01)
F25D 23/00 (2006.01)
F25D 23/04 (2006.01)
F25D 23/08 (2006.01)
F25D 25/02 (2006.01)

(52) U.S. Cl.

CPC *E05D 7/081* (2013.01); *E05D 11/0081* (2013.01); *E05D 11/06* (2013.01); *E05D 11/1078* (2013.01); *E05F 5/00* (2013.01); *F25D 23/00* (2013.01); *F25D 23/02* (2013.01); *F25D 23/025* (2013.01); *F25D 23/04* (2013.01); *F25D 23/087* (2013.01); *F25D 25/027* (2013.01)

(58) Field of Classification Search

USPC 16/365, 366, 317, 284; 312/405, 321.5, 312/291, 292, 293.1, 293.2, 326, 328, 312/329, 324, 204, 405.1; 49/61–63, 65, 49/142, 98, 104, 109; 292/197, 198
 See application file for complete search history.

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Fig. 1

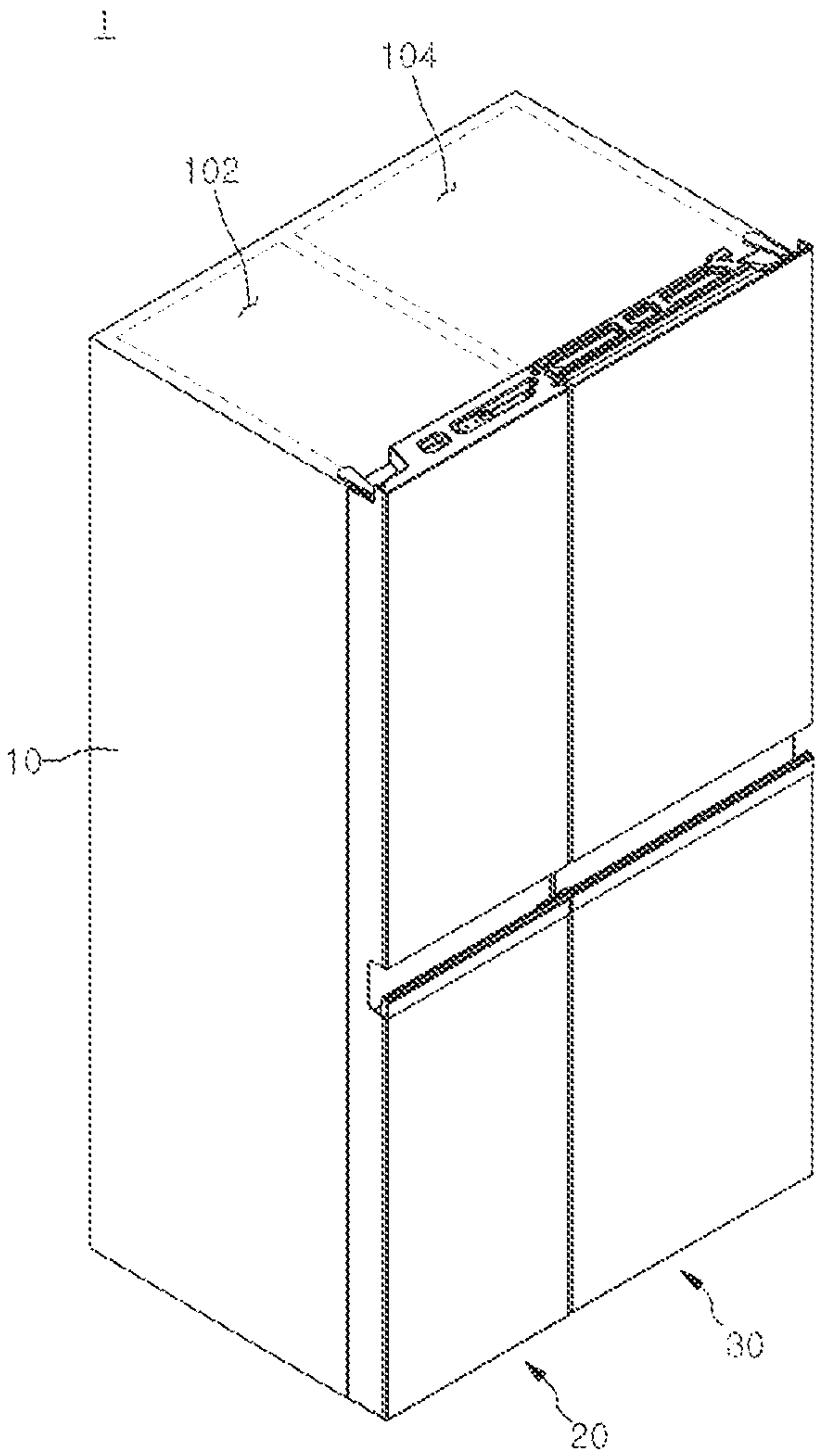


Fig. 2

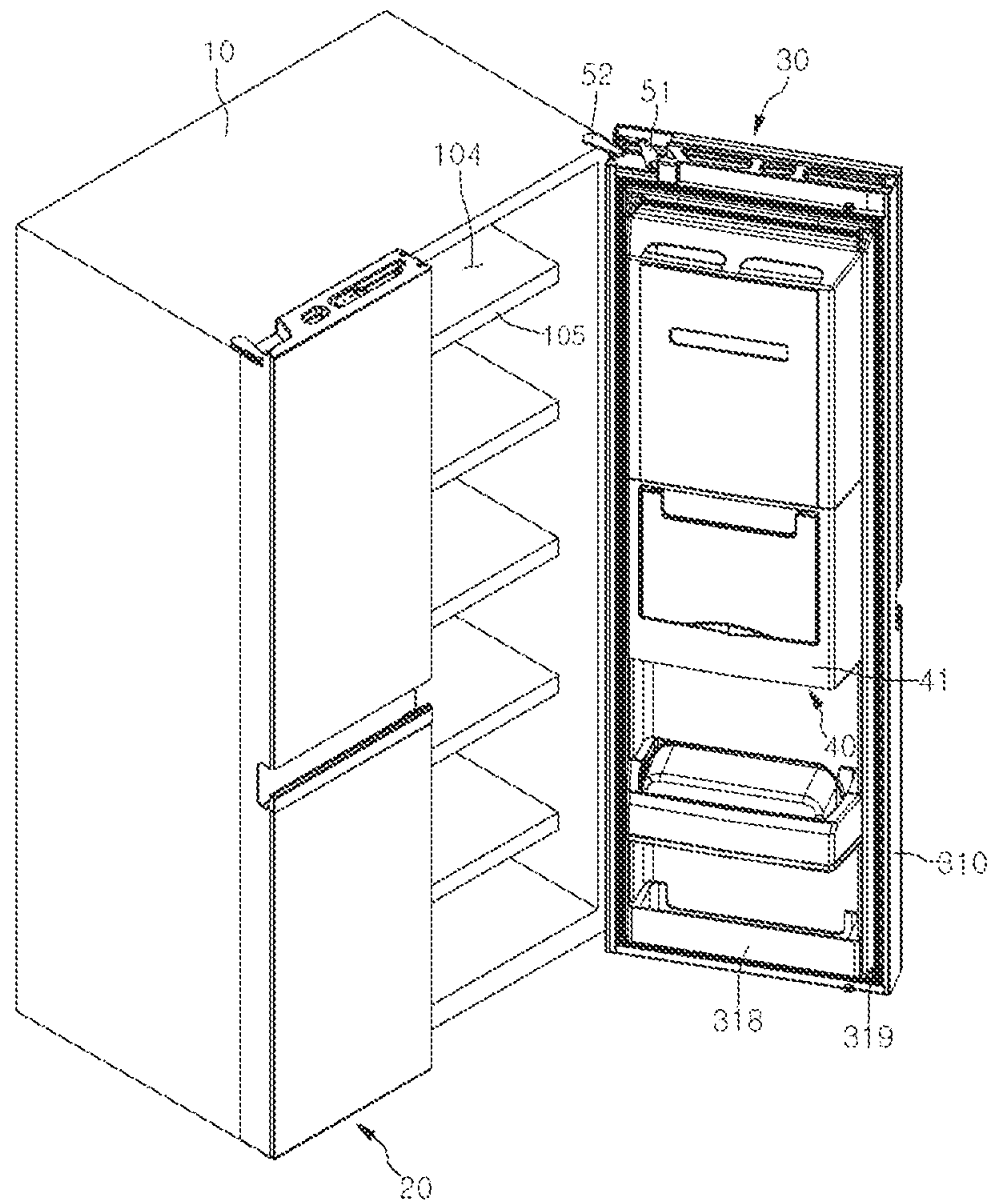


Fig. 3

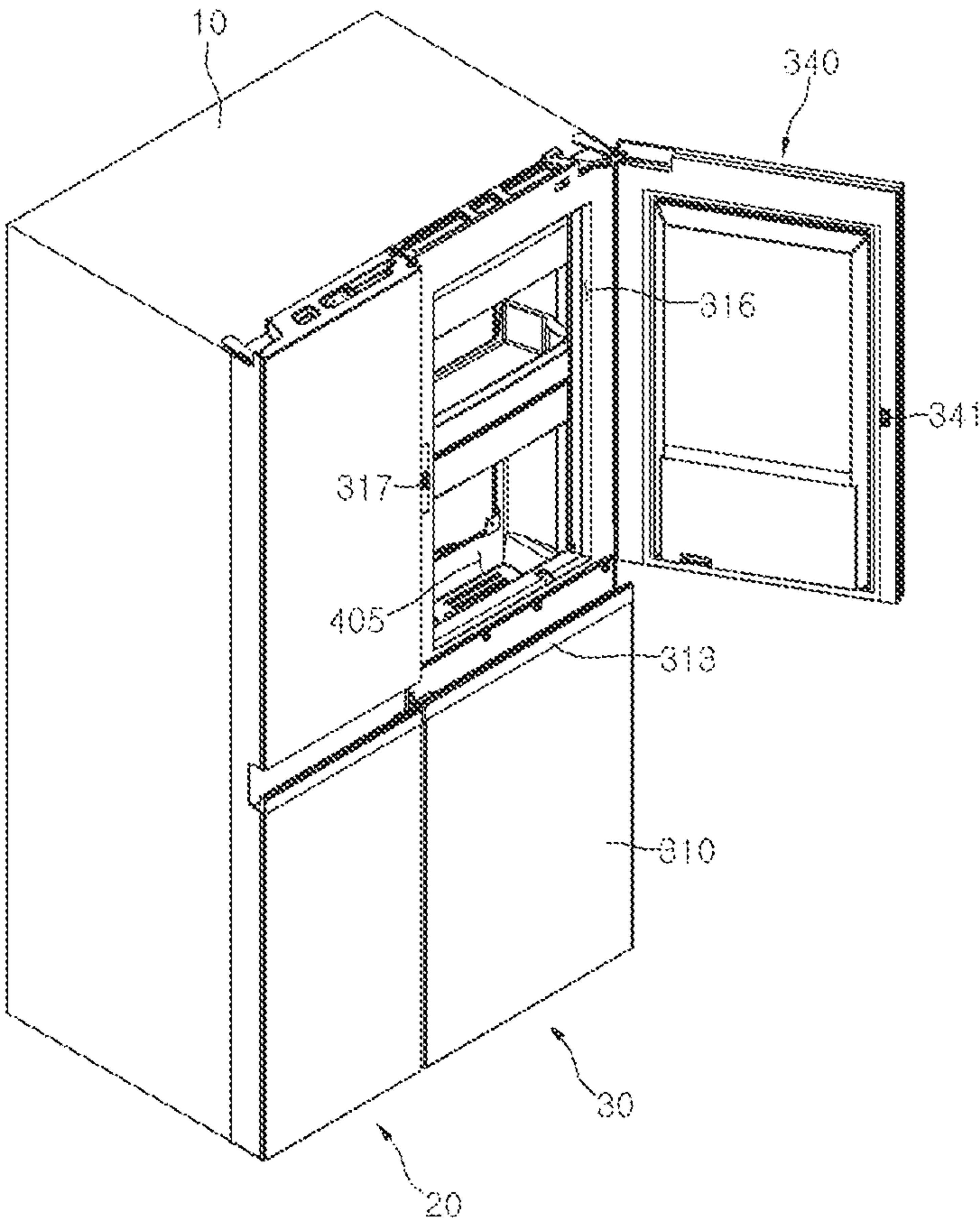


Fig. 4

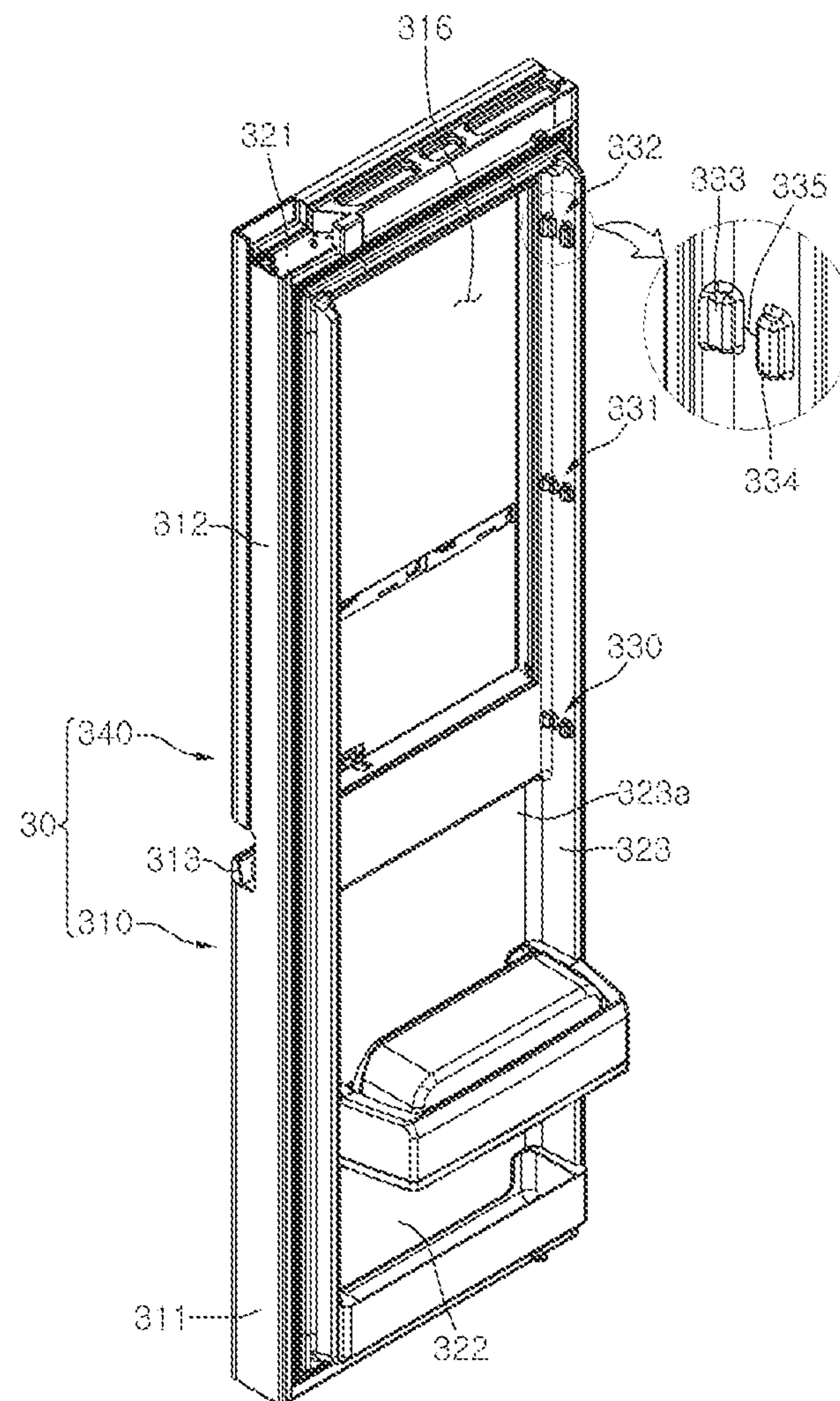


Fig. 5

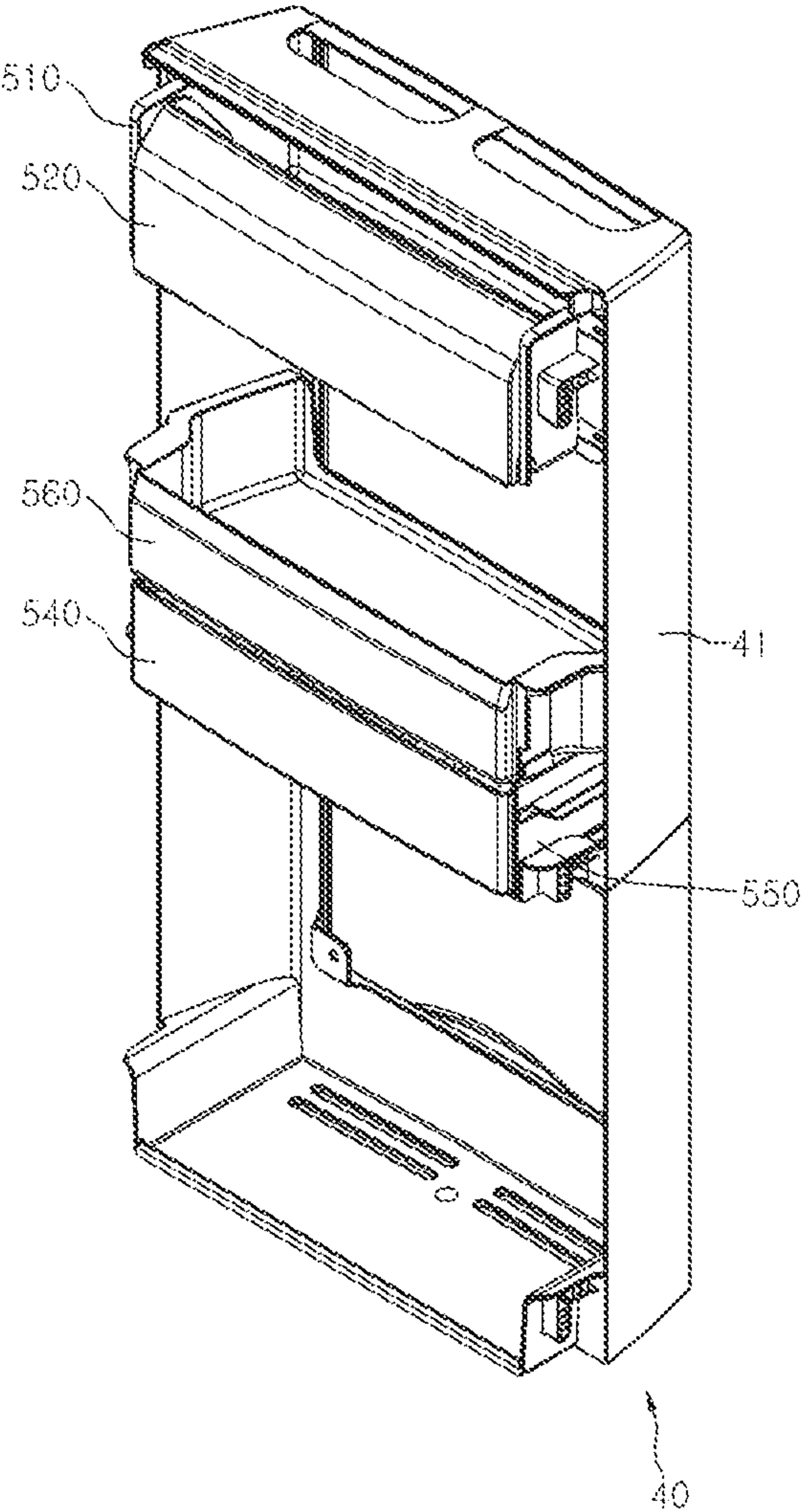


Fig. 6

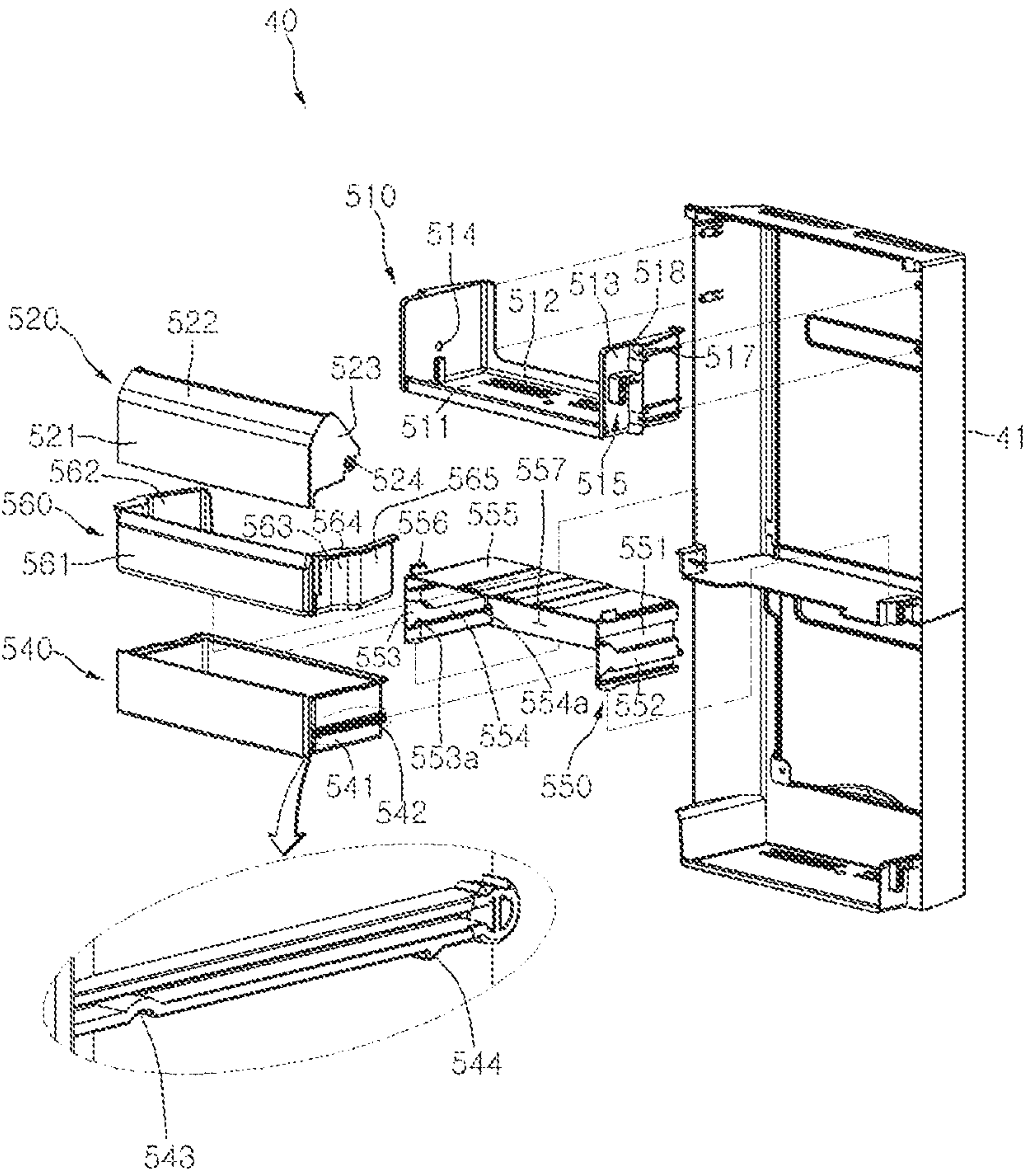


Fig. 7

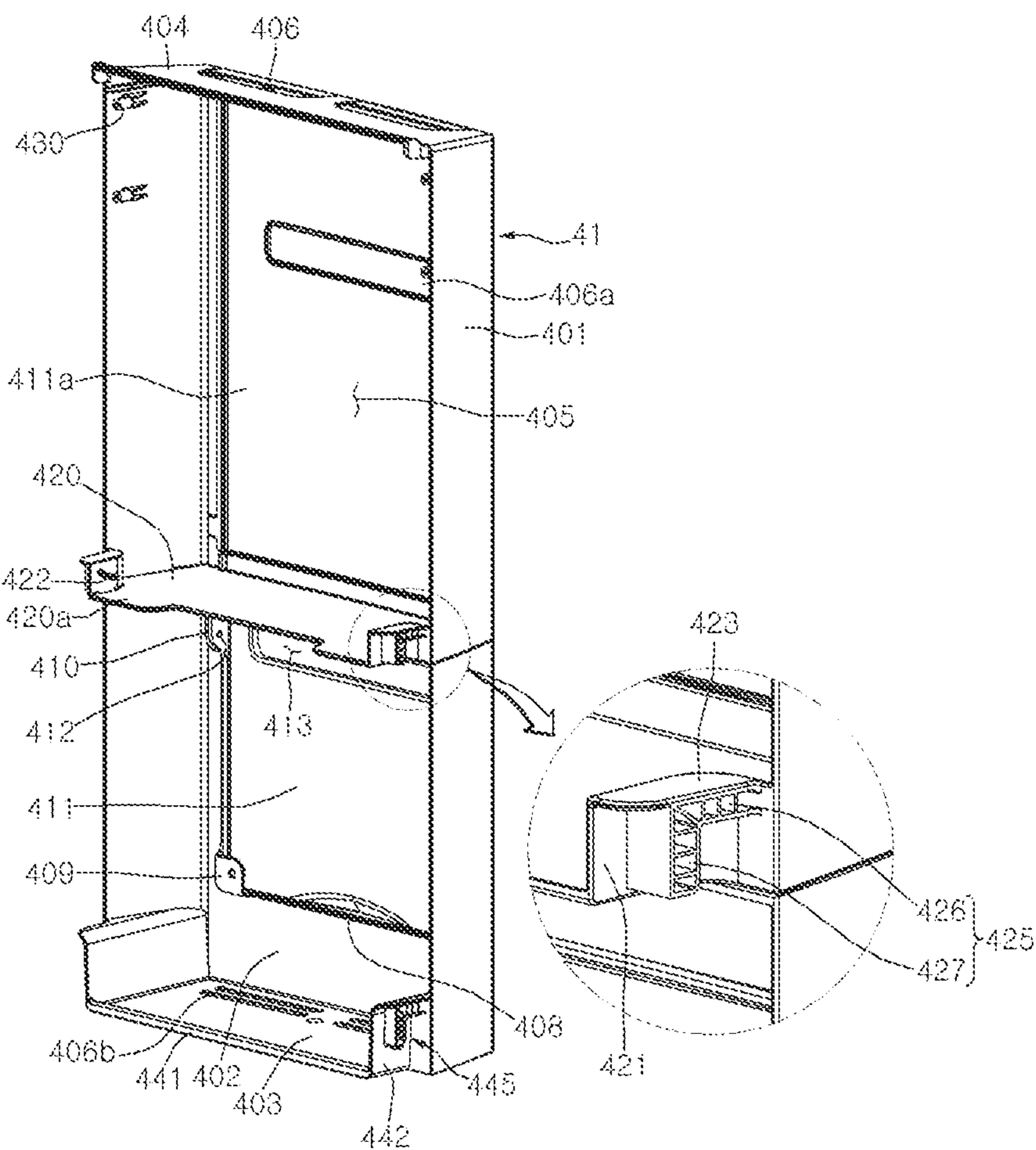


Fig. 8

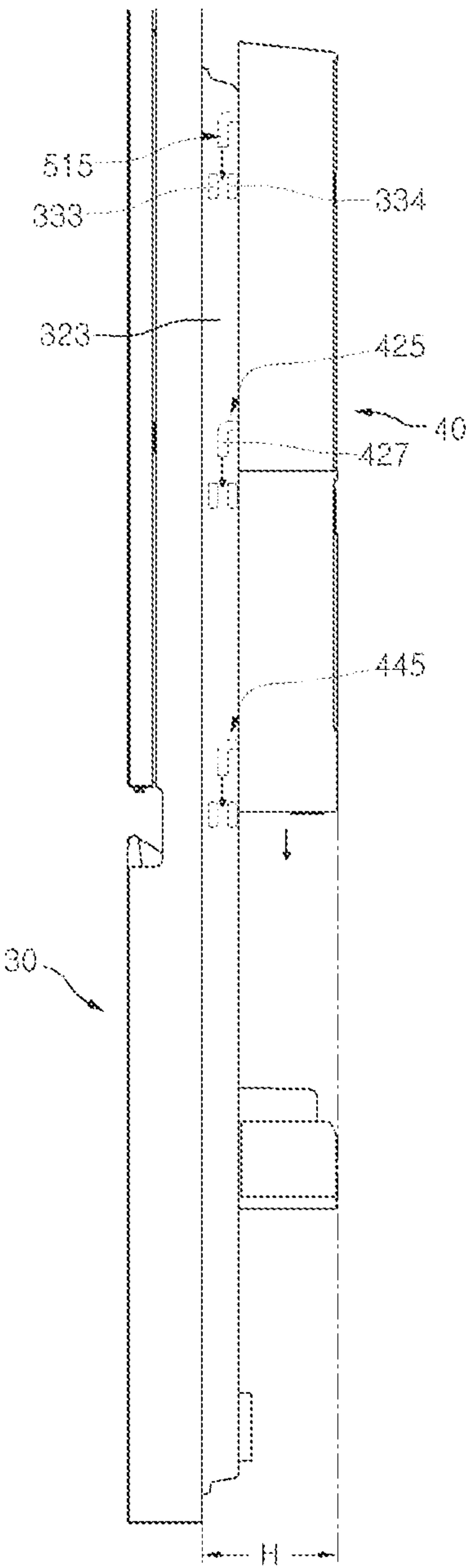


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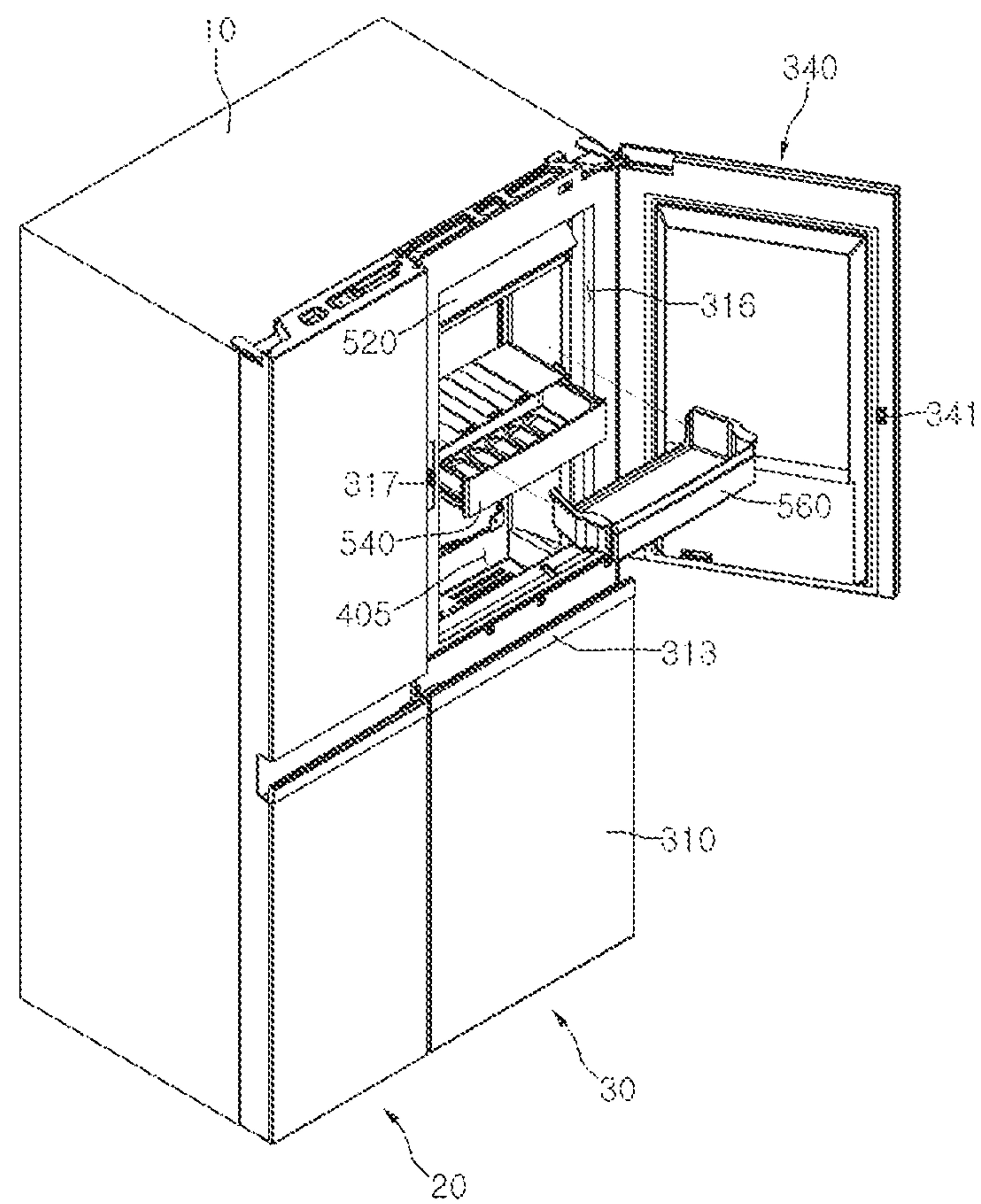


Fig. 10

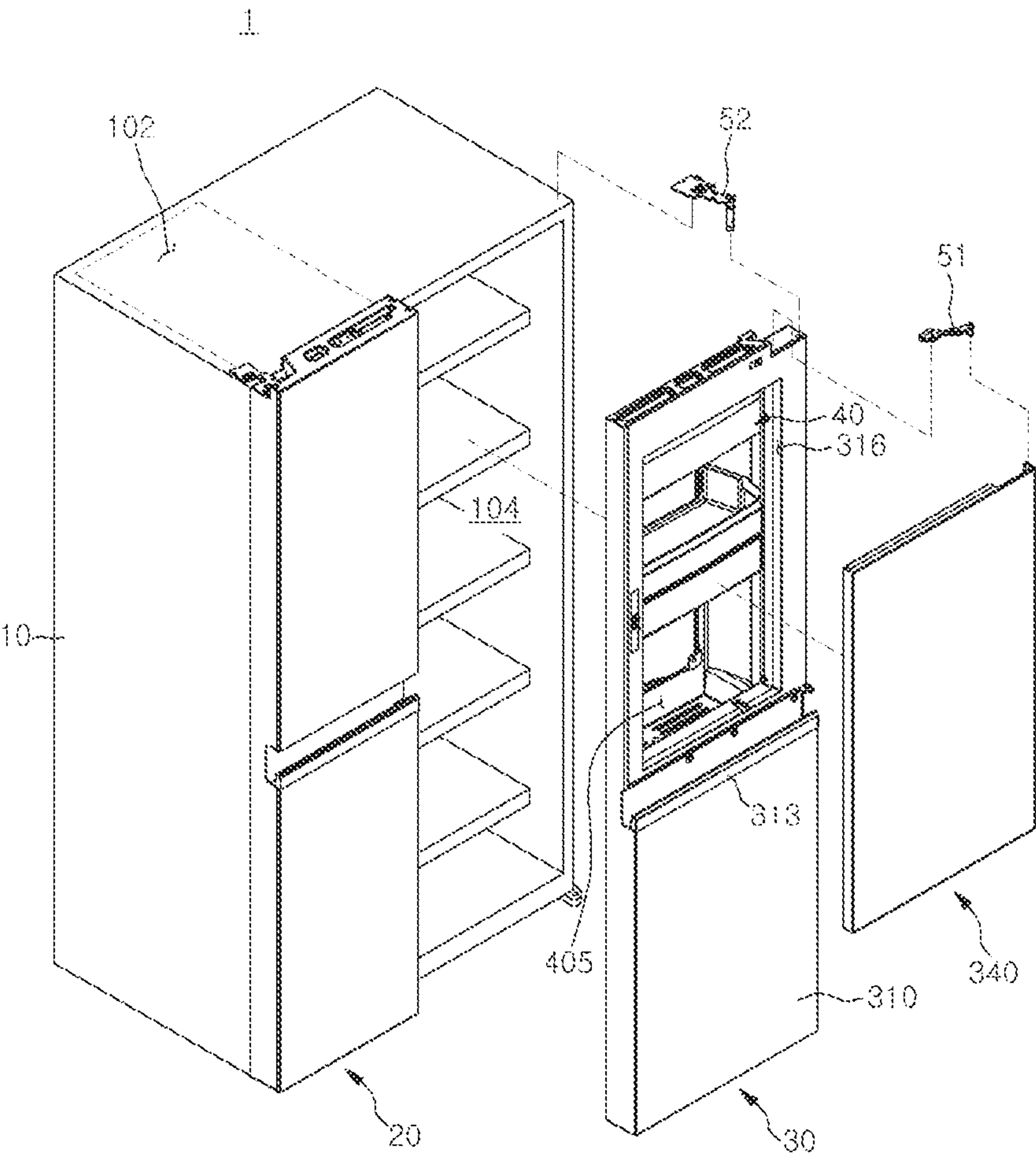


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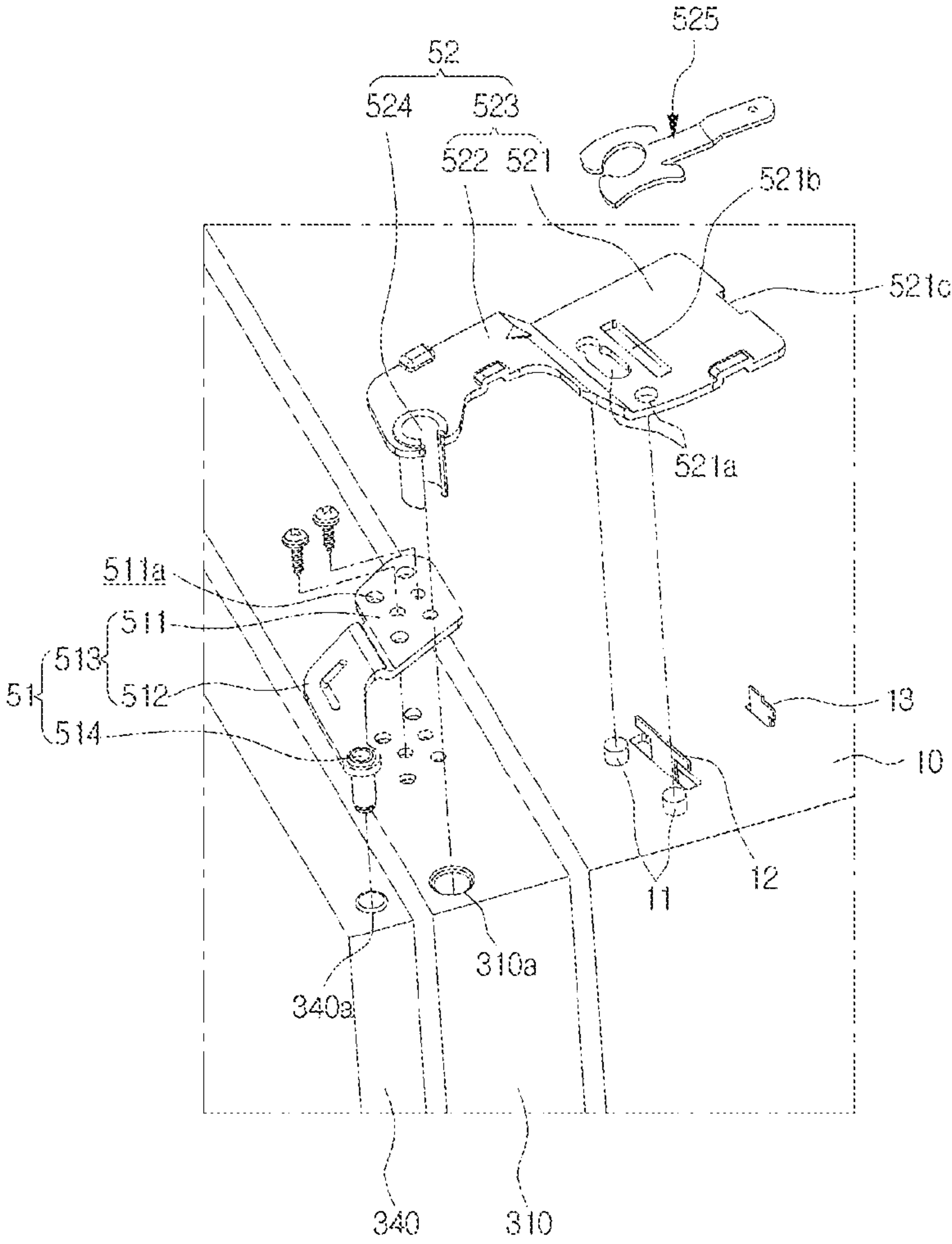


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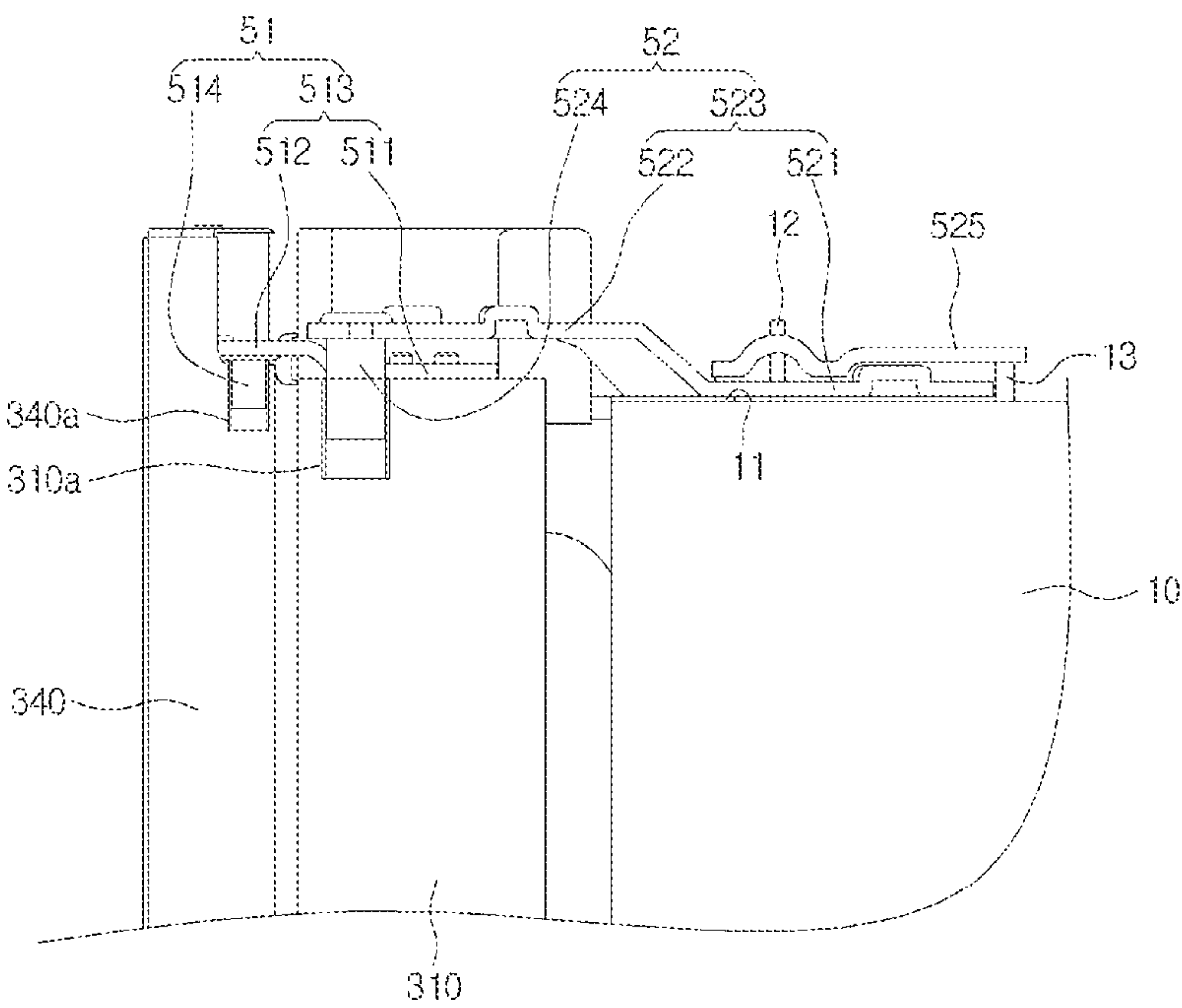


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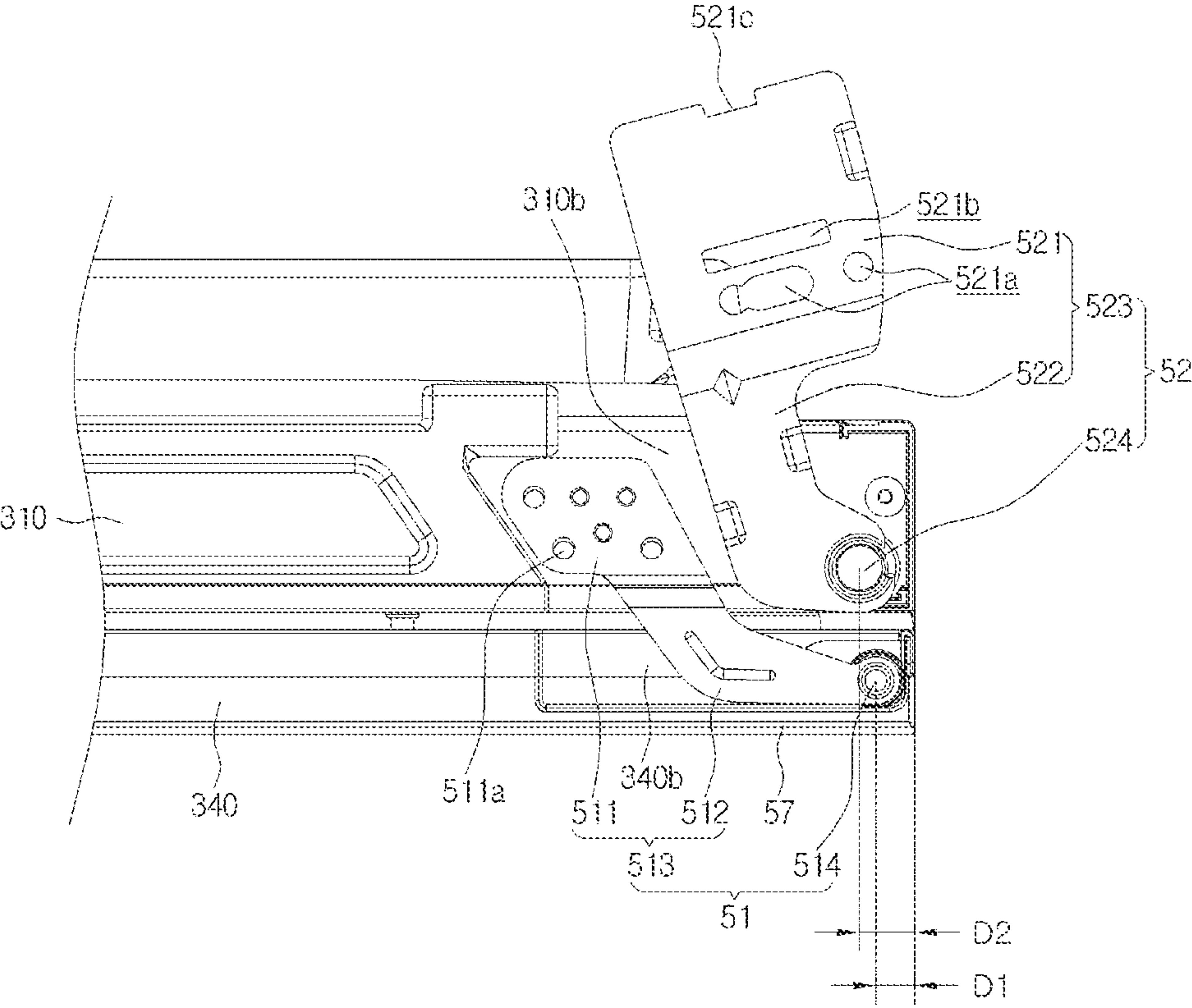


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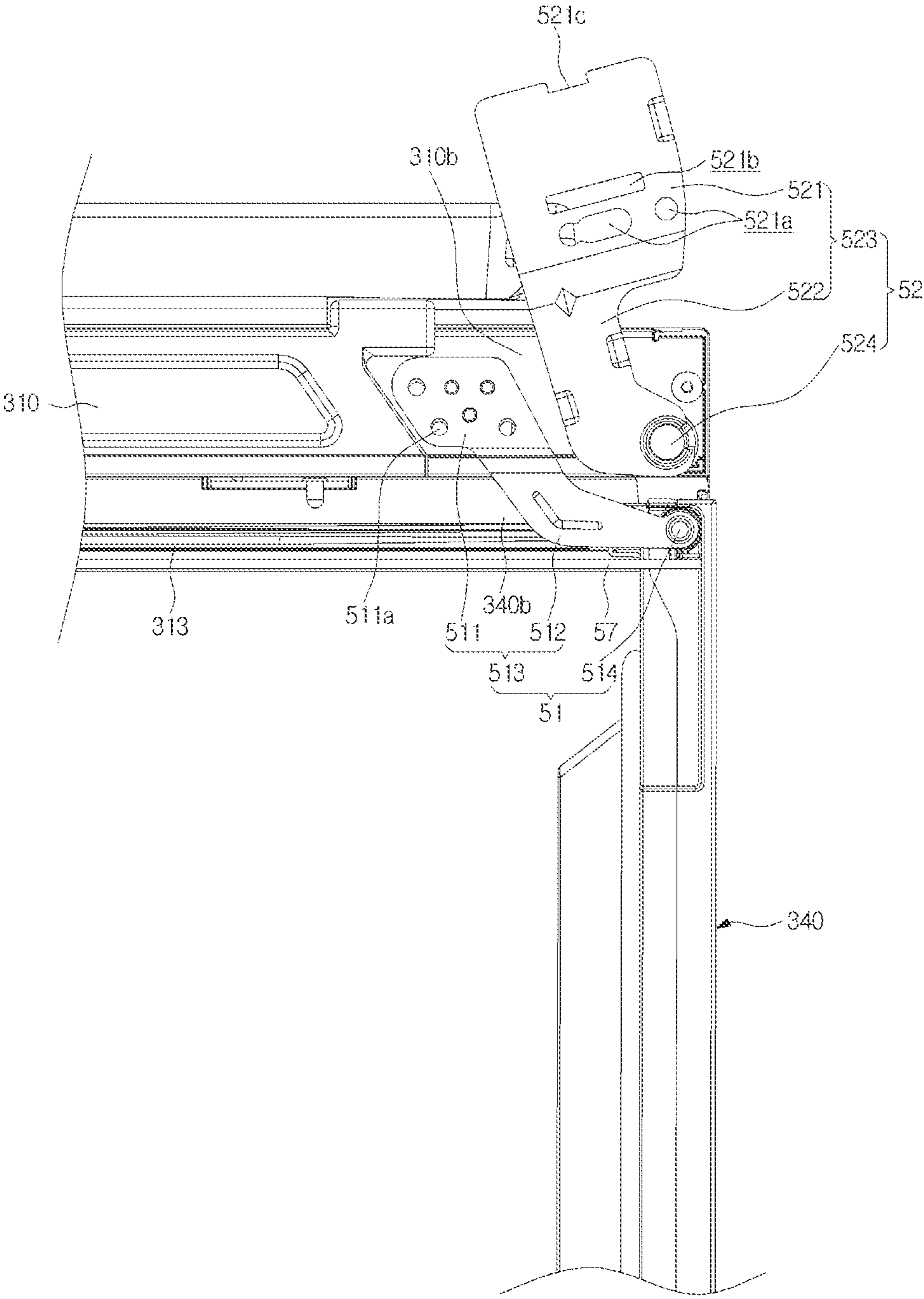


Fig. 15

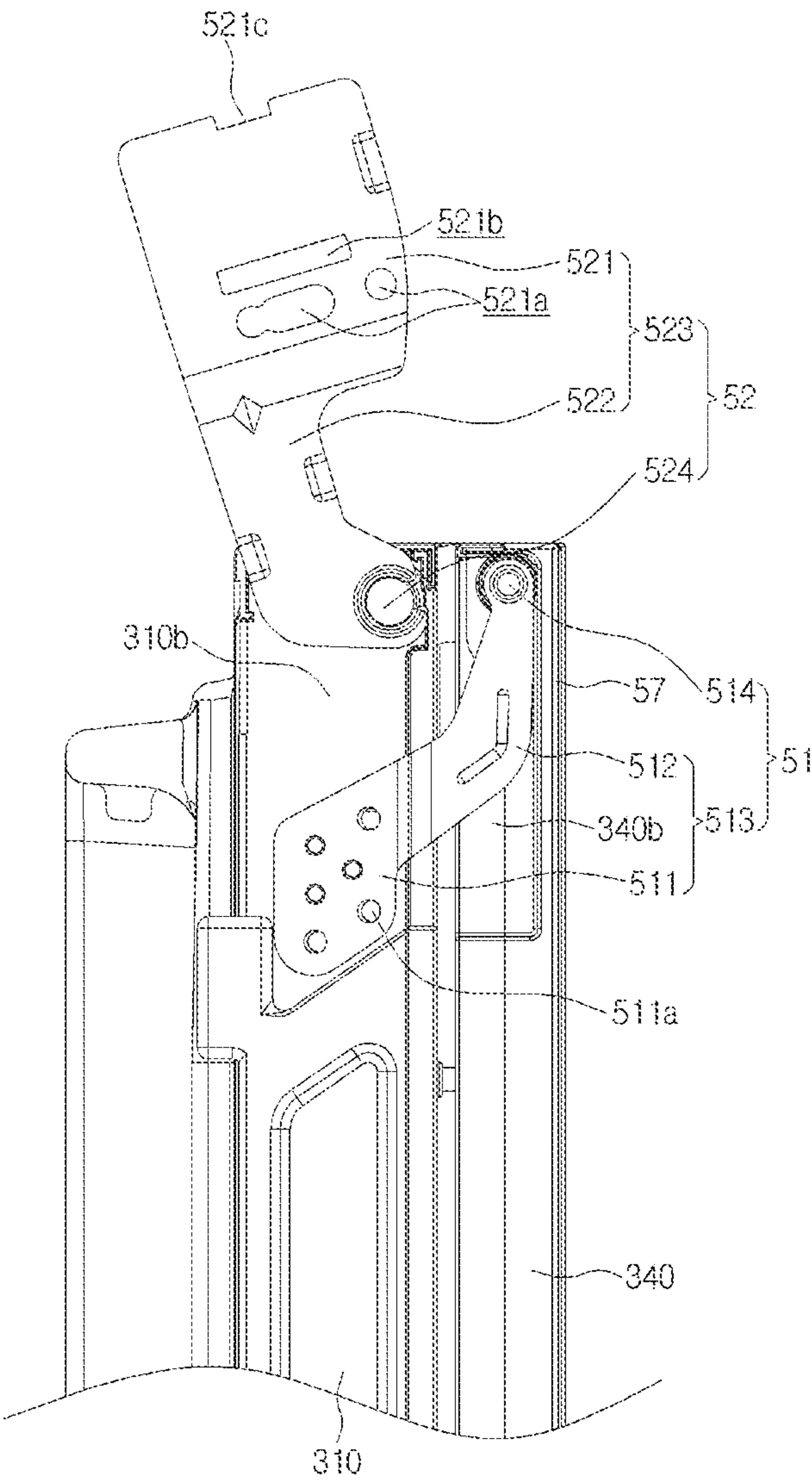


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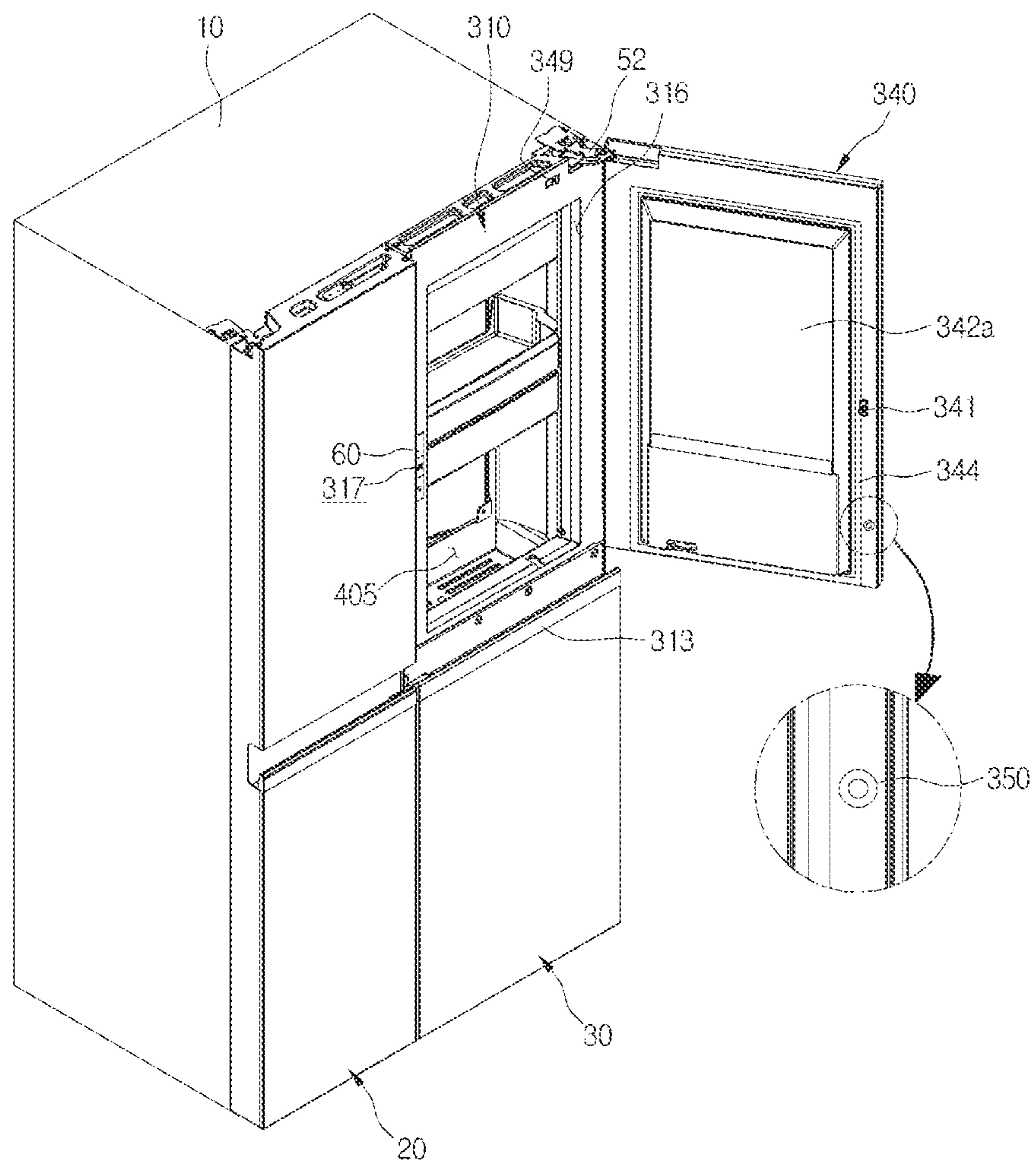


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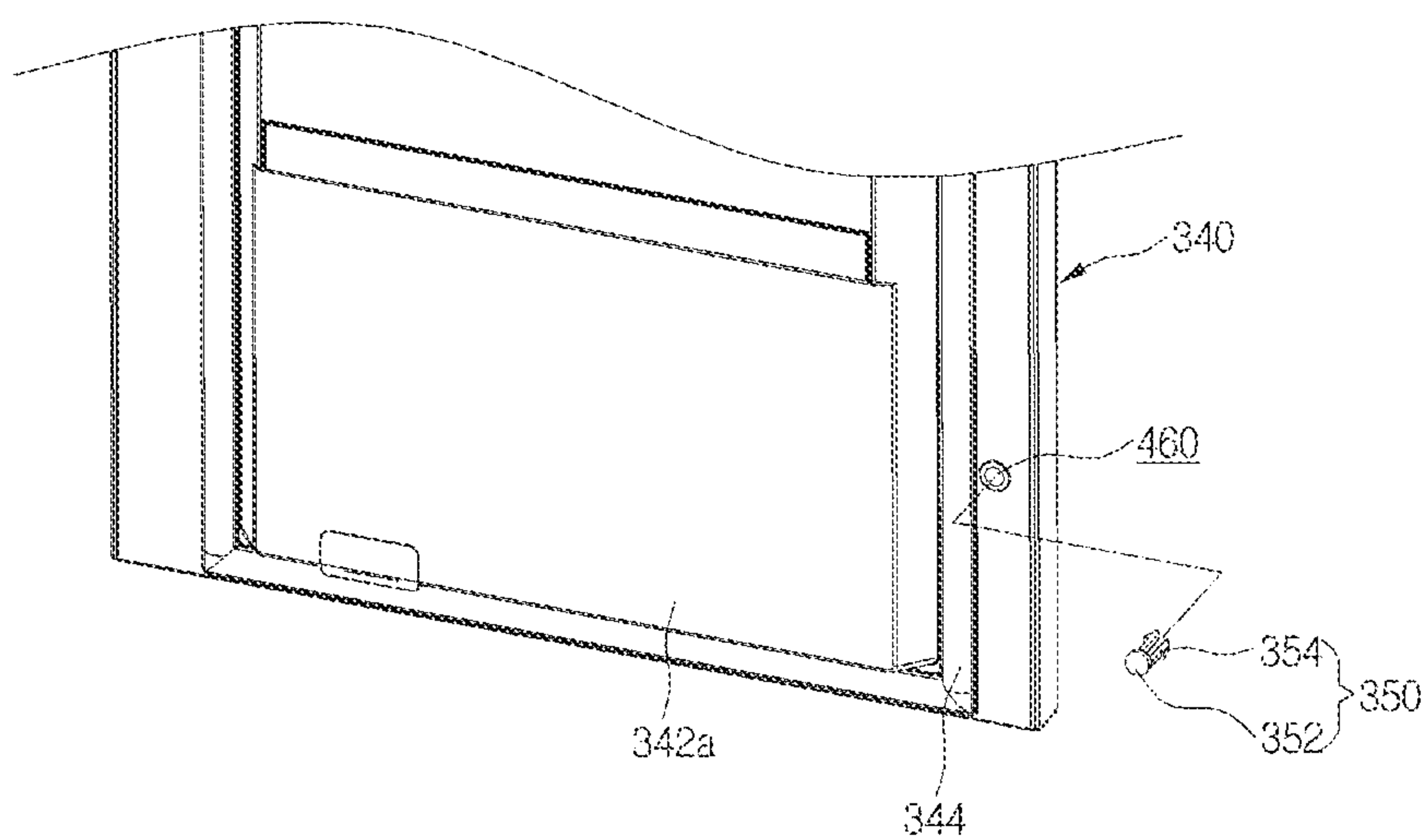


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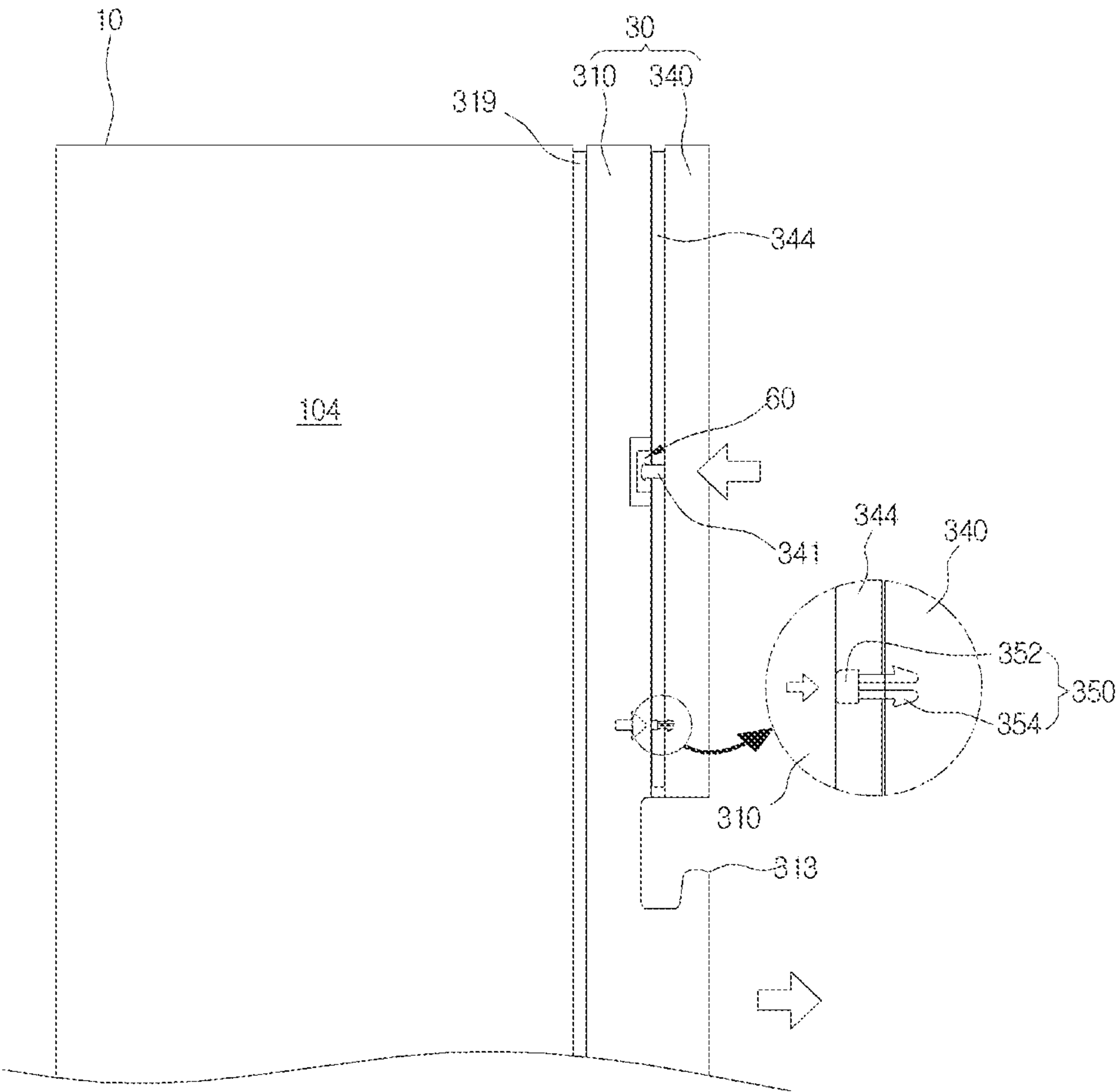


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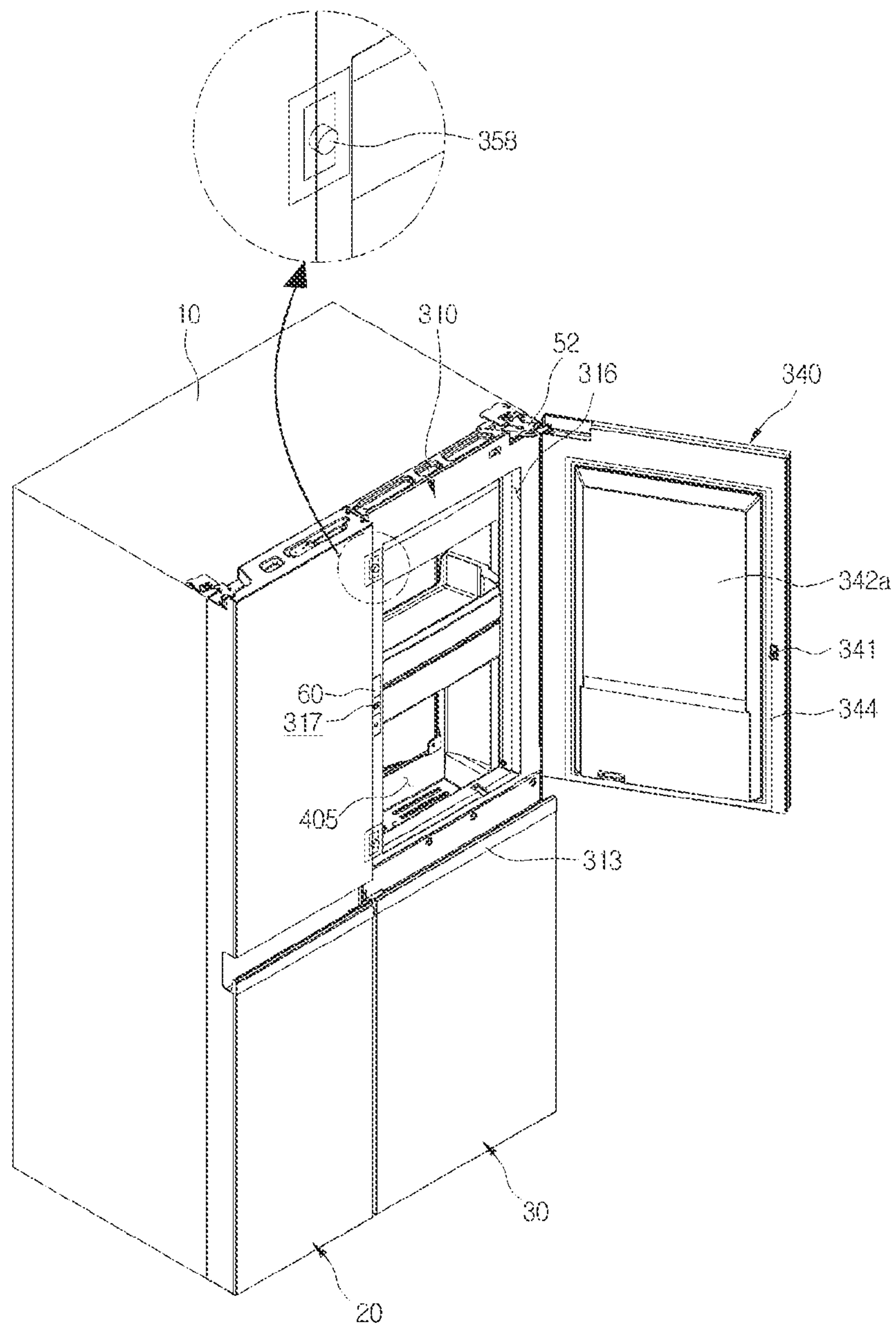


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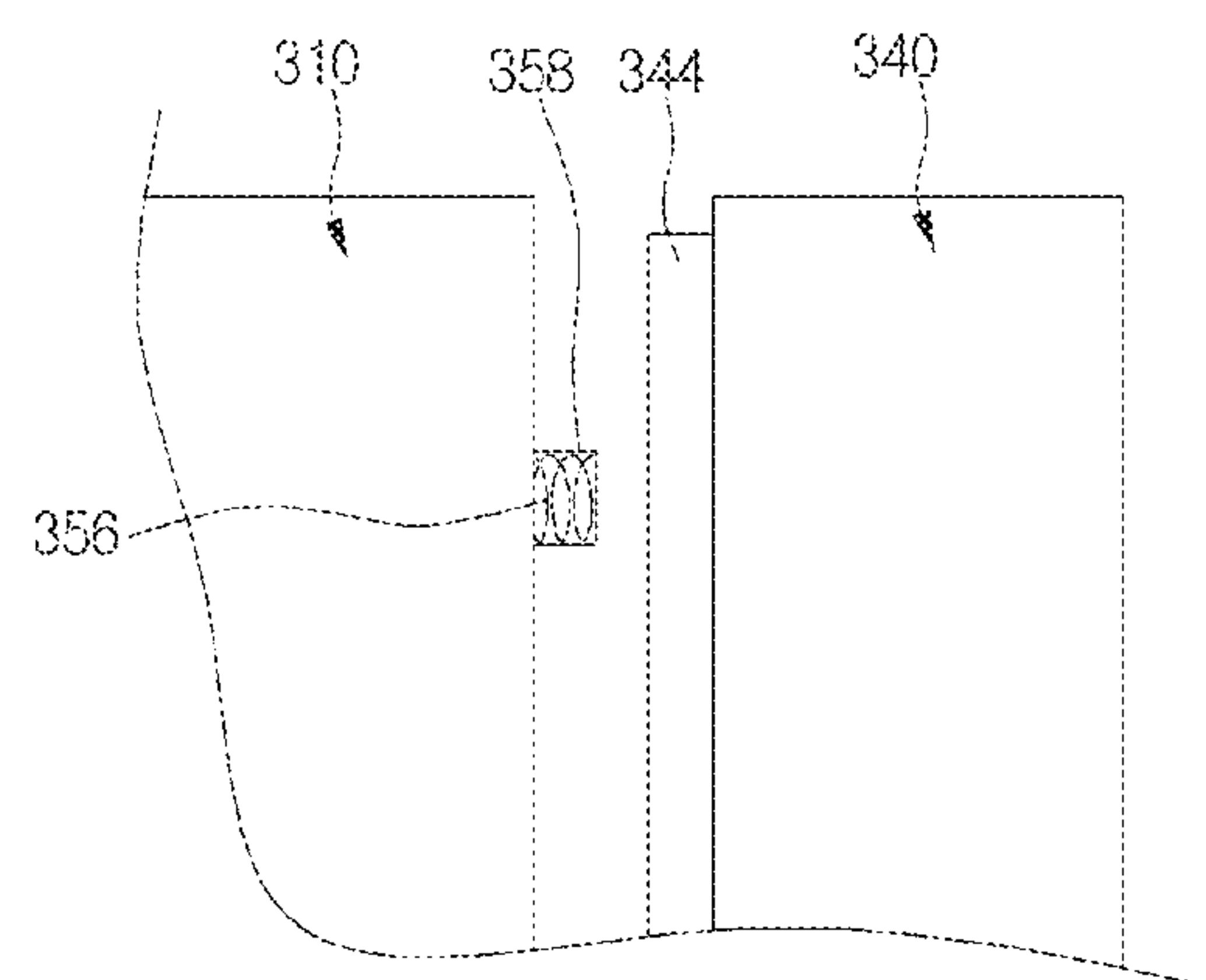


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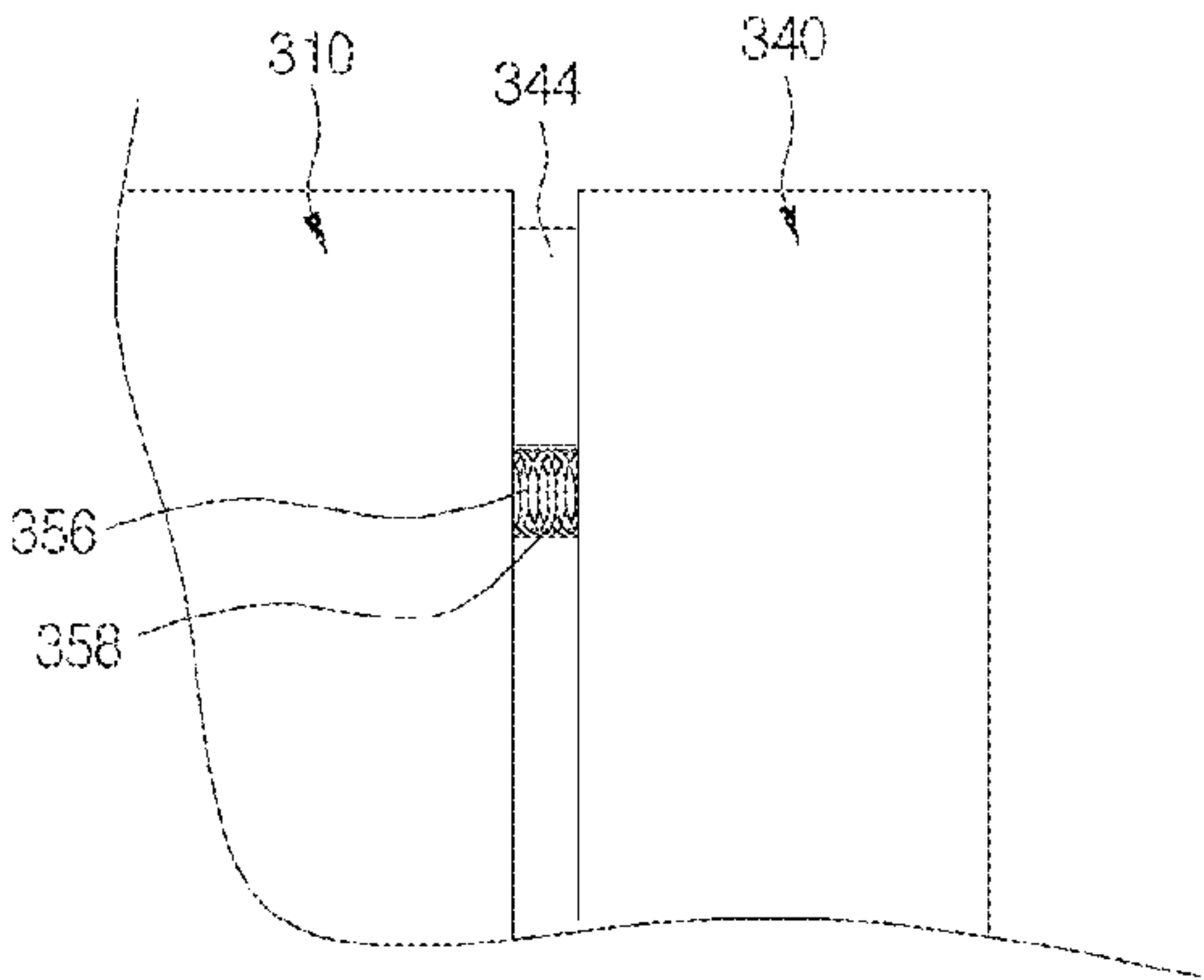


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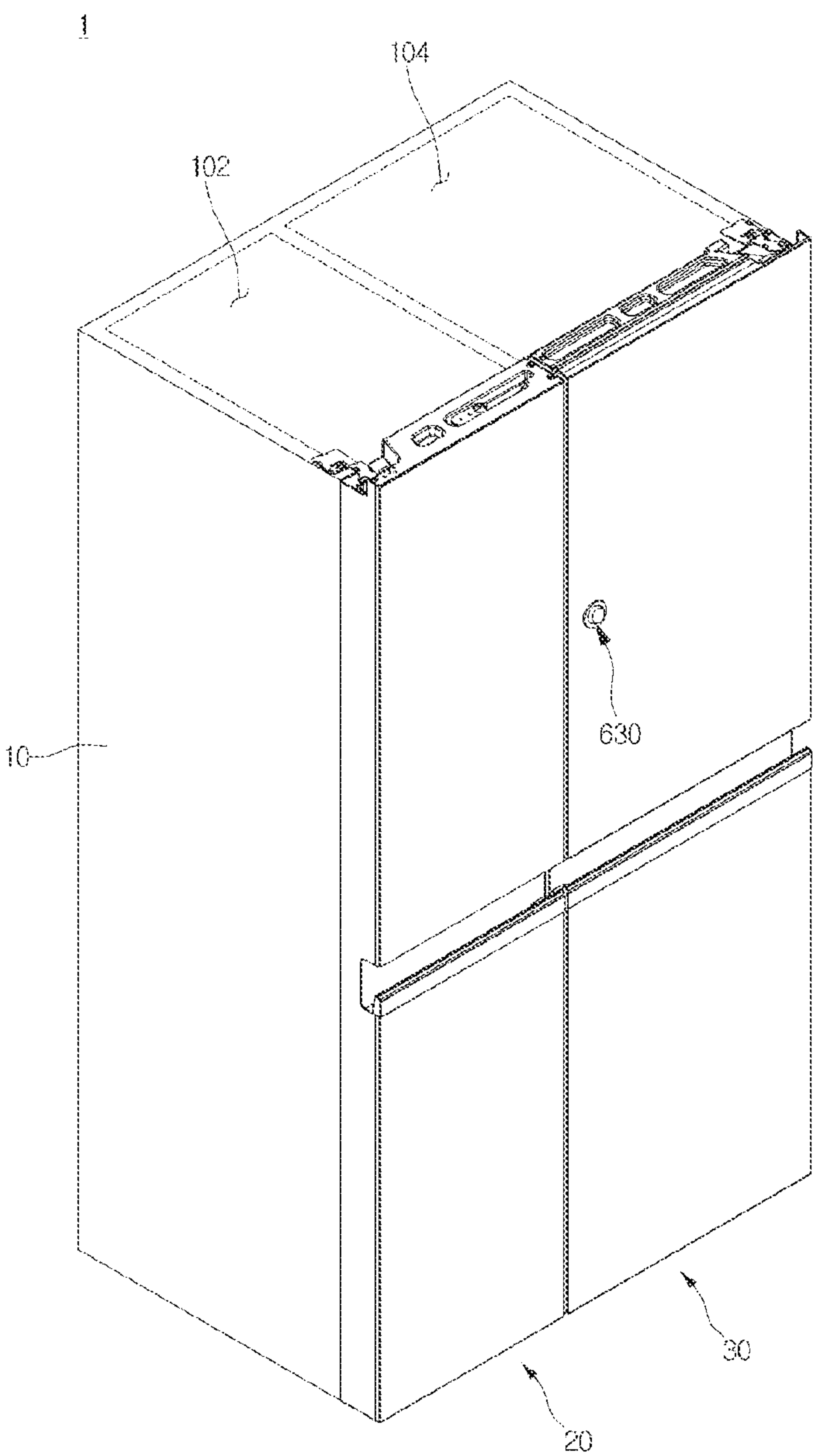


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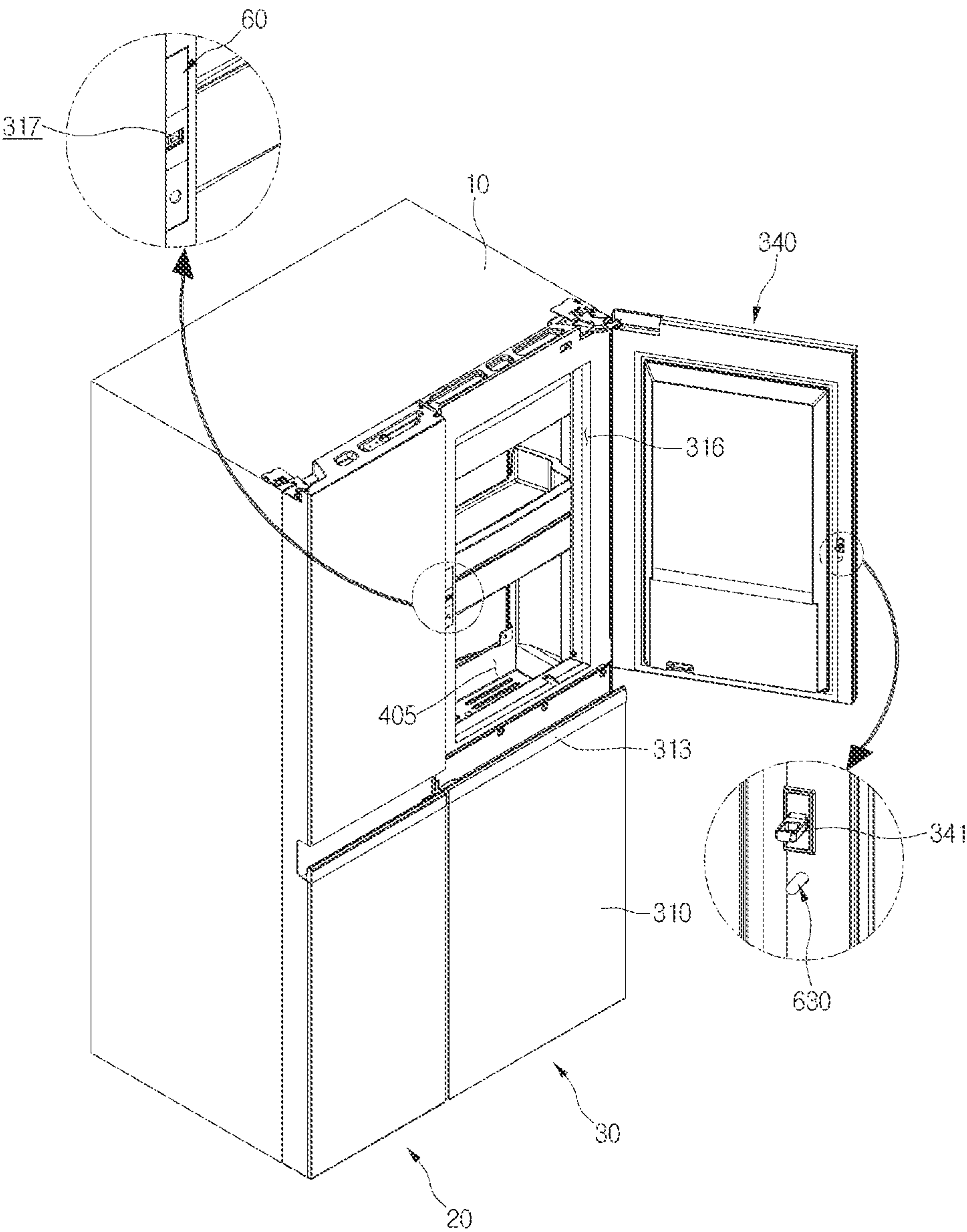


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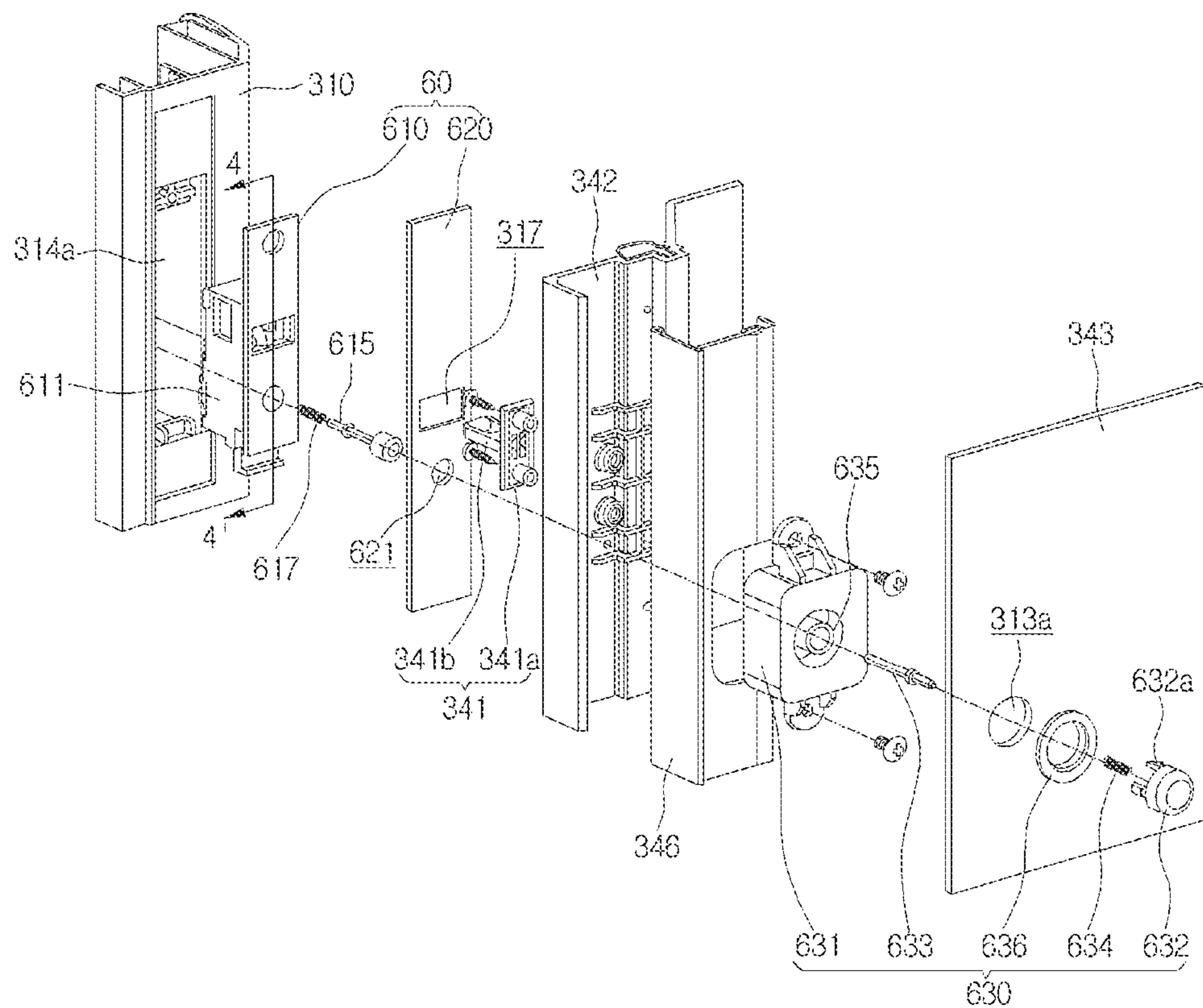


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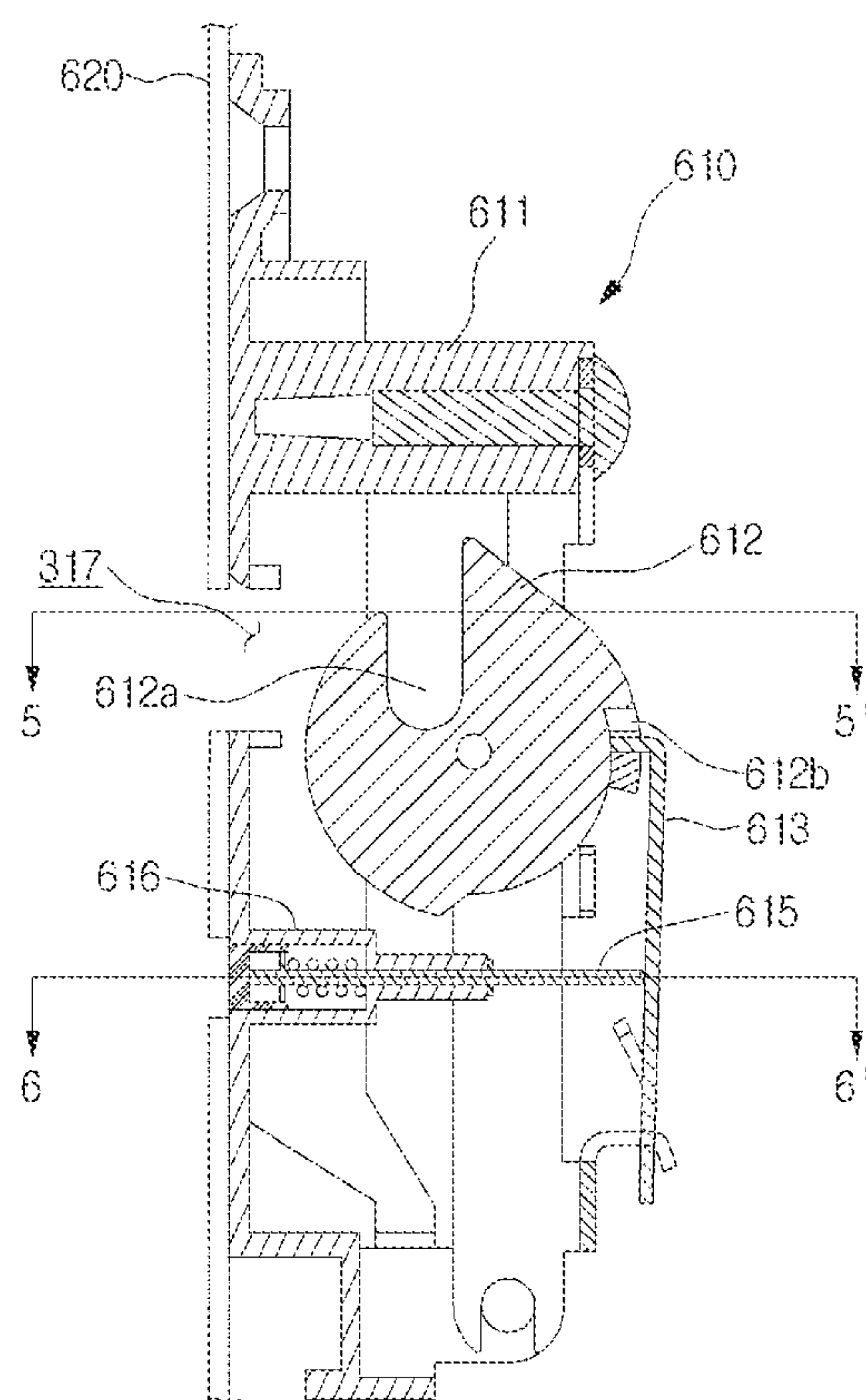


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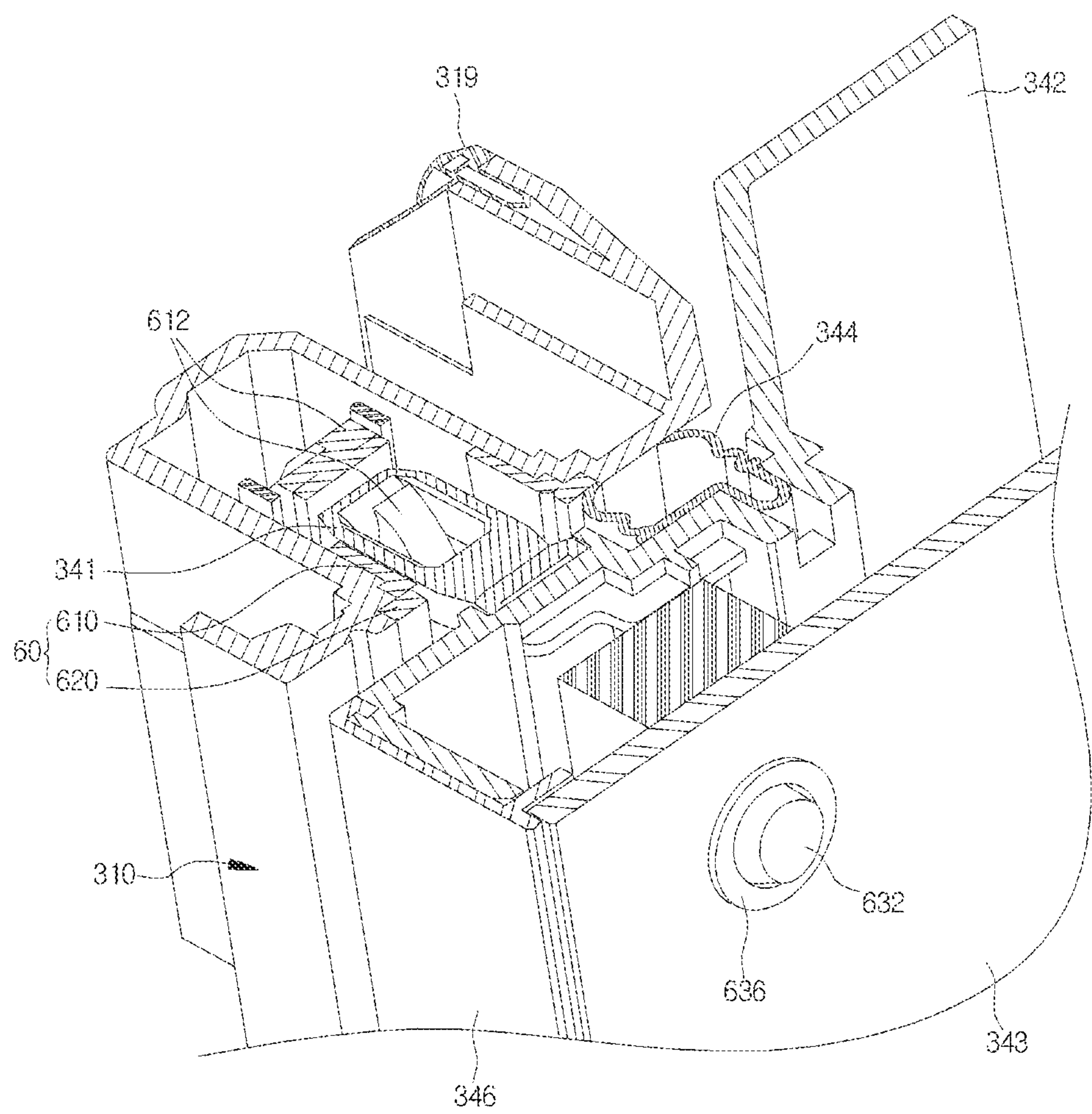


Fig. 27

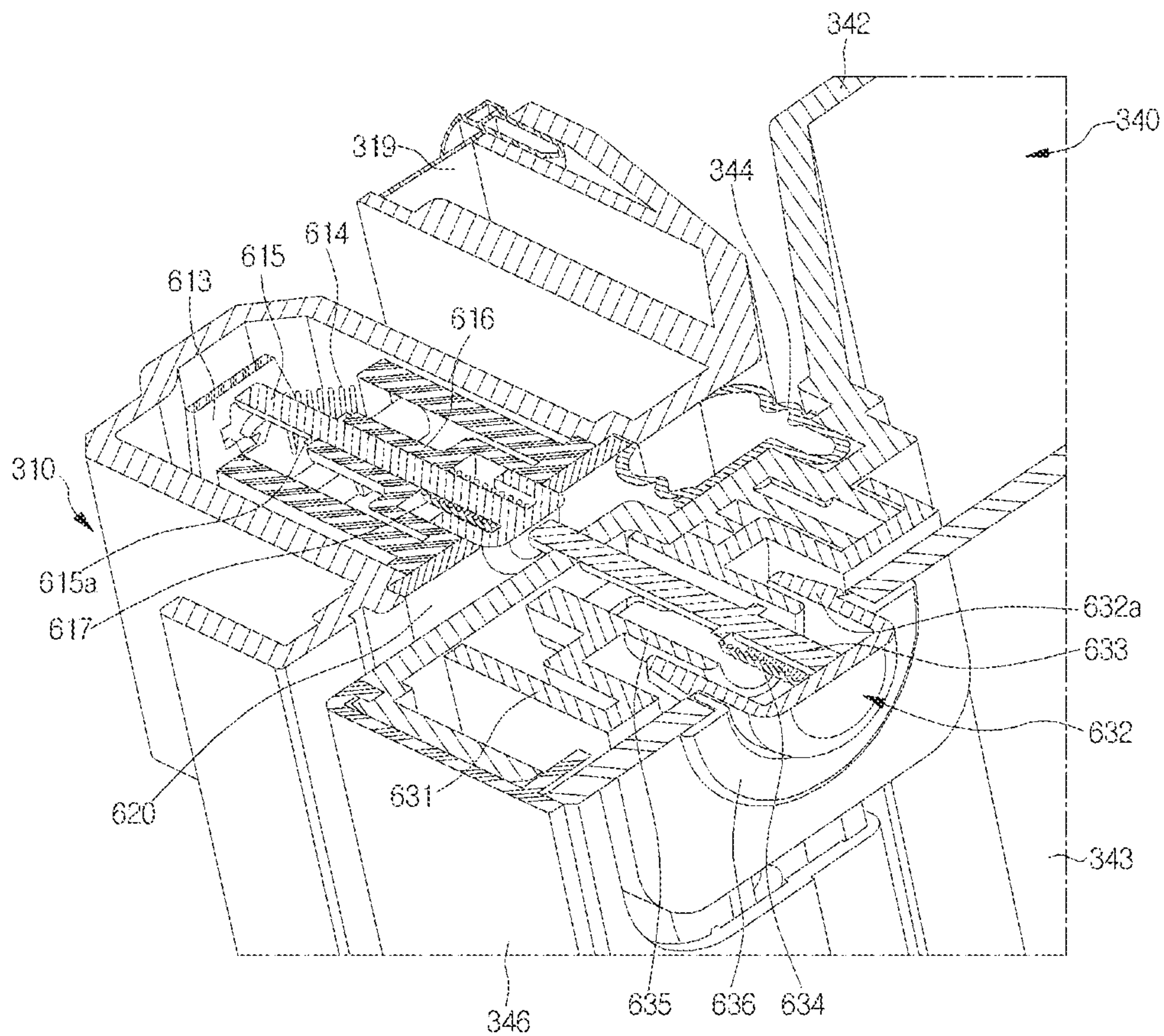


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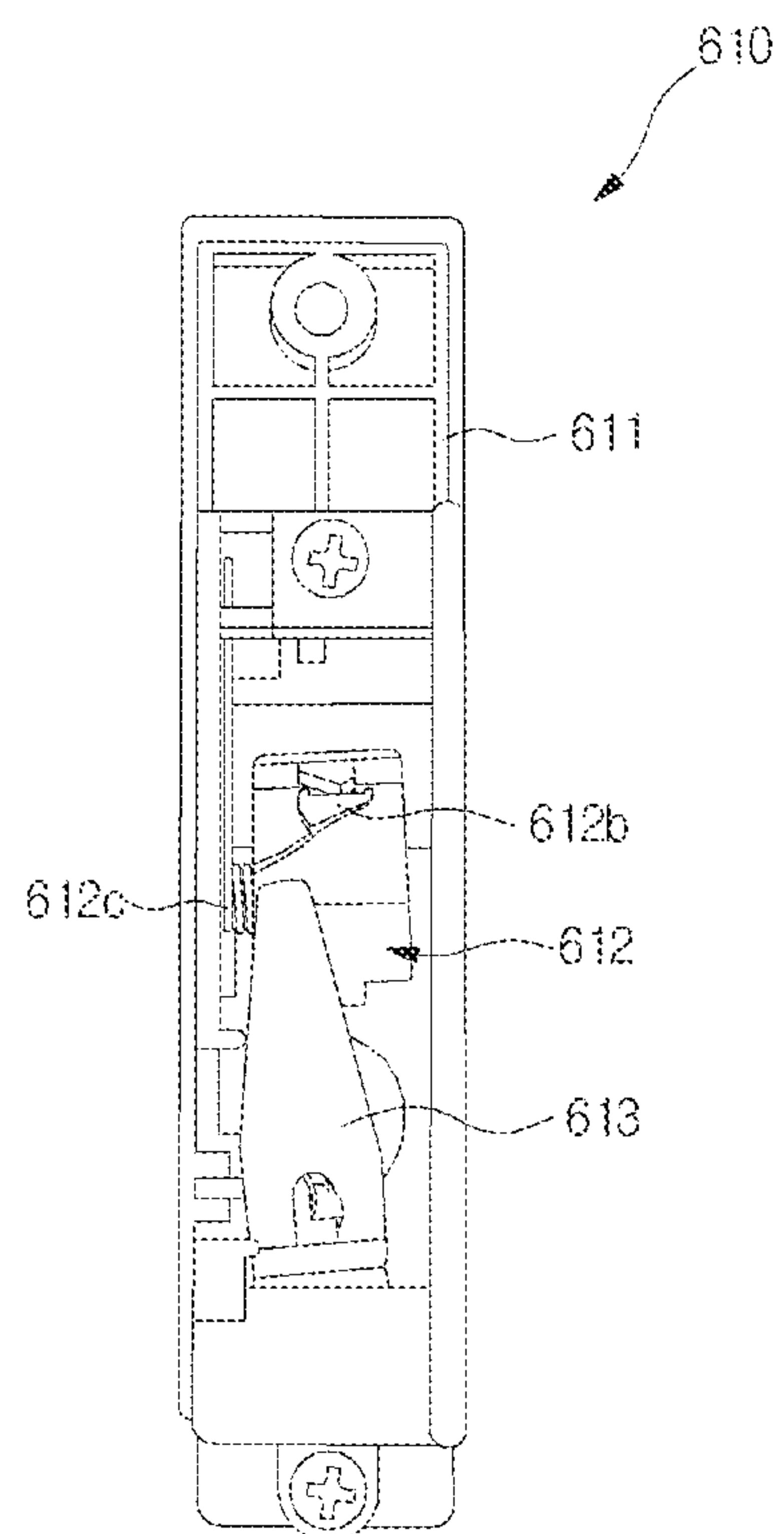


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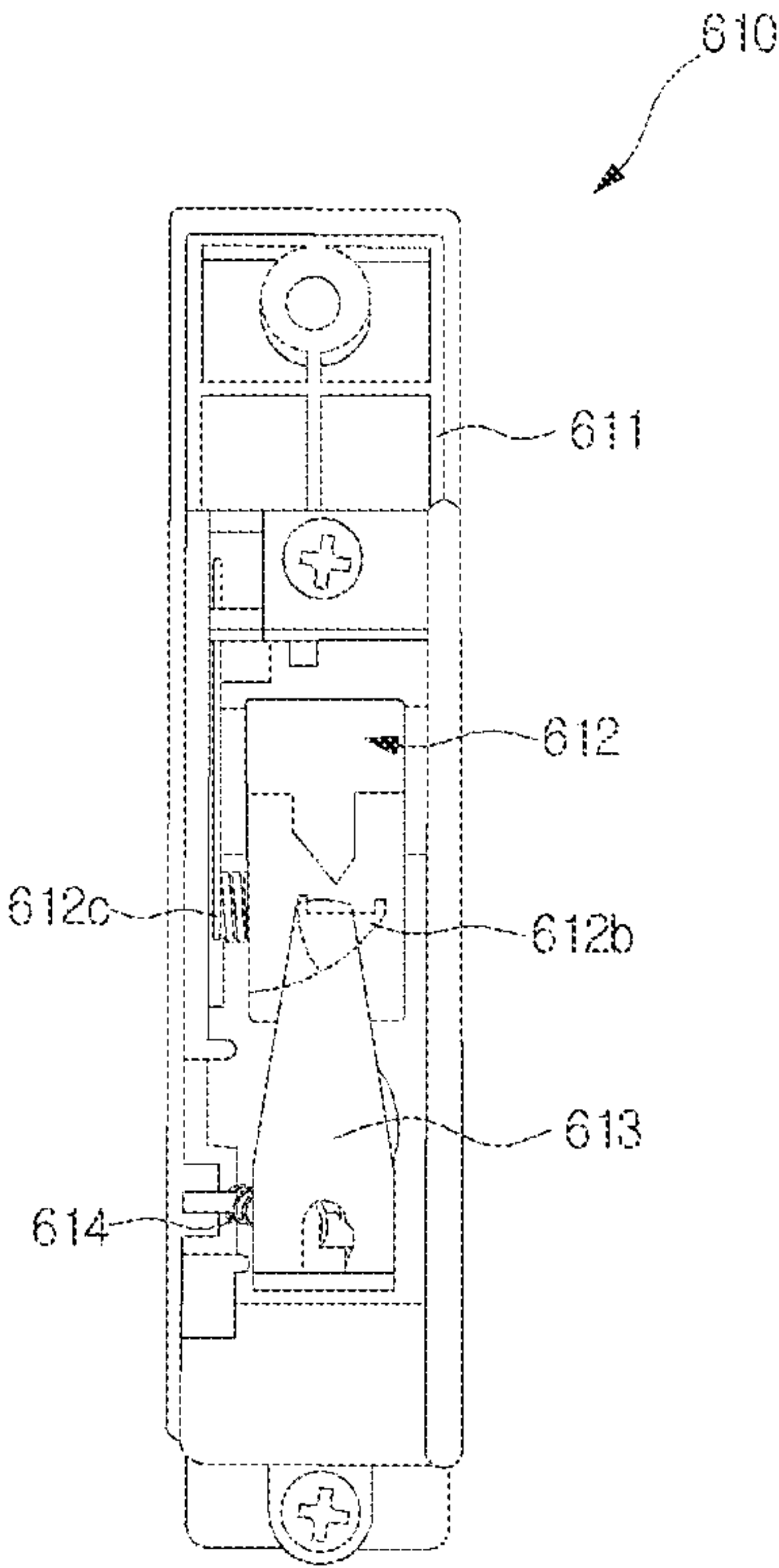


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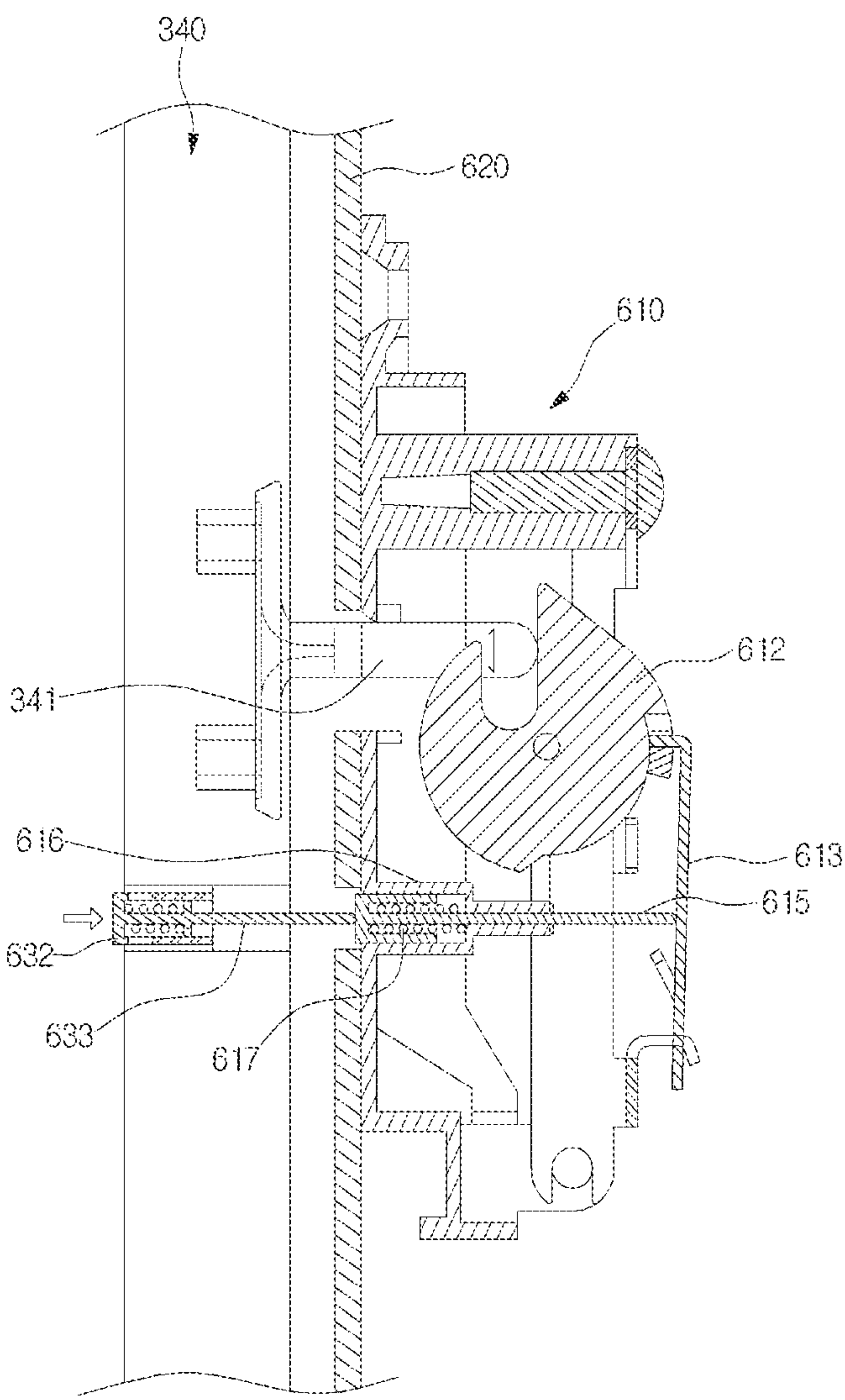


Fig. 31

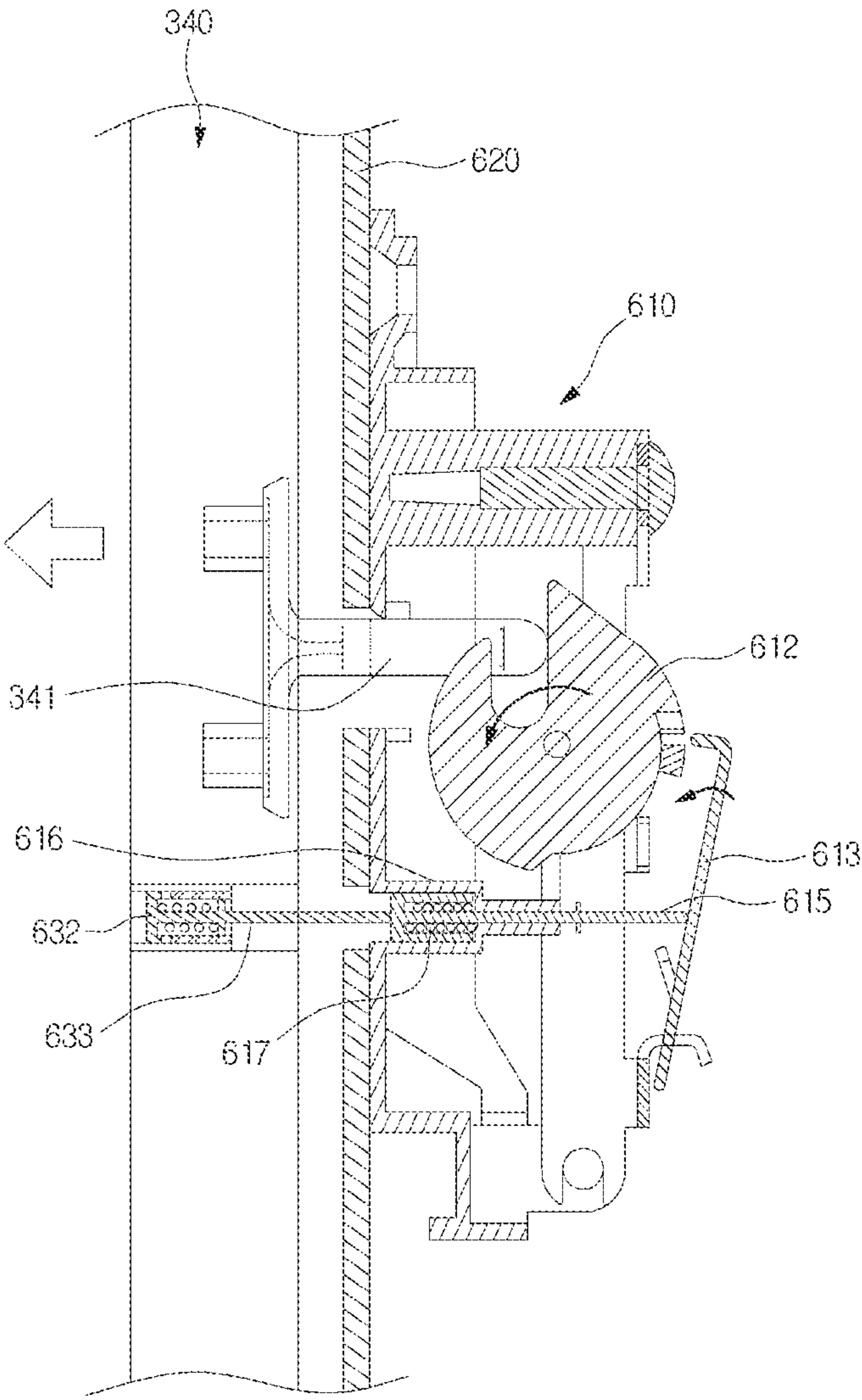


Fig. 32

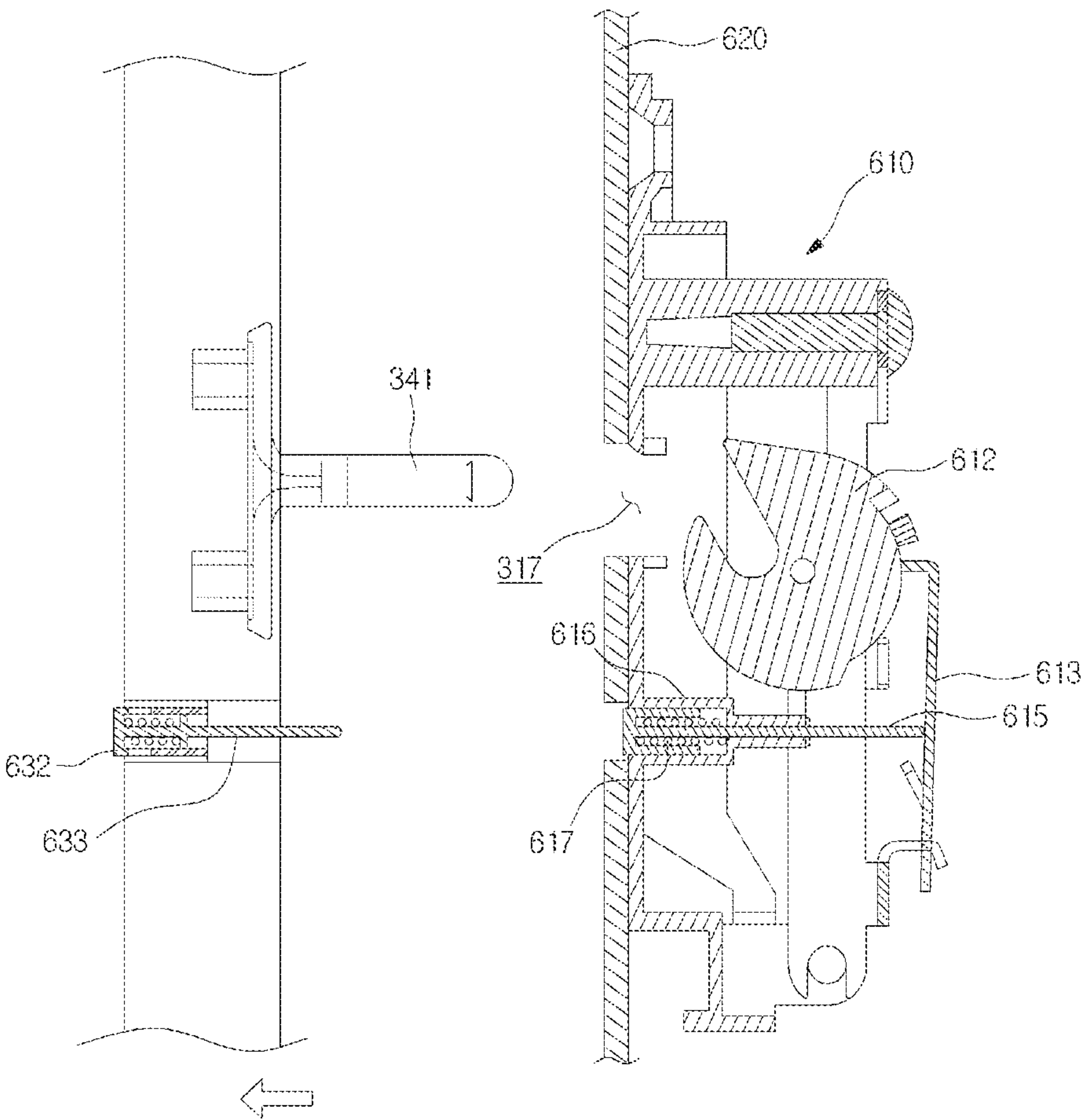


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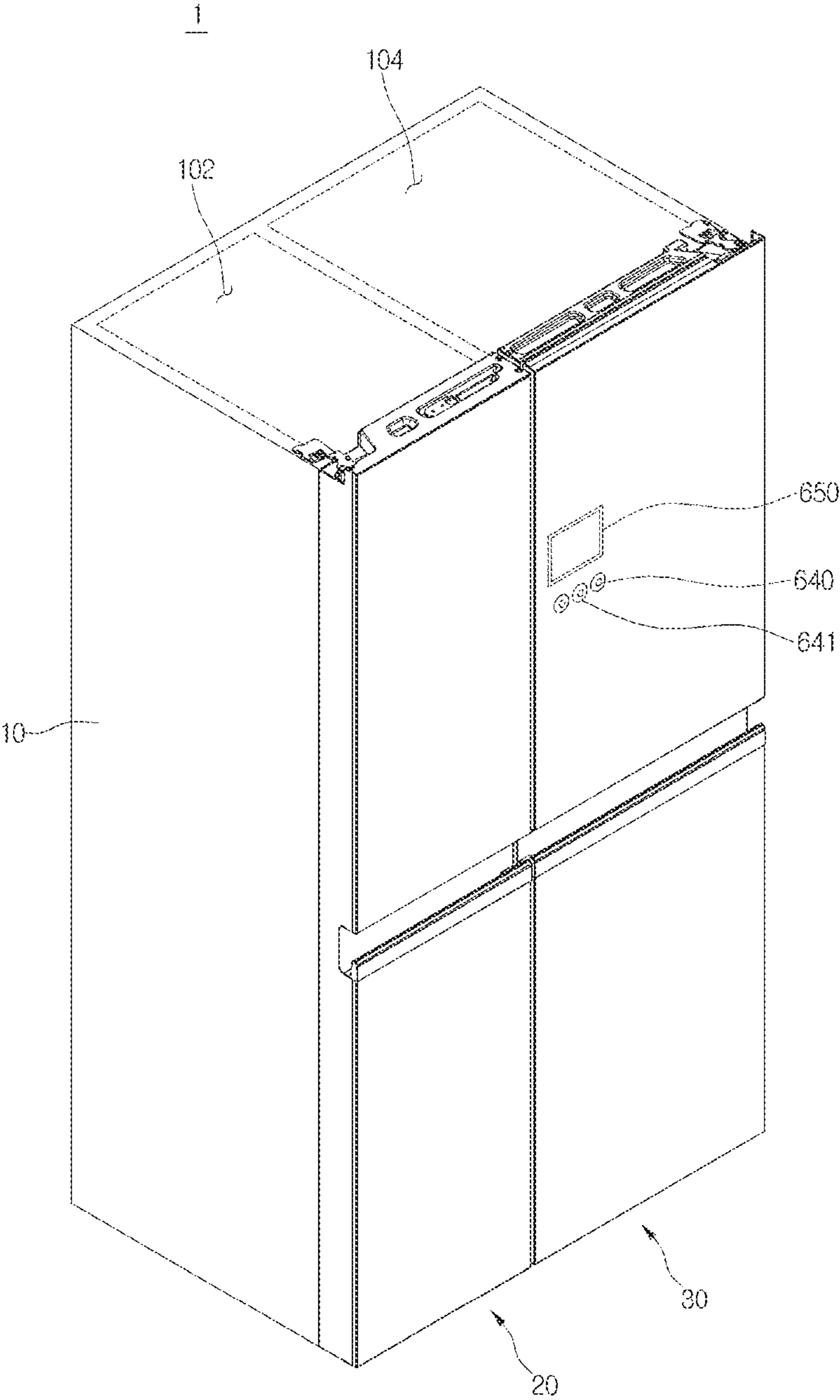


Fig. 34

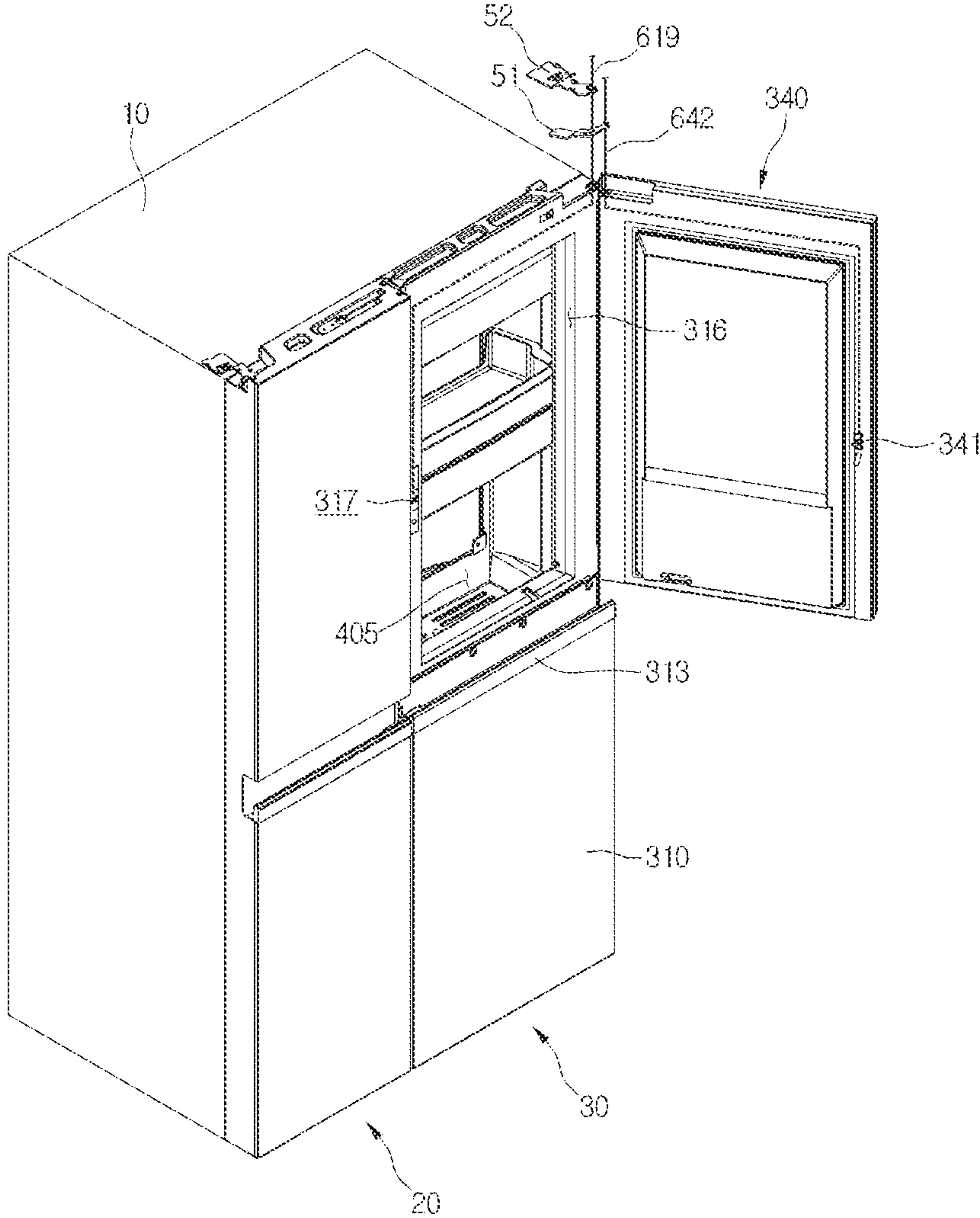


Fig. 35

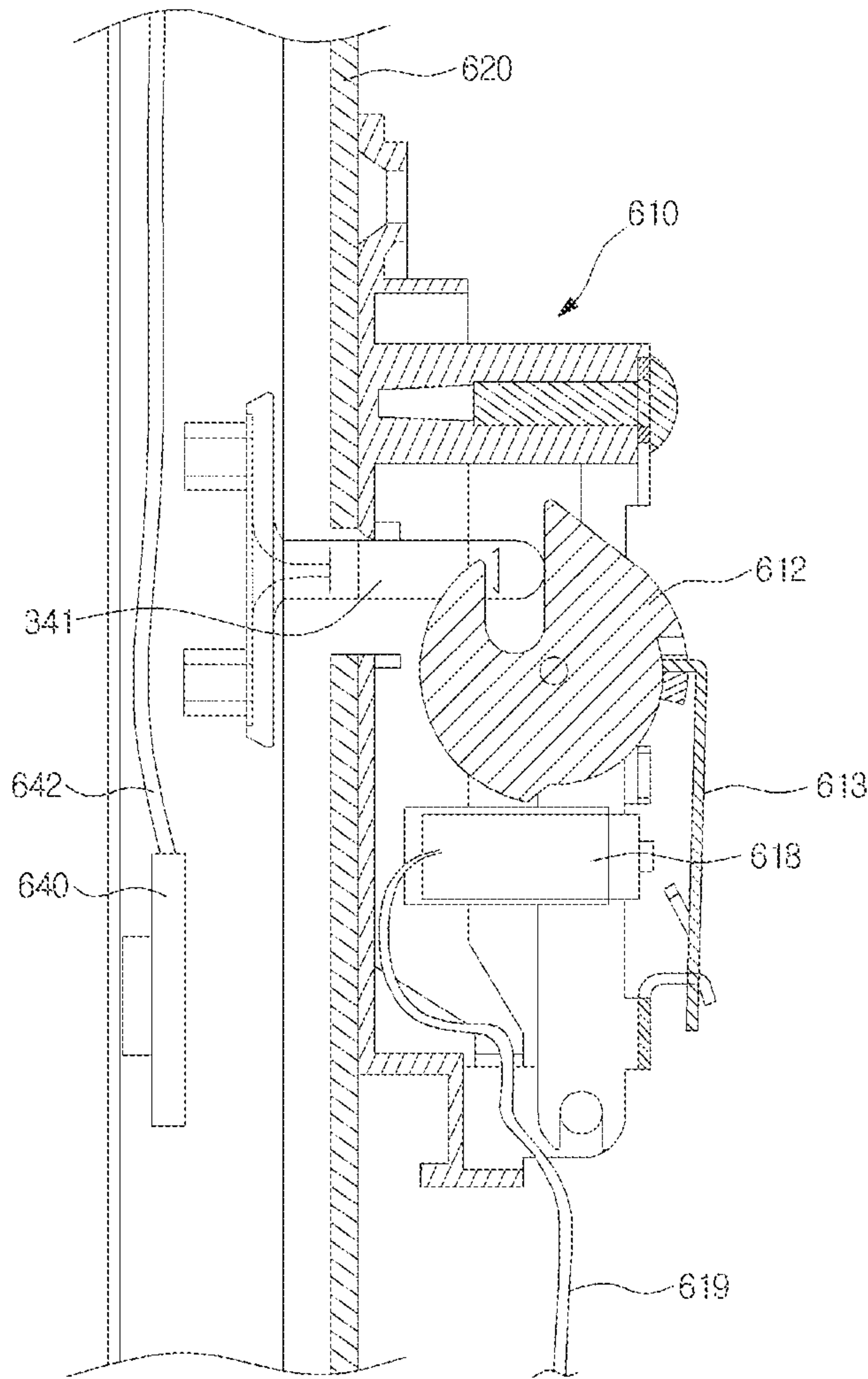


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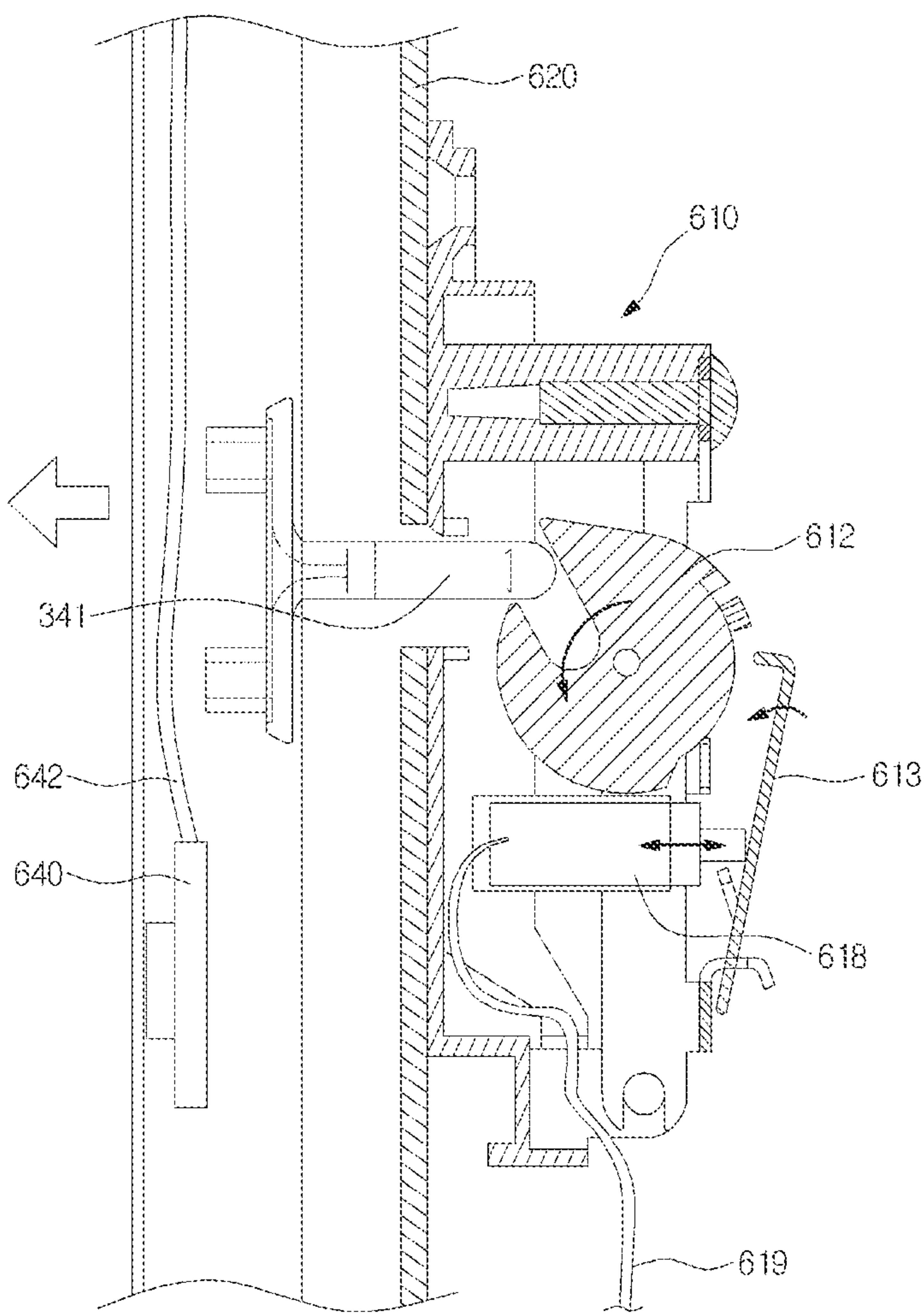


Fig. 38

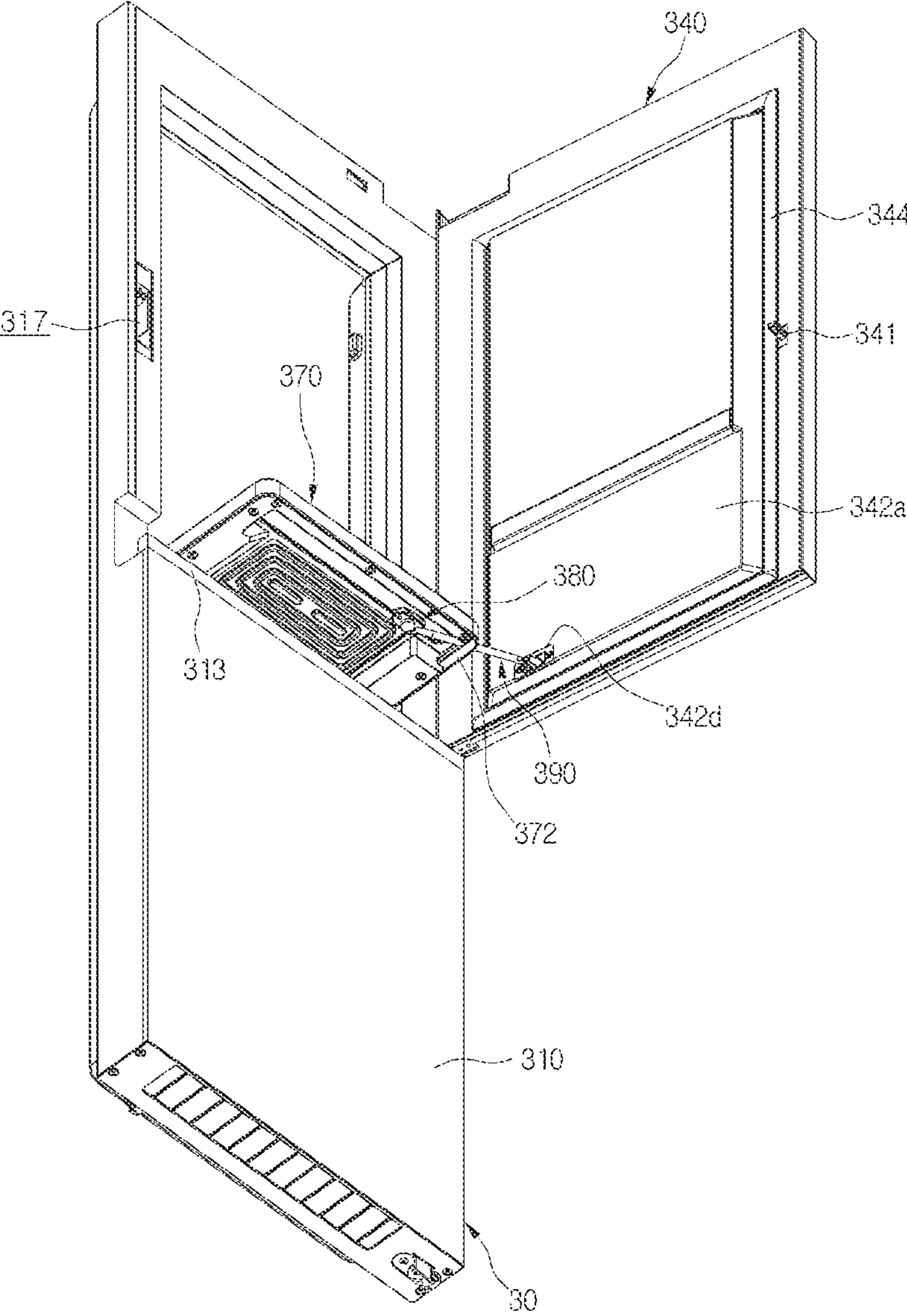


Fig. 39

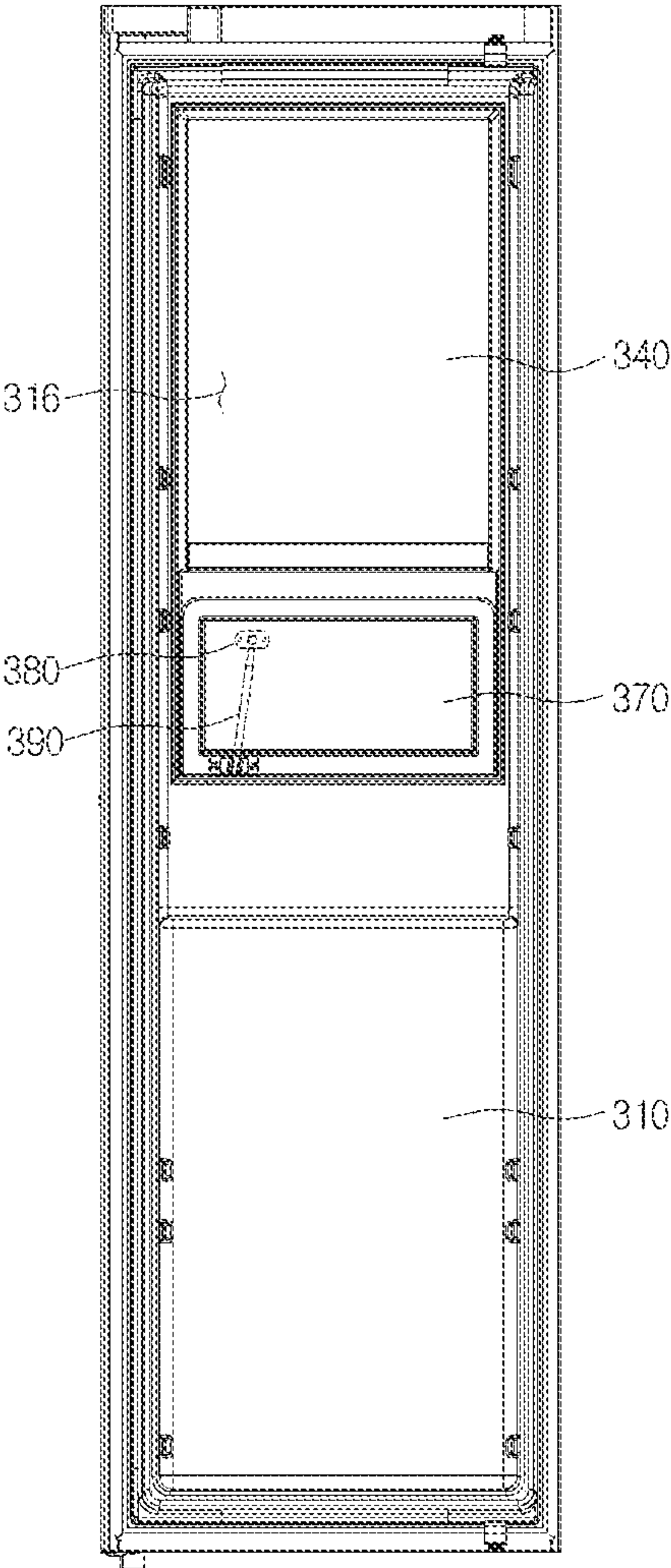


Fig. 40

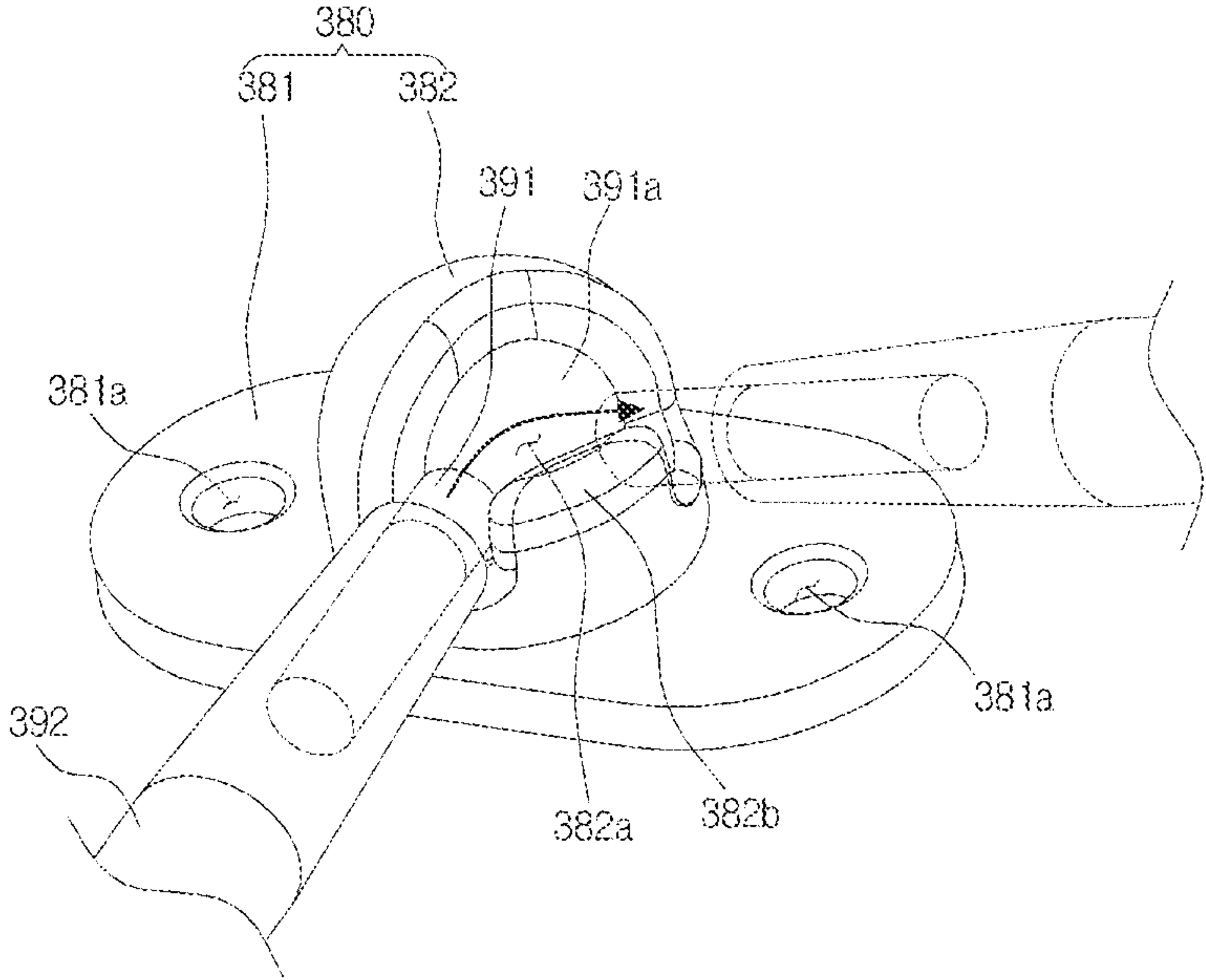


Fig. 41

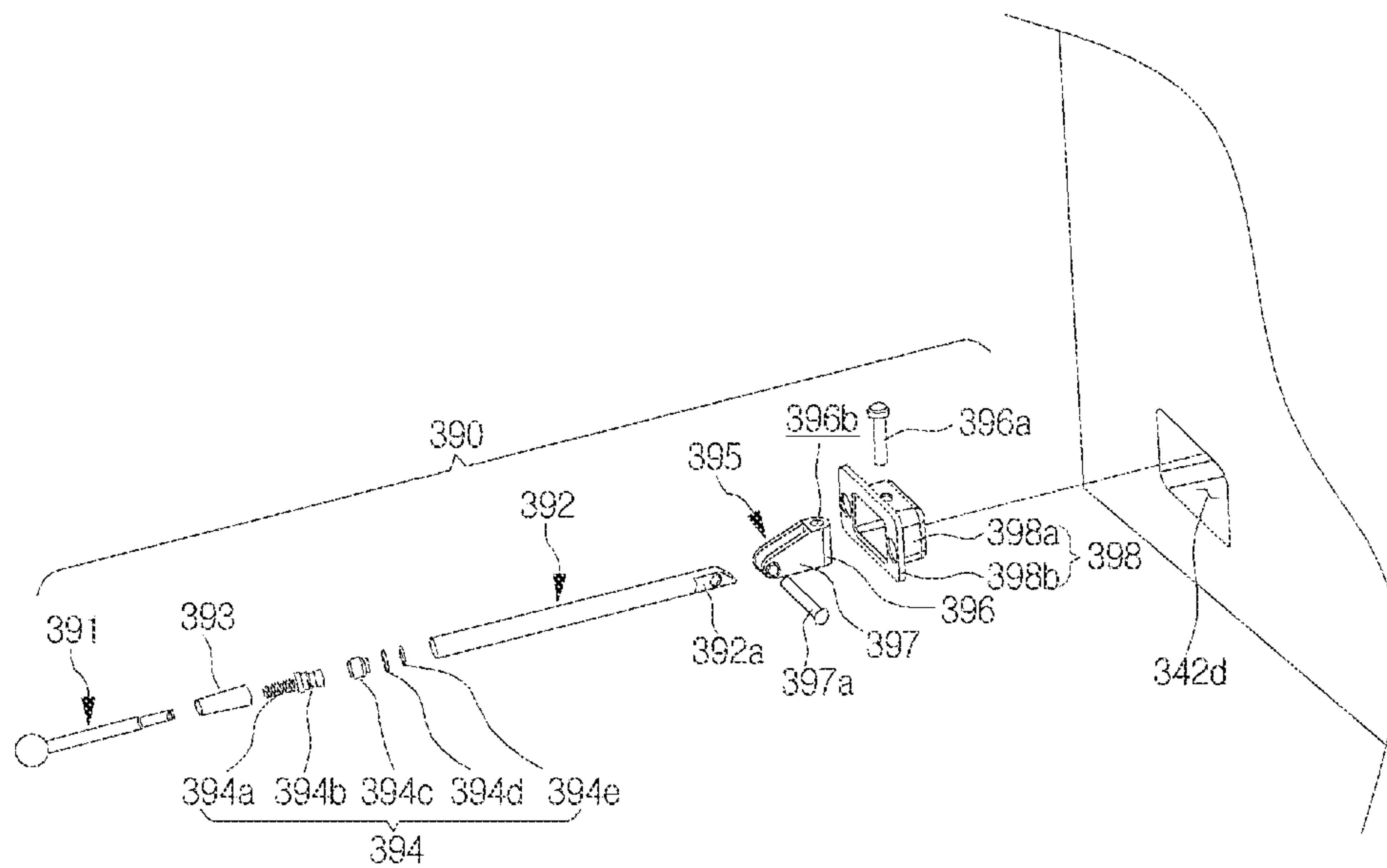


Fig. 42A

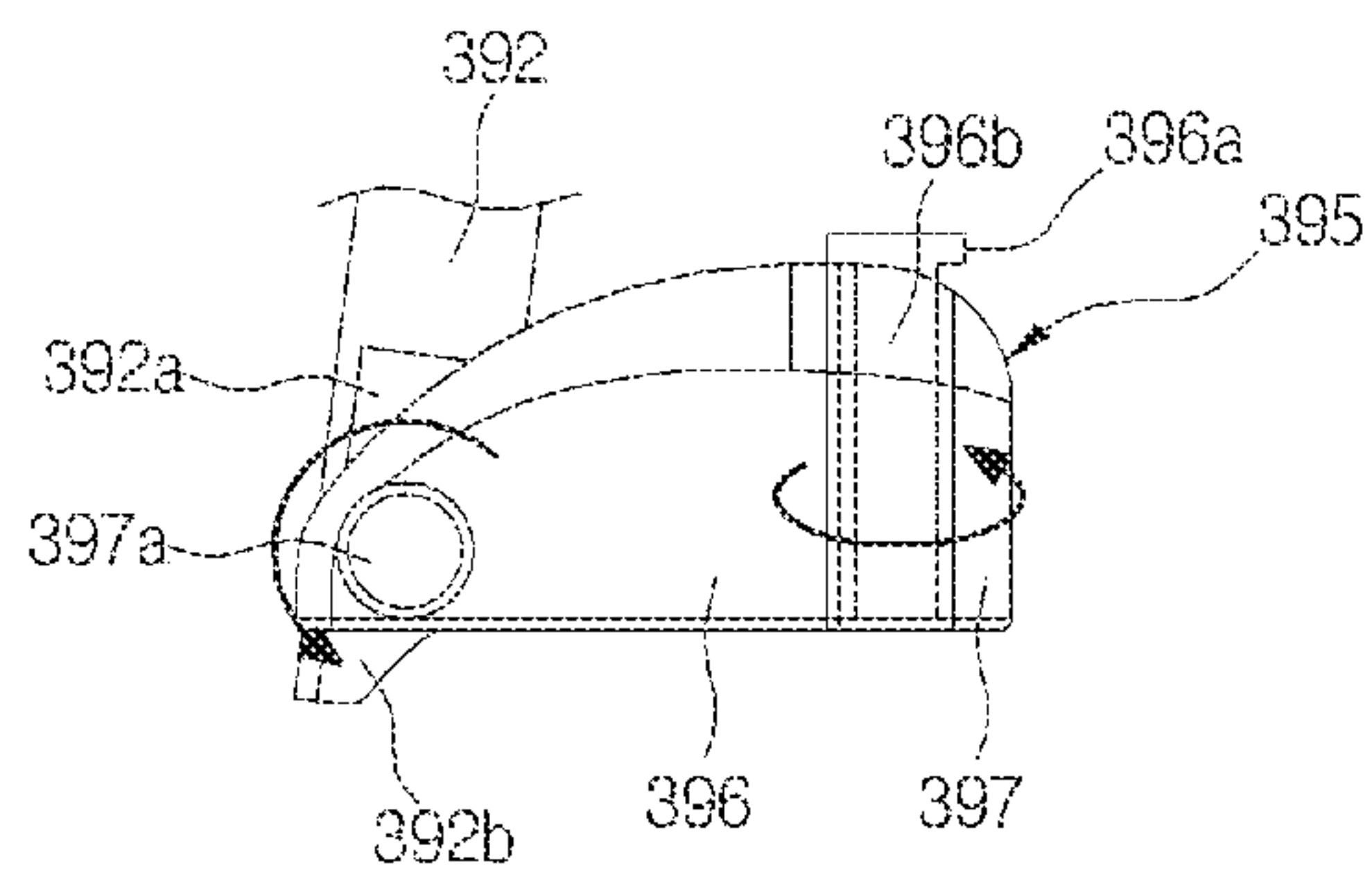


Fig. 42B

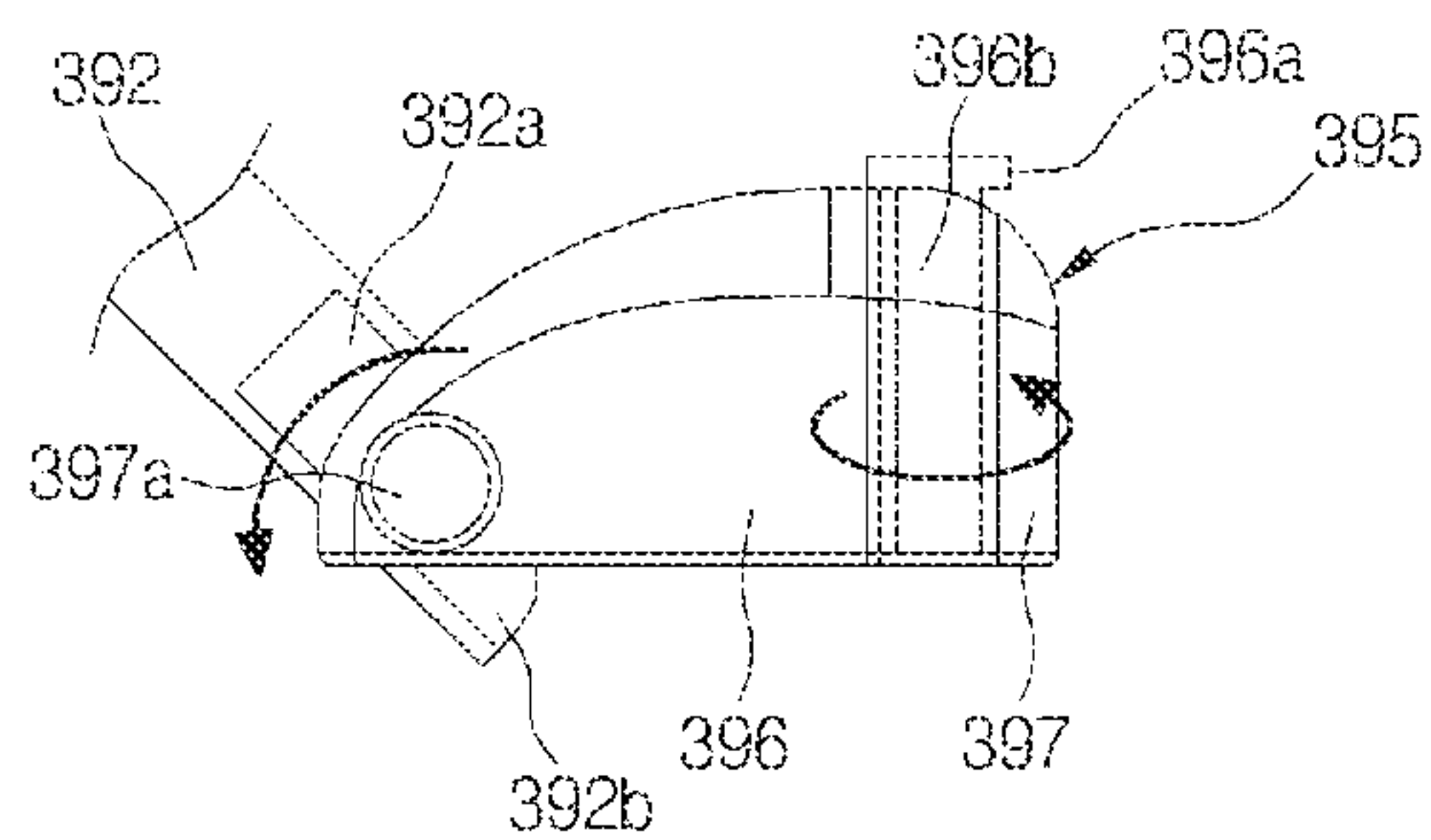


Fig. 42C

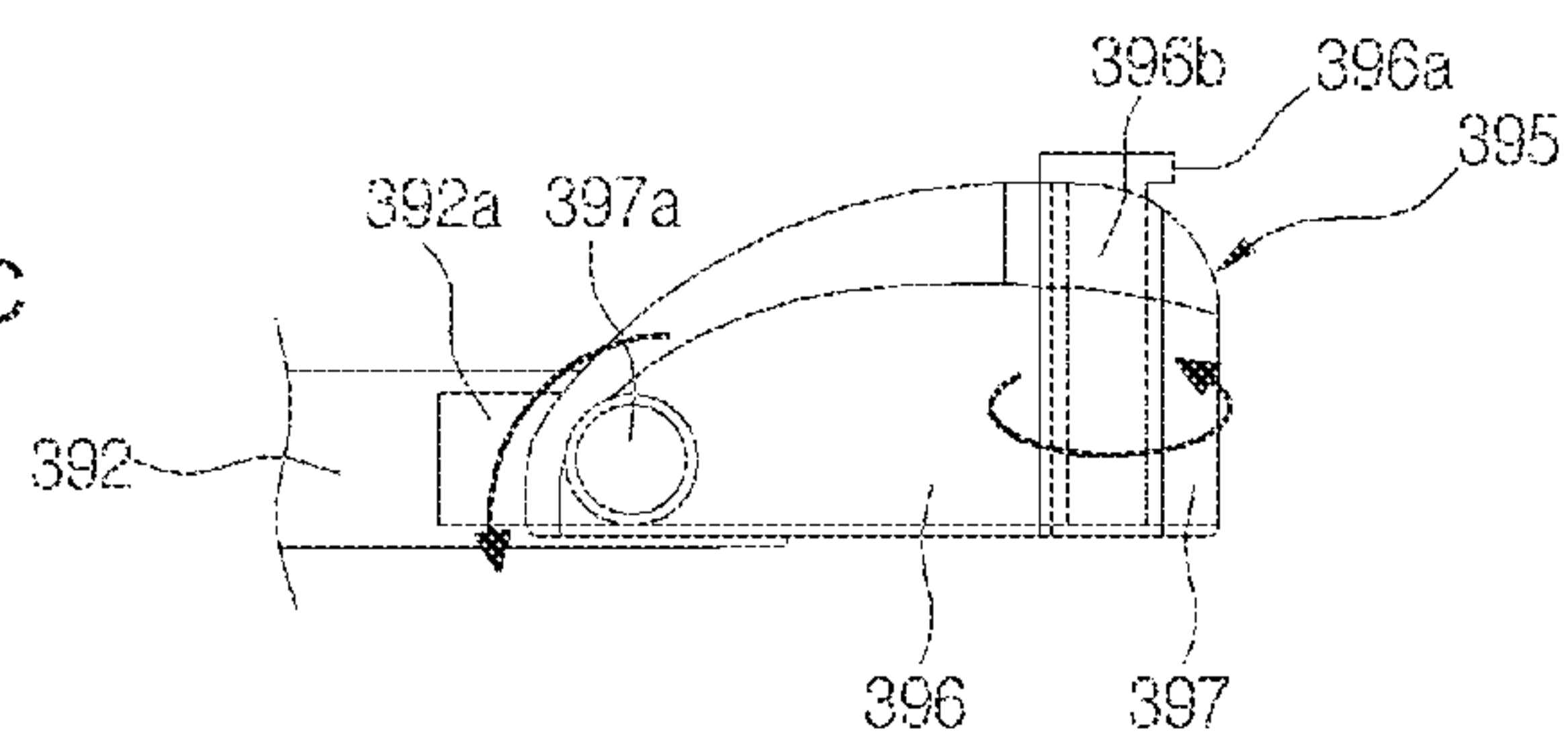


Fig. 43

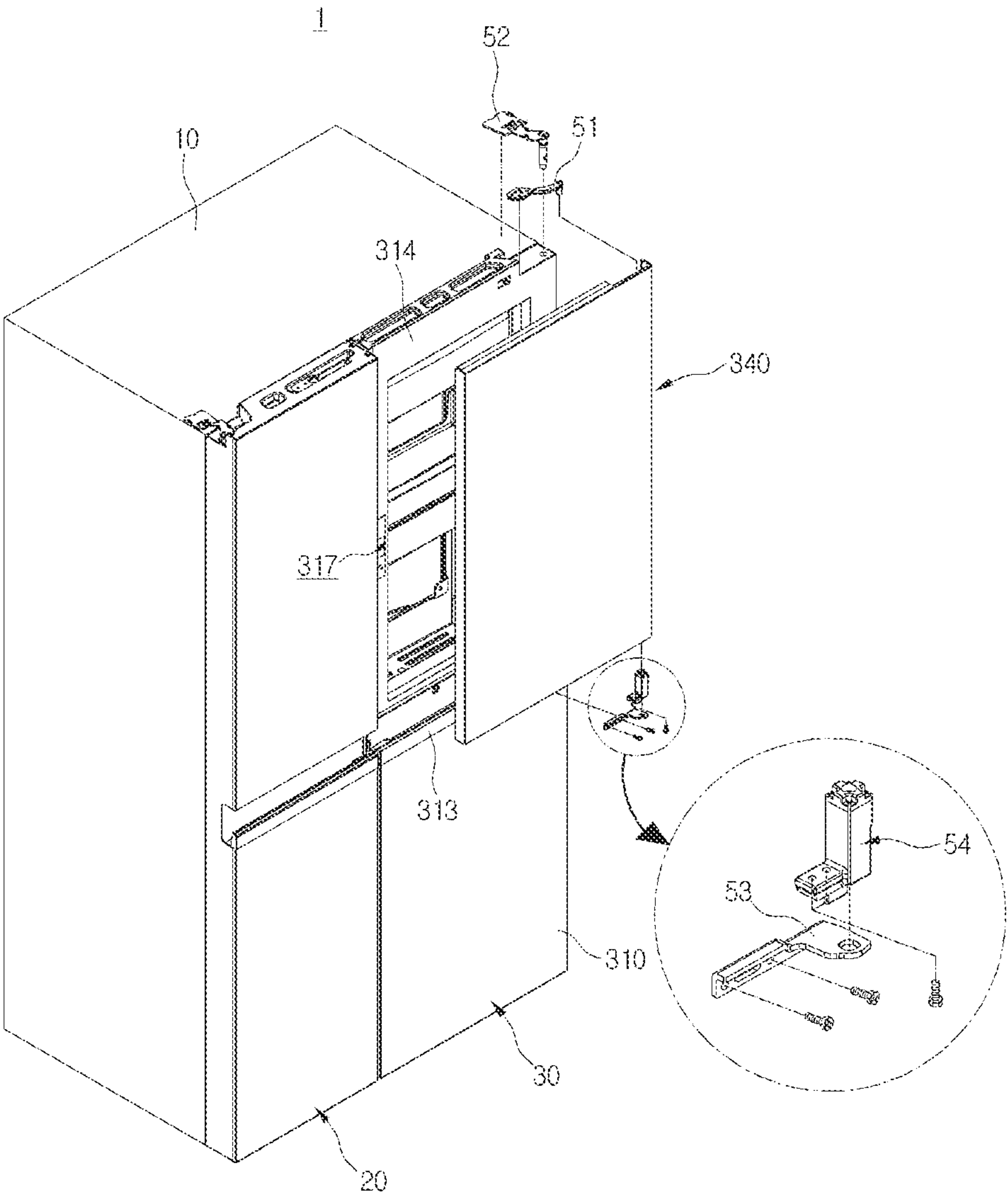


Fig. 44

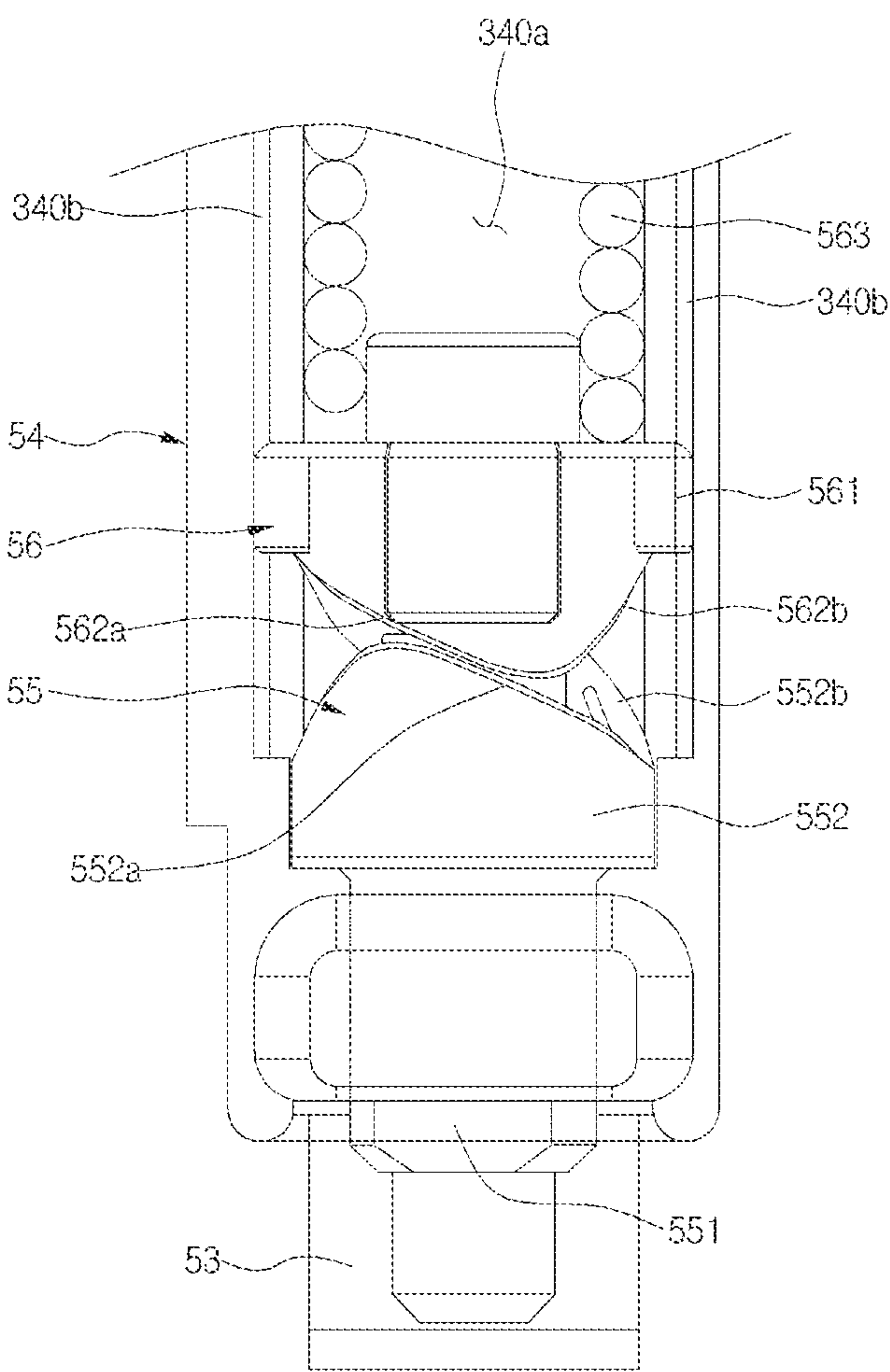


Fig. 45

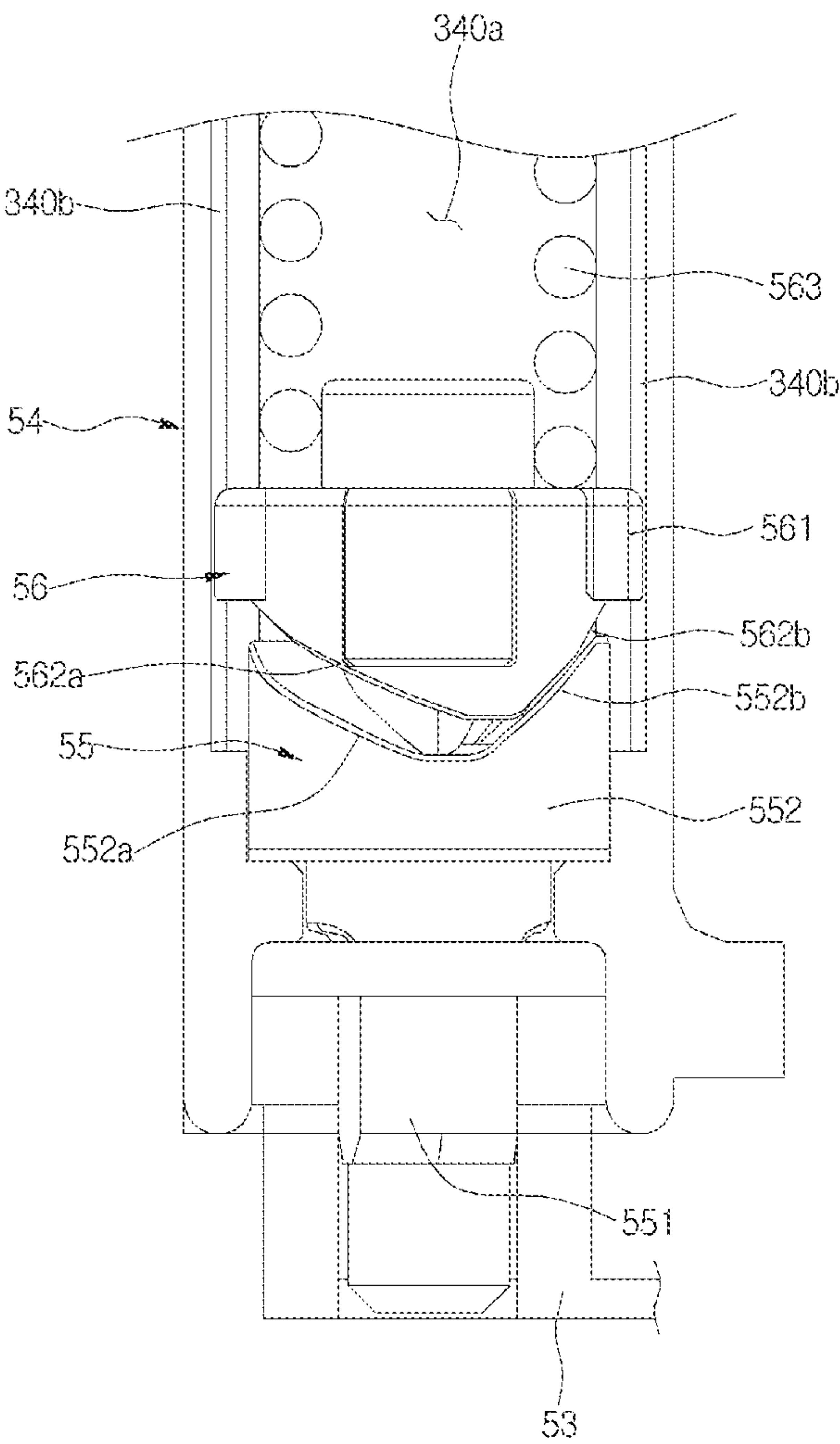


Fig. 46

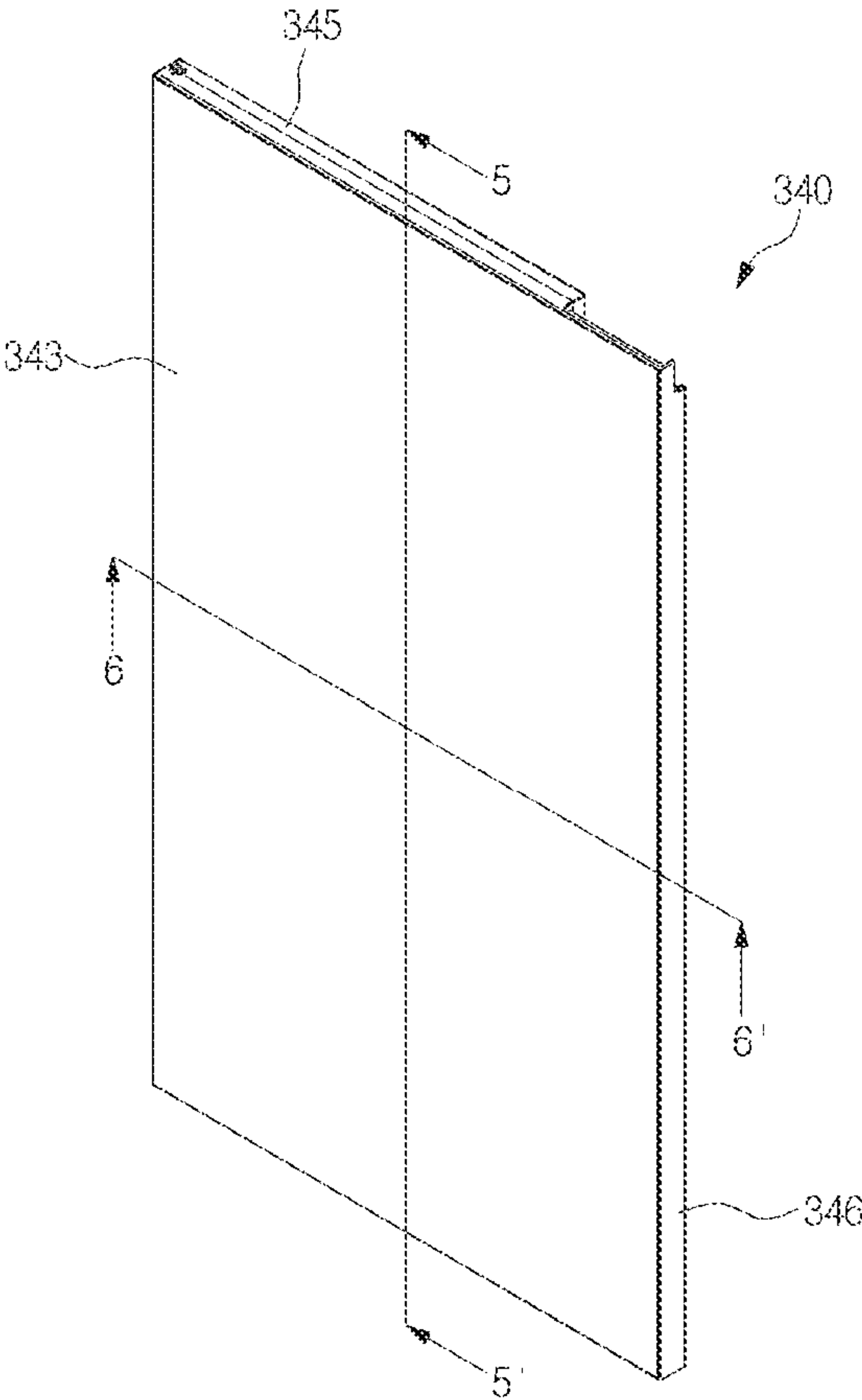


Fig. 47

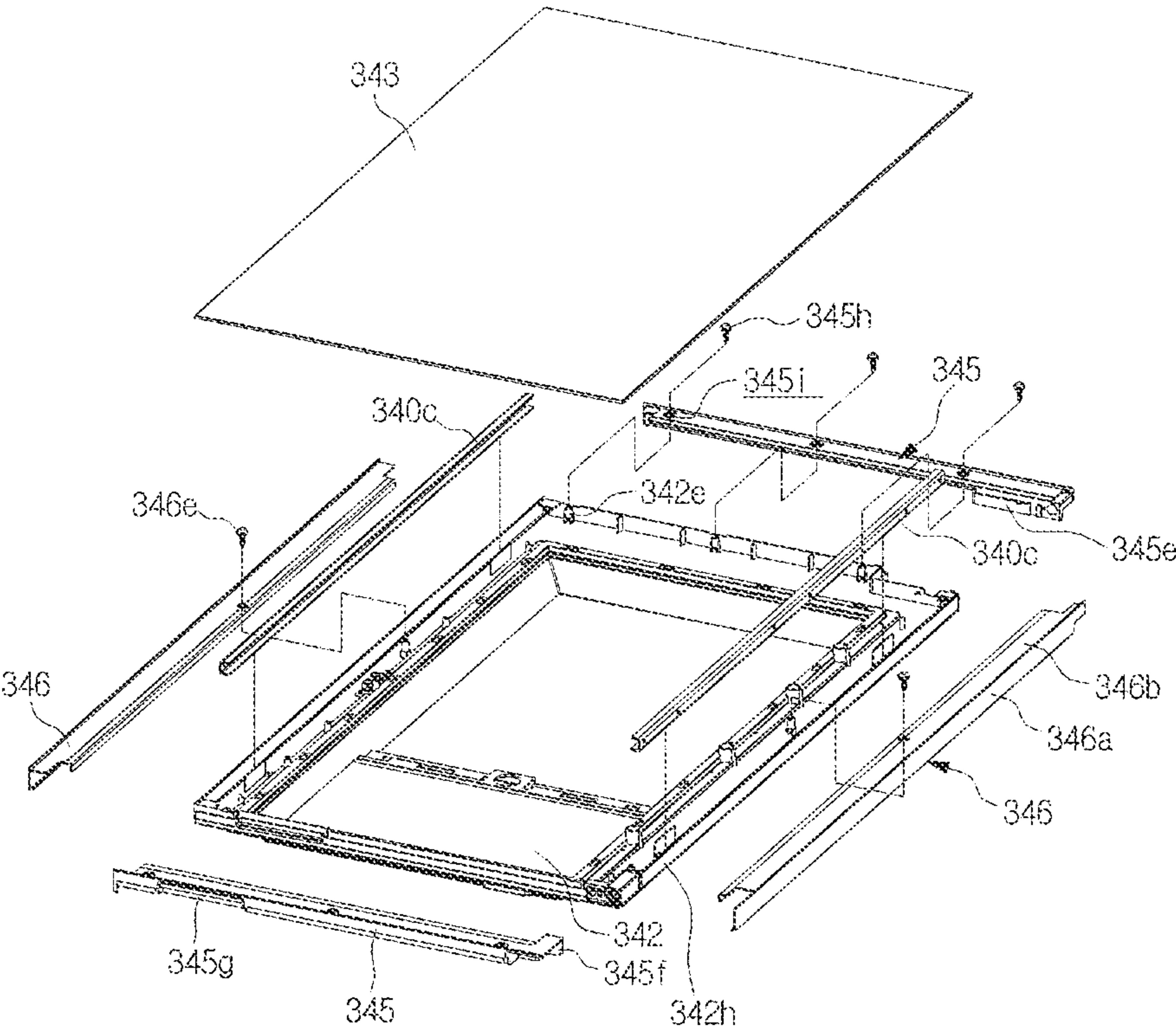


Fig. 48

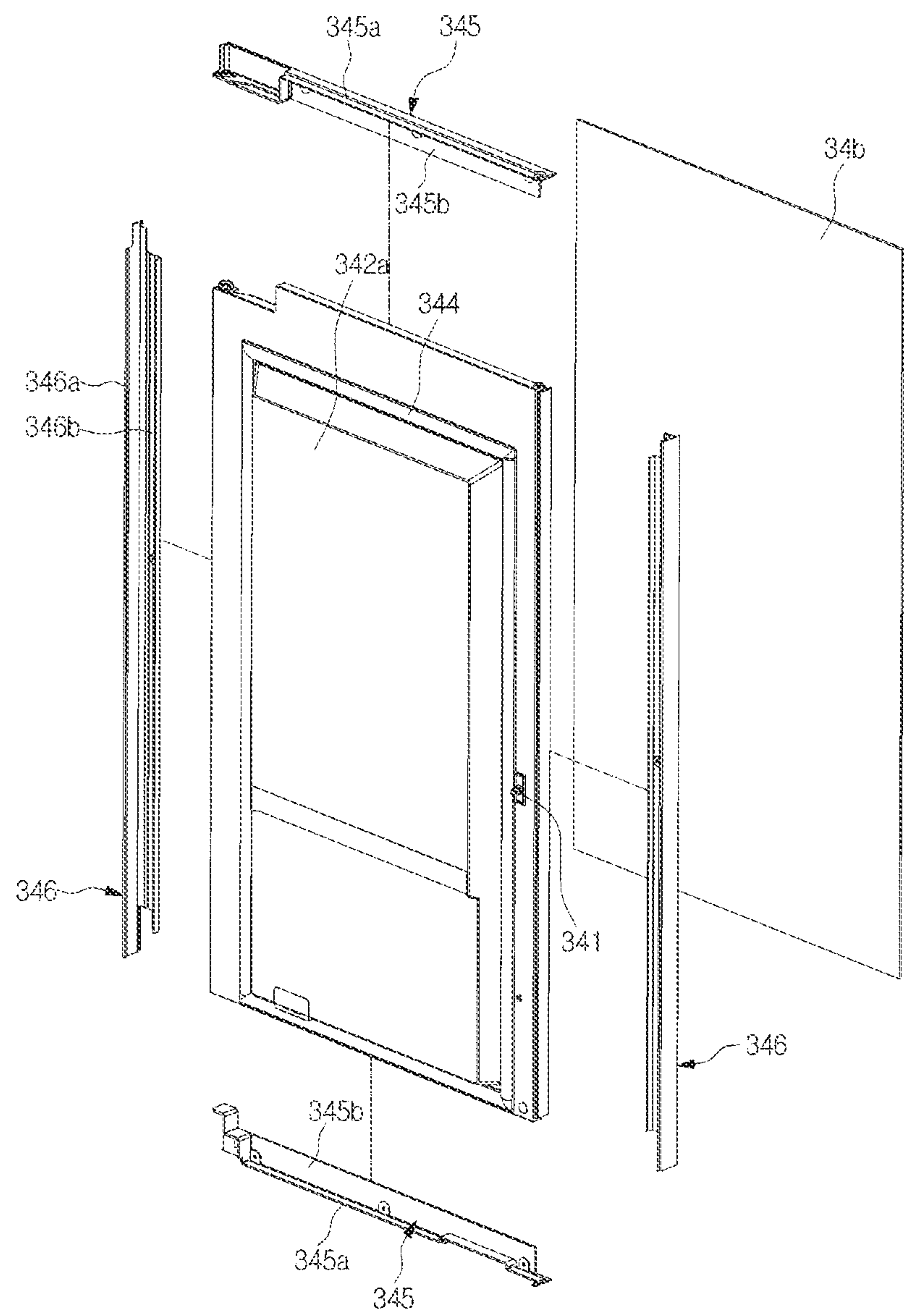


Fig. 49

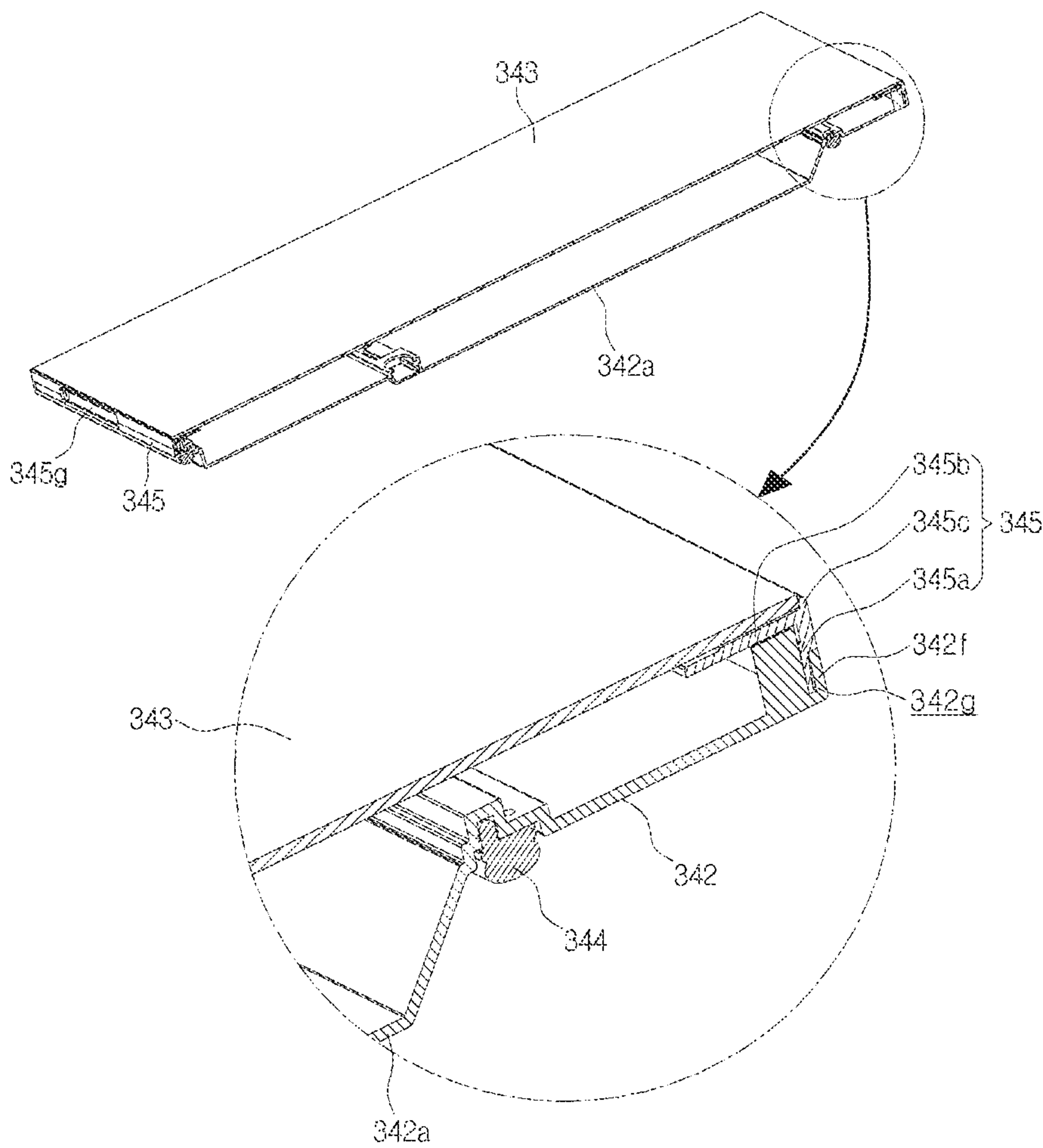


Fig. 50

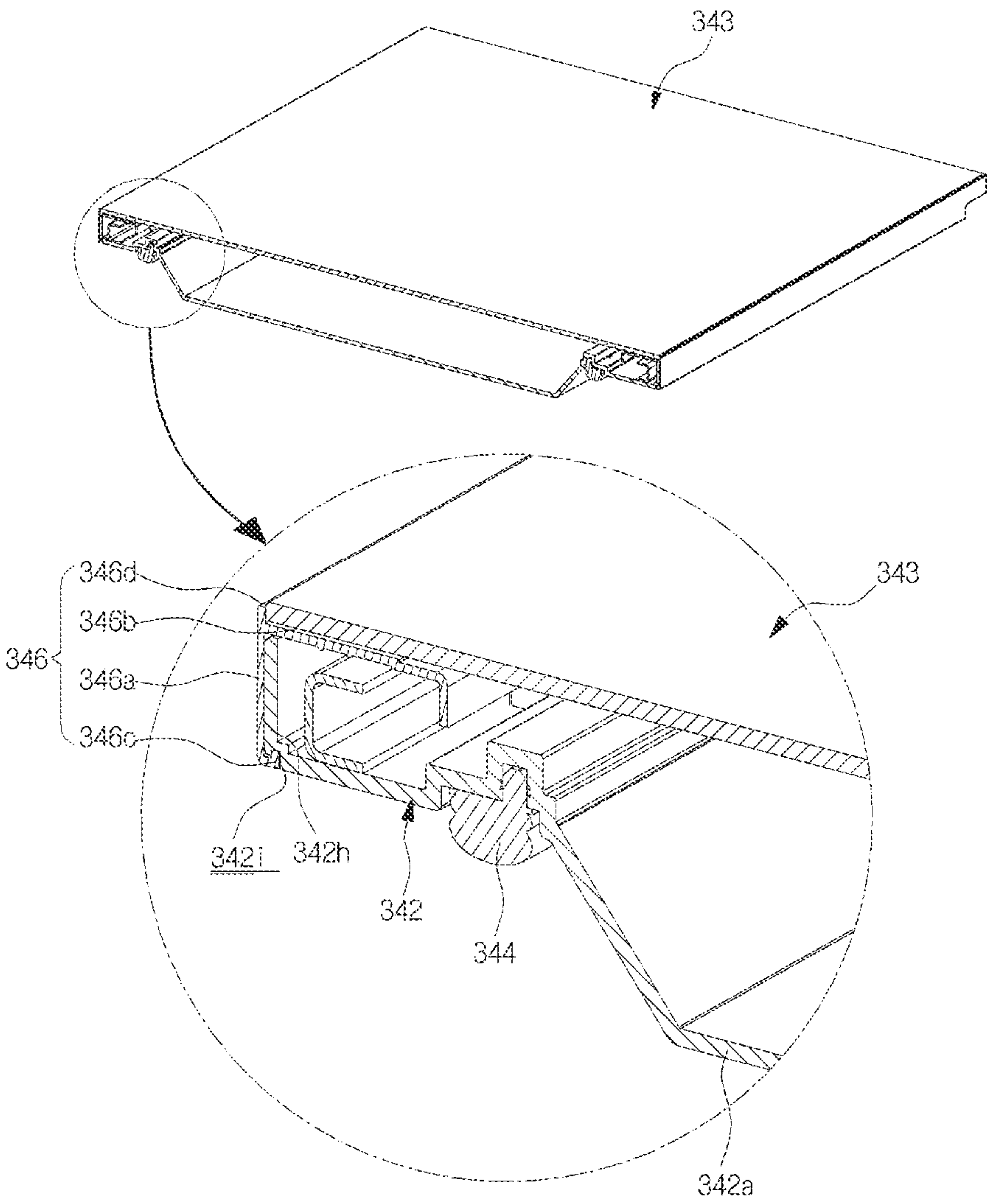


Fig. 51

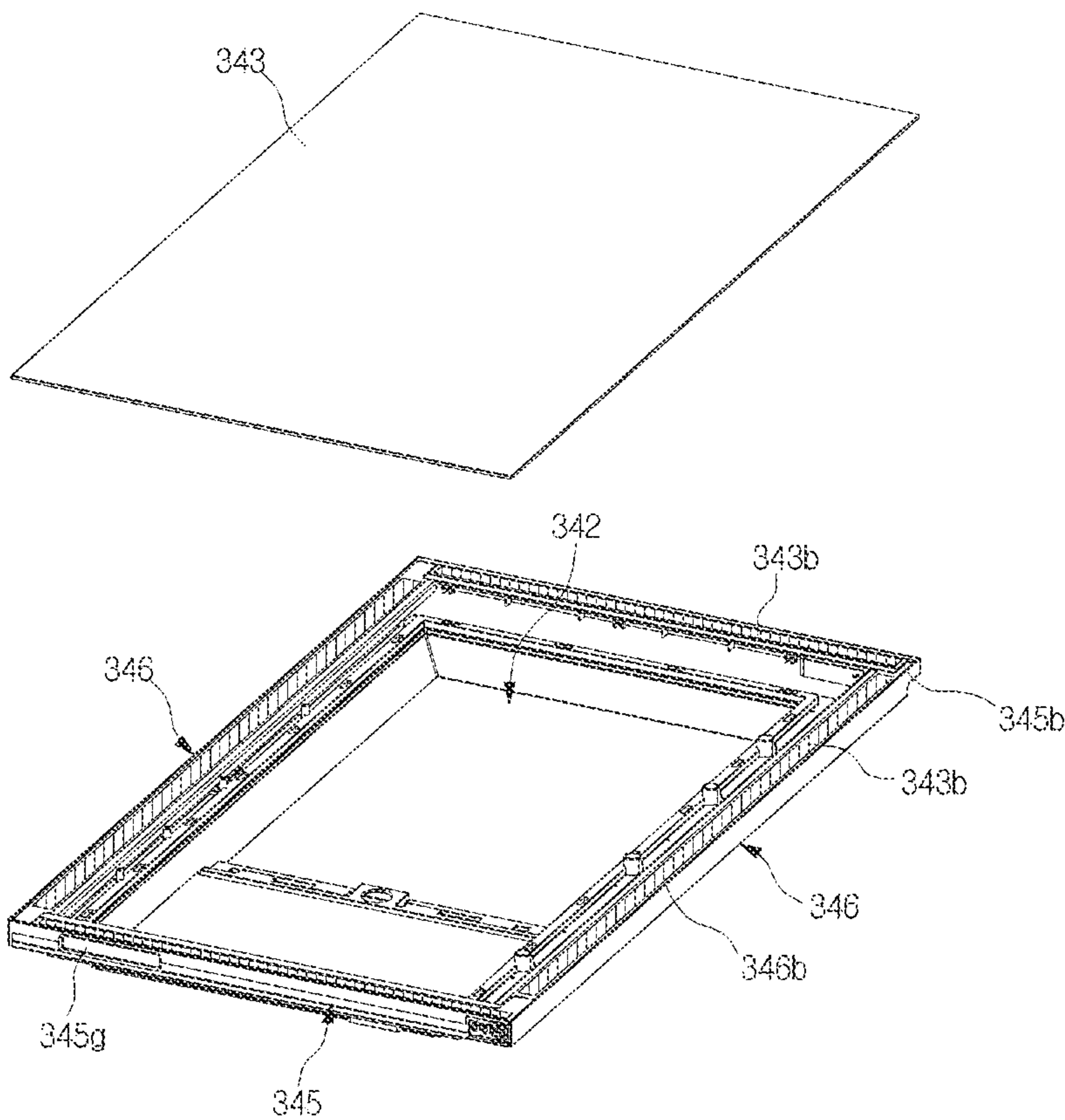


Fig. 52

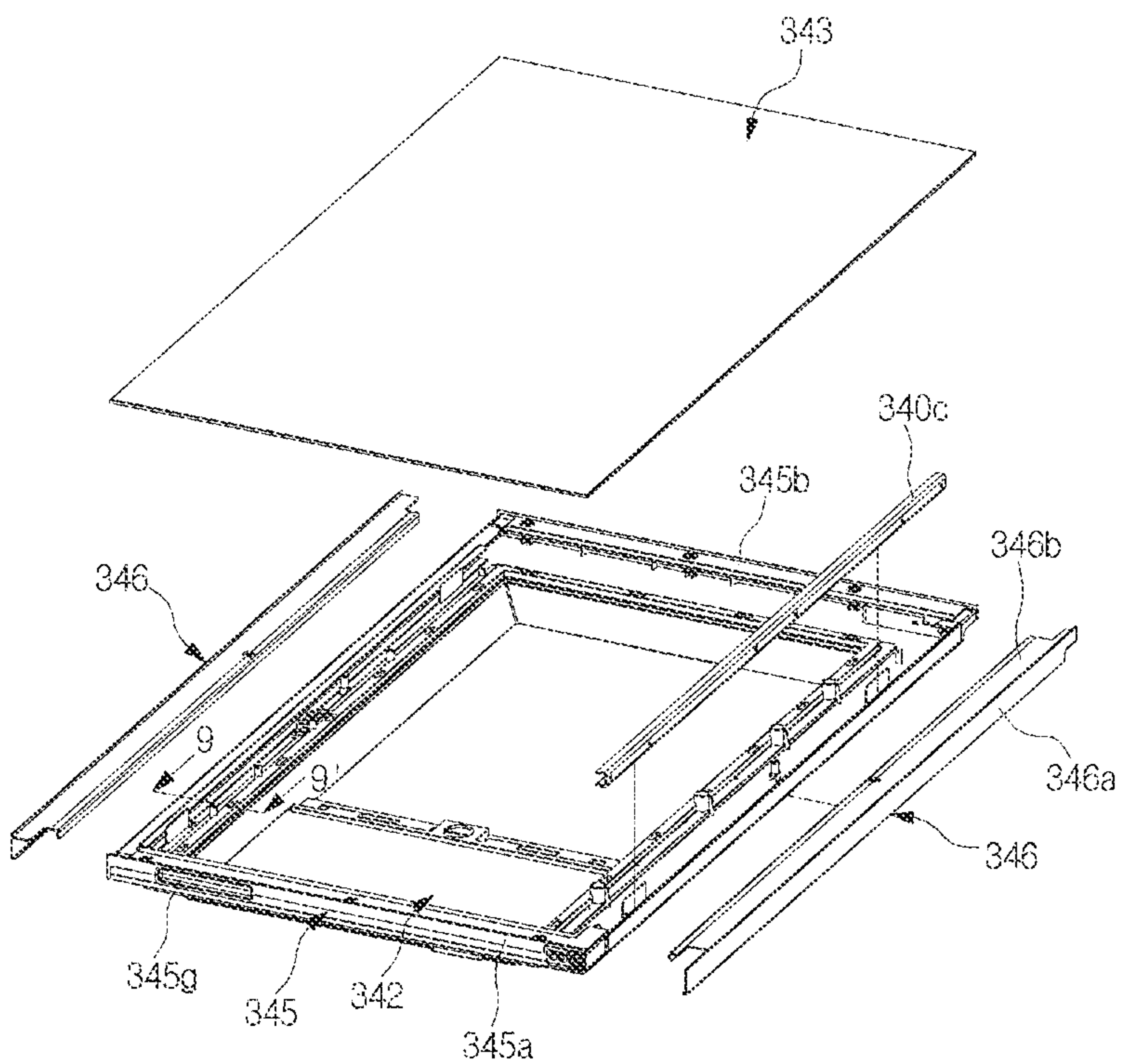


Fig. 53

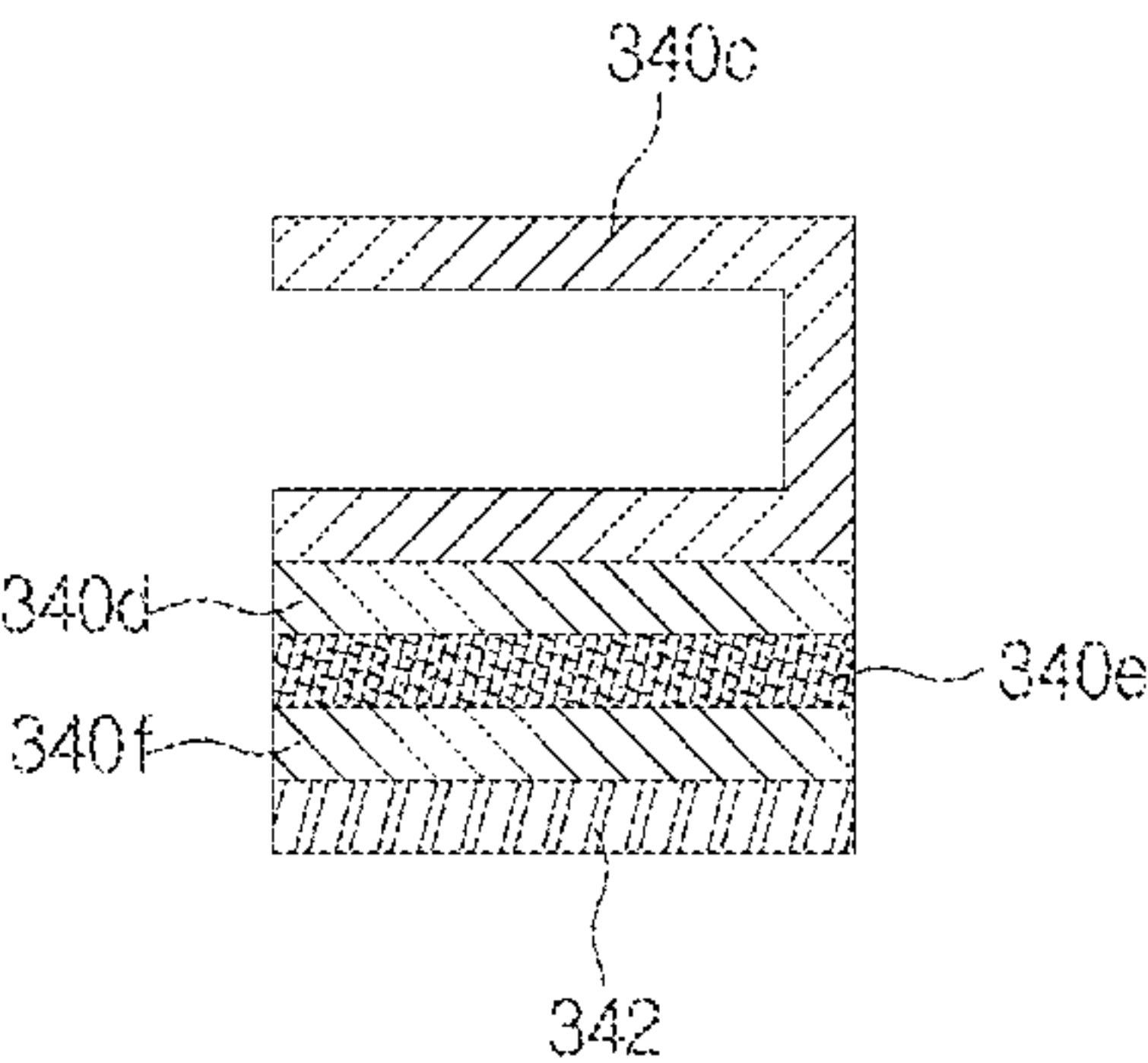


Fig. 54

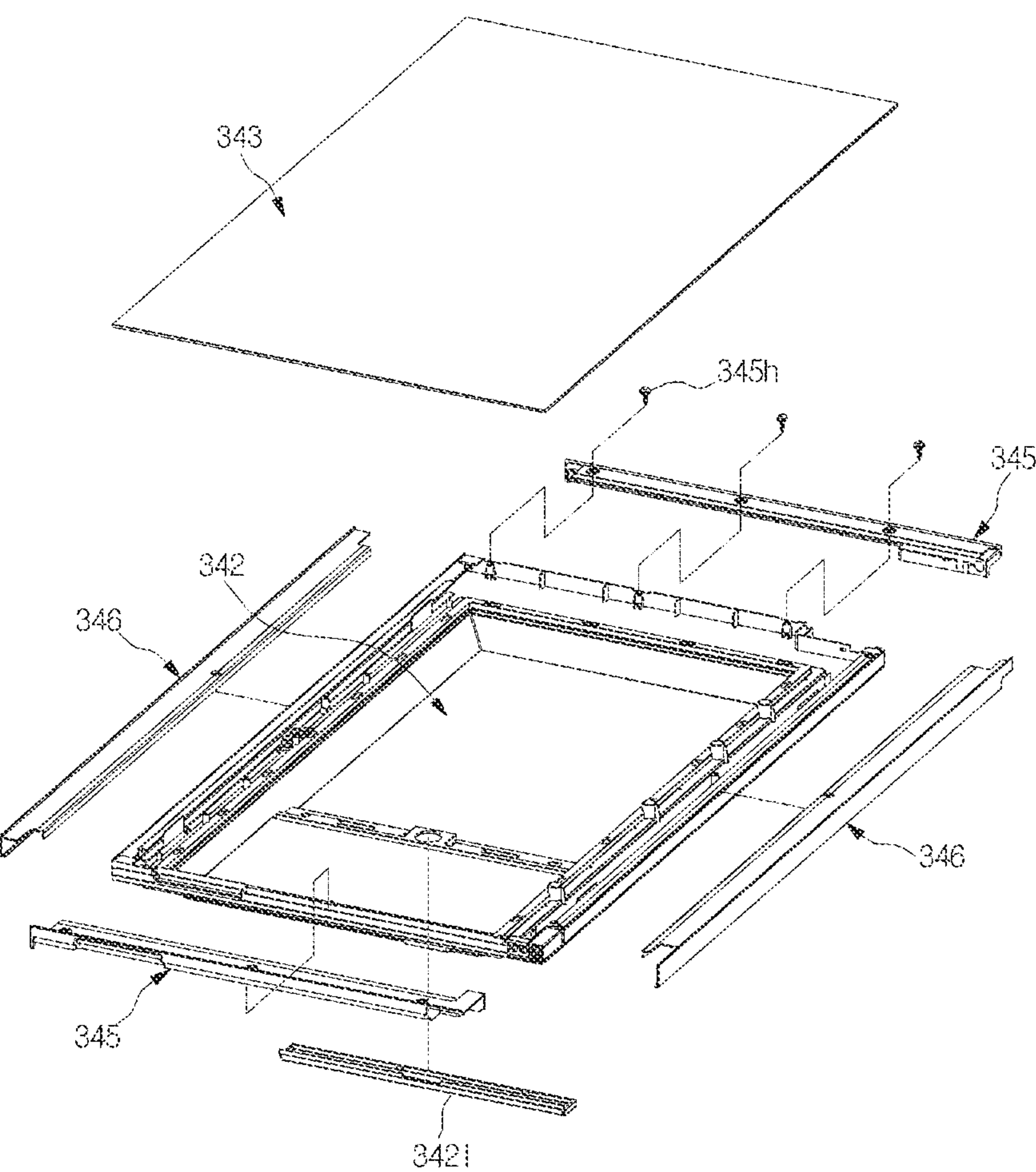


Fig. 55

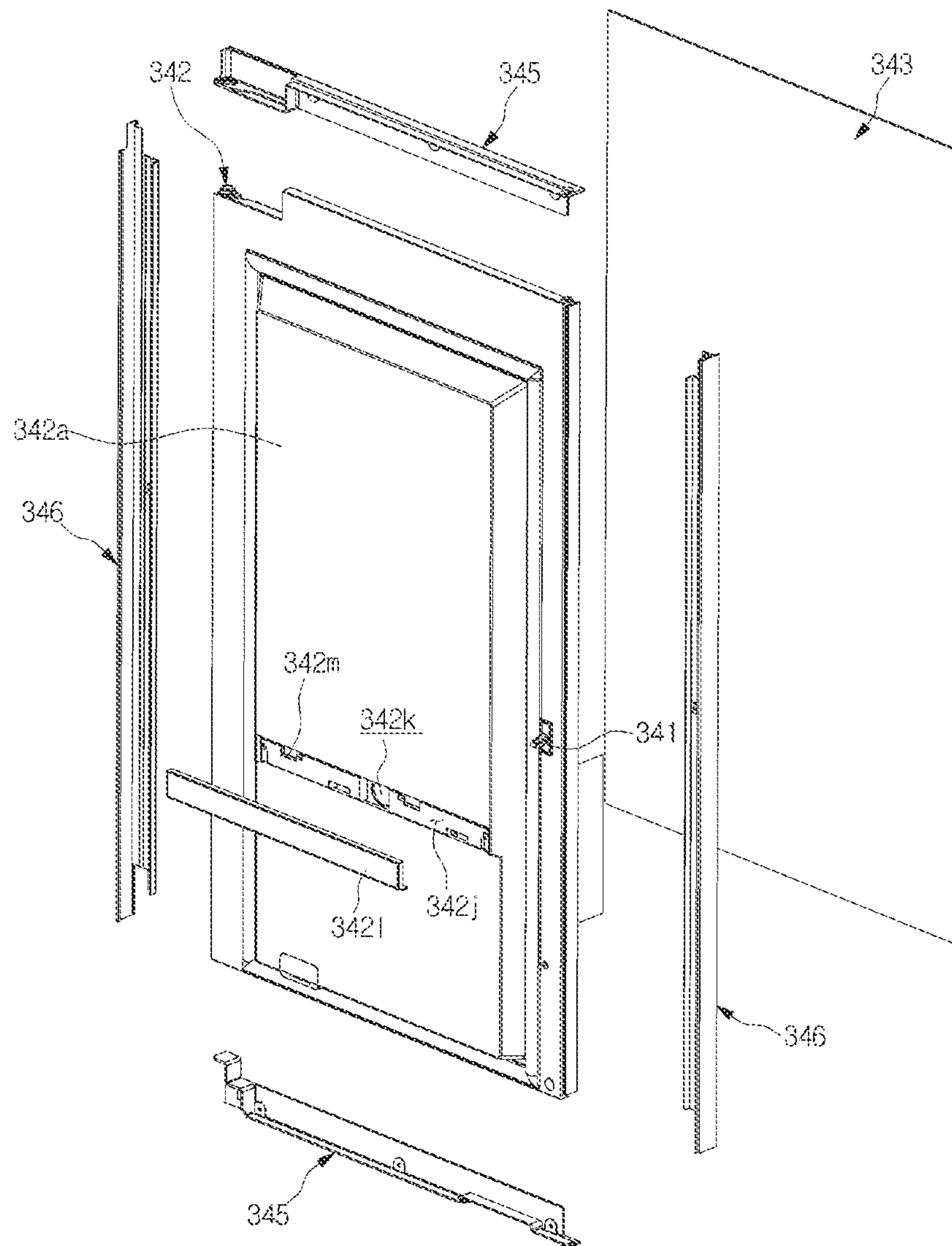


Fig. 56

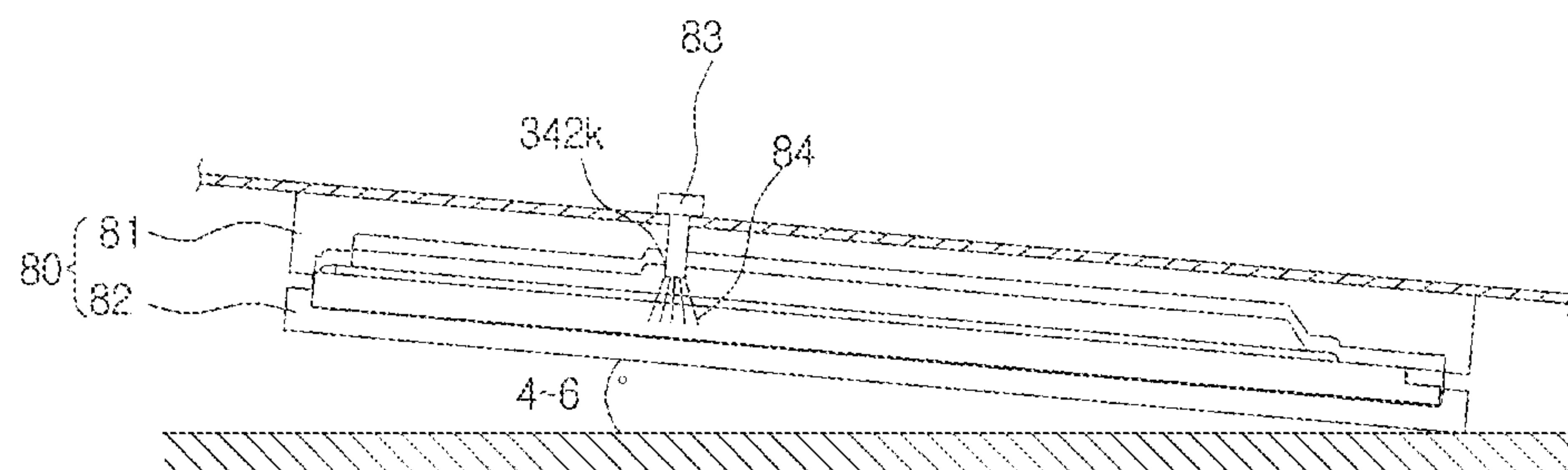


Fig. 57

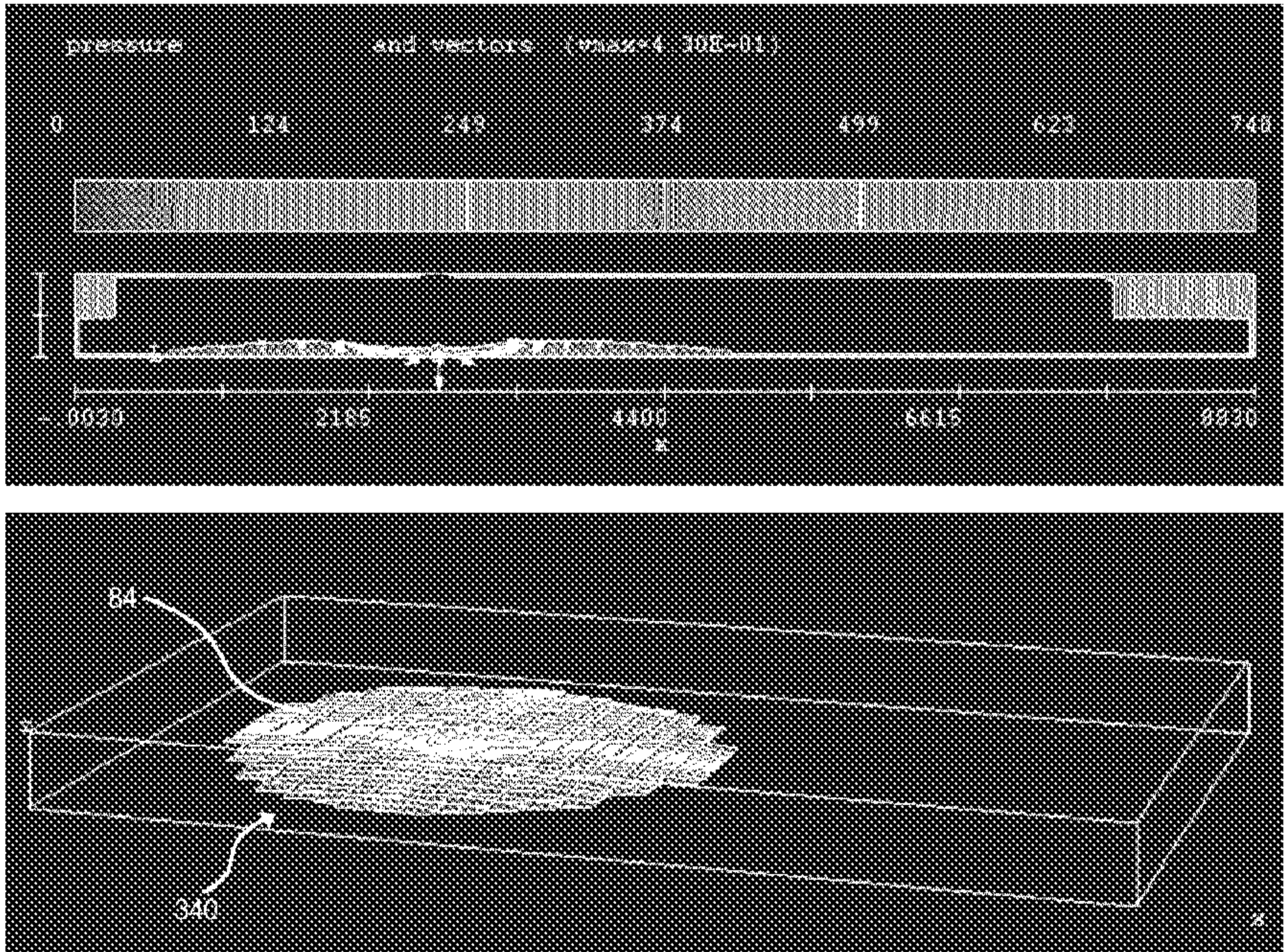


Fig. 58

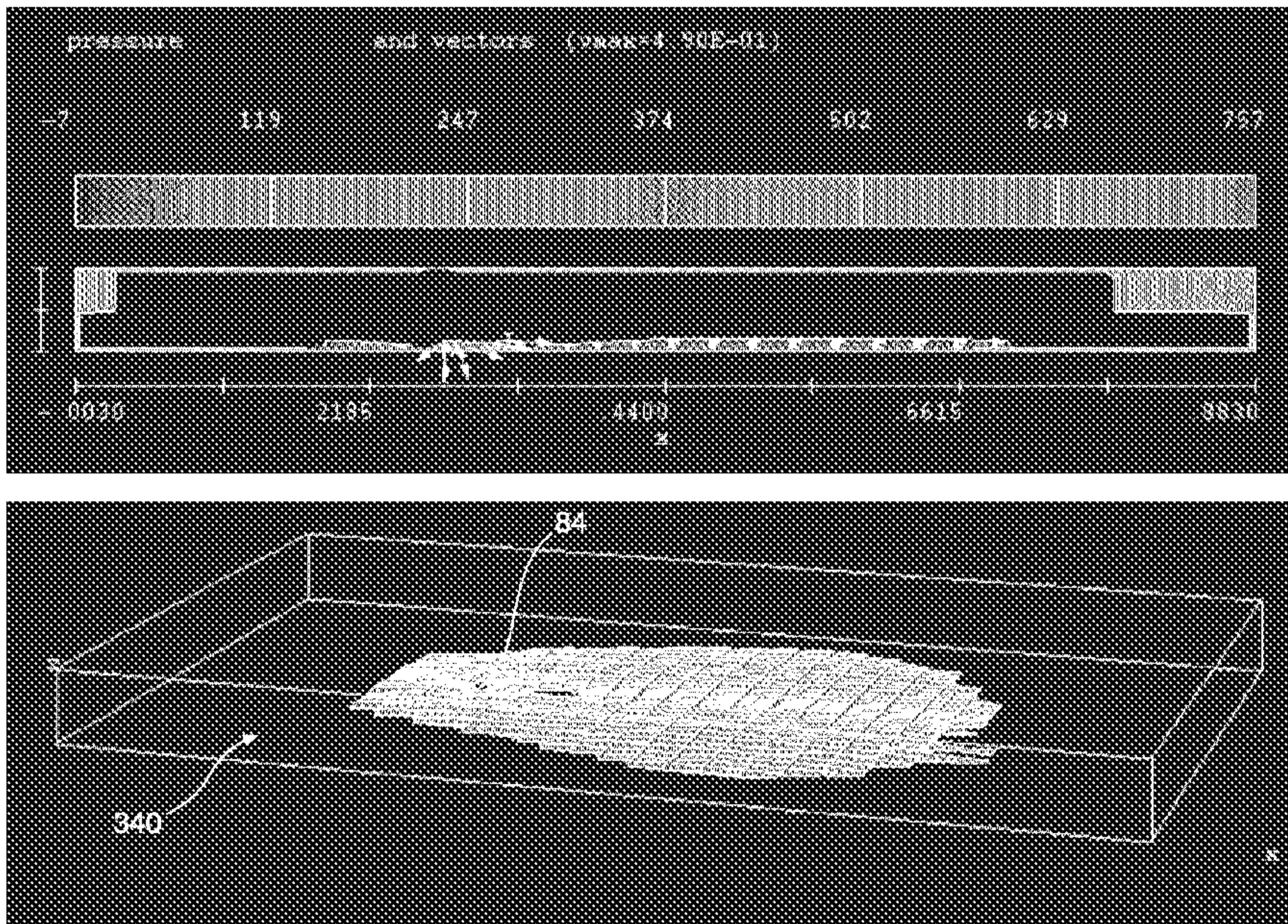


Fig. 59

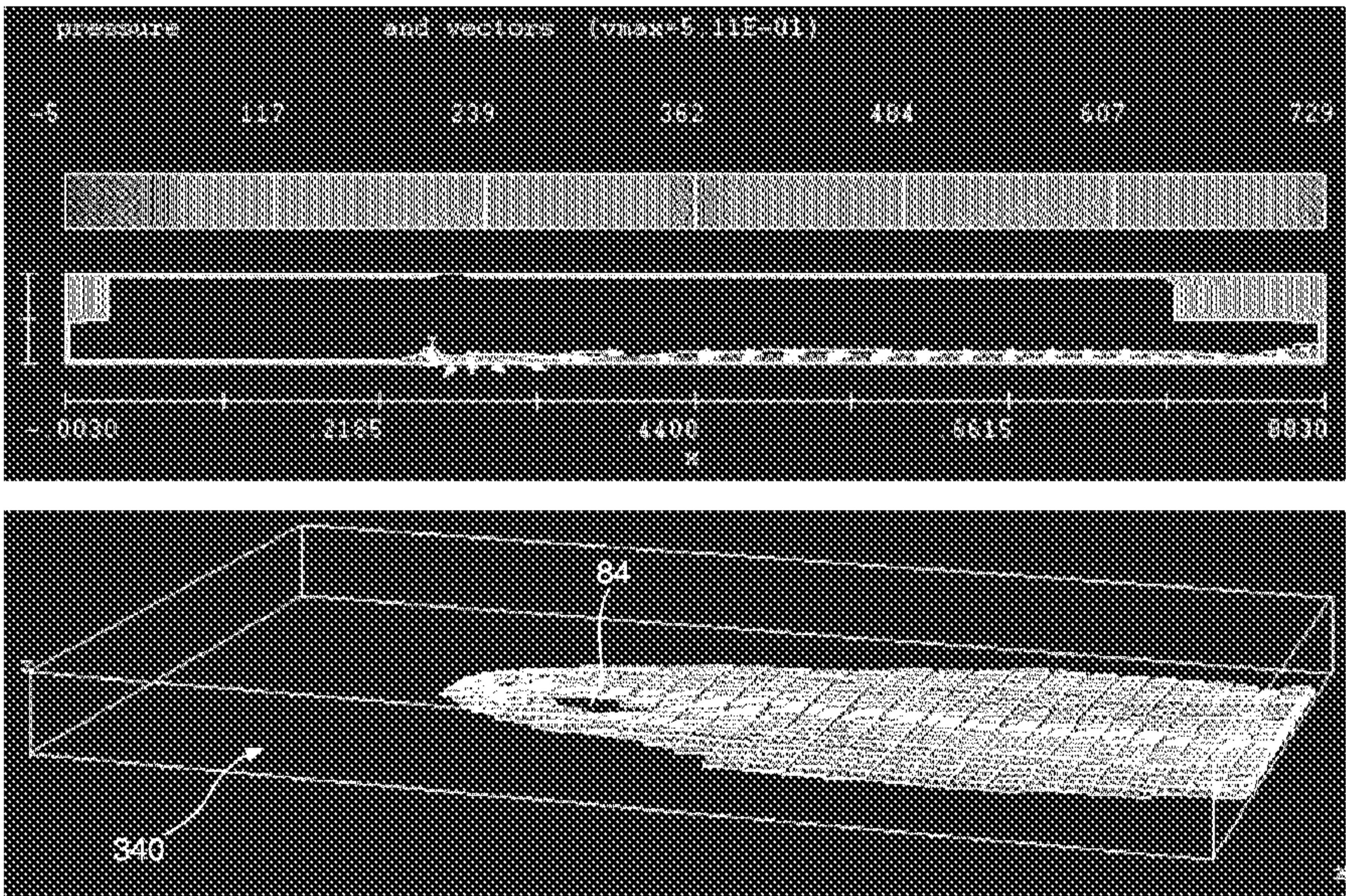


Fig. 60

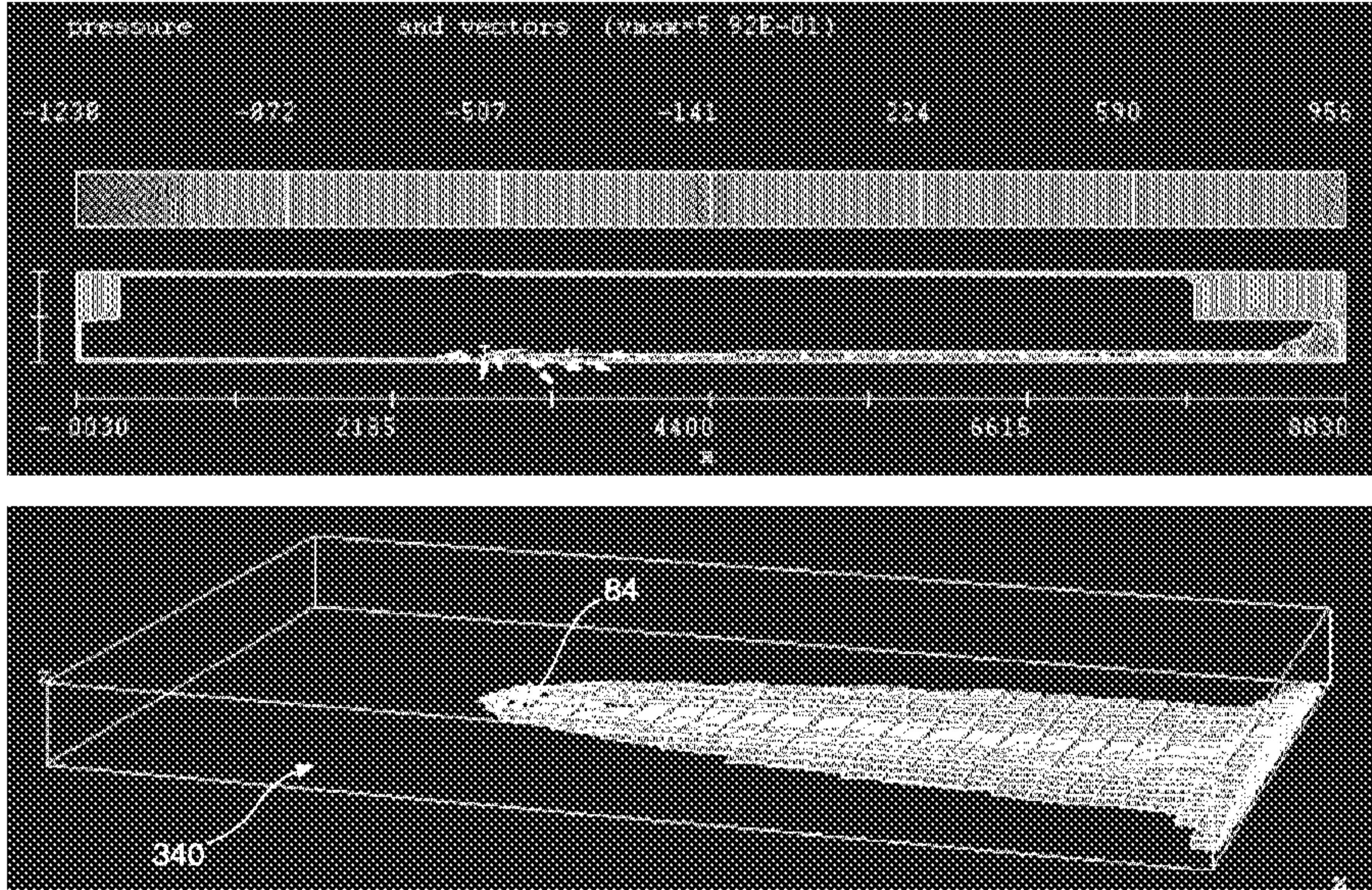


Fig. 61

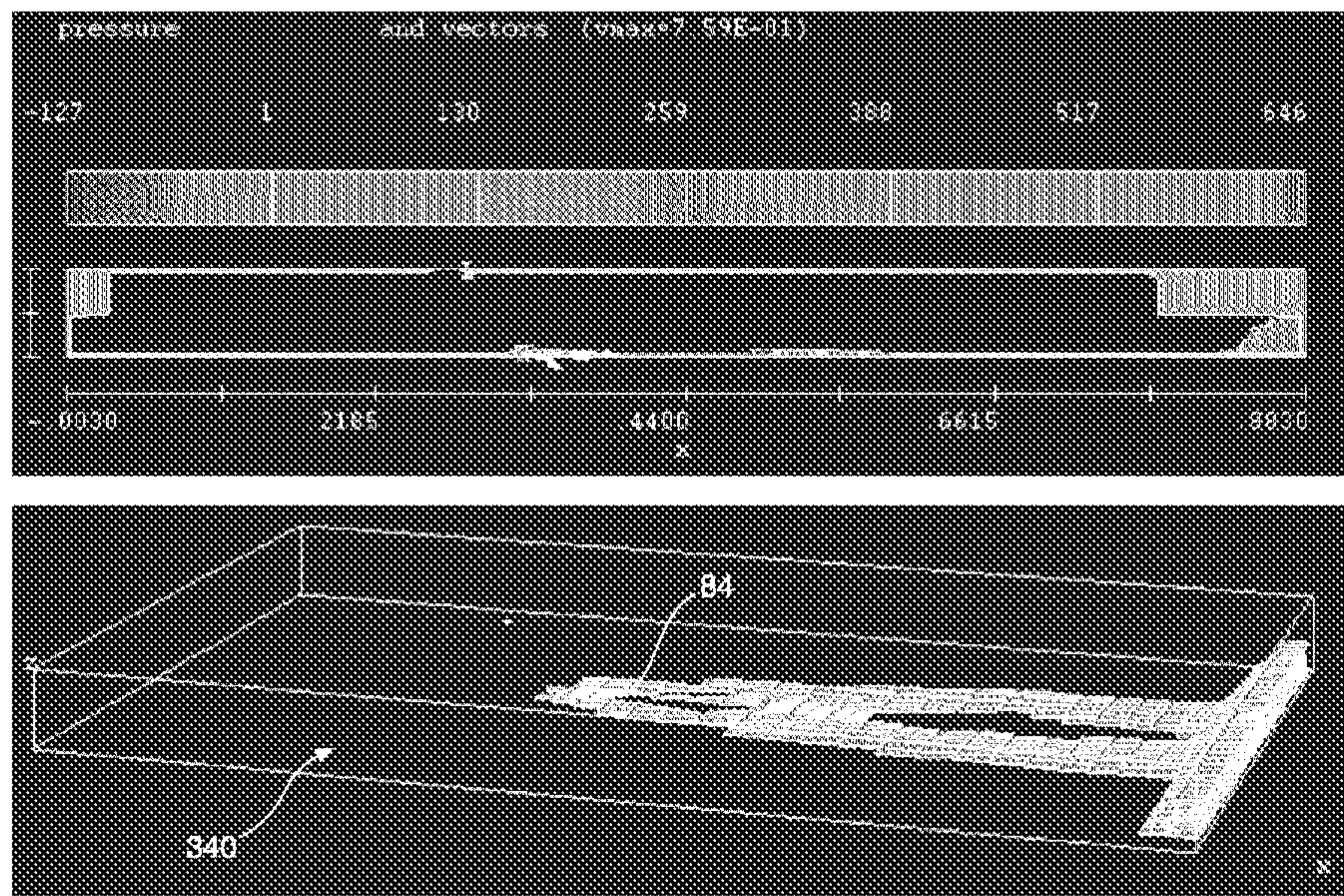


Fig. 62

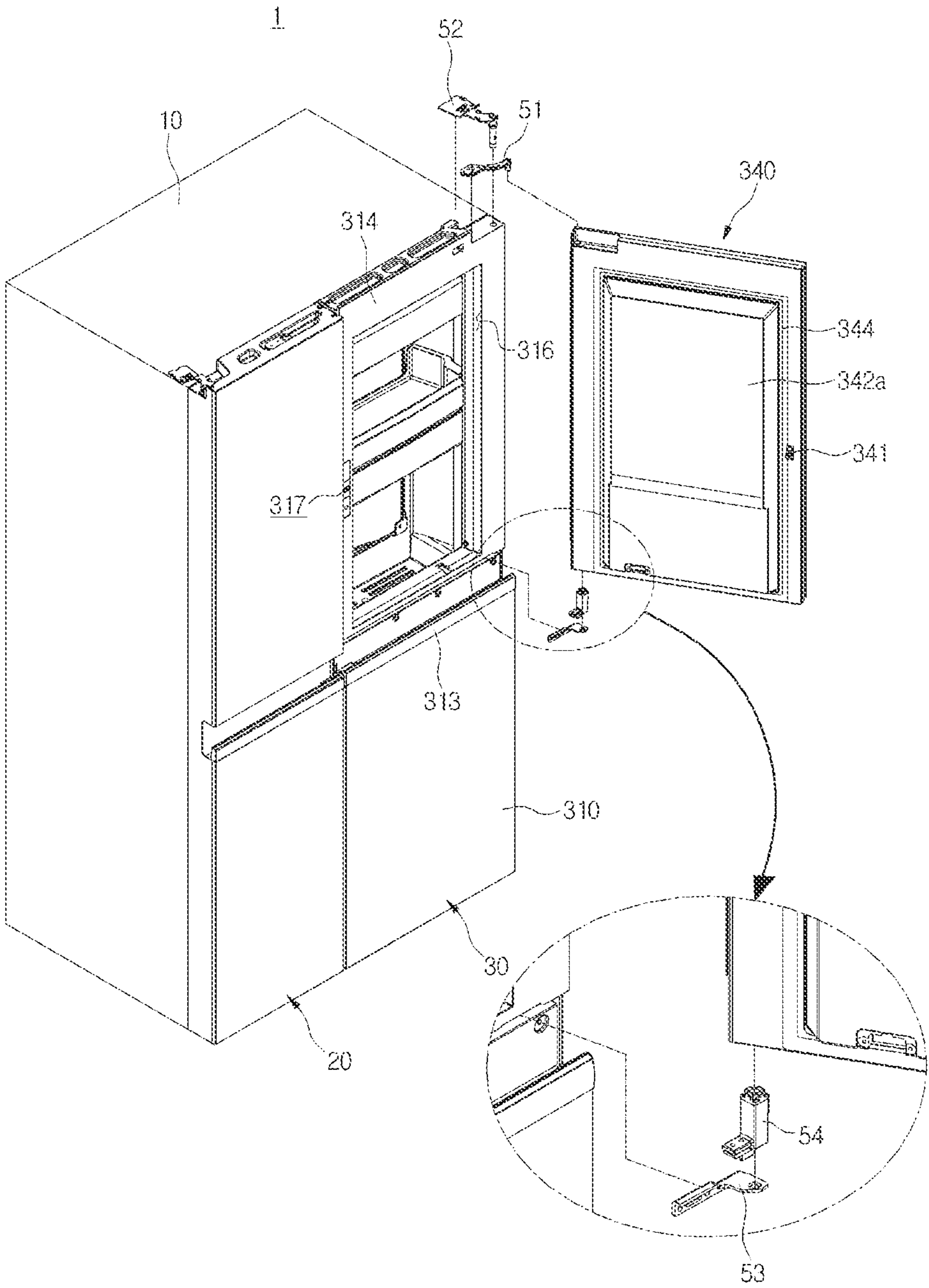


Fig. 63

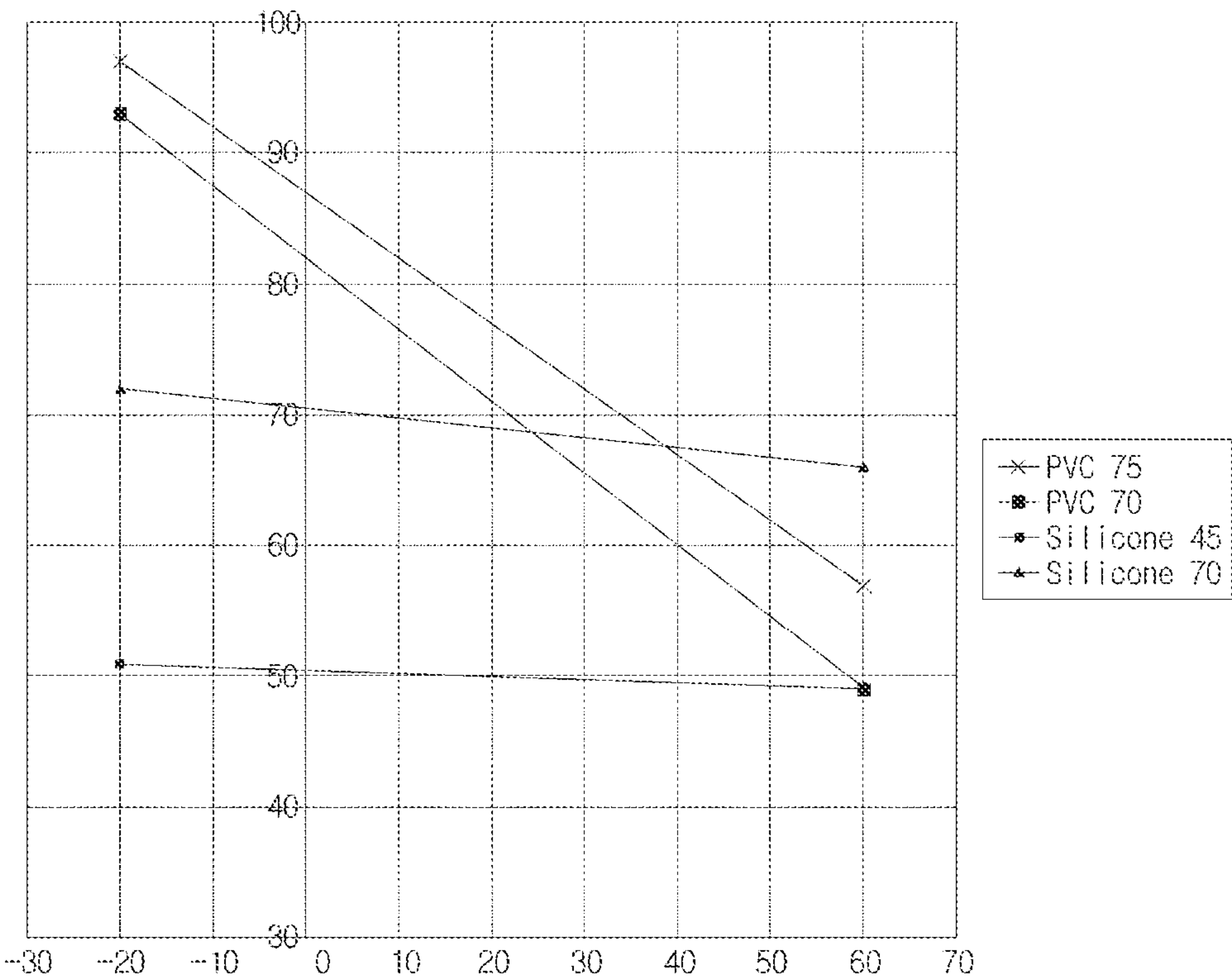


Fig. 64

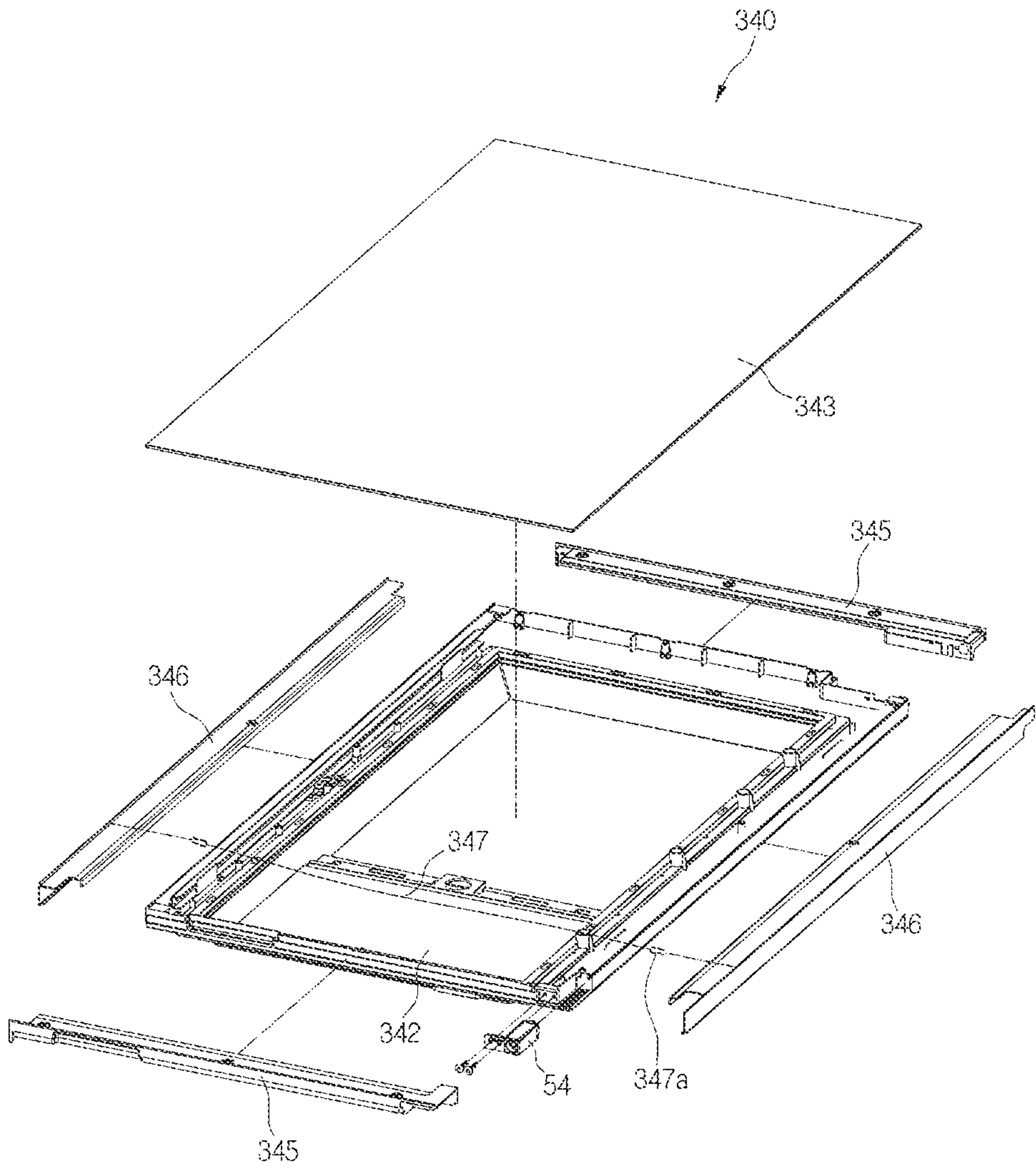


Fig. 65

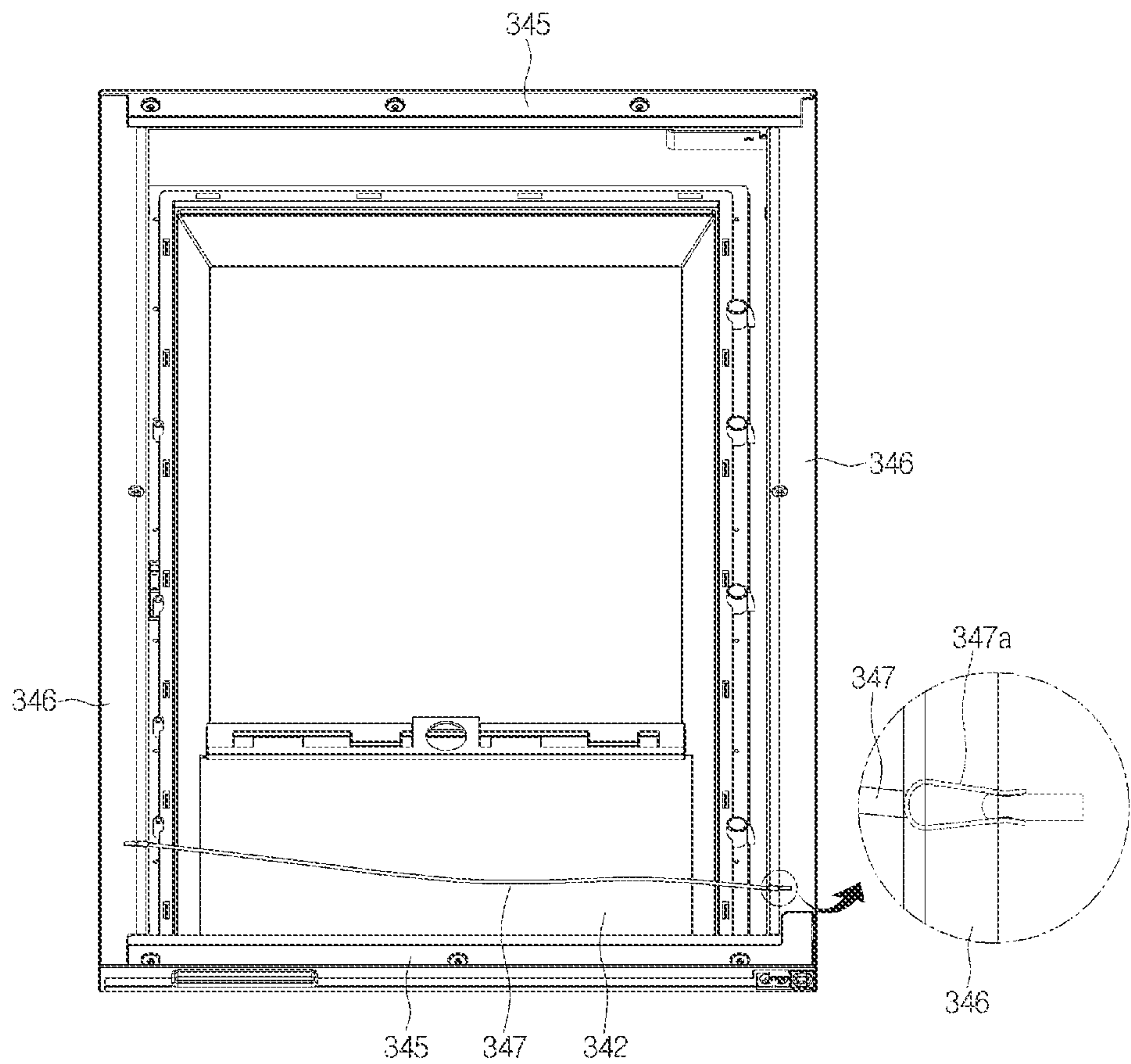


Fig. 66A

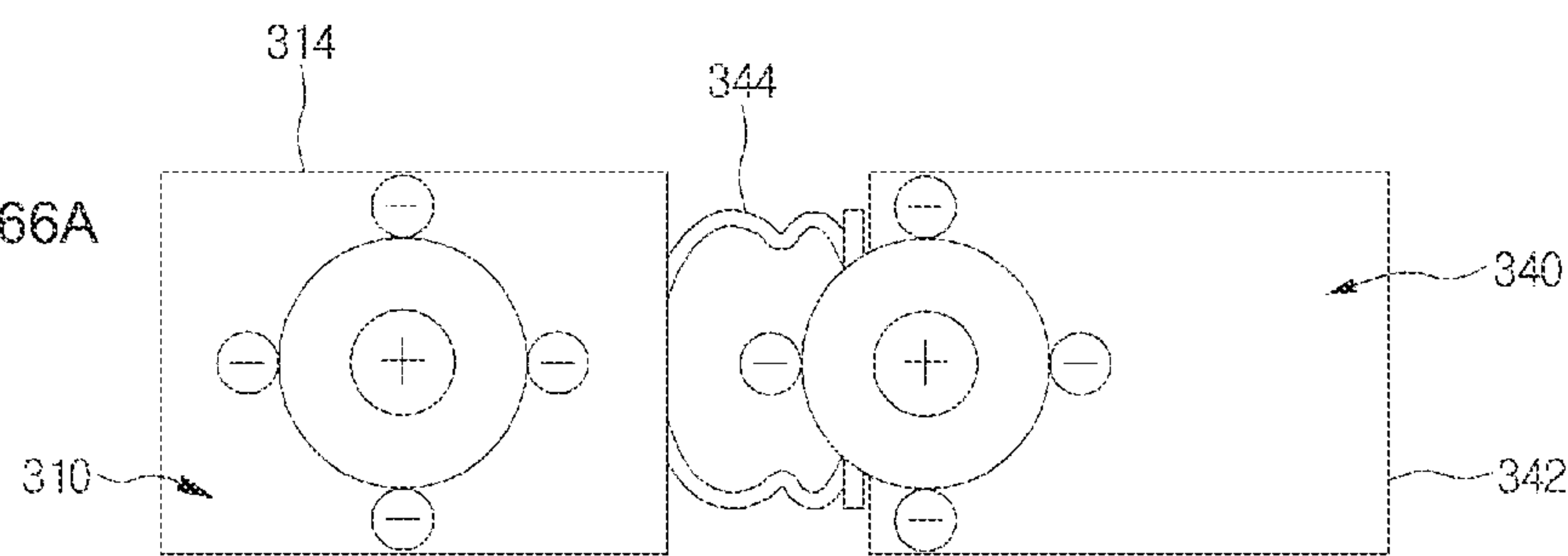


Fig. 66B

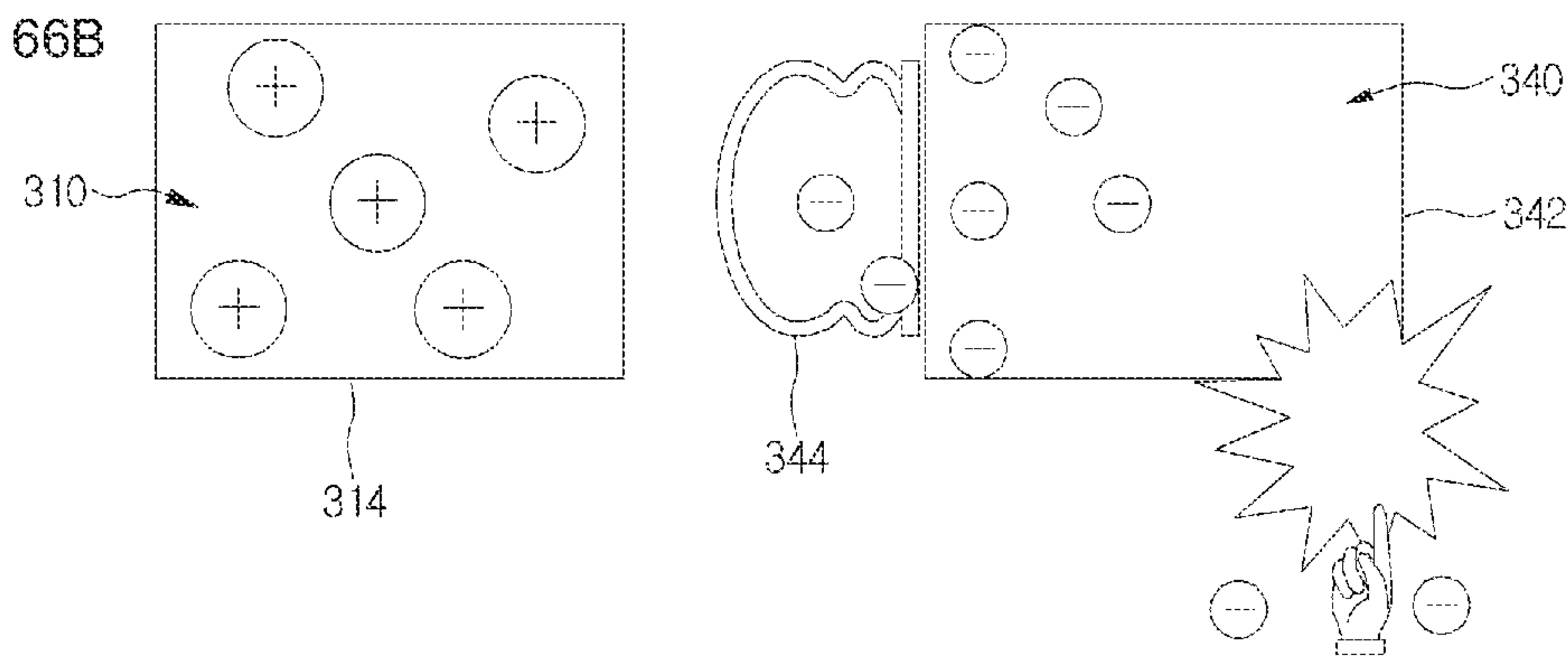


Fig. 67

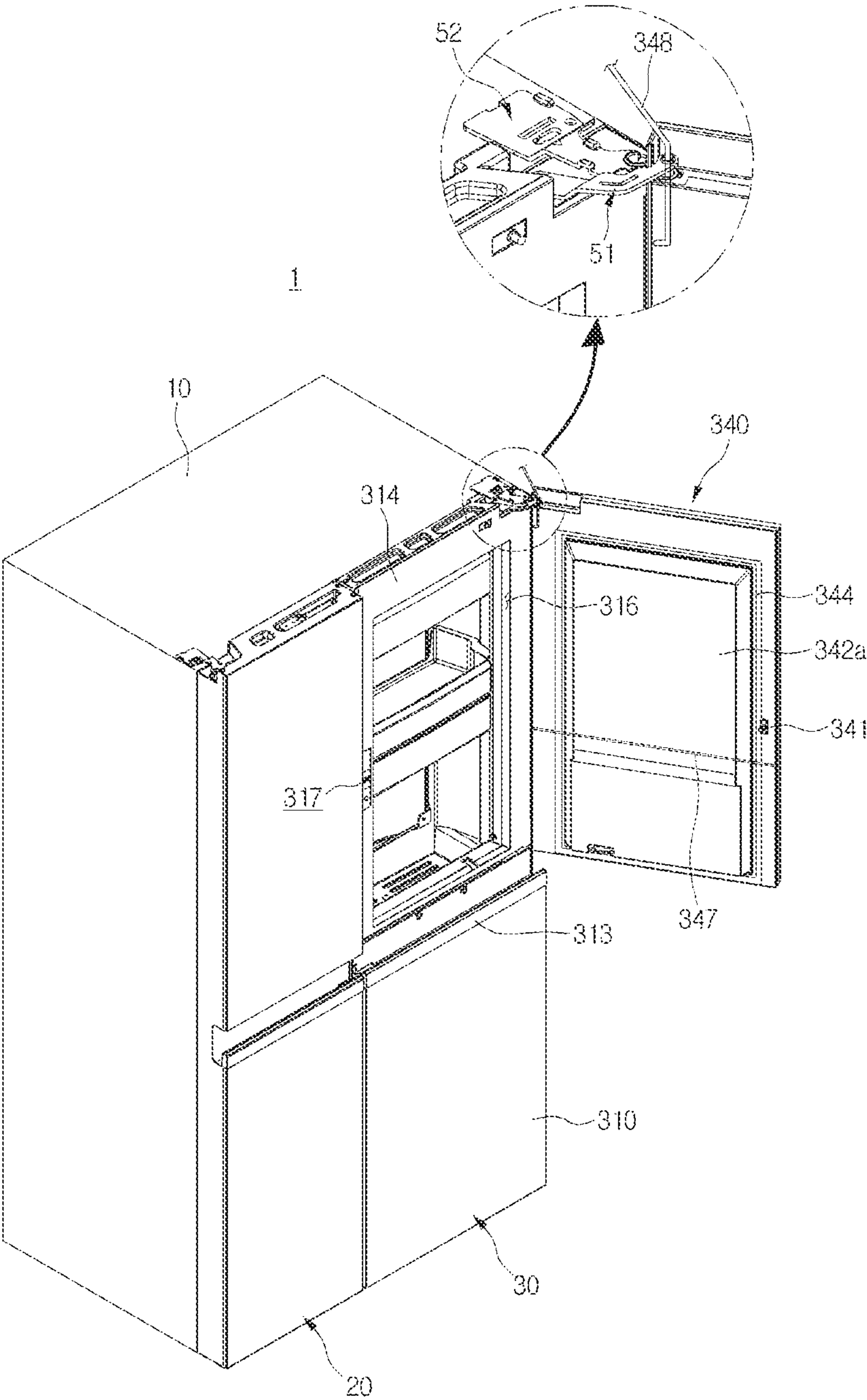


Fig. 68

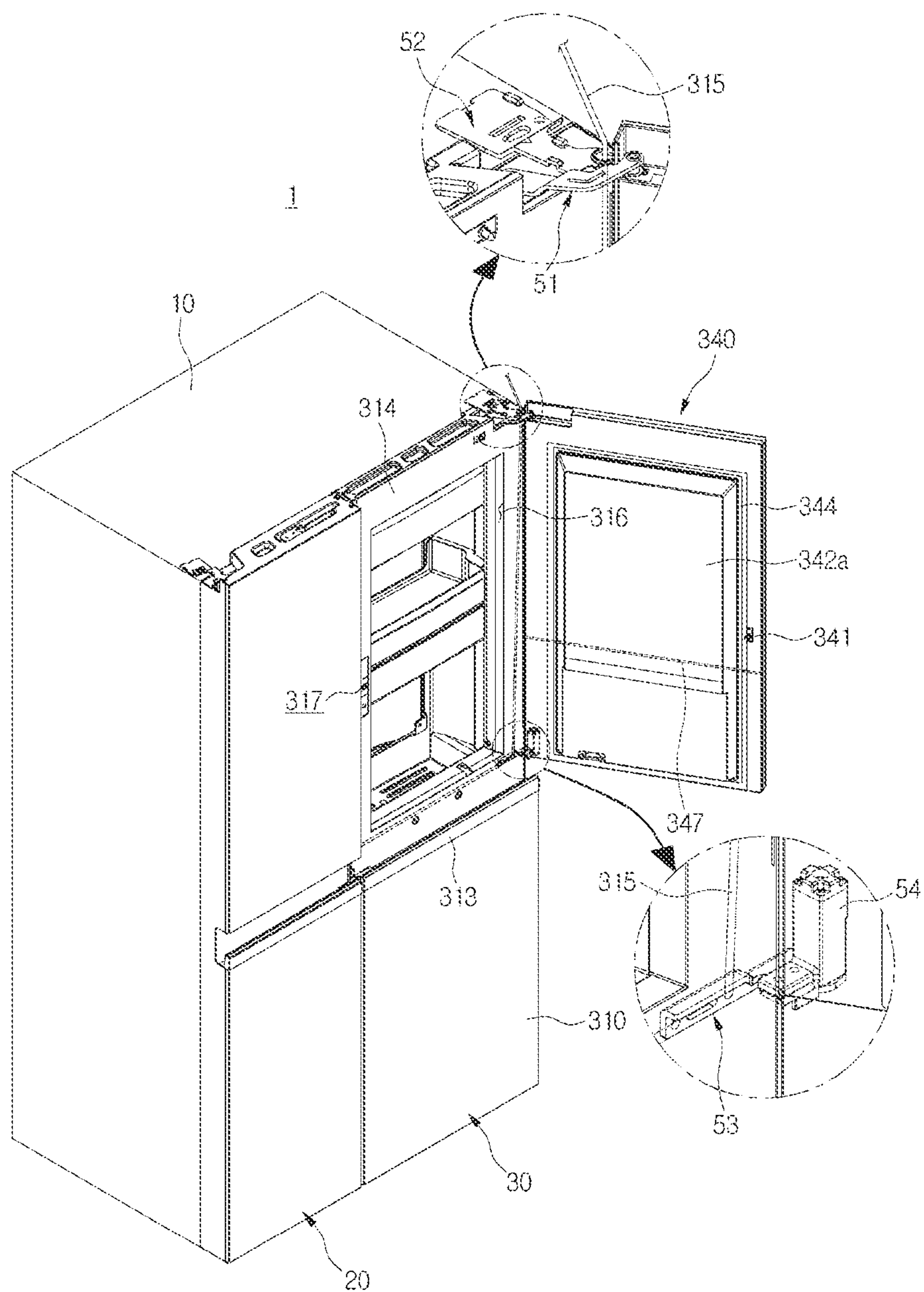


Fig. 69

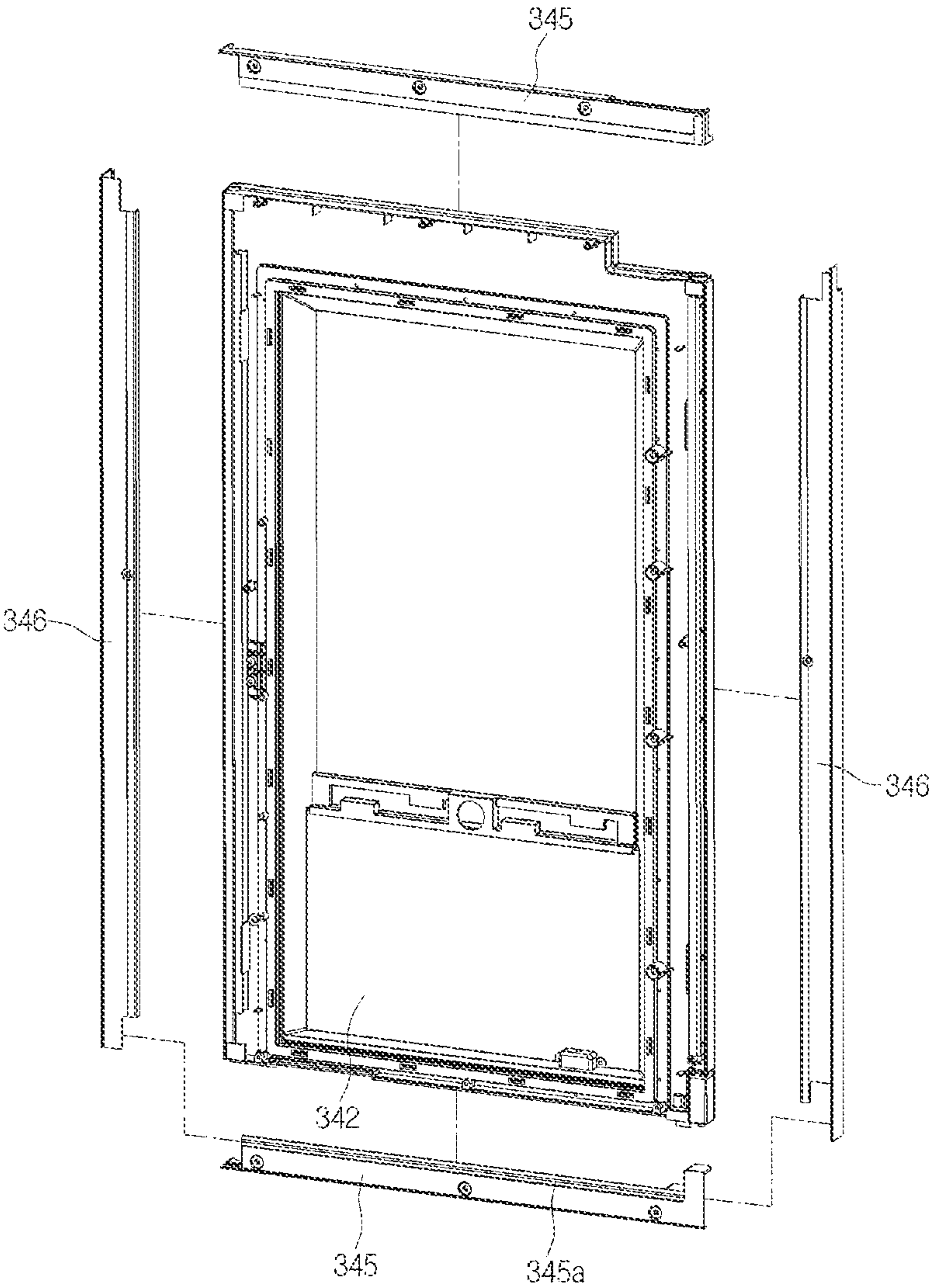


Fig. 70

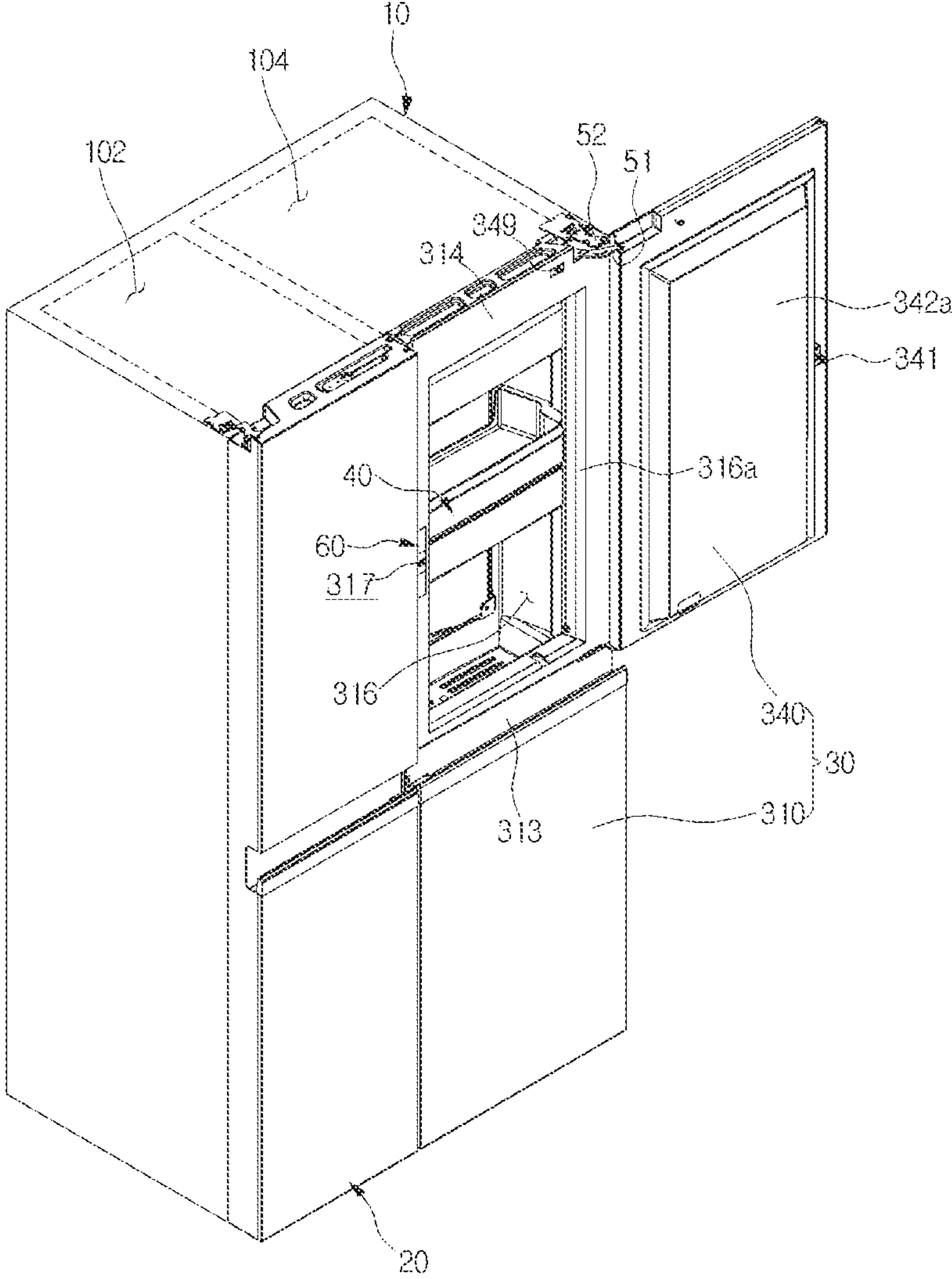


Fig. 71

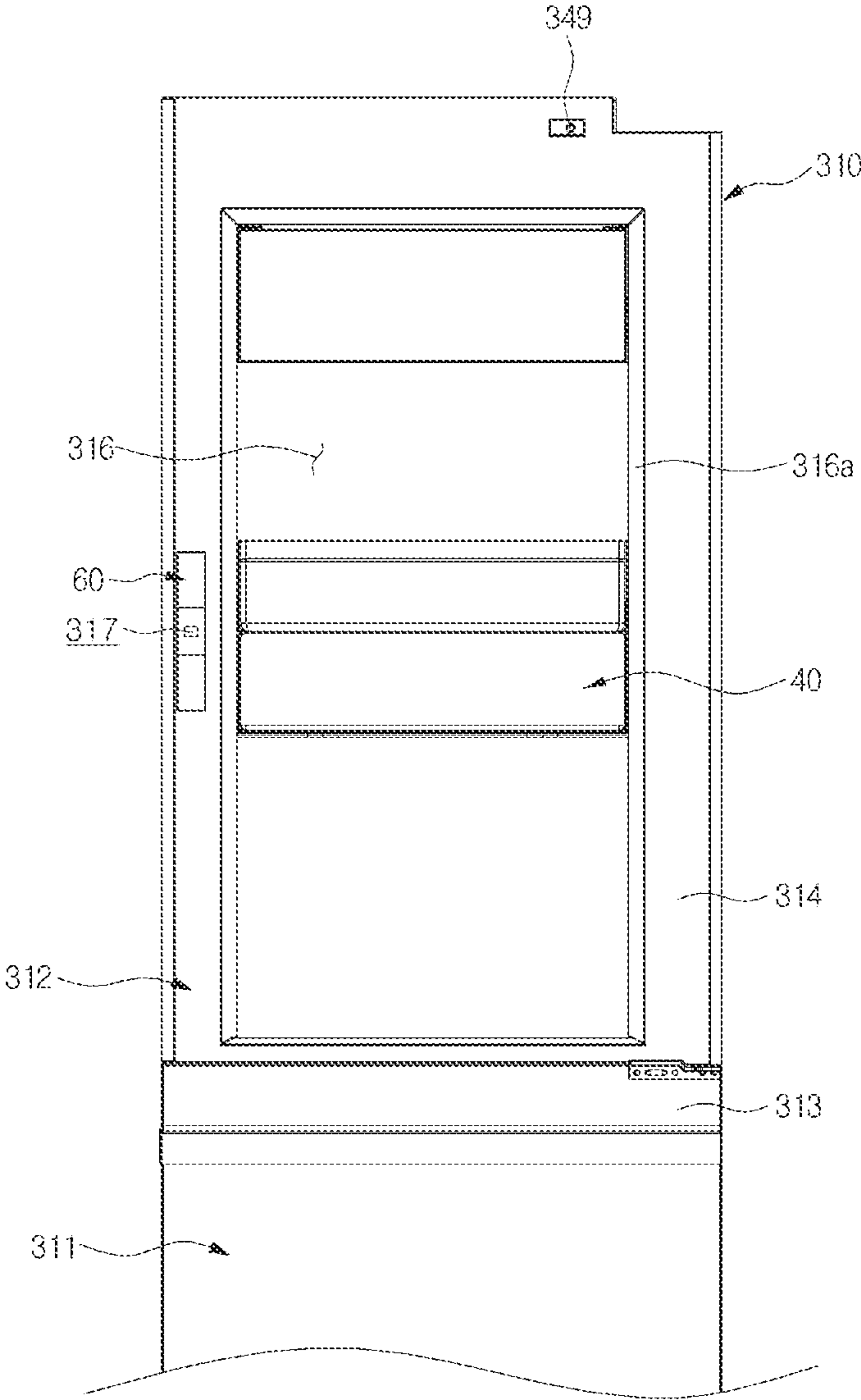


Fig. 72

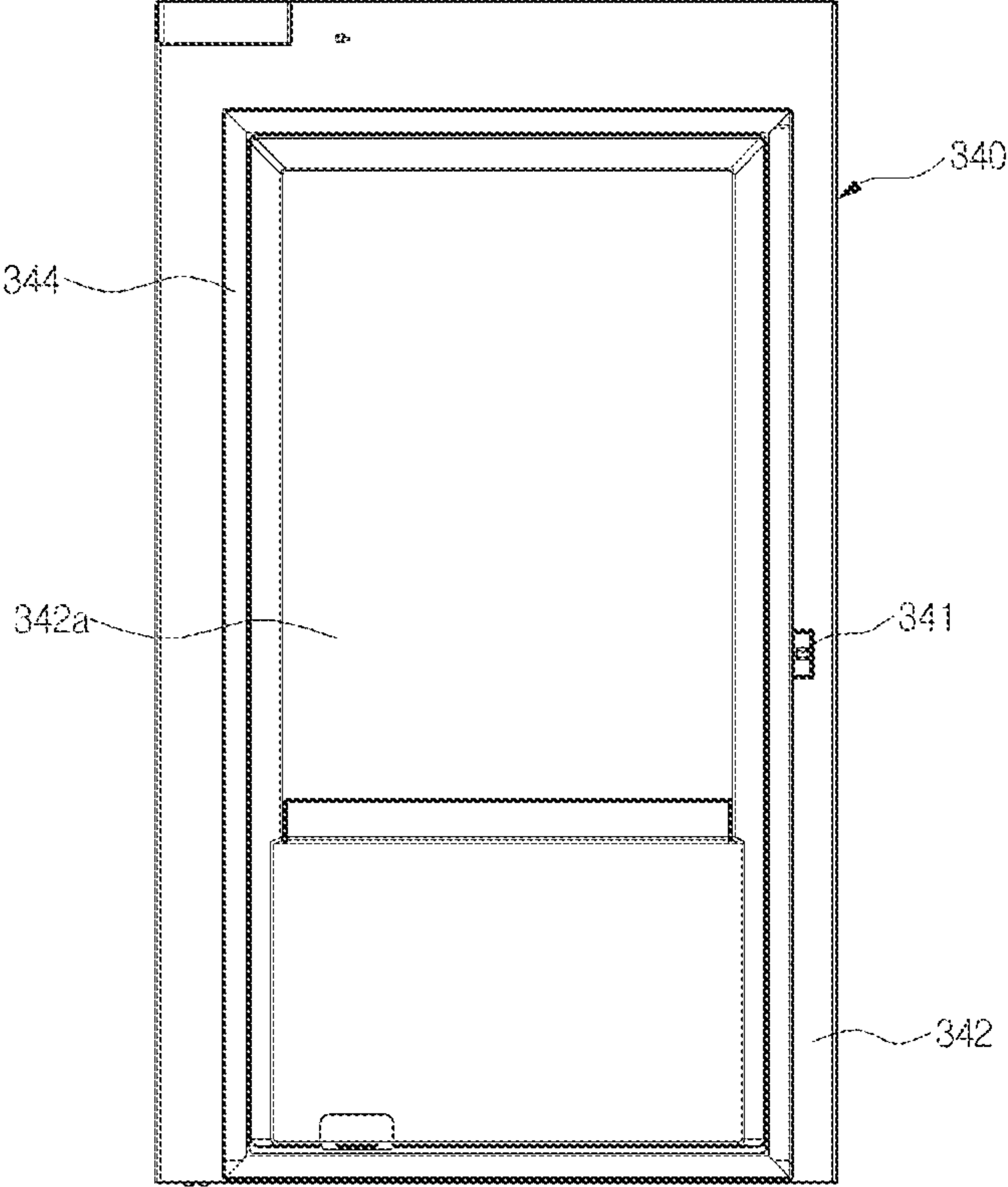


Fig. 73

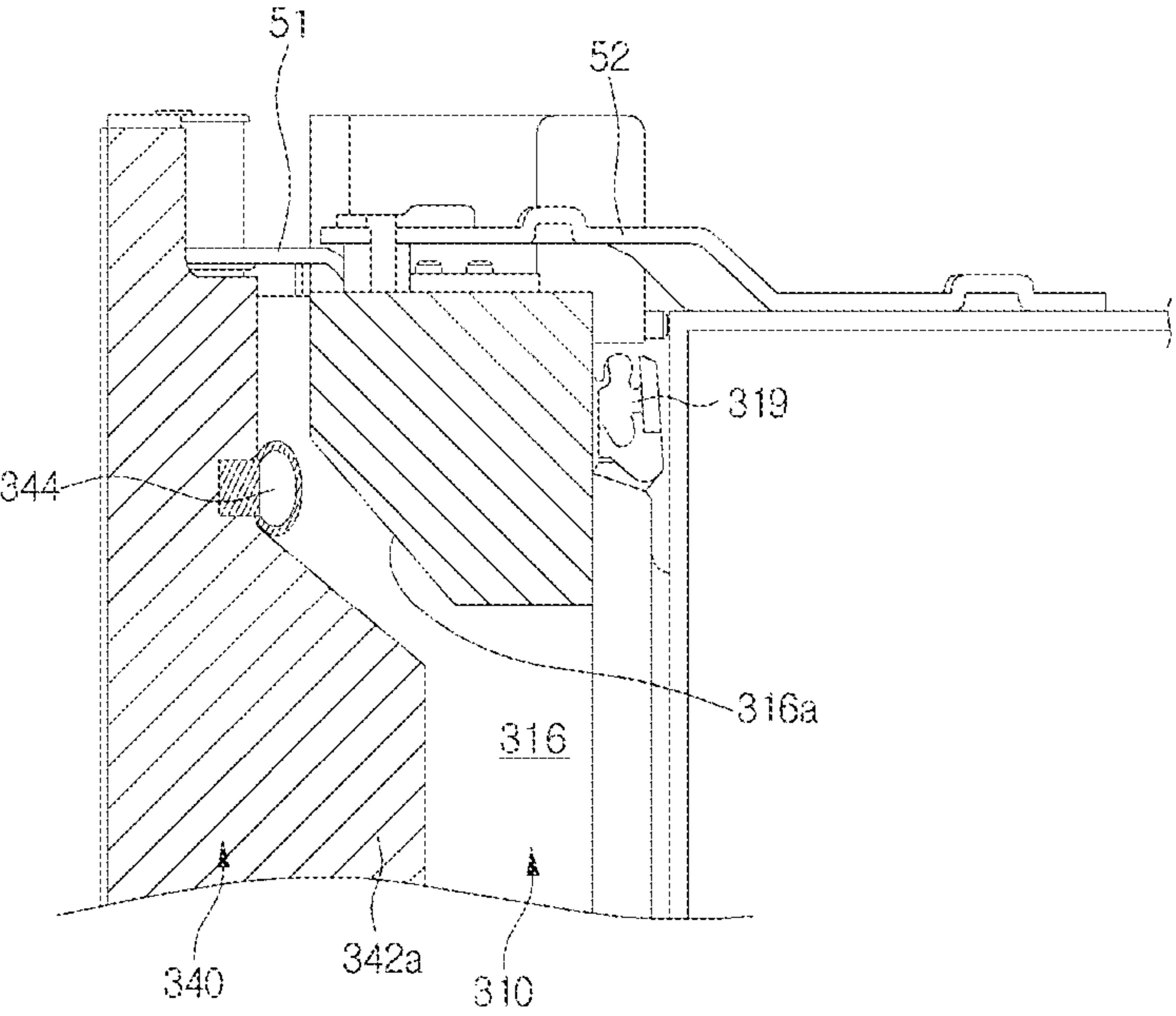


Fig. 74

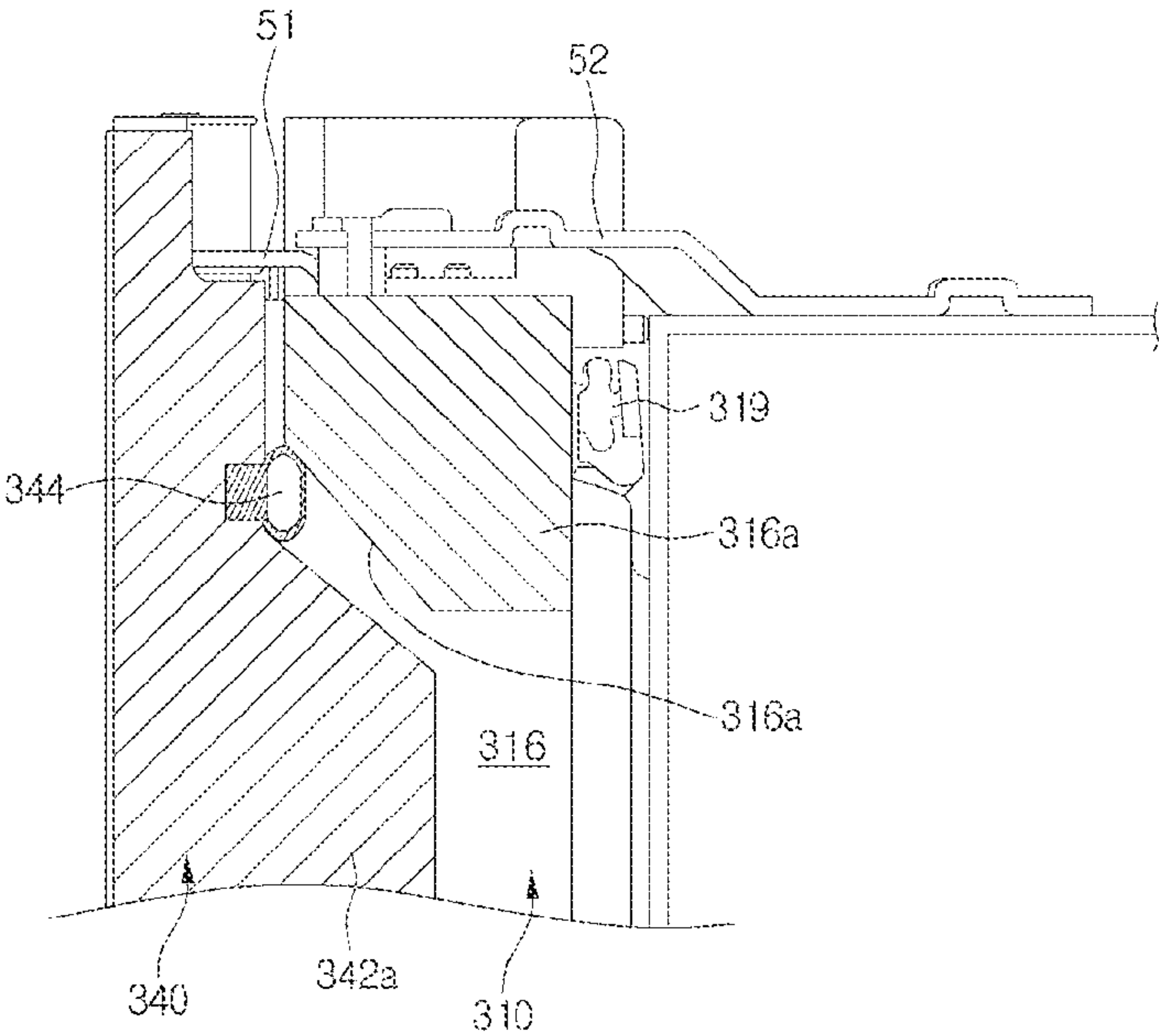


Fig. 75

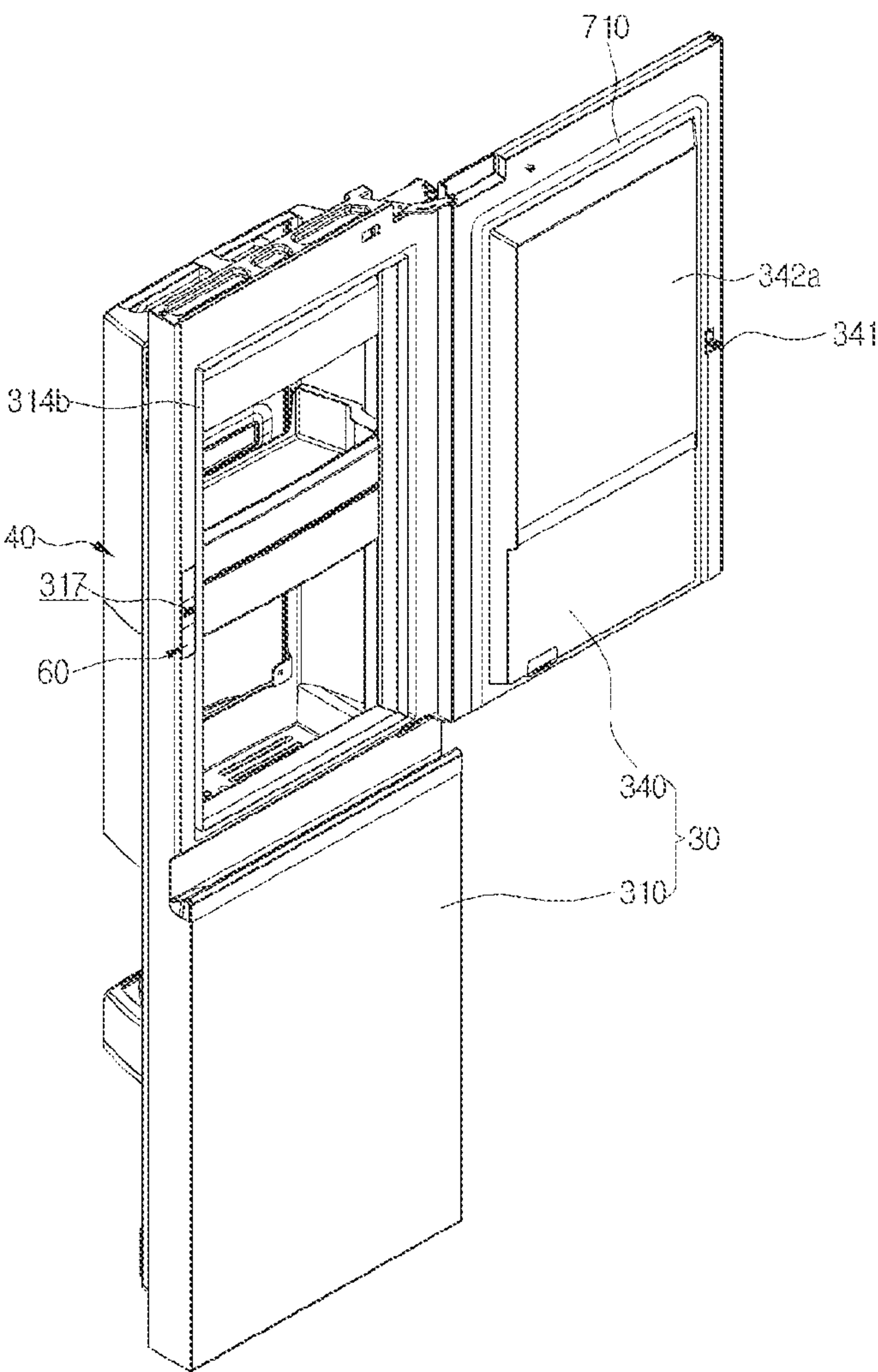


Fig. 76

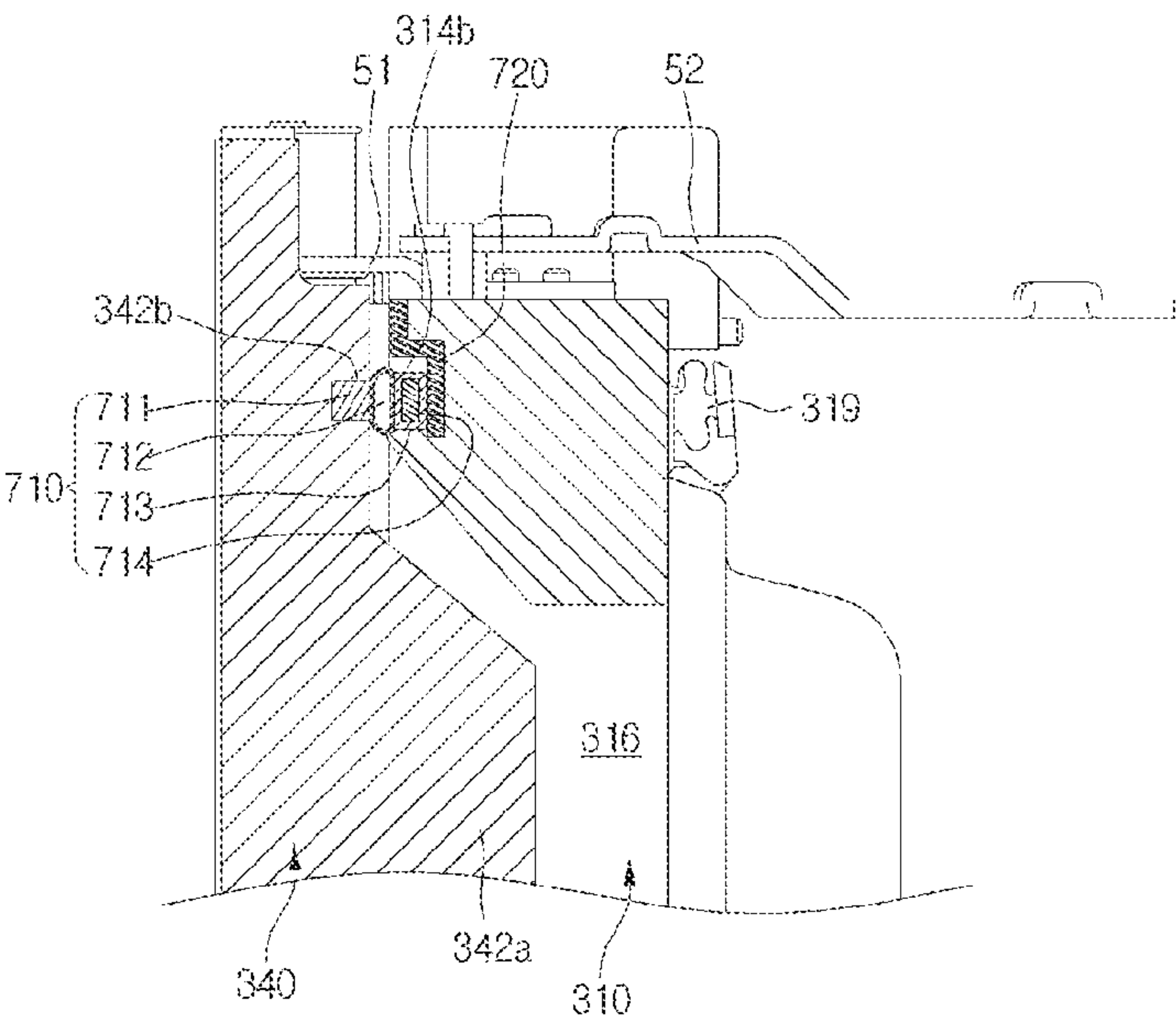


Fig. 77

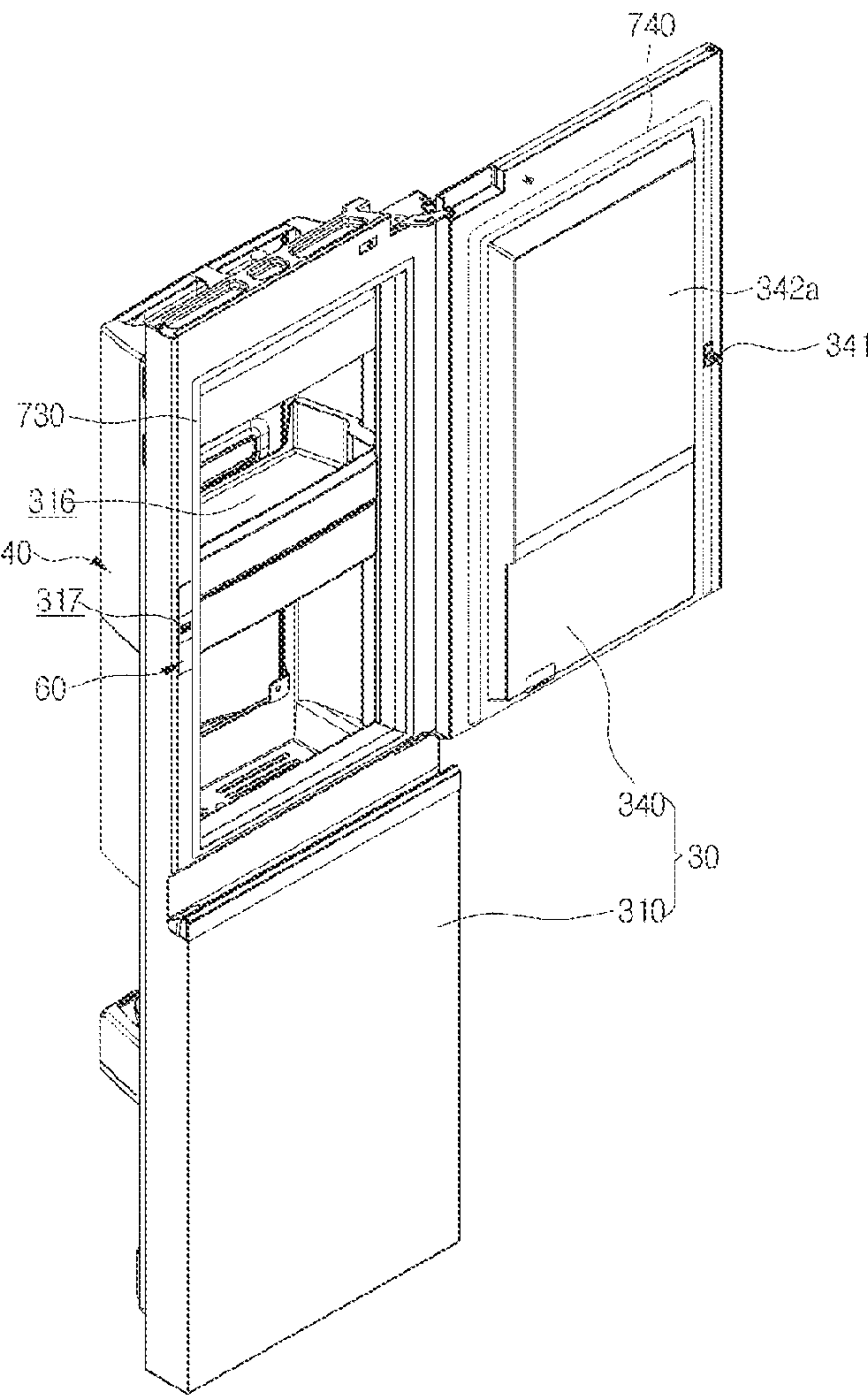


Fig. 78

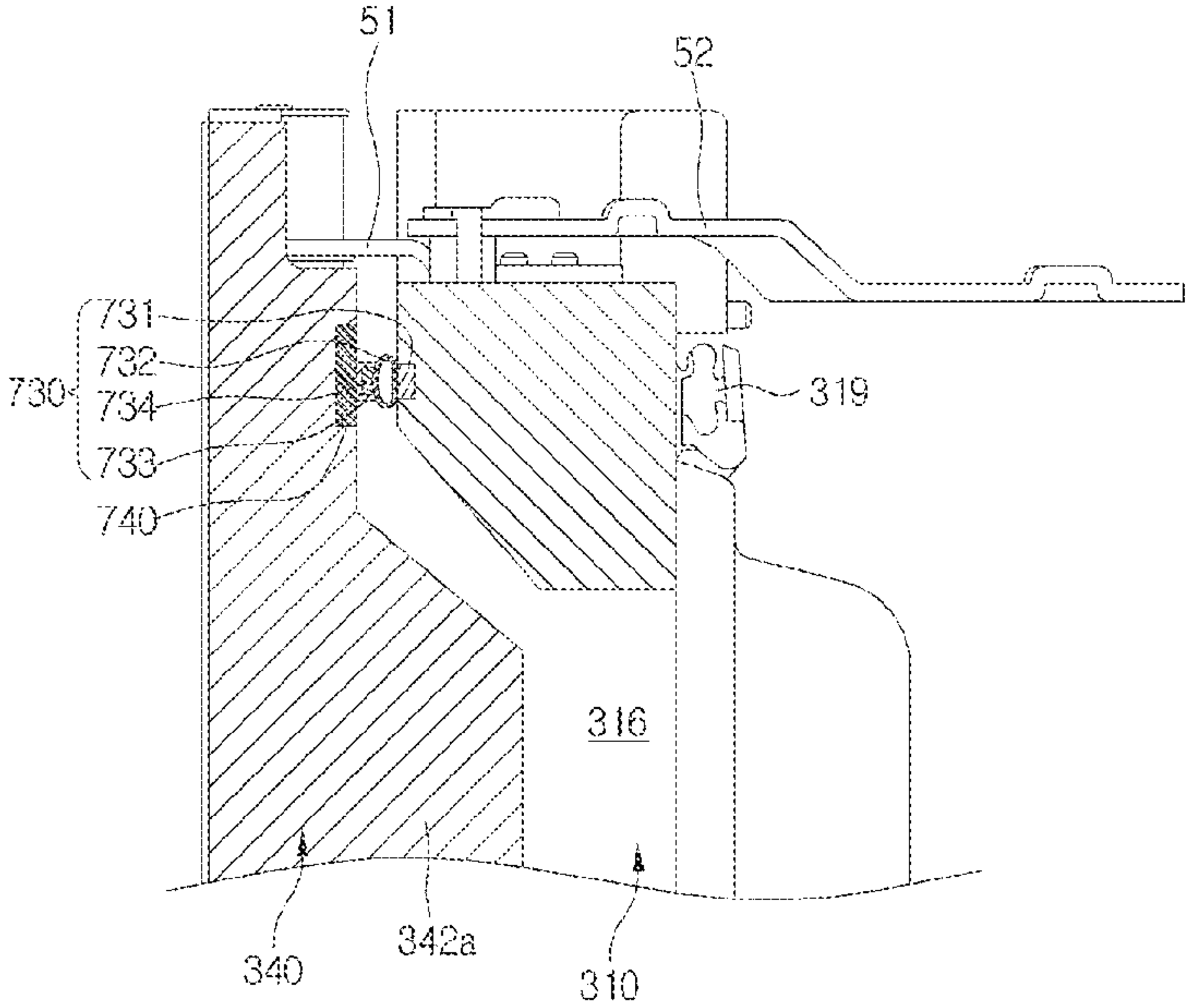


Fig. 79

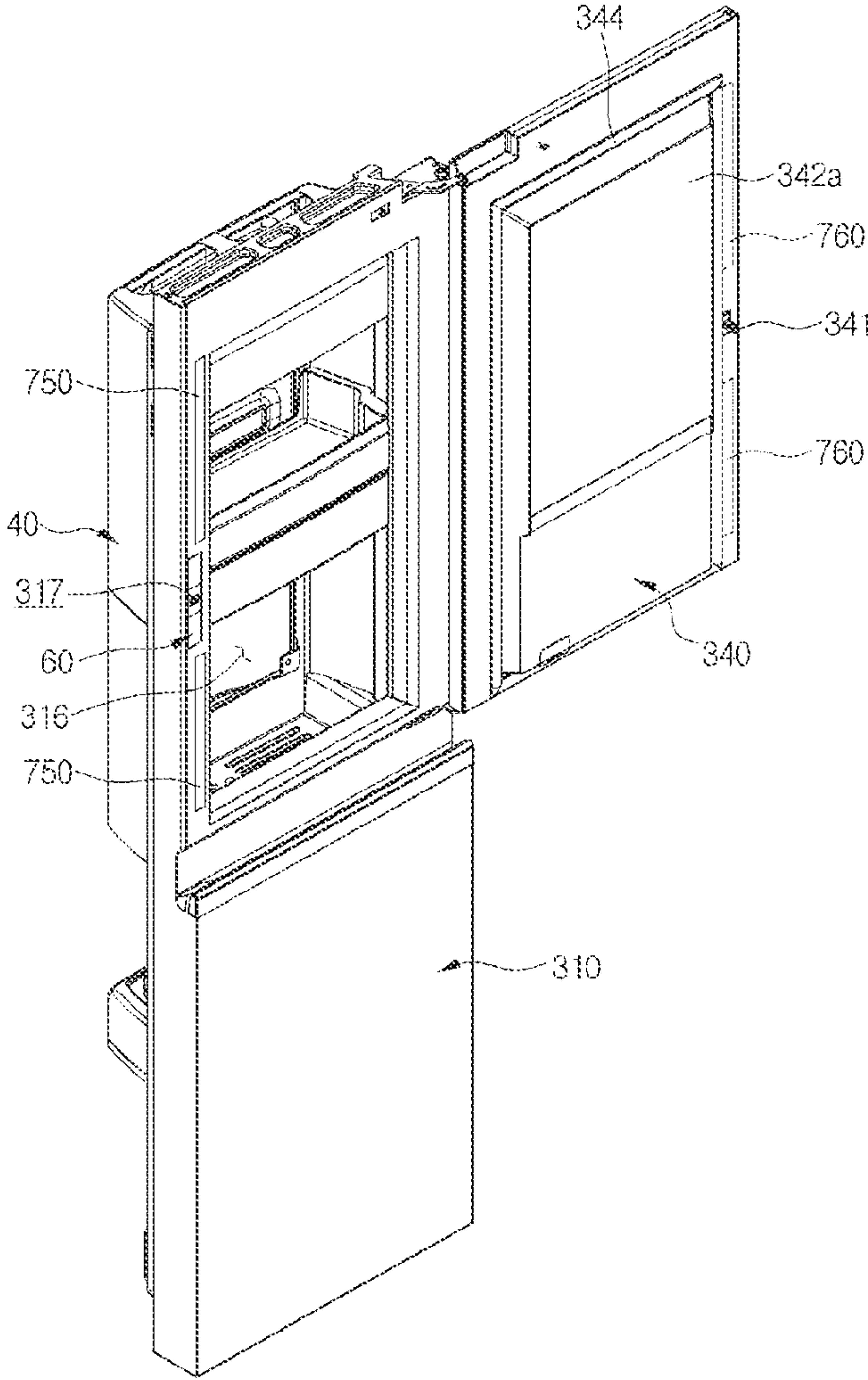


Fig. 80

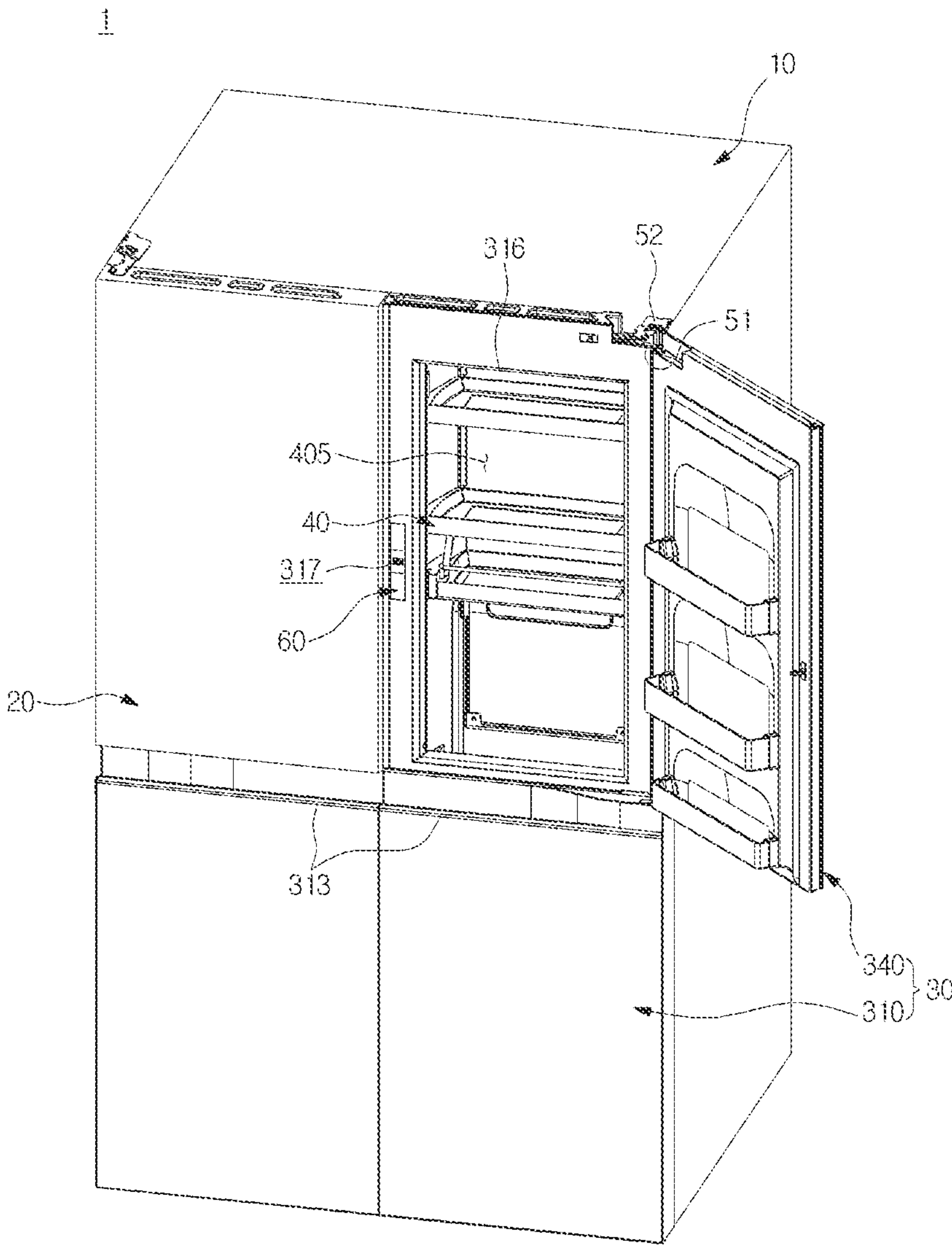


Fig. 81

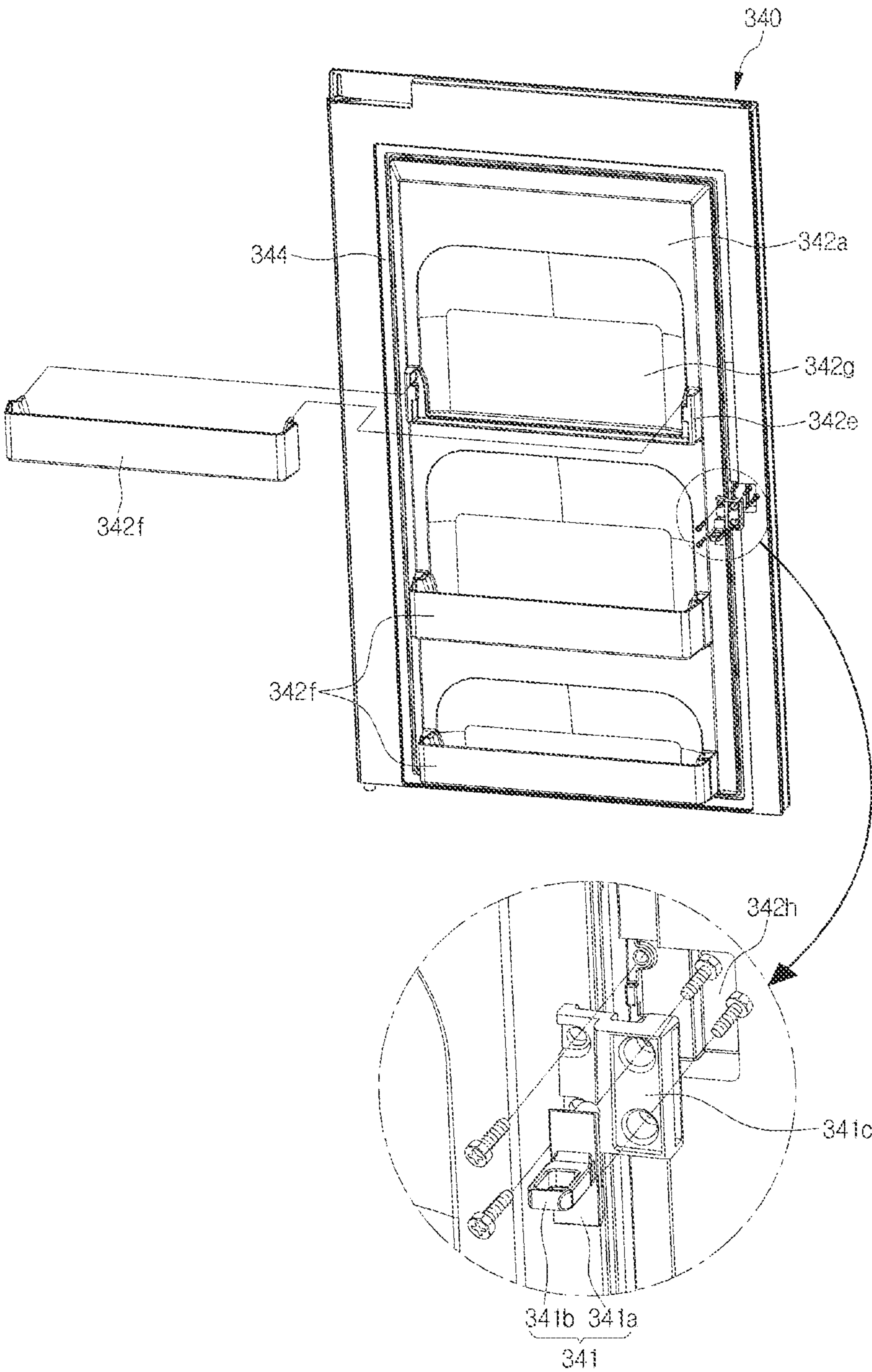


Fig. 82

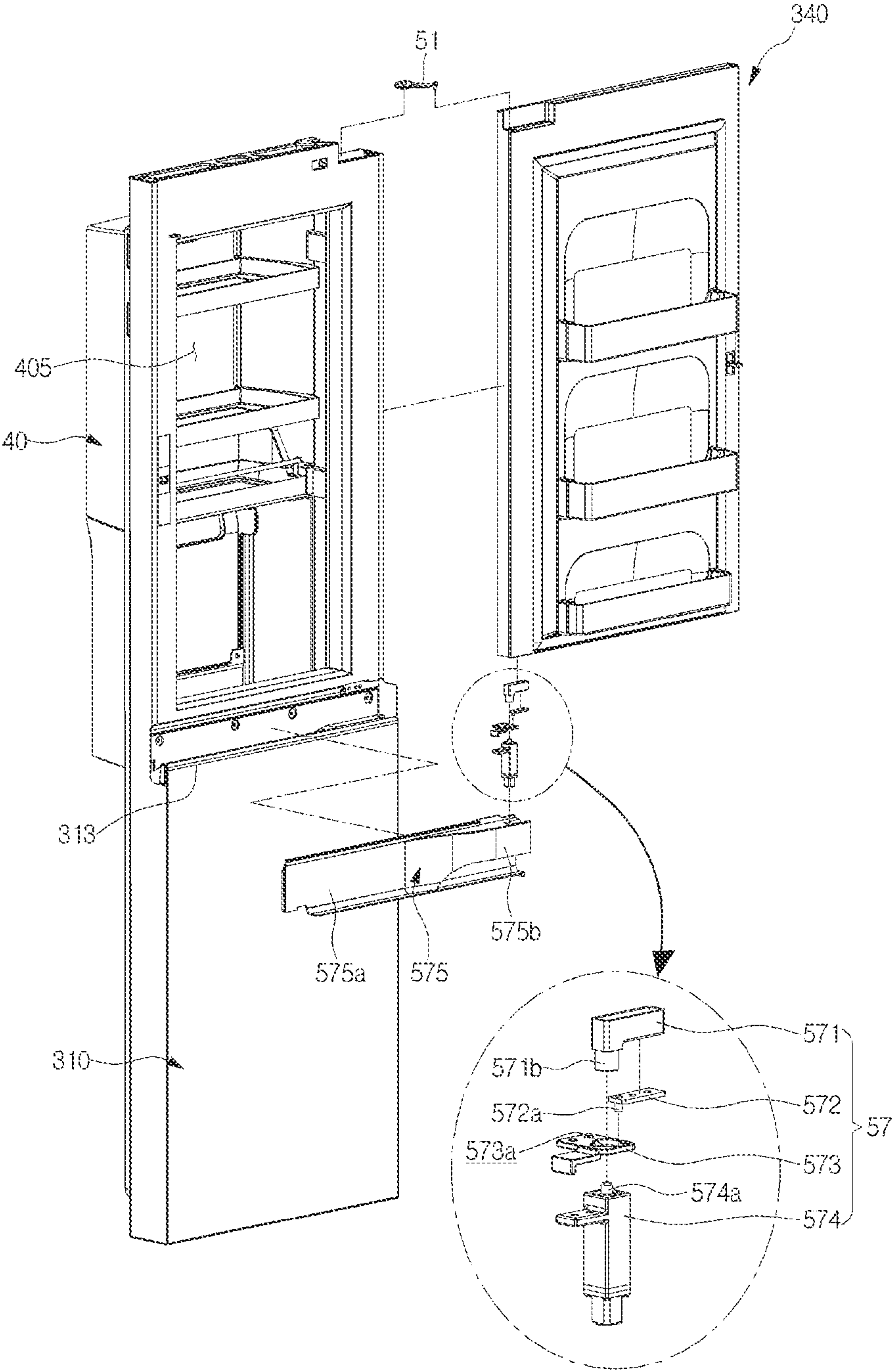


Fig. 83

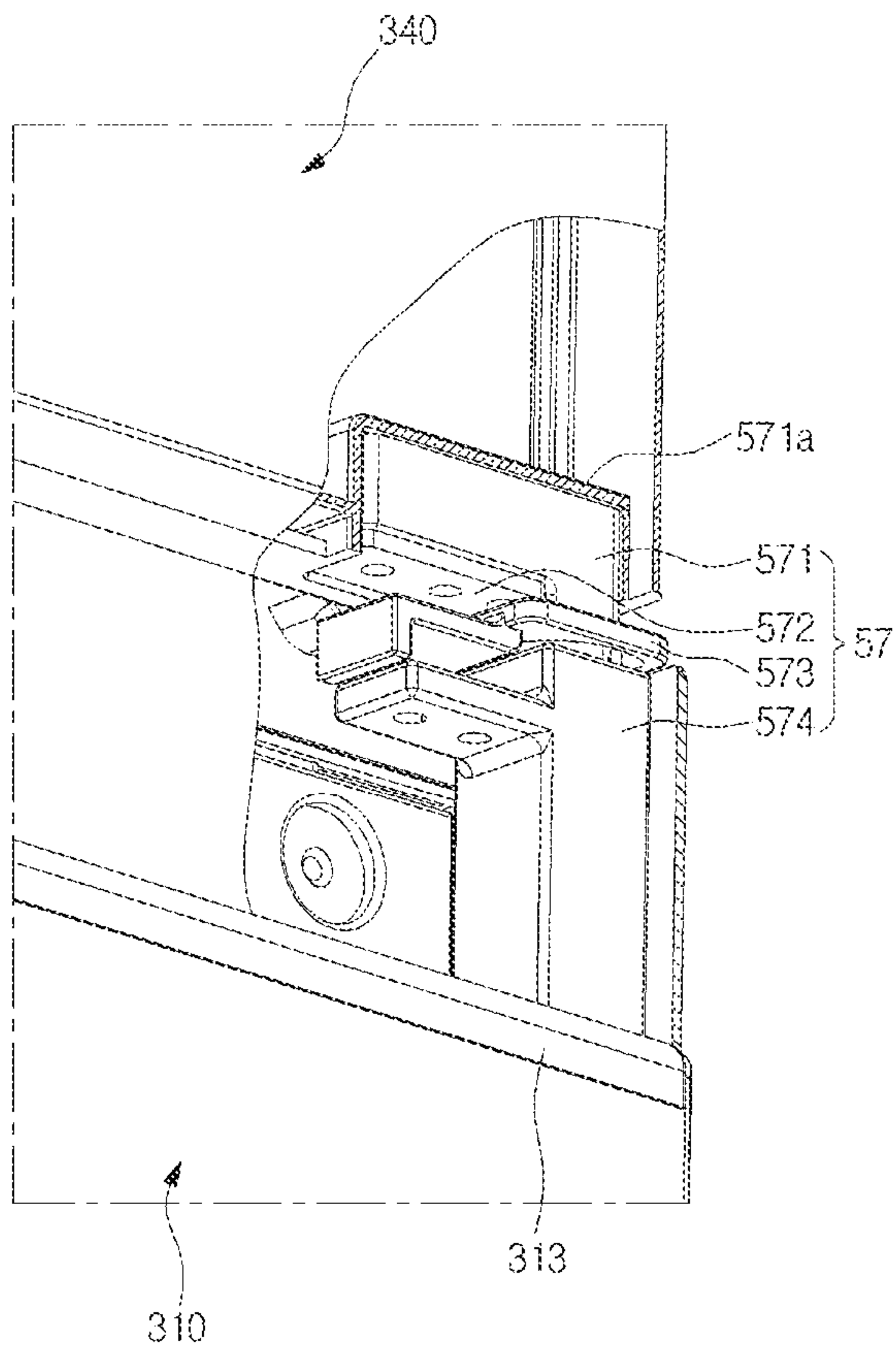


Fig. 84

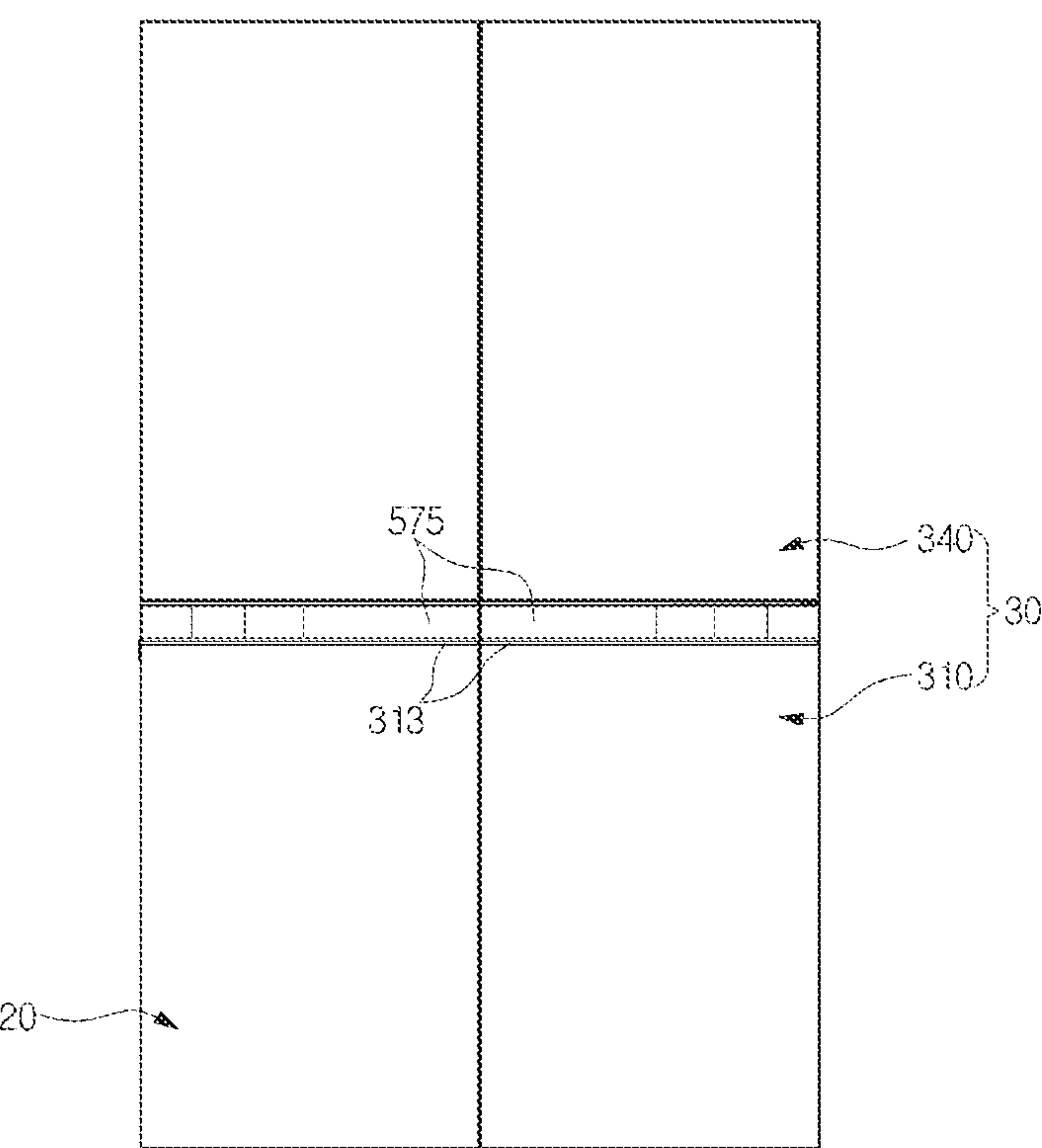


Fig. 85

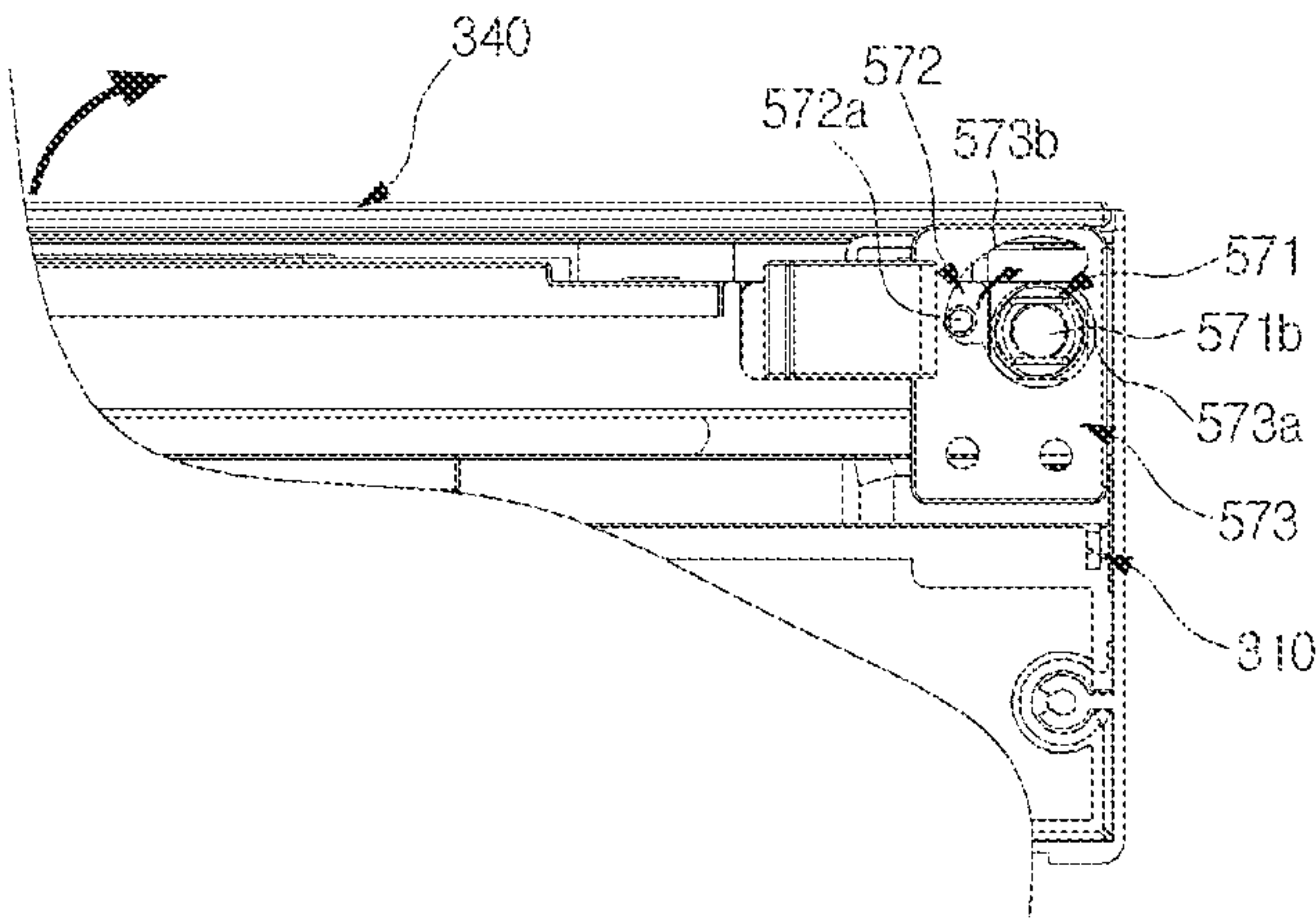


Fig. 86

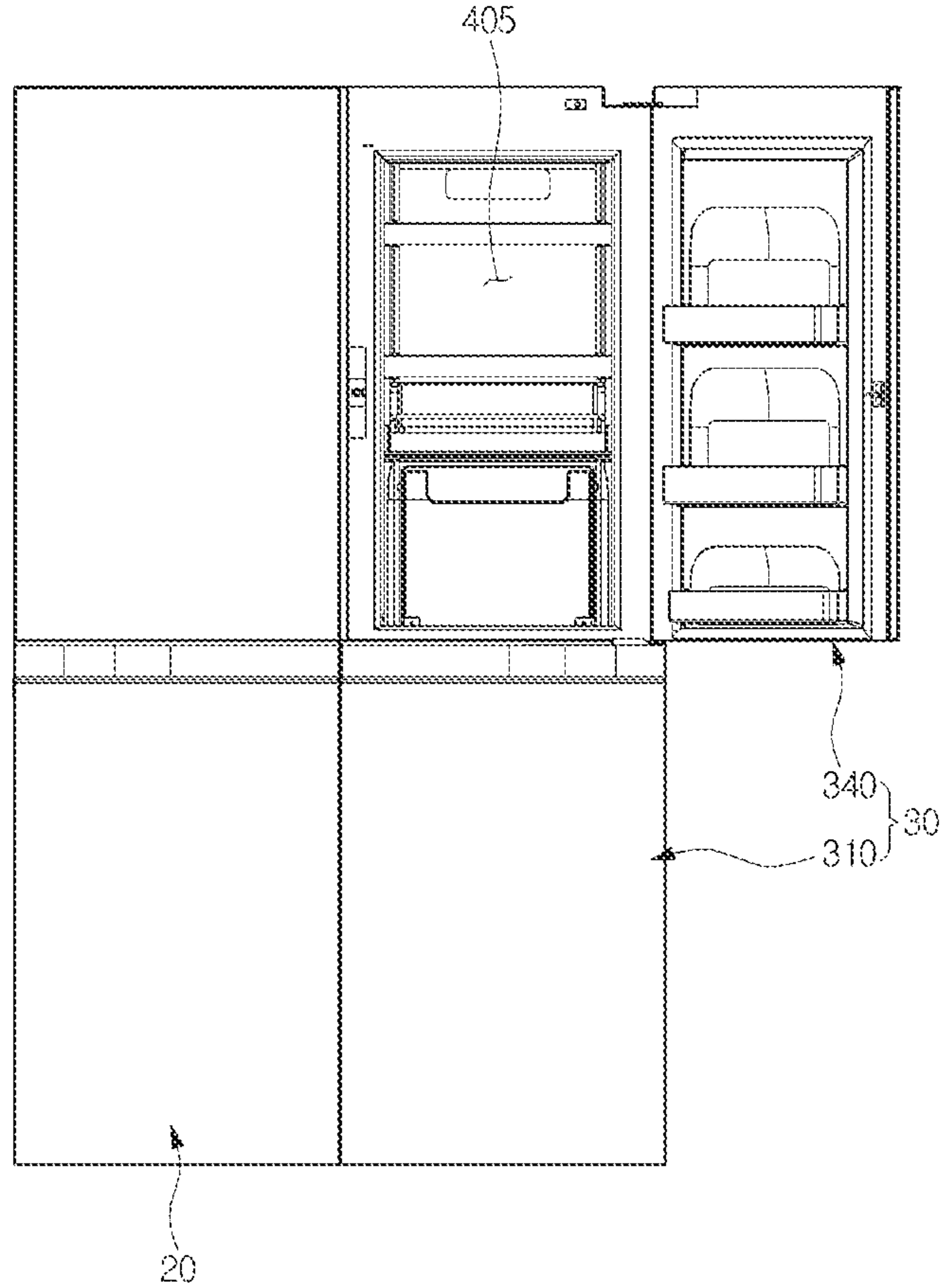
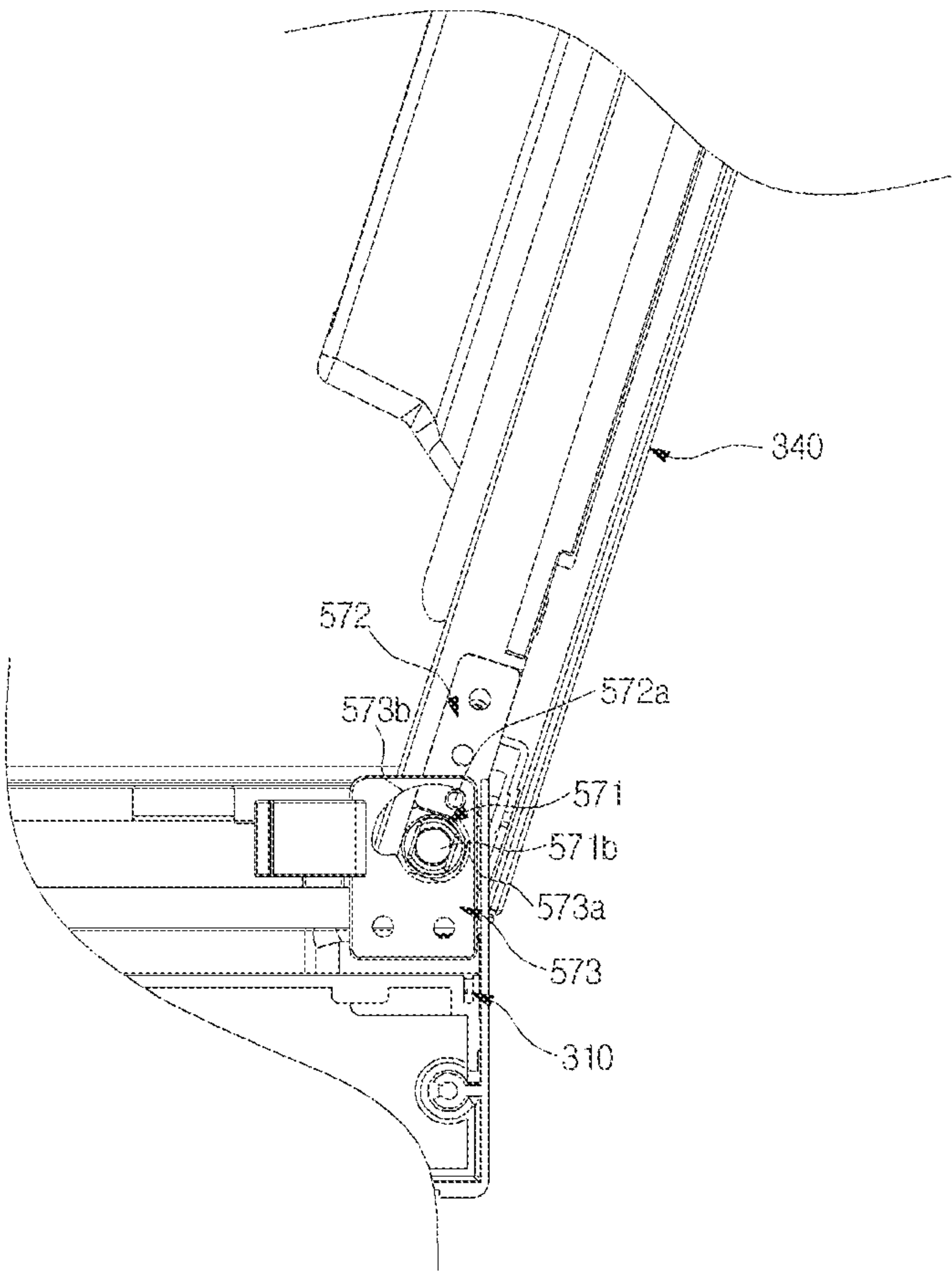


Fig. 87



REFRIGERATOR INCLUDING MULTIPLE STORAGE COMPARTMENTS

Matter enclosed in heavy brackets [] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue; a claim printed with strikethrough indicates that the claim was canceled, disclaimed, or held invalid by a prior post-patent action or proceeding.

CROSS REFERENCE TO RELATED APPLICATIONS

Multiple reissue applications have been filed for U.S. Pat. No. 9,322,591. In addition to the present application, U.S. application Ser. No. 15/963,465 was filed on Apr. 26, 2018, and issued as U.S. Pat. No. RE47,753. U.S. application Ser. No. 16/700,781 was filed on Dec. 2, 2019, and issued as U.S. Pat. No. RE48,724. U.S. application Ser. No. 16/700,808 was filed on Dec. 2, 2019, and issued as U.S. Pat. No. RE48,733. U.S. application Ser. No. 17/465,474 was filed on Sep. 2, 2021, and is currently pending.

This application is a reissue of U.S. Pat. No. 9,332,591, and a reissue continuation of U.S. application Ser. No. 16/700,781, filed on Dec. 2, 2019 (now reissued as U.S. Pat. No. RE48,724), which is a reissue continuation of U.S. application Ser. No. 15/963,465, filed Apr. 26, 2018, now U.S. Pat. No. RE47,753, which is another reissue application of U.S. Pat. No. 9,322,591, filed as U.S. application Ser. No. 14/609,005 on Jan. 29, 2015, which is a divisional of U.S. application Ser. No. 13/500,980, filed Oct. 17, 2012, now [pending] abandoned, which is a U.S. National Phase of International Application PCT/KR2010/006297, filed on Sep. 15, 2010, which claims the benefit of a foreign priority application filed in Korea as Serial No. 10-2010-0000086, on Jan. 4, 2010, the entire contents of the prior applications are hereby incorporated by reference in their entireties.

TECHNICAL FIELD

The present disclosure relates to a refrigerator.

BACKGROUND ART

Refrigerators are apparatuses configured to store food under low temperature conditions.

Such a refrigerator includes a main body provided with a storage compartment, and a door movably connected to the main body to open and close the storage compartment.

For example, the storage compartment may be divided into a refrigerator compartment and a freezer compartment, and the door includes a refrigerator compartment door opening and closing the refrigerator compartment, and a freezer compartment door opening and closing the freezer compartment.

Thus, a user should open the refrigerator compartment door and the freezer compartment door to take out food stored in the refrigerator compartment door and the freezer compartment door.

DISCLOSURE OF INVENTION

Technical Problem

Embodiments provide a refrigerator that includes a large storage compartment in a first door to improve a storing

efficiency and a user's convenience, and the first door and a second door configured to close the storage compartment provide the sense of unity, thus improving the appearance.

Solution to Problem

In one embodiment, a refrigerator includes: a cabinet that defines a first storage compartment; a first door that is opened or closed to allow or prevent access to an interior of the first storage compartment; a storing device coupled to the first door to define a second storage compartment, wherein, when the first door is closed, the second storage compartment is disposed in the first storage compartment; and a second door connected to the first door and configured to be opened or closed to allow or prevent access to an interior of the second storage compartment, wherein the interior of the second storage compartment is accessible when the first door is closed and the second door is opened, wherein the first door includes a plurality of first coupling parts to which the storing device is coupled, wherein the storing device includes: a frame; and a basket installed on the frame, wherein each of the frame and the basket includes at least one second coupling part interacting with at least one of the plurality of first coupling parts, wherein a front surface of the second door is positioned to be generally coplanar with at least a portion of a front surface of the first door.

In another embodiment, a refrigerator includes: a cabinet that defines a first storage compartment; a first door that is opened or closed to allow or prevent access to an interior of the first storage compartment; a storing device coupled to a rear surface of the first door to define a second storage compartment, wherein, when the first door is closed, the second storage compartment is disposed in the first storage compartment; and a second door connected to the first door and configured to be opened or closed to allow or prevent access to an interior of the second storage compartment, wherein the storing device includes: a frame that defines the second storage compartment; a basket installation part disposed at the second storage compartment; and a basket slidably installed on the basket installation part, wherein the basket installation part and the basket are accessible when the first door is closed and at least the second door is opened, wherein a front surface of the second door is positioned to be generally coplanar with at least a portion of a front surface of the first door.

In another embodiment, a refrigerator includes: a cabinet that defines a first storage compartment; a first door that is opened or closed to allow or prevent access to an interior of the first storage compartment; a storing device coupled to the first door to define a second storage compartment, wherein the second storage compartment is disposed within the first storage compartment when the first door is closed; and a second door connected to the first door and configured to be opened or closed to allow or prevent access to an interior of the second storage compartment when the storing device is disposed within the first storage compartment, wherein the storing device includes: a frame that defines the second storage compartment; a basket installation part disposed at the second storage compartment, and defining a receiving part; a first basket received in the receiving part of the basket installation part such that the first basket is taken out; and a second basket removably placed on an upper surface of the basket installation part, wherein a front surface of the second door is positioned to be generally coplanar with at least a portion of a front surface of the first door.

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In another embodiment, a refrigerator includes: a cabinet that defines a first storage compartment; a first door that is opened or closed to allow or prevent access to an interior of the first storage compartment; a storing device coupled to the first door to define a second storage compartment that is disposed within the first storage compartment when the first door closes; and a second door connected to the first door to open and close the second storage compartment, wherein the storing device includes: a frame that defines the second storage compartment; a first basket fixed to the frame; a basket installation part disposed at the second storage compartment; and a second basket removably installed on the basket installation part, wherein the second door is configured to be opened when the first door is closed to provide access to the storing device, wherein a front surface of the second door is positioned to be generally coplanar with at least a portion of a front surface of the first door.

In another embodiment, a refrigerator includes: a cabinet that defines a first storage compartment; a first door that is opened or closed to allow or prevent access to an interior of the first storage compartment; a storing device coupled to the first door to define a second storage compartment, wherein, when the first door is closed, the second storage compartment is disposed in the first storage compartment; a second door connected to the first door and configured to be opened or closed to allow or prevent access to an interior of the second storage compartment, wherein the interior of the second storage compartment is accessible when the first door is closed and the second door is opened; a first hinge that rotatably connects the first door to the cabinet; and a second hinge that rotatably connects the second door to the first door, wherein a hinge shaft of the second hinge is disposed nearer to a side surface of the first door than a hinge shaft of the first hinge is.

In another embodiment, a refrigerator includes: a cabinet that defines a first storage compartment; a first door that is opened or closed to allow or prevent access to an interior of the first storage compartment; a storing device coupled to the first door to define a second storage compartment, wherein, when the first door is closed, the second storage compartment is disposed in the first storage compartment; a second door connected to the first door and configured to be opened or closed to allow or prevent access to an interior of the second storage compartment, wherein the interior of the second storage compartment is accessible when the first door is closed and the second door is opened; a locking unit provided to a rear surface of the first door and a rear surface of the second door to selectively confine the first door to the second door by a pressing operation; and a limiting member provided to one of a front surface of the first door and the rear surface of the second door to prevent a rotation of the second door from inertia.

In another embodiment, a refrigerator includes: a cabinet that defines a first storage compartment; a first door that is opened or closed to allow or prevent access to an interior of the first storage compartment; a storing device coupled to the first door to define a second storage compartment, wherein, when the first door is closed, the second storage compartment is disposed in the first storage compartment; a second door connected to the first door and configured to be opened or closed to allow or prevent access to an interior of the second storage compartment, wherein the interior of the second storage compartment is accessible when the first door is closed and the second door is opened; a locking unit provided to the first door and the second door to selectively confine the second door to the first door; and a release

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member provided to the first door and the second door and pressed to release the locking unit.

In another embodiment, a refrigerator includes: a cabinet that defines a first storage compartment; a first door that is opened or closed to allow or prevent access to an interior of the first storage compartment; a storing device coupled to the first door to define a second storage compartment, wherein, when the first door is closed, the second storage compartment is disposed in the first storage compartment; a second door connected to the first door and configured to be opened or closed to allow or prevent access to an interior of the second storage compartment, wherein the interior of the second storage compartment is accessible when the first door is closed and the second door is opened; a shelf rotatably connected to the first door; and a connection assembly that connects the shelf to the second door to rotate the shelf forward when the second door is opened.

In another embodiment, a refrigerator includes: a cabinet that defines a first storage compartment; a first door that is opened or closed to allow or prevent access to an interior of the first storage compartment; a storing device coupled to the first door to define a second storage compartment, wherein, when the first door is closed, the second storage compartment is disposed in the first storage compartment; and a second door connected to the first door and configured to be opened or closed to allow or prevent access to an interior of the second storage compartment, wherein the interior of the second storage compartment is accessible when the first door is closed and the second door is opened, wherein the second door includes: a door case forming a rear exterior thereof; a pair of cap decors respectively coupled to an upper end and a lower end of the door case; a pair of side decors respectively coupled to a left end and a right end of the door case; a door plate placed on upper surfaces of the cap decors and the side decors to form a frontal exterior thereof; and an insulation layer between the door plate and the door case, wherein the door plate is formed of tempered glass.

In another embodiment, a refrigerator includes: a cabinet that defines a first storage compartment; a first door that is opened or closed to allow or prevent access to an interior of the first storage compartment; a storing device coupled to the first door to define a second storage compartment, wherein, when the first door is closed, the second storage compartment is disposed in the first storage compartment; and a second door connected to the first door and configured to be opened or closed to allow or prevent access to an interior of the second storage compartment, wherein the interior of the second storage compartment is accessible when the first door is closed and the second door is opened, wherein the second door includes: a door case forming a rear exterior thereof; a pair of cap decors respectively coupled to an upper end and a lower end of the door case; a pair of side decors respectively coupled to a left end and a right end of the door case; a door plate placed on upper surfaces of the cap decors and the side decors to form a frontal exterior thereof; and an insulation layer between the door plate and the door case, wherein a portion of the door case between a lower end and a middle of the second door is provided with an ingate through which a foaming agent for forming the insulation layer is injected.

In another embodiment, a method for manufacturing refrigerator includes: a cabinet that defines a first storage compartment; a first door that is opened or closed to allow or prevent access to an interior of the first storage compartment; a storing device coupled to the first door to define a second storage compartment, wherein, when the first door is

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closed, the second storage compartment is disposed in the first storage compartment; and a second door connected to the first door and configured to be opened or closed to allow or prevent access to an interior of the second storage compartment, wherein the interior of the second storage compartment is accessible when the first door is closed and the second door is opened, the second door including: a door case forming a rear exterior thereof; a pair of cap decors respectively coupled to upper and lower ends of the door case; a pair of side decors respectively coupled to left and right side ends of the door case; a door plate mounted on upper surfaces of the cap decors and the side decors to form a frontal exterior thereof; and an insulation layer formed in a space between the door plate and the door case, wherein an ingate into which a foaming agent is injected for forming the insulation layer is formed in the door case at a predetermined position between a lower end and a center of the second door, the method including: injecting the foaming agent to form the insulation layer into the ingate in a state where the second door is inclined such that the lower end of the second door is higher than the upper end of the second door.

In another embodiment, a refrigerator includes: a cabinet that defines a first storage compartment; a first door that is opened or closed to allow or prevent access to an interior of the first storage compartment; a storing device coupled to the first door to define a second storage compartment, wherein, when the first door is closed, the second storage compartment is disposed in the first storage compartment; a second door connected to the first door and configured to be opened or closed to allow or prevent access to an interior of the second storage compartment, wherein the interior of the second storage compartment is accessible when the first door is closed and the second door is opened; the second door including: a door case forming a rear exterior thereof; a gasket extending along an edge of the door case; a pair of metal cap decors respectively coupled to upper and lower ends of the door case; a pair of side decors respectively coupled to left and right ends of the door case; a door plate mounted on upper surfaces of the cap decors and the side decors to form a frontal exterior thereof; an insulation layer formed in a space between the door plate and the door case; and a ground member connecting the side decors.

In another embodiment, a refrigerator includes: a cabinet that defines a first storage compartment; a first door that is opened or closed to allow or prevent access to an interior of the first storage compartment, the first door having an opening; a storing device coupled to the first door to define a second storage compartment, wherein, when the first door is closed, the second storage compartment is disposed in the first storage compartment, and the opening is configured to communicate with the second storage compartment; a second door connected to the first door and configured to be opened or closed to allow or prevent access to an interior of the second storage compartment, wherein the interior of the second storage compartment is accessible through the opening when the first door is closed and the second door is opened; an inclined surface disposed on an inner border of the opening; and a gasket attached to a rear surface of the second door, wherein the gasket contacts the inclined surface when the second door is closed.

In another embodiment, a refrigerator includes: a cabinet that defines a first storage compartment; a first door that is opened or closed to allow or prevent access to an interior of the first storage compartment; a storing device coupled to the first door to define a second storage compartment, wherein, when the first door is closed, the second storage

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compartment is disposed in the first storage compartment; a second door connected to the first door and configured to be opened or closed to allow or prevent access to an interior of the second storage compartment, wherein the interior of the second storage compartment is accessible when the first door is closed and the second door is opened; a gasket provided to one of the first door and the second door; a metal attachment member provided to one of the first door and the second door; and a magnetic member provided to the door contacting the door provided with the attachment member and selectively contacting the attachment member, wherein the first door is provided with an opening that allow access to the storing device while the first door is closed, and the gasket, the attachment member, and the magnetic member are disposed in a region adjacent to an edge of the opening.

The details of one or more embodiments are set forth in the accompanying drawings and the description below. Other features will be apparent from the description and drawings, and from the claims.

Advantageous Effects of Invention

According to the embodiments, the baskets arrayed along the up and down direction can be used to effectively store food in the second storage compartment.

In addition, since the baskets can be removed from the accommodation device, and be taken out through the opening of the first door, food can be easily put in or taken out to or from the baskets.

In addition, since the second door has the same left and right length as the left and right length of the first door, the appearance of the refrigerator compartment door is improved.

In addition, one group of the second coupling parts is disposed on the frame, and the other group is disposed on the basket. Thus, the load of the frame applied to the basket can be reduced. In addition, the load of the basket applied to the frame can be reduced. Thus, the damages of the boundaries respectively between the second coupling parts and the first basket or the frame can be prevented.

In addition, since the space in which a portion of the second coupling part is inserted is disposed between the first projection part and the second projection part, the second coupling part contacts the first projection part to prevent the rotation of the accommodation device and maintain stable coupling of the accommodation device to the refrigerator compartment door.

In addition, since the storage compartment of the first door is large, a storing efficiency can be improved.

In addition, since the second door and the first door rotate in the same direction, the large storage compartment can be easily opened and closed, thus improving a user's convenience.

In addition, since the first door and the second door share the upper, left, and right surfaces, and the lower end of the second door is provided with the door handle, the first door and the second door can be perceived as a single body from the front side. Thus, the exterior of the refrigerator can be improved.

BRIEF DESCRIPTION OF DRAWINGS

FIG. 1 is a perspective view illustrating a refrigerator according to an embodiment.

FIG. 2 is a perspective view illustrating a refrigerator with a first storage compartment being opened, according to an embodiment.

FIG. 3 is a perspective view illustrating a refrigerator with a second storage compartment being opened, according to an embodiment.

FIG. 4 is a perspective view illustrating the rear surface of a refrigerator compartment door according to an embodiment.

FIG. 5 is a perspective view illustrating a storing device according to an embodiment.

FIG. 6 is an exploded perspective view illustrating a storing device according to an embodiment.

FIG. 7 is a perspective view illustrating a frame according to an embodiment.

FIG. 8 is a side view illustrating a state where a storing device is coupled to a refrigerator compartment door.

FIG. 9 is a perspective view illustrating a state where a basket is taken out when a second door opens a second storage compartment.

FIG. 10 is an exploded perspective view illustrating a refrigerator including a first door and a second door according to an embodiment.

FIG. 11 is an exploded perspective view illustrating a first hinge and a second hinge according to an embodiment.

FIG. 12 is a side view illustrating an installation state of the first and second hinges of FIG. 11.

FIG. 13 is a plan view illustrating the first and second hinges of FIG. 11 when the first and second doors of FIG. 10 are closed.

FIG. 14 is a plan view illustrating first and second hinges when a first door is opened.

FIG. 15 is a plan view illustrating first and second hinges when a second door is opened.

FIG. 16 is a perspective view illustrating a refrigerator when a second door is opened according to an embodiment.

FIG. 17 is a partial perspective view illustrating a second door with a coupling structure of a limiting member according to an embodiment.

FIG. 18 is a partial side view illustrating a refrigerator with a limiting member when first and second doors are closed according to an embodiment.

FIG. 19 is a perspective view illustrating a refrigerator when a second door is opened according to an embodiment.

FIG. 20 is a schematic view illustrating a limiting member when first and second doors are opened according to an embodiment.

FIG. 21 is a schematic view illustrating a limiting member when a second door is closed according to an embodiment.

FIG. 22 is a perspective view illustrating a refrigerator according to an embodiment.

FIG. 23 is a perspective view illustrating a refrigerator when a second door is opened according to an embodiment.

FIG. 24 is an exploded perspective view illustrating a locking device and an opening unit according to an embodiment.

FIG. 25 is a cross-sectional view taken along line 4-4' of FIG. 24.

FIG. 26 is a cut-away perspective view taken along line 5-5' of FIG. 25 while a second door is closed.

FIG. 27 is a cut-away perspective view taken along line 6-6' of FIG. 25 while the second door is closed.

FIG. 28 is a rear view illustrating a locking assembly when a stopper is pushed by a latch rod, according to an embodiment.

FIG. 29 is a rear view illustrating a locking assembly when a second door is closed and a stopper is caught to a latch cam, according to an embodiment.

FIG. 30 is a schematic view illustrating the locking device and the opening unit when the second door is closed, according to an embodiment.

FIG. 31 is a schematic view illustrating the locking device and the opening unit when the opening unit is operated, according to an embodiment.

FIG. 32 is a schematic view illustrating the locking device and the opening unit when the second door is opened, according to an embodiment.

FIG. 33 is a perspective view illustrating a refrigerator according to an embodiment.

FIG. 34 is a perspective view illustrating a refrigerator when a second door is opened, according to an embodiment.

FIG. 35 is a schematic view illustrating a locking unit when the second door is closed.

FIG. 36 is a schematic view illustrating the locking unit when a signal for opening the second door is input.

FIG. 37 is a perspective view illustrating a refrigerator when a second door is opened, according to an embodiment.

FIG. 38 is a schematic view illustrating a shelf rotated by the opening of the second door.

FIG. 39 is a schematic view illustrating the rear surface of a first door when the second door is closed.

FIG. 40 is a schematic view illustrating a joint member coupled to a connection assembly according to an embodiment.

FIG. 41 is an exploded perspective view illustrating a connection assembly according to an embodiment.

FIGS. 42A, 42B and 42C are schematic views illustrating an operation of the connection assembly.

FIG. 43 is an exploded perspective view illustrating an installation structure of the second door.

FIG. 44 is a schematic view illustrating a lower hinge assembly when the second door is closed.

FIG. 45 is a schematic view illustrating the lower hinge assembly when the second door is opened.

FIG. 46 is a perspective view illustrating the second door.

FIG. 47 is an exploded perspective view illustrating the front side of the second door.

FIG. 48 is an exploded perspective view illustrating the rear side of the second door.

FIG. 49 is a cross-sectional view taken along line 7-7' of FIG. 46.

FIG. 50 is a cross-sectional view taken along line 8-8' of FIG. 46.

FIG. 51 is a perspective view illustrating a second door when only a door plate is removed from the second door.

FIG. 52 is an exploded perspective view illustrating a second door coupled with reinforcement members according to an embodiment.

FIG. 53 is a cross-sectional view taken along line 9-9' of FIG. 52.

FIG. 54 is an exploded perspective view illustrating the front side of the second door.

FIG. 55 is an exploded perspective view illustrating the rear side of the second door.

FIG. 56 is a perspective view illustrating the second door installed on a jig.

FIGS. 57 to 61 are graphs illustrating filling states of a foaming agent according to angles of the jig.

FIG. 62 is an exploded perspective view illustrating a refrigerator with a removed second door according to an embodiment.

FIG. 63 is a graph illustrating hardness variations of gaskets formed of different materials according to a temperature variation according to an embodiment.

FIG. 64 is an exploded perspective view illustrating the front side of the second door.

FIG. 65 is a rear view illustrating a second door in which a ground wire is disposed.

FIGS. 66A and 66B are schematic views illustrating static electricity occurring at the second door.

FIG. 67 is a perspective view illustrating a refrigerator including a second door is opened according to an embodiment.

FIG. 68 is a perspective view illustrating a refrigerator including a second door according to another embodiment.

FIG. 69 is a perspective view illustrating a refrigerator including a second door according to another embodiment.

FIG. 70 is a perspective view illustrating a refrigerator when a second door is opened, according to an embodiment.

FIG. 71 is a partial front view illustrating a first door according to an embodiment.

FIG. 72 is a rear view illustrating a second door according to an embodiment.

FIG. 73 is a cross-sectional view illustrating a refrigerator compartment door when the second door is opened, according to an embodiment.

FIG. 74 is a cross-sectional view illustrating the refrigerator compartment door when the second door is closed.

FIG. 75 is a perspective view illustrating a refrigerator compartment door when a second door is opened, according to an embodiment.

FIG. 76 is a cross-sectional view illustrating a refrigerator compartment door according to an embodiment.

FIG. 77 is a perspective view illustrating a refrigerator when a second door is opened according to an embodiment.

FIG. 78 is a cross-sectional view illustrating a refrigerator compartment door according to an embodiment.

FIG. 79 is a perspective view illustrating a refrigerator compartment door when a second door is opened, according to an embodiment.

FIG. 80 is a perspective view illustrating a refrigerator when a second door is opened, according to an embodiment.

FIG. 81 is an exploded perspective view illustrating the second door.

FIG. 82 is an exploded perspective view illustrating a refrigerator compartment door with the second door and a lower hinge.

FIG. 83 is a partial cut-away perspective view illustrating the refrigerator compartment door coupled with the second door.

FIG. 84 is a front view illustrating the refrigerator when the second door is closed.

FIG. 85 is a bottom view illustrating a portion of the second door with the lower hinge assembly when the second door is closed.

FIG. 86 is a front view illustrating the refrigerator when the second door is opened.

FIG. 87 is a bottom view illustrating a portion of the second door with the lower hinge assembly when the second door is opened.

MODE FOR THE INVENTION

Reference will now be made in detail to the embodiments of the present disclosure, examples of which are illustrated in the accompanying drawings.

FIG. 1 is a perspective view illustrating a refrigerator according to an embodiment. FIG. 2 is a perspective view illustrating a refrigerator with a first storage compartment being opened, according to an embodiment. FIG. 3 is a

perspective view illustrating a refrigerator with a second storage compartment being opened, according to an embodiment.

Referring to FIGS. 1 to 3, a refrigerator 1 according to an embodiment includes a cabinet 10 providing a storage compartment, and doors 20 and 30 opening and closing to provide or prevent access to an interior of the storage compartment.

The storage compartment includes a freezer compartment 102 and a refrigerator compartment 104. The freezer compartment 102 and the refrigerator compartment 104 may be arrayed along the left and right direction, and be separated by a separation part.

The doors 20 and 30 include a freezer compartment door (which is also denoted by 20), and a refrigerator compartment door (which is also denoted by 30), respectively. The freezer compartment door 20 and the refrigerator compartment door 30 open and close to provide or prevent access to an interior of the freezer compartment 102, and open and close to provide or prevent access to an interior of the refrigerator compartment 104, respectively.

A storing device 40 is disposed in the rear surface of the refrigerator compartment door 30 to accommodate food. The storing device 40 includes a frame 41 providing an accommodation space. The frame 41 is removably coupled to the rear surface of the refrigerator compartment door 30.

The refrigerator compartment 104 may be divided into a plurality of spaces by one or more shelves 105.

When the refrigerator compartment door 30 closes the refrigerator compartment 104, the frame 41 is disposed in the refrigerator compartment 104. In other words, when the refrigerator compartment door 30 is closed, the accommodation space provided by the frame 41 of the storing device 40 is disposed in the refrigerator compartment 104. In the current embodiment, the refrigerator compartment 104 may be referred to as a first storage compartment, and a space provided by the frame 41 may be referred to as a second storage compartment 405. Hereinafter, the first storage compartment is also denoted by 104.

Thus, when the refrigerator compartment door 30 closes the first storage compartment 104, the second storage compartment 405 is disposed within the first storage compartment 104.

The refrigerator compartment door 30 includes a first door 310 opening and closing the first storage compartment 104, and a second door 340 rotatably connected to the first door 310 to open and close the second storage compartment 405. Thus, the second storage compartment 405 is accessible when the second door 340 opens.

The first door 310 is rotatably coupled to the cabinet 10 through a hinge assembly.

The hinge assembly includes a second hinge 51 connecting the second door 340 to the first door 310, and a first hinge 52 connecting the first door 310 to the cabinet 10.

An opening 316 is disposed in the first door 310 such that food is taken out from or put in to the second storage compartment 405 when the first door 310 closes the first storage compartment 104. Thus, when the first door 310 closes the first storage compartment 104, the opening 316 is opened to put in or take out food to or from the second storage compartment 405.

The left and right width of the second door 340 is the same as that of the first door 310. Thus, oneness of the second door 340 and the first door 310 is improved, so that the appearance of the refrigerator compartment door 30 can be improved.

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The rear surface of the second door **340** is provided with a latch hook **341** for coupling to the first door **310**, and a second part **312** of the first door **310** is provided with a latch slot **317** for coupling with the latch hook **341**.

Since the structures of the latch hook **341** and the latch slot **317** are well known in the art, descriptions thereof will be omitted.

Thus, in the state where the first door **310** closes the first storage compartment **104**, when the front surface of the second door **340** is pressed, the latch hook **341** is released from the latch slot **317**, so that the second door **340** can be rotated.

The rear surface of the first door **310** is provided with a sealer **319** for preventing chilly air of the first storage compartment **104** from leaking. A magnet is disposed in the sealer **319**, and attraction between the magnet and the front surface of the cabinet **10** maintains the state where the first door **310** closes the first storage compartment **104**.

The rear surface of the first door **310** may be coupled with one or more baskets **318** for storing food.

FIG. **4** is a perspective view illustrating the rear surface of a refrigerator compartment door according to an embodiment.

Referring to FIGS. **2** to **4**, the refrigerator compartment door **30** includes the first door **310** and the second door **340** as described above.

A side surface of the first door **310** has a stepped shape. In detail, the first door **310** includes a first part **311**, and the second part **312** extending to the upper side of the first part **311**. The second part **312** has a thickness less than that of the first part **311**.

The opening **316** is disposed in the second part **312**, and the second door **340** is connected to the second part **312**, so as to open and close the opening **316** and the second storage compartment **405**.

The upper side of the first part **311** is provided with a grip part **313** that is held by a user. The grip part **313** extends upward from the upper surface of the first part **311**.

For a user to hold the grip part **313**, the grip part **313** is spaced apart from the front surface of the second part **312** and the lower surface of the second door **340**. That is, the up and down length of the second door **340** is less than that of the second part **312**.

When the grip part **313** held by a user is pulled, the first door **310** is rotated to open the first storage compartment **104**.

The first door **310** includes an outer case **321** and a door liner **322** coupled to the outer case **321**. Substantially, the door liner **322** closes the first storage compartment **104**.

The door liner **322** includes a plurality of dikes **323** that are spaced apart from each other along the left and right direction. Each of the dikes **323** is elongated along the up and down direction. The dikes **323** constitute a portion of the door liner **322**.

The storing device **40** and a part of the baskets **318** are disposed between the dikes **323**.

Each of the dikes **323** includes one or more first coupling parts for coupling with the storing device **40**. To stably couple the storing device **40** to each of the dikes **323**, a plurality of first coupling parts **330**, **331**, and **332** may be disposed on each of the dikes **323**. The first coupling parts **330**, **331**, and **332** are spaced apart from one another along the up and down direction.

Each of the first coupling parts **330**, **331**, and **332** includes a first projection part **333** and a second projection part **334**.

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The first and second projection parts **333** and **334** protrude from each of the dikes **323** in the direction in which they come closer to each other.

The first and second projection parts **333** and **334** are spaced apart from each other along the front and rear direction of the refrigerator compartment door **30**. Thus, a space is formed between the first and second projection parts **333** and **334**.

The first projection part **333** is adjacent to the opening **316** of the first door **310**. That is, the distance between the first projection part **333** and the opening **316** is less than the distance between the second projection part **334** and the opening **316**.

A stepped part **323a** that is stepped with a predetermined depth is disposed in the rear surface of the first door **310** corresponding to the lower side of the storing device **40**. Thus, a horizontal protrusion length of the dikes **323** in the region provided with the storing device **40** is shorter than a horizontal protrusion length in the region corresponding to the lower side of the storing device **40**. Accordingly, a back and forth width of a basket installed on the rear surface of the first door **310**, that is, on the rear surface of the first door **310** corresponding to the lower side of the storing device **40** can be greater than a back and forth width of a basket installed in the storing device **40**.

A coupling relationship between the storing device **40** and the first coupling parts **330**, **331**, and **332** will be described with reference to FIG. **8**.

FIG. **5** is a perspective view illustrating a storing device according to an embodiment. FIG. **6** is an exploded perspective view illustrating a storing device according to an embodiment. FIG. **7** is a perspective view illustrating a frame according to an embodiment.

Referring to FIGS. **4** to **7**, the storing device **40** includes the frame **41**, and a plurality of baskets **510**, **540**, and **560** for storing food. The baskets **510**, **540**, and **560** are spaced apart from one another along the up and down direction on the frame **41**.

The baskets **510**, **540**, and **560** include a first basket that is also denoted by **510**, a second basket that is also denoted by **540** and disposed at the lower side of the first basket **510**, and a third basket that is also denoted by **560** and disposed between the first basket **510** and the second basket **540**.

The first basket **510** is fixed to the frame **41** through a coupling member such as a screw. The second basket **540** and the third basket **560** are removably coupled to the frame **41**. As a matter of course, the first basket **510** may be removed from the frame **41**.

When the second door **340** opens the second storage compartment **405**, the second basket **540** and the third basket **560** can be taken out to the outside of the second storage compartment **405** through the opening **316** of the first door **310**.

Thus, food can be effectively stored in the second storage compartment **405**, using the first basket **510**, the second basket **540**, and the third basket **560**, which are arrayed along the up and down direction.

The frame **41** includes both side surfaces **401**, a rear surface **402**, a lower surface **403**, and an upper surface **404** to provide the second storage compartment **405**.

The frame **41** includes one or more communication holes **406** such that the first storage compartment **104** communicates with the second storage compartment **405**.

The rear surface **402** of the frame **41** is provided with an opening **408** to put in or take out food to or from the second storage compartment **405** in the state where the first door

310 opens the first storage compartment 104. The opening 408 can be opened and closed by a cover 411.

The rear surface 402 is provided with a hinge coupling part 410 for coupling with a hinge 412 provided to the cover 411. The hinge 412 may be disposed at the upper portion of the cover 411. Thus, the cover 411 can rotate about the hinge 412 disposed at the upper portion of the cover 411.

The rear surface 402 is provided with a stopper 409 that stops the cover 411 at a predetermined position when the cover 411 rotates in a direction closing the opening 408. Thus, a user can put food into or take food out from the second storage compartment 405 through the opening 316 of the first door 310, or the opening 408 of the frame 41. The cover 411 is provided with a hole 413 such that the first storage compartment 104 communicates with the second storage compartment 405.

The upper portion of the frame 41 is provided with a plurality of coupling bosses 430 for coupling with the first basket 510. In detail, the coupling bosses 430 are disposed at the upper portions respectively of the side surfaces 401.

A supporter 420 is integrally formed with the middle portion of the frame 41. Alternatively, the supporter 420 may be removably coupled to the frame 41.

The supporter 420 connects the side surfaces 401 to each other. The front and rear length of the supporter 420 is greater than that of the side surfaces 401. That is, the supporter 420 includes an extension part 420a that extends to the front side of the side surfaces 401 in a side view of the frame 41.

The extension part 420a includes a plurality of vertical surfaces 421 that are respectively disposed at both sides of the extension part 420a, and horizontal surfaces 423 that horizontally extend from the vertical surfaces 421. The horizontal surfaces 423 extend in directions going away from the vertical surfaces 421, respectively.

Sides respectively of the vertical surfaces 421 are provided with second coupling parts 425 that interact with the first coupling parts 331. The second coupling parts 425 may be integrally formed with the vertical surfaces 421 and the horizontal surfaces 423.

Thus, a load applied to the supporter 420 is prevented from damaging the boundaries between the second coupling parts 425 and the supporter 420 when the second coupling parts 425 are coupled to the first coupling parts 331.

The second coupling parts 425 include a placement part 426 extending horizontally and an insertion part 427 extending downward from an end of the placement part 426. The insertion part 427 is inserted in a space 335 between the first and second projection parts 333 and 334, and the placement part 426 is placed on the upper surface of the second projection part 334. That is, the second projection part 334 supports the placement part 426.

The width of the space 335 may be equal to or greater than the width of the insertion part 427.

Alternatively, the insertion part 427 may be disposed in the middle of the placement part 426. In this case, when the insertion part 427 is inserted in the space 335, the first projection part 333 and the second projection part 334 may support the placement part 426.

Surfaces of the vertical surfaces 421, which face each other, that is, another surface of each of the vertical surfaces 421 is provided with guide ribs 422 that guide installation of a basket installation part 550 to be described later.

The lower surface 403 of the frame 41 includes an extension part 441 extending to the front side of the side surfaces 401 in the side view of the frame 41. Vertical surfaces 442 are disposed at both sides of the extension part

441, respectively. The vertical surfaces 442 are respectively provided with second coupling parts 445 that interact with the first coupling parts 330.

The second coupling parts 445 disposed in the lower portion of the frame 41 have the same shapes as those of the second coupling parts 425 disposed in the middle portion of the frame 41. That is, in the current embodiment, the frame 41 includes the second coupling parts 425 and 445 that are arrayed along the up and down direction. Thus, loads of the frame 41 and food can be distributed to the second coupling parts 425 and 445.

The first basket 510 has open front, upper and rear surfaces. That is, the first basket 510 includes a closed lower surface 511 and both closed side surfaces 513. The lower surface 511 is provided with one or more holes 512 through which chilly air can pass.

The side surfaces 513 are respectively provided with second coupling parts 515 that interact with the first projection parts 333. Since the second coupling parts 515 have the same shapes as those of the second coupling parts 425 and 445 provided to the frame 41, descriptions thereof will be omitted.

The side surfaces 513 are respectively provided with fixation parts 517 to be fixed to the frame 41. The fixation parts 517 are provided with coupling holes 518 through which coupling members pass. The coupling members pass through the coupling holes 518 are coupled to the coupling bosses 430 of the frame 41.

Each of the second coupling parts 515 is integrally formed with the side surface 513 and the fixation part 517. Thus, loads of the first basket 510 and food can be prevented from damaging the boundaries between the first basket 510 and the second coupling parts 515.

According to the current embodiment, one group of the second coupling parts is disposed on the frame 41, and the other group is disposed on the first basket 510. Thus, the load of the frame 41 to the first basket 510 can be reduced. In addition, the load of the first basket 510 to the frame 41 can be reduced. Thus, damages of the boundaries between the second coupling parts and the first basket, or between the second coupling parts and the frame can be prevented.

The first basket 510 is connected with a cover 520 for covering food placed on the first basket 510. The cover 520 includes a front surface 521, an oblique surface 522 obliquely extending from the front surface 521, and a couple of side surfaces 523 connected to the front surface 521 and the oblique surface 522. Rotation shafts 524 are disposed on the side surfaces 523, respectively. The rotation shafts 524 are inserted in shaft insertion holes 514 disposed in the side surfaces 513 of the first basket 510. Thus, the cover 520 covers food on the first basket 510 through a rotational motion.

Since the cover 520 covers food placed on the first basket 510, when the second door 340 opens the second storage compartment 405, the food placed on the first basket 510 is prevented from being exposed to the outside.

The basket installation part 550 is placed on the supporter 420. The basket installation part 550 includes a couple of side surfaces 551 and an upper surface 555. The side surfaces 551 and the upper surface 555 provide a receiving part 557 that receives the second basket 540.

The side surfaces 551 are provided with second guide parts 552 for guiding a sliding installation along the front and rear direction of the second basket 540. The second guide parts 552 interact with first guide parts 542 provided to the second basket 540. For example, the first guide parts 542 may slide into the second guide parts 552.

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The second guide parts **552** extend along the front and rear direction on the side surfaces **551**, respectively. The second guide parts **552** include first parts **553** and second parts **554** extending from the first parts **553** to the rear side (to the rear surface of the frame **41**). Along the up and down direction, the first part **553** has a height greater than that of the second part **554**. The height of the first part **553** may decrease toward the second part **554**.

The upper surface **555** of the basket installation part **550** is provided with a plurality of movement prevention parts **556** to prevent a front and rear movement and a left and right movement of the third basket **560** when the third basket **560** is placed on the upper surface **555**. The movement prevention parts **556** are disposed at both ends of the upper surface **555**.

The second basket **540** has an open upper surface. When the second basket **540** is installed on the basket installation part **550**, the open upper surface of the second basket **540** is covered by the upper surface **555** of the basket installation part **550**.

Both side surfaces **541** of the second basket **540** are provided with the first guide parts **542** that interact with the second guide parts **552**. The first guide parts **542** extend along the front and rear direction on the side surfaces **541** of the second basket **540**, respectively.

The second guide parts **552** receive the first guide parts **542**. The up and down lengths of inlets of the first parts **553** are greater than those of the first guide parts **542**. The up and down lengths of the second parts **554** are equal to or greater than those of the first guide parts **542**.

Since the up and down lengths of the inlets of the first parts **553** are greater than those of the first guide parts **542**, the first guide parts **542** can be easily inserted into the first parts **553**.

The first parts **553** of the second guide parts **552** are provided with first projection parts **553a** inserted in the first guide parts **542**, and the first guide parts **542** are provided with first insertion recesses **543** in which the first projection parts **553a** are inserted. The first guide parts **542** are provided with second projection parts **544**, and the second parts **554** of the second guide parts **552** are provided with second insertion recesses **554a** in which the second projection parts **544** are inserted.

The second projection parts **544**, the first projection parts **553a**, the first insertion recesses **543**, and the second insertion recesses **554a** prevent the front and rear movement of the second basket **540** in the state where the second basket **540** is installed on the basket installation part **550**.

The left and right length of the second basket **540** may be less than that of the opening **316** such that the second basket **540** can be taken out from the basket installation part **550** through the opening **316**.

The third basket **560** is placed on the upper surface **555** of the basket installation part **550**. The third basket **560** is placed on and removed from the basket installation part **550** along the up and down direction.

The third basket **560** has an open upper surface, a front surface **561**, both side surfaces **562**, and a lower surface (not shown).

Each of the side surfaces **562** of the third basket **560** includes a first side surface **563** extending rearward from the front surface **561**, a second side surface **564** obliquely extending rearward from the first side surface **563**, and a third side surface **565** extending rearward from the second side surface **564**.

The first side surfaces **563** are substantially parallel to the third side surfaces **565**. The second side surfaces **564**

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obliquely extend in directions in which they go away from each other (in outward directions) from the first side surfaces **563**.

Because of the second side surfaces **564**, the distance between the first side surfaces **563** is less than the distance between the third side surfaces **565**.

When the third basket **560** is placed on the basket installation part **550**, the movement prevention parts **556** are disposed at the outsides of the first side surfaces **563** of the third basket **560**. The movement prevention parts **556** prevent the left and right movement of the third basket **560**, and prevent the forward removal of the third basket **560** when the first door **310** or the second door **340** is moved. Thus, when the first door **310** is closed, the second door **340** can be opened to access the frame **41**, the basket installation part **550**, and the plurality of baskets **510**, **540**, and **560**.

FIG. **8** is a side view illustrating a state where a storing device is coupled to a refrigerator compartment door.

Referring to FIGS. **4** and **8**, first, the second coupling parts **425**, **445**, and **515** of the storing device **40** are disposed between the dikes **323** of the refrigerator compartment door **30** to couple the storing device **40** to the refrigerator compartment door **30**.

At this point, the second coupling parts **425**, **445**, and **515** are disposed between the dikes **323** in the manner where the second coupling parts **425**, **445**, and **515** not interfere with the first coupling parts **330**, **331**, and **332**.

As illustrated in FIG. **8**, the second coupling parts **425**, **445**, and **515** do not interfere with the first coupling parts **330**, **331**, and **332**.

When the second coupling parts **425**, **445**, and **515** are disposed between the dikes **323**, the insertion parts **427** respectively of the second coupling parts **425**, **445**, and **515** are aligned with the spaces **335** between the first projection parts **333** and the second projection parts **334**, respectively.

In this state, the storing device **40** is moved downward to be coupled to the refrigerator compartment door **30**. Then, the insertion parts **427** are inserted into the spaces **335**, and the second projection parts **334** support the placement parts **426** of the second coupling parts **425**, **445**, and **515**.

Since food is accommodated in the storing device **40** at positions spaced apart from the second coupling parts **425**, **445**, and **515**, when food is accommodated in the storing device **40**, the storing device **40** tends to rotate about the second coupling parts **425**, **445**, and **515**.

However, in the current embodiment, the spaces **335** are provided to dispose the insertion parts **427** between the first projection parts **333** and the second projection parts **334**. Thus, the insertion parts **427** contact the first projection parts **333** to prevent the rotation of the storing device **40** and maintain stable coupling of the storing device **40** to the refrigerator compartment door **30**.

When the storing device **40** is installed on the first door **310**, the rear surface of the storing device **40** protrudes a predetermined distance **H** from the rear surface of the first door **310**. At least one of the baskets **318** may be installed on the rear surface of the first door **310** corresponding to the lower side of the storing device **40**. The rear surface of the basket **318** may protrude the predetermined distance **H** from the rear surface of the first door **310**.

In detail, when the storing device **40** and the basket **318** are installed on the first door **310**, the rear surfaces thereof protrude the same distance. That is, the rear surfaces of the storing device **40** and the basket **318** are disposed in the same extension line. Thus, when the first door **310** is closed,

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the storing device 40 and the basket 318 do not interfere with shelves and drawers within the first storage compartment 104.

FIG. 9 is a perspective view illustrating a state where a basket is taken out when a second door opens a second storage compartment.

Referring to FIGS. 1 to 9, first, the front surface of the second door 340 is pressed to put in or take out food to or from the second storage compartment 405. Then, the latch hook 341 and the latch slot 317 are released from each other, so that the second door 340 can be rotated.

After the second door 340 is rotated, a user can rotate the cover 520 covering the first basket 510.

In addition, a user can raise the third basket 560 to the upper side of the basket installation part 550 to remove the third basket 560 from the basket installation part 550.

In addition, a user can pull the second basket 540 forward such that the second basket 540 slides out of the second storage compartment 405.

According to the embodiments, the baskets arrayed along the up and down direction can be used to effectively store food in the second storage compartment.

In addition, since the baskets can be removed from the accommodation device, and be taken out through the opening of the first door, food can be easily put in or taken out to or from the baskets.

In addition, since the second door has the same left and right length as the left and right length of the first door, the appearance of the refrigerator compartment door is improved.

In addition, one group of the second coupling parts is disposed on the frame, and the other group is disposed on the basket. Thus, the load of the frame applied to the basket can be reduced. In addition, the load of the basket applied to the frame can be reduced. Thus, the damages of the boundaries respectively between the second coupling parts and the first basket or the frame can be prevented.

In addition, since the space in which a portion of the second coupling part is inserted is disposed between the first projection part and the second projection part, the second coupling part contacts the first projection part to prevent the rotation of the accommodation device and maintain stable coupling of the accommodation device to the refrigerator compartment door.

FIG. 10 is an exploded perspective view illustrating a refrigerator including a first door and a second door according to an embodiment. FIG. 11 is an exploded perspective view illustrating a first hinge and a second hinge according to an embodiment. FIG. 12 is a side view illustrating an installation state of the first and second hinges of FIG. 11. FIG. 13 is a plan view illustrating the first and second hinges of FIG. 11 when the first and second doors of FIG. 10 are closed.

Hereinafter, a description of the same configuration as that of the refrigerator 1 will be omitted.

Referring to FIGS. 10 to 13, as described above, the exterior of the refrigerator 1 may be formed by the cabinet 10 and the doors 20 and 30. The cabinet 10 defines a storage space, and the doors 20 and 30 open and close the storage space. The refrigerator 1 may be a side by side type refrigerator in which the freezer compartment 102 and the refrigerator compartment 104 are disposed at the left and right sides, respectively. The second door 340 may be provided to the refrigerator compartment door 30 that opens and closes the refrigerator compartment 104.

The opening 316 provided to the first door 310 may extend from the grip part 313 to an adjacent position to the

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upper end of the first door 310 and to adjacent positions to the left and right ends of the first door 310. The front surface of the storing device 40 is open to communicate with the opening 316 of the first door 310.

A first installation part 310b is disposed on the upper surface of the first door 310. The second hinge 51 is fixed to the first installation part 310b, and a portion of the first hinge 52 is disposed on the first installation part 310b. The first installation part 310b extends to a side end of the first door 310. A portion of the upper surface of the first door 310 has a stepped shape, and the first hinge 52 is disposed on the first installation part 310b that is recessed downward. Thus, the first hinge 52 is disposed at a lower position than the upper surface of the first door 310.

The second door 340 opens and closes the opening 316, and is rotatably connected to the first door 310 through the second hinge 51. The second hinge 51 has an end fixed to the first installation part 310b of the first door 310, and is rotatably connected to the upper surface of the second door 340. A lower hinge assembly to be described later is installed at the lower end of the second door 340, and is fixed to the front surface of the second door 340 through a hinge bracket to be described later. According to this structure, even when the first door 310 is closed, the second door 340 can independently rotate and selectively opens and closes the opening 316. The second door 340 rotates in the rotation direction of the first door 310.

A second installation part 340b provided with the second hinge 51 is recessed in the upper surface of the second door 340. The second installation part 340b extends to a side end of the second door 340. A portion of the upper surface of the second door 340 has a stepped shape for the second installation part 340b. Thus, the second hinge 51 is disposed on the second installation part 340b that is recessed downward, so that the second hinge 51 is disposed at a lower position than the upper end of the second door 340.

In detail, a shield part 57 is disposed in front of the second installation part 340b. The shield part 57 forms the front surface of the second door 340. That is, the upper and side ends of the shield part 57 and the upper and side ends of the second door 340 are disposed in the same planes, respectively. This is because the second installation part 340b is recessed at the rear side of the upper surface of the second door 340. The shield part 57 covers the first hinge 52 and the second hinge 51 placed on the first installation part 310b and the second installation part 340b. That is, when being viewed from the front side of the refrigerator 1, the first hinge 52 and the second hinge 51 are not exposed to the outside, and the second door 340 and the first door 310 can be perceived as a single body.

The first hinge 52 is configured such that the first door 310 is rotatably installed on the cabinet 10. A portion of the first hinge 52 is disposed on the cabinet 10, and the other portion is disposed on the first installation part 310b. The first hinge 52 may include a first hinge plate 523 and a first hinge shaft 524.

The first hinge plate 523 may have a plate shape, so that the first hinge 52 can be fixed to the cabinet 10. The first hinge plate 523 may include a first coupling part 521 fixed to the cabinet 10, and a first extension 522 extending from the first coupling part 521 to the first door 310.

The first coupling part 521 has fixing holes 521a for fixing the first hinge plate 523, an insertion hole 521b, and a fixing recess 521c. In detail, the fixing holes 521a are perforated such that fixing protrusions 11 of the upper surface of the cabinet 10 can be inserted in the fixing holes 521a. The insertion hole 521b is opened with a predetermined length

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and a predetermined width. A confinement part **12** protruding from the upper portion of the cabinet **10** to fix a confinement lever **525** is inserted in the insertion hole **521b**. The fixing recess **521c** is recessed at the rear end of the first coupling part **521** to receive a fixing segment **13** protruding from the upper surface of the cabinet **10**.

The confinement lever **525** is installed to fix the first hinge **52** installed on the cabinet **10**, and is placed on the upper surface of the first coupling part **521** to fix the first hinge plate **523**.

The first extension **522** may extend from an end of the first coupling part **521**, and may have a stepped or inclined portion to be disposed above the first coupling part **521**. An end of the first extension **522** may be bent toward the outside of the first door **310**, and is provided with the first hinge shaft **524**.

The first hinge shaft **524** vertically extends downward from the end of the first extension **522**, and is inserted in a first hinge recess **310a** of the first door **310** to function as a rotation center of the first door **310**. The first hinge shaft **524** may have a tube shape that is opened at the upper and lower sides, and have a cut out. Thus, an electric wire, a ground wire, or a water supply tube, which is guided into the first door **310**, can be guided through the inside of the first hinge shaft **524**.

The first hinge shaft **524** has a greater diameter than that of a second hinge shaft **514**. This is because the first door **310** is larger than the second door **340**. Furthermore, since the storing device **40** is installed on the first door **310**, when food is stored in the storing device **40**, the first door **310** becomes heavier. Thus, the diameter of the first hinge shaft **524** may be large to stably support the rotating first door **310**. Also, the diameter of the first hinge recess **310a** in which the first hinge shaft **524** is inserted may be large.

The second hinge **51** is configured such that the second door **340** is rotatably installed on the first door **310**. A portion of the second hinge **51** is installed in the first installation part **310b**, and the other portion is installed in the second installation part **340b**. The second hinge **51** may include a second hinge plate **513** and a second hinge shaft **514**.

The second hinge plate **513** has a plate shape to be coupled to the upper surface of the first door **310**. In detail, the second hinge plate **513** may include a second coupling part **511** coupled to the first door **310** and a second extension **512** extending from the second coupling part **511** to a rotation shaft of the second door **340**. The second coupling part **511** is provided with a plurality of coupling holes **511a**, and is coupled to the upper surface of the first door **310** through a coupling member such as a screw.

The second coupling part **511** is disposed at the inside of the first hinge **52** (left side in FIG. 13). The second extension **512** extends outward from the second coupling part **511**, and may be bent to a side surface of the second door **340**. An end of the second extension **512** is disposed at the outside of an end of the first extension **522** of the first hinge **52** (right side in FIG. 13).

In detail, the end of the second extension **512** may be provided with the second hinge shaft **514**. Thus, the second hinge shaft **514** is disposed nearer to the side edge of the second door **340** than the first hinge shaft **524**. That is, a distance **D1** from the outer end of the refrigerator compartment door **30** to the center of the second hinge shaft **514** is less than a distance **D2** from the outer end of the refrigerator compartment door **30** to the center of the first hinge shaft **524**.

The first hinge shaft **524** has relatively larger diameter, and supports the first door **310** applying a large load. Thus,

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when the first hinge shaft **524** is disposed nearer to the side edge than the second hinge shaft **514**, the first hinge shaft **524** may be broken. However, since the second door **340** does not have a separate storing space and is significantly smaller in thickness and size than the first door **310**, the second hinge shaft **514** may be disposed nearer to the outside than the first hinge shaft **524**. As the second hinge shaft **514** is disposed nearer to the outside than the first hinge shaft **524** and closes to the outer edge of the second door **340**, the second door **340** is prevented from interfering with the first door **310** during the rotation of the second door **340**. As a result, when the second door **340** is closed, the distance between the first door **310** and the second door **340** can be further decreased. Thus, when being viewed from the outside, the first door **310** and the second door **340** can be perceived as a single door, thus improving the sense of unity.

The second hinge shaft **514** vertically extends downward from the end of the second extension **512**, and is inserted in a second hinge recess **340a** of the second door **340** to function as a rotation center of the second door **340**. The second hinge shaft **514** may have a tube shape that is opened at the upper and lower sides, and have a cut out. Thus, an electric wire, a ground wire, or a water supply tube, which is guided into the second door **340**, can be guided through the inside of the second hinge shaft **514**.

As the second hinge shaft **514** may have a smaller diameter than that of the first hinge shaft **524**, the second hinge recess **340a** in which the second hinge shaft **514** is installed has a small diameter.

Hereinafter, opening and closing of a first door and a second door will now be described with reference to the accompanying drawings according to an embodiment.

FIG. 14 is a plan view illustrating first and second hinges when a first door is opened. FIG. 15 is a plan view illustrating first and second hinges when a second door is opened.

Referring to FIG. 13, the first door **310** and the second door **340** are closed. In detail, when the first door **310** and the second door **340** are closed as illustrated in FIG. 13, the first door **310** completely closes the first refrigerator compartment **104**, and the second door **340** completely closes the second storage compartment **405**.

To open the first door **310**, the grip part **313** is held and pulled forward to rotate the first door **310**. At this point, the first door **310** rotates about the first hinge shaft **524** of the first hinge **52** as a rotation center, which is illustrated in FIG. 15. In this state, the refrigerator compartment **104** is opened by the rotation of the first door **310**.

To open the second door **340**, a separate handle provided to the second door **340** may be held, or a confinement of a locking unit provided to the second door **340** is released, and then, the second door **340** is held to rotate it. At this point, the second door **340** rotates about the second hinge shaft **514** of the second hinge **51** as a rotation center, which is illustrated in FIG. 14. Thus, the second storage compartment **405** is opened by the rotation of the second door **340**.

At this point, since the second hinge shaft **514** functioning as the rotation shaft of the second door **340** is disposed nearer to the side surface of the second door **340** than the first hinge shaft **524**, an interference of the rotating second door **340** with the first door **310** is minimized. Thus, a back and forth distance between the first door **310** and the second door **340** can be reduced in design.

FIG. 16 is a perspective view illustrating a refrigerator when a second door is opened according to an embodiment.

Referring to FIG. 16, the above-described refrigerator **1** will be described in brief.

In detail, the front surface of the second door **340** and the front surfaces of the first door **310** and the door **20** are formed of the same material and have a continuous figure or pattern. When the second door **340** is closed, the front surface of the second door **340** and the front surface of the refrigerator compartment door **30** disposed at the lower side of the second door **340** are disposed in the same plane.

The rear surface of the second door **340** may be provided with a protrusion part **342a** protruding inward. The protrusion part **342a** is constituted by a portion of the rear surface of the second door **340**, and has a shape corresponding to the opening **316**. Thus, when the second door **340** is closed, the protrusion part **342a** is disposed inside the opening **316**, and engages with the opening **316** to primarily prevent a leakage of cool air.

A gasket **344** extends along the edge of the protrusion part **342a**. The gasket **344** is formed of a material such as rubber or silicone that can be elastically deformed, and is closely adhered to the front surface of the first door **310** when the second door **340** is closed. In detail, the gasket **344** is closely adhered to the front surface of the second part **321** of the first door **310** corresponding to the inner periphery surface of the opening **316** or the outer edge of the opening **316**. At this point, the gasket **344** is compressed to prevent the leakage of cool air from the storing device **40**.

The upper end of the refrigerator compartment door **30** may be provided with a second door switch **349** that senses opening and closing of the second door **340**. The second door switch **349** may be configured to output an alarm signal when the second door **340** is opened.

A locking unit is provided to a side end of the rear surface of the second door **340** disposed at the opposite side to the side connected to the rotation shaft of the second door **340**, and the front surface of the first door **310** corresponding to the opposite side. The locking unit maintains the closing state of the second door **340**, and switches a confinement state by a pressing operation to selectively confine the second door **340**.

The locking unit has the same structure as that of a typical pressing switch, and may include a locking device **60** installed on the refrigerator compartment door **30**, and a latch hook **341** provided to the second door **340**. In addition, the front surface of the refrigerator compartment door **30** provided with the locking device **60** is provided with a latch slot **317**. The locking unit may be a push-pull button in which the latch hook **341** is caught to the locking device **60** by a primary pressing operation and the catching state of the latch hook **341** is released by a secondary pressing operation.

Thus, when the second door **340** is closed, the latch hook **341** can be inserted in the latch slot **317**, and be coupled to the locking device **60**. In this case, when the opened second door **340** is closed and pressed, the latch hook **341** is inserted into the latch slot **317** and coupled to the locking device **60** to maintain the closing state of the second door **340**. Then, when the second door **340** is pressed again, the latch hook **341** is released from the locking device **60** and taken out through the latch slot **317** to allow the opening of the second door **340**.

A limiting member **350** is disposed at the vertical lower side of the latch hook **341**. The limiting member **350** prevents the locking unit from being undesirably opened by a rotation of the first door **310** when the second door **340** is closed. The limiting member **350** is disposed outside the gasket **344** and closely adhered to the front surface of the first door **310** outside the opening **316**.

Hereinafter, the limiting member **350** will now be described in more detail with reference to the accompanying drawings.

FIG. **17** is a partial perspective view illustrating a second door with a coupling structure of a limiting member according to an embodiment.

Referring to FIG. **17**, the limiting member **350** is disposed in the lower portion of the rear surface of the second door **340**. The limiting member **350** may be formed of rubber, silicone, or synthetic resin, which can be elastically deformed. The limiting member **350** may include a contact **352** contacting the first door **310**, and an installation part **354** fixed to the second door **340**.

The contact **352** may have a cylindrical or hemisphere shape having a predetermined height, and protrudes from the rear surface of the second door **340**. A protrusion height of the contact **352** may be smaller than the height of the gasket **344** when external force is not applied thereto.

When the second door **340** is closed, the limiting member **350** may contact the first door **310** or be slightly spaced apart from the first door **310**. In the state where the second door **340** is closed, even when a predetermined amount of external force is applied to the limiting member **350**, the limiting member **350** maintains the distance between the first door **310** and the second door **340**. That is, the external force is prevented from causing the latch hook **341** to press the locking device **60** and release the latch hook **341**.

Thus, when the second door **340** is closed, the gasket **344** contacts the first door **310** first. When the gasket **344** is compressed over a predetermined degree, the end of the contact **352** contacts the rear surface of the first door **310**.

The installation part **354** extends from a side of the contact **352**, and may be formed in a hook structure that can be deformed by pressing. The installation part **354** may have a plurality of hook structures, and is pressed into an installation hole **342b** provided to the rear surface of the second door **340**.

Thus, after the second door **340** is assembled, when the installation part **354** is pressed into the installation hole **342b**, the limiting member **350** is continually fixed to the rear surface of the second door **340**.

Hereinafter, opening and closing of the refrigerator door configured as described above will now be described with reference to the accompanying drawings.

FIG. **18** is a partial side view illustrating a refrigerator with a limiting member when first and second doors are closed according to an embodiment.

Referring to FIG. **18**, to store food in the refrigerator compartment **104**, the grip part **313** is held and pulled forward. Then, the first door **310** rotates and the refrigerator compartment **104** is opened. At this point, the second door **340** rotates, closely adhering to the first door **310**.

To store food in the storing device **40**, a portion of the front surface of the second door **340** corresponding to the locking unit is pressed and released. Then, the latch hook **341** is released and removed from the latch slot **317**, and the second door **340** rotates from the first door **310**. At this point, the refrigerator compartment door **30** may be still closed.

When the second door **340** is closed, the protrusion part **342a** of the second door **340** is disposed inside the opening **316** of the refrigerator compartment door **30**. The gasket **344** closely adheres to the front surface of the refrigerator compartment door **30** around the opening **316** to seal the inner space of the storing device **40**.

After the second door **340** is closed, the latch hook **341** is continually disposed in the latch slot **317**. That is, the latch hook **341** is continually confined by the locking device **60**.

While the second door **340** is continually closed by the locking unit, the gasket **344** is maintained in a slight compression state as illustrated in FIG. **18**. The limiting member **350** contacts the front surface of the first door **310**, or is spaced a short distance from the front surface of the first door **310**.

In this state, to open the second door **340**, the portion of the second door **340** corresponding to the position where the locking unit is disposed is pressed first. When the second door **340** is pressed, the second door **340** presses the front surface of the first door **310**, and the latch hook **341** is removed from the locking device **60**. At this point, the gasket **344** is compressed, and the limiting member **350** is also slightly compressed, contacting the first door **310**. That is, to remove the coupling state of the locking unit, the second door **340** should be pressed with a predetermined amount of force to compress the limiting member **350**.

While the second door **340** is closed, when the refrigerator compartment door **30**, particularly, the first door **310** is suddenly rotated to open or close, inertia may be applied to the second door **340**. For example, when the grip part **313** is held and the refrigerator compartment door **30** is pulled, the second door **340** presses the front surface of the first door **310** by inertia applied to the second door **340**. That is, since force is generated along the direction in which the second door **340** presses the first door **310**, the gasket **344** is further compressed. This phenomenon may occur when the first door **310** closely adhered to the cabinet **10** by magnetic force is pulled to remove the first door **310** from the front surface of the cabinet **10**.

When the second door **340** rotates along the direction in which the second door **340** presses the front surface of the first door **310**, that is, in the opposite direction to the rotation direction of the first door **310**, the limiting member **350** presses the front surface of the first door **310**. Thus, the limiting member **350** prevents the rotation of the second door **340** from pressing the first door **310**.

When inertia applied to the second door **340** is greater than force compressing the limiting member **350**, the second door **340** may press the first door **310**. Thus, the refrigerator **1** may be designed such that inertia applied to the second door **340** by a rotation of the refrigerator compartment door **30** is smaller than force compressing the limiting member **350**. In other words, the refrigerator **1** may be designed such that the limiting member **350** is compressed to remove the coupling state of the locking unit only when the second door **340** is pressed with greater force than the inertia. Then, while the first door **310**, that is, the refrigerator compartment door **30** rotates, the limiting member **350** prevents the second door **340** from compressing the front surface of the first door **310**. The coupling state of the locking unit is maintained to prevent the second door **340** from being inadvertently opened while the first door **310** is opened and to maintain the closing state of the second door **340**.

A refrigerator according to the present disclosure will be described according to various embodiments. Hereinafter, a refrigerator will now be described according to another embodiment.

The refrigerator according to the current embodiment includes an elastic limiting member between a first door and a second door to prevent the second door from being inadvertently opened, and the second door is automatically rotated by elastic force when the second door is opened.

Thus, in the current embodiment, the rest parts except for the limiting member is the same as the previous embodiments, a description thereof will be omitted, and like reference numeral denote like elements.

FIG. **19** is a perspective view illustrating a refrigerator when a second door is opened according to another embodiment.

Referring to FIG. **19**, limiting members **356** according to the current embodiment are configured to prevent the second door **340** from being inadvertently opened and automatically rotate and open the second door **340** when the second door **340** is opened.

In detail, the limiting members **356** may be disposed on the front surface of the first door **310** outside the opening **316**. The limiting member **356** may be disposed outside the opening **316** at the opposite side to the side where the rotation shaft of the second door **340** is disposed. That is, the limiting members **356** may be disposed in a vertical line passing through the locking device **60**.

The limiting members **356** may be formed of an elastic material such as a spring or in a structure that is elastically deformed. The limiting members **356** are compressed when the second door **340** is closed, and limiting member covers **358** are disposed outside the limiting member **356** to cover the limiting member **356** from the outside. The limiting member covers **358** may be movable in a back and forth direction from the front surface of the first door **310**, so that the limiting member covers **358** can move together with the limiting members **356** when the limiting members **356** are compressed or extended. The limiting member covers **358** may be formed of an elastic material such as rubber or silicone.

The limiting member **356** may be provided in a pair respectively at upper and lower points spaced the same distance from the middle of the second door **340** to prevent the second door **340** from being inclined in the back and forth direction when the second door **340** is closed. Alternatively, the limiting members **356** may be disposed on the rear surface of the second door **340** in the same manner.

FIG. **20** is a schematic view illustrating a limiting member when first and second doors are opened according to a embodiment. FIG. **21** is a schematic view illustrating the limiting member of FIG. **20** when the second door is closed.

Referring to FIGS. **20** and **21**, states of the limiting member **356** will now be described according to opening and closing of the first door **310** and the second door **340**.

First, when the second door **340** is opened, external force is not applied to the limiting member **356** in a normal state as illustrated in FIG. **20**. As the second door **340** rotates to be closed, the second door **340** comes closer to the end of the limiting member **356**. Before the second door **340** is completely closed, the end of the limiting member **356** contacts the second door **340**.

To maintain the closing state of the second door **340**, the latch hook **341** is inserted in the latch slot **317** and coupled with the locking device **60**. To this end, the second door **340** should further rotate to the front surface of the first door **310**. At this point, the limiting member **356** is compressed by the movement of the second door **340**, and simultaneously, the gasket **344** is in contact with the second door **340** and compressed to be closely adhered to the outer front surface of the opening **316** of the first door **310**.

When the second door **340** is completely closed, the limiting member **356** is compressed and the adhering state of the gasket **344** to the opening **316** is maintained, as illustrated in FIG. **21**. When the second door **340** is closed, the latch hook **341** is continually caught to the locking device **60** to prevent the second door **340** from being by resilient force of the limiting member **356** and the gasket **344**.

In this state, when the refrigerator compartment door **30** is suddenly rotated to open the refrigerator compartment,

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inertia of the second door 340 presses the limiting member 356. Then, resilient force along a direction in which the second door 340 is pushed is applied to the limiting member 356, and the catching state of the latch hook 341 to the locking device 60 is maintained. That is, a push-pull function is limited. Thus, inadvertent opening of the second door 340 due to a push-pull operation is prevented although the first door 310 is suddenly rotated.

To open the second door 340 that is completely closed as illustrated in FIG. 21, the portion of the front surface of the second door 340 corresponding to the position of the latch hook 341 is pressed to activate the push-pull operation. Then, the latch hook 341 is released from the locking device 60. At this point, since the limiting member 356 is further compressed, when the force pressing the front surface of the second door 340 is removed, the resilient force of the limiting member 356 rotates the second door 340 in the open direction. Thus, a user can easily open the second door 340 with small force.

FIG. 22 is a perspective view illustrating a refrigerator according to an embodiment. FIG. 23 is a perspective view illustrating a refrigerator when a second door is opened according to an embodiment.

Referring to FIGS. 22 and 23, an opening unit 630 as a release member for releasing the confinement state of the locking unit is disposed on a side of the second door 340 at a position corresponding to the locking device 60. The opening unit 630 is moved in the back and forth direction by a user's operation to remove the coupling of the locking device 60 and the latch hook 341, and is exposed to the front surface of the second door 340. Thus, when the opening unit 630 is operated through the front surface of the second door 340, the locking device 60 and the latch hook 341 is uncoupled from each other to allow the opening of the second door 340.

Hereinafter, the locking unit and the opening unit will now be described in more detail.

FIG. 24 is an exploded perspective view illustrating a locking device and an opening unit according to an embodiment.

Referring to FIG. 24, the latch hook 341 constituting the locking unit may be fixed through screws to the rear surface of the second door 340. The locking device 60 constituting the locking unit may be disposed at a portion of the front surface of the first door 310 corresponding to the latch hook 341.

The latch hook 341 is fixed to the rear surface of the second door 340, and includes a hook fixing part 341a coupled with the screws, and a hook part 341b extending from the rear surface of the hook fixing part 341a. The hook part 341b is inserted through the latch slot 317, and is selectively confined by the locking device 60.

The locking device 60 includes a locking assembly 610 installed on a locking device installation part 314a recessed in the first door 310, and a locking device cover 620 covering the locking assembly 610. The locking device cover 620 covers the locking assembly 610 to shield it.

A side of the locking assembly 610 is caught to the inside of the locking device installation part 314a, another side is fixed through a screw to the inside of the locking device installation part 314a. A latch rod 615 that is pressed by a push rod 633 of the opening unit 630 is installed on the locking assembly 610. The latch rod 615 is elastically supported in the locking assembly 610 by an elastic member 617 such as a spring.

The locking device cover 620 has a plate shape, and has the latch slot 317 that is open to receive the latch hook 341. A rod hole 621 is disposed at a side of the locking device 60

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corresponding to the latch rod 615. The rod hole 621 may be disposed at a position corresponding to the push rod 633 to allow access of the push rod 633.

The opening unit 630 may be disposed inside the second door 340, and at least one portion thereof may be exposed through the front surface of the second door 340 to allow a user's operation.

The opening unit 630 may include an opening unit body 631 that is fixed to the inside of the second door 340, an operation button 632 that is movable in the back and forth direction on the opening unit body 631 and pressed by a user, and the push rod 633 that is moved in the back and forth direction by an operation of the operation button 632 to push the latch rod 615.

The opening unit body 631 may be fixed through screws to a door case 342 constituting the rear surface of the second door 340. A side decor 346 of the second door 340 provided with the opening unit body 631 may be cut out not to interfere with the opening unit body 631. The rear surface of the opening unit body 631 is fixed to the door case 342, and the front surface thereof contacts the rear surface of a door plate 343.

The opening unit body 631 may include a rod guide part 635 to guide the back and forth movement of the push rod 633. The rod guide part 635 may have a boss shape passing through the opening unit body 631. The front portion of the rod guide part 635 protrudes in a boss shape to be inserted in the operation button 632. Thus, the operation button 632 is allowed to move in the back and forth direction along the outer circumferential surface of the boss, which constitutes the front portion of the rod guide part 635.

The push rod 633 extends a predetermined length, and is inserted in the rod guide part 635. The push rod 633 may have a length to protrude rearward through a hole of the door case 342 when the operation button 632 is operated. The front end of the push rod 633 may contact the rear surface of the operation button 632. The push rod 633 may contact the latch rod 615 while the second door 340 is closed. A support flange protrudes in the radial direction from the outer circumferential surface of the push rod 633, so that the push rod 633 can be supported by an elastic member 634 such as a spring. Thus, after the operation button 632 is operated, the push rod 633 and the operation button 632 returns their original positions by resilient force of the elastic member 634.

The operation button 632 is placed on the rod guide part 635, and can move back and forth along the rod guide part 635. The operation button 632 is exposed to the front surface of the second door 340 through the hole 343a of the door plate 343, and can be pressed by a user. The operation button 632 includes button fixing parts 632a having hook shapes, and the button fixing parts 632a are confined by a fixing ring 636 installed on the hole 313a of the door plate 343, so that the button fixing parts 632a are prevented from being removed forward.

FIG. 25 is a cross-sectional view taken along line 4-4' of FIG. 24. FIG. 26 is a cut-away perspective view taken along line 5-5' of FIG. 25 while a second door is closed. FIG. 27 is a cut-away perspective view taken along line 6-6' of FIG. 25 while the second door is closed.

Referring to FIGS. 25 through 27, the locking device 60 includes the locking assembly 610 and the locking device cover 620.

In detail, the locking assembly 610 includes a locking assembly case 611 that is fixed to the locking device installation part 314a, a latch cam 612 that is rotatably installed within the locking assembly case 611 to selectively

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confine the latch hook 341, a stopper 613 that selectively limits the rotation of the latch cam 612, and the latch rod 615 that pushes the stopper 613 rearward to allow the rotation of the latch cam 612.

The front surface of the locking assembly case 611 has an opening to receive the latch hook 341. The opening matches with the latch slot 317 of the locking device cover 620. A space for storing the latch cam 612, the stopper 613, and the latch rod 615 is defined in the locking assembly case 611.

The latch cam 612 is rotatably disposed within the locking assembly case 611, and the rotated latch cam 612 can return its original position by a torsion spring 612c (refer to FIG. 28). The latch cam 612 is provided with a hook insertion part 612a that receives and catches the latch hook 341. The hook insertion part 612a is recessed to be selectively coupled with the latch hook 341. Thus, when the second door 340 is closed, the latch hook 341 inserted through the latch slot 317 pushes and rotates the latch cam 612. When the latch cam 612 rotates and the latch hook 341 is caught to the hook insertion part 612a, the latch hook 341 is confined by the latch cam 612. A catching part 612b such as a protrusion or a stepped part may be disposed at an outer side surface of the latch cam 612. The catching part 612b is illustrated in detail in FIG. 28, but the present disclosure is not limited thereto.

The stopper 613 is disposed at the lower side of the latch cam 612 to selectively limit the rotation of the latch cam 612. The lower end of the stopper 613 may be coupled to the locking assembly case 611 using a method such as shaft-coupling to rotate left and right or back and forth. The upper end of the stopper 613 is bent forward to selectively contact the catching part 612b. The upper end of the stopper 613 moves along a surface of the catching part 612b when the latch cam 612 rotates. The stopper 613 may be connected to a side of the locking assembly case 611 through an elastic member 614 (refer to FIG. 27) such as a spring, and returns its original position by the elasticity of the elastic member 614, after moving back and forth or left and right.

A rod installation part 616 is disposed at the front side of the stopper 613, and the latch rod 615 can move back and forth within the rod installation part 616. The rod installation part 616 is open to the front side of the locking assembly case 611. In this case, the rod installation part 616 is disposed at a position corresponding to the position of the push rod 633.

The latch rod 615 may be movable back and forth within the rod installation part 616. The front end of the latch rod 615 is disposed in the rod hole 621 provided to the locking device cover 620, and the rear end contacts the stopper 613. A rod support 615a may protrude outward from the latch rod 615 and interfere with the rod installation part 616 to limit a forward movement. Since the latch rod 615 is supported by the elastic member 617 such as a spring, when external force is removed after the latch rod 615 moves rearward, the latch rod 615 returns to its original position by the elastic force of the elastic member 617.

Thus, when the rear end of the push rod 633 presses the front end of the latch rod 615, and the latch rod 615 moves rearward, the latch rod 615 pushes the stopper 613. At this point, the stopper 613 is pushed rearward and is removed from the catching part 612b of the latch cam 612. Simultaneously, the latch cam 612 is rotated forward by the resilient force of the torsion spring 612c, and the latch cam 612 and the latch hook 341 are allowed to be removed from each other.

FIG. 28 is a rear view illustrating a locking assembly when a stopper is pushed by a latch rod, according to an embodiment. FIG. 29 is a rear view illustrating a locking

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assembly when a second door is closed and a stopper is caught to a latch cam, according to an embodiment.

Referring to FIG. 28, when the latch rod 615 pushes the stopper 613, the bent upper end of the stopper 613 is removed from the catching part 612b of the latch cam 612. Then, the latch cam 612 is rotated forward by the resilient force of the torsion spring 612c installed on the rotation shaft of the latch cam 612. Thus, the hook part 341b is allowed to be removed from the latch cam 612.

The elastic member 614 is connected to the stopper 613, and an end of the elastic member 614 is disposed at a position laterally spaced apart from the other end as illustrated in FIG. 27. Thus, when the stopper 613 is pressed rearward by the latch rod 615, the stopper 613 is rotated by the elastic force of the elastic member 614. Thus, as illustrated in FIG. 28, when being pressed by the latch rod 615, the stopper 613 slightly rotates left. However, this is just one embodiment, and thus, the elastic member 614 may be bent back and forth without the left rotation.

Referring to FIG. 29, while the second door 340 is closed, the hook part 341b pushes the latch cam 612 rearward. Then, the latch cam 612 rotates rearward, and the outer circumferential surface of the latch cam 612 rotates, contacting the bent upper end of the stopper 613. Then, the upper end of the stopper 613 is caught to the catching part 612b disposed on the outer circumferential surface of the latch cam 612.

Hereinafter, opening and closing of a second door of a refrigerator door configured as described above will now be described in more detail with reference to the accompanying drawings according to an embodiment.

FIG. 30 is a schematic view illustrating a locking device and an opening unit when a second door is closed according to an embodiment. FIG. 31 is a schematic view illustrating the locking device and the opening unit when the opening unit is operated. FIG. 32 is a schematic view illustrating the locking device and the opening unit when the second door is opened.

Referring to FIGS. 30 to 32, while the second door 340 is closed, the hook part 341b of the latch hook 341 is inserted in the latch slot 317 as illustrated in FIG. 30. At this point, the hook part 341b is inserted in and caught to the hook insertion part 612a provided to the latch cam 612. In addition, the stopper 613 is caught to the catching part 612b of the latch cam 612 to stop the rotation of the latch cam 612.

In this state, a user operates the opening unit 630 to open the second door 340. In detail, the user presses the operation button 632 to open the second door 340. Then, as illustrated in FIG. 31, the push rod 633 is moved rearward (right side in FIG. 31). Then, the latch rod 615 contacting the push rod 633 is also moved rearward. Then, the latch rod 615 presses the stopper 613 rearward, and thus, the upper end of the stopper 613 is removed from the catching part 612b. Then, the latch cam 612 is rotated forward (counterclockwise in FIG. 31) by the resilient force of the torsion spring 612c. Simultaneously, the second door 340 is opened by the elastic resilient force of the gasket 344 and the torque of the latch cam 612. Thus, the hook part 341b of the latch hook 341 is removed from the hook insertion part 612a and taken out of the latch slot 317. As a result, the second door 340 is completely released as illustrated in FIG. 32.

While the push rod 633 and the latch rod 615 are moved rearward by pressing the operation button 632 to open the second door 340, the elastic members 617 and 634 supporting the push rod 633 and the latch rod 615 are compressed. Then, when the operation button 632 is released, the resilient

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force of the elastic members 617 and 634 returns the operation button 632, the push rod 633, and the latch rod 615 to their original positions.

As illustrated in FIG. 32, when the second door 340 is opened, the latch cam 612 rotates forward, and an entrance of the hook insertion part 612a faces the latch slot 317. At this point, the stopper 613 is disposed at the lower side of the latch cam 612 and contacts the outer circumferential surface of the latch cam 612.

In this state, when the second door 340 is closed again, the hook part 341b of the latch hook 341 is inserted into the latch slot 317, and then, is caught to the hook insertion part 612a. At this point, the hook part 341b pushes the rear surface of the hook insertion part 612a, and the latch cam 612 is rotated rearward (clockwise). Then, the torsion spring 612c is compressed, and the latch cam 612 rotates in the state where the outer circumferential surface of the latch cam 612 contacts the upper end of the stopper 613. Then, the upper end of the stopper 613 is caught to the catching part 612b of the latch cam 612 as illustrated in FIG. 30.

In summary, a release member for releasing the confined state of the locking unit, particularly, a release member for releasing the coupling (or confined state) between the latch hook 341 and the latch cam 612 includes a first member including the operation button 632, the push rod 633, and the elastic member 634, and a second member including the latch rod 615 and the elastic member 617.

A refrigerator according to the present disclosure will be described according to various embodiments. Hereinafter, a refrigerator will now be described according to another embodiment.

In the refrigerator according to the current embodiment, an input member that is provided to the second door and can input an electrical signal is manipulated to operate an actuator provided to the locking device, and the actuator operates to release the coupling between the locking device and the latch hook, so that the second door can be opened.

Thus, in the current embodiment, the rest parts except for the input member and the actuator is the same as the previous embodiments, a description thereof will be omitted, and like reference numeral denote like elements.

FIG. 33 is a perspective view illustrating a refrigerator according to an embodiment. FIG. 34 is a perspective view illustrating the refrigerator of FIG. 33 when a second door is opened. FIG. 35 is a schematic view illustrating a locking unit when the second door of FIG. 34 is closed. FIG. 36 is a schematic view illustrating the locking unit of FIG. 35 when a signal for opening the second door is input.

Referring to FIGS. 33 to 36, the second door 340 may be provided with an input member 640 for uncoupling the locking unit. The input member 640 may convert a user's operation to an electrical signal and transmit the electrical signal to an actuator 618 of the locking device 60.

The input member 640 may be disposed on the rear side or the rear surface of the door plate 343 (refer to FIG. 24) constituting the front appearance of the second door 340. Thus, the input member 640 is not exposed directly to the outside of the second door 340. However, to manipulate the input member 640, a print part 641 may be disposed on the door plate 343 at a portion corresponding to the input member 640 to display the position of the input member 640.

The input member 640 includes a touch switch that senses a variation in electrostatic capacity to operate, or a pressure switch. However, the present disclosure is not limited to the switches provided that a user's operation is sensed. Even in this case, the input member 640 may be provided to the rear

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surface of the door plate 343. The input member 640 may be provided in plurality if necessary, and, in this case, the input members 640 may be manipulated to control the refrigerator 1.

The second door 340 may include a display 650. The display 650 may be disposed at the rear side of the second door 340 to contact the rear surface of the door plate 343. Thus, while the display 650 is turned off, the display 650 is not visible on the door plate 343, and when the display 650 is turned on, information can be displayed through the door plate 343. The input member 640 may be integrally formed with the display 650.

An electric wire 642 connected to the input member 640 and the display 650 passes through the second door 340, and is guided to the outside through the hinge shaft of the second hinge 51. At this point, when a ground wire is disposed within the second door 340, the electric wire 642 together with the ground wire may be guided to the outside through the hinge shaft of the second hinge 51. An electric wire 619 and the electric wire 642 may be connected to a main controller (not shown) provided to the cabinet 10 through the first hinge 52.

The locking device 60 may include the locking assembly 610 that is installed at the inside of the first door 310, and the locking device cover 620 that shields the locking assembly 610. The locking assembly 610 includes the locking assembly case 611, the latch cam 612 that is installed within the locking assembly case 611 to confine the latch hook 341, the stopper 613 that selectively limits the rotation of the latch cam 612, and the actuator 618 that moves the stopper 613 to allow the rotation of the latch cam 612. The configuration of the locking device 60 except for the actuator 618 is the same as that of the previous embodiment.

The actuator 618 may include a solenoid. When an operation signal is input to the actuator 618, the actuator 618 pushes the stopper 613 to release the latch cam 612. The operation signal is transmitted to the actuator 618 by manipulating the input member 640, and the actuator 618 momentarily pushes the stopper 613, and then, returns its original position.

Alternatively, the actuator 618 may include another power member or mechanism, and may selectively push the stopper 613 to release the latch cam 612.

The electric wire 619 connected to the actuator 618 passes through the first door 310, and is guided to the outside of the first door 310 through the hinge shaft of the first hinge 52. The electric wire 619 guided to the outside of the first door 310, and the electric wire 642 guided to the outside through the second hinge 51 may be connected to the main controller of the cabinet 10. Also at this point, when a ground wire is disposed within the first door 310, the electric wire 619 together with the ground wire may be guided to the cabinet 10. Thus, when the input member 640 is manipulated, an operation signal is transmitted to the actuator 618 to release the locking unit.

In detail, when the second door 340 is completely closed, the latch hook 341 is fixed to the hook insertion part 612a of the latch cam 612 as illustrated in FIG. 35. Thus, the second door 340 is maintained in the closing state.

In this state, a user touches the print part 641 to open the second door 340 as illustrated in FIG. 36. Then, the input member 640 senses the touch and transmits an operation signal to the main controller, and the main controller commands the actuator 618 to operate.

At this point, the actuator 618 pushes the stopper 613, and the stopper 613 is removed from the latch cam 612, and the latch cam 612 rotates counterclockwise (in FIG. 36) by the

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resilient force of the stopper 613. When the latch cam 612 rotates, the latch hook 341 and the latch cam 612 are released from each other, and the latch hook 341 is removed to the outside through the latch slot 317. In this state, the second door 340 can freely rotate.

When the opened second door 340 is closed, the latch hook 341 is inserted into the latch slot 317 to rotate the latch cam 612, and is fixed to the hook insertion part 612a to maintain the closing state, as illustrated in FIG. 35.

In the current embodiment, a release member may include a first member that includes the input member 640 provided to the first door 310, and the actuator 618 provided to the second door 340.

FIG. 37 is a perspective view illustrating a refrigerator when a second door is opened according to an embodiment.

Referring to FIG. 37, as described above, the rear surface of the second door 340 may be provided with the protrusion part 342a. The protrusion part 342a includes a stepped part at the lower portion, and a shelf 370 to be described later is vertically stored in the stepped part.

Thus, the depth of the stepped part may correspond to the thickness of the shelf 370.

In detail, the shelf 370 that is rotatable forward is disposed at a side of the first door 310, and a connection assembly 390 that connects the shelf 370 to the second door 340 is disposed at a side of the second door 340. Thus, the rotation of the shelf 370 is linked with the opening and closing of the second door 340.

The shelf 370 is coupled to the inner edge of the opening 316 such that the shelf 370 can rotate up and down. Shelf rotation shafts 317 are disposed at the left and right sides of the shelf 370, and are inserted in both side edges of the opening 316 at the lower end of the opening 316. Alternatively, the shelf rotation shafts 317 may protrude from the inner edge of the opening 316 and are inserted in the side edges of the shelf 370.

The shelf 370 may have a width corresponding to the lateral width of the opening 316, so that the shelf 370 can be stored in the opening 316. The width of the shelf 370 may correspond to the width of the protrusion part 342a, so that the shelf 370 can be stored in the protrusion part 342a when the second door 340 is closed, as illustrated in FIG. 37.

A connection assembly installation part 342d is disposed at the lower side of the rear surface of the second door 340. The connection assembly installation part 342d may be disposed on the protrusion part 342a of the second door 340, and is recessed to receive an end of the connection assembly 390.

Hereinafter, the shelf 370 will now be described in more detail with reference to the accompanying drawings.

FIG. 38 is a schematic view illustrating the shelf of FIG. 37 rotated by the opening of the second door. FIG. 39 is a schematic view illustrating the rear surface of the first door of FIG. 37 when the second door of FIG. 38 is closed. FIG. 40 is a schematic view illustrating a joint member coupled to the connection assembly, according to an embodiment.

Referring to FIGS. 38 to 40, the bottom surface of the shelf 370 may be provided with a joint member 380 that is coupled with the connection assembly 390. The joint member 380 may include a joint coupling part 381 that is coupled with the shelf 370, and a joint receiving part 382 in which an end of the connection assembly 390 is rotatably disposed.

In detail, the joint coupling part 381 has a plate shape, and screw holes 381a are disposed respectively at both sides of the joint coupling part 381 such that the joint coupling part

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381 is coupled with the shelf 370. Thus, the joint member 380 is installed on the shelf 370 by screws coupled to the screw holes 381a.

The joint receiving part 382 receives a ball-shaped bearing 391a constituting the connection assembly 390, so that the bearing 391a is surrounded by the joint receiving part 382. The joint coupling part 381 that constitutes the bottom surface of the joint receiving part 382 is open to receive the bearing 391a. A side of the joint receiving part 382 is provided with a cutout part 382a that is cut to define a rotation path of a joint rod 391.

The shape of the cutout part 382a defines a portion of a movement path of the joint rod 391, and the cutout part 382a prevents the bearing 391a from being removed from the joint receiving part 382. A guide part 382b protrudes from a side of the cutout part 382a.

When the shelf 370 is completely folded and completely unfolded, the bearing 391a is disposed in recesses at both ends of the cutout part 382a.

A side of the shelf 370 may be provided with a confining member 372 (refer to FIG. 38) that confines the connection assembly 390. The confining member 372 is disposed on the bottom surface of the shelf 370, and the connection assembly 390 passes through the confining member 372. Thus, the connection assembly 390 is prevented from moving along an unintended path when the shelf 370 rotates.

FIG. 41 is an exploded perspective view illustrating a connection assembly according to an embodiment. (a), (b) and (c) in FIG. 42 are schematic views illustrating an operation of the connection assembly.

Referring to FIGS. 41, 42, the connection assembly 390 includes the joint rod 391 connected to the joint member 380, a damping unit 394 that adjusts the length of the joint rod 391 and absorbs shock during the movement of the joint rod 391, an installation member 398 installed on the connection assembly installation part 342d of the second door 340, a connection member 395 rotatably coupled to the installation member 398, and a connecting rod 392 that connects the joint rod 391 to the connection member 395.

In detail, an end of the joint rod 391 is provided with the sphere-shaped bearing 391a that is rotatably coupled to the joint member 380. The other end of the joint rod 391 is inserted in the connecting rod 392. The joint rod 391 goes in and out of the connecting rod 392 according to movement paths of the connection assembly 390 during the rotation of the shelf 370.

The connecting rod 392 receives an end of the joint rod 391, and may be shaft-coupled to the connection member 395. In detail, a hollow part having a predetermined length from an end of the connecting rod 392 is formed in the connecting rod 392 to receive the joint rod 391 and the damping unit 394. The end of the connecting rod 392 is provided with a rod cap 393 in which the joint rod 391 is inserted. The rod cap 393 may be coupled to the end of the connecting rod 392. Both ends of the rod cap 393 may be open to receive the joint rod 391 and at least one portion of the damping unit 394. The other end of the connecting rod 392 is provided with a rod connection part 392a. The rod connection part 392a may be disposed within the connection member 395, and the rod connection part 392a is rotatably connected to an end of the connection member 395 through a rod shaft 397a. Thus, the connecting rod 392 can rotate about the rod shaft 397a. The other end of the connection member 395 is rotatably connected to the installation member 398 through a rotation shaft 396a. The rotation center of the connecting rod 392 is perpendicular to the rotation center of the connection member 395. That is, the rotation shaft

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396a is vertically inserted in the installation member 398, and the rod shaft 397a is horizontally connected to the connection member 395.

An end 392b of the rod connection part 392a has a curved surface with a predetermined curvature as illustrated in (b) of FIG. 42. Thus, while the connecting rod 392 rotates according to the rotation of the second door 340, even when a user's hand contacts the connecting rod 392, the hand is not caught to the connecting rod 392 and slips along the curved surface, thus preventing an accident.

The damping unit 394 is disposed in the connecting rod 392 and supports an end of the joint rod 391 to absorb the shock caused by the moving joint rod 391. The damping unit 394 includes a spring 394a that supports the end of the joint rod 391, a stopper 394b that slides within the connecting rod 392 and supports the spring 394a, an O-ring 394c installed on the stopper 394b and contacting the inner surface of the connecting rod 392 to provide frictional force, a washer 394d installed on the stopper 394b to prevent the removal of the O-ring 394c, and a snap ring 394e that fixes the washer 394d and prevents the movement of the stopper 394b.

When the shelf 370 rotates, since the joint rod 391 goes in or out of the connecting rod 392 through the damping unit 394, the shelf 370 can efficiently rotate. When the joint rod 391 goes in and out of the connecting rod 392, the spring 394a is extended or compressed. Accordingly, the stopper 394b moves to absorb shock transmitted from the joint rod 391 to decelerate the joint rod 391. Since the joint rod 391 is decelerated, a quick rotation of the shelf 370 can be prevented.

In the current embodiment, the damping unit 394 is provided only to an end of the connecting rod 392, but the damping unit 394 may be provided to both ends of the connecting rod 392, so that the connecting rod 392 can experience stroke variations at both the ends of the connecting rod 392.

The installation member 398 is inserted in the connection assembly installation part 342d, and may include a cup 398a that defines a receiving space for the connection member 395, and a flange 398b disposed around the cup 398a and coupled to the second door 340 through screws.

In detail, the connection member 395 more effectively rotates the connection assembly 390, and is rotatably connected to the installation member 398 through the rotation shaft 396a. The connection member 395 includes a shaft coupling part 396 through which the rotation shaft 396a passes, and a receiving rib 397 that receives the rod connection part 392a. The shaft coupling part 396 has a shaft insertion hole 396b that is vertically open. The rotation shaft 396a passes through the cup 398a, and is installed in the shaft insertion hole 396b. Thus, the rotation shaft 396a functions as the rotation center of the connection member 395. The connecting rod 392 is disposed within the receiving rib 397 that may be disposed at both sides of the connecting rod 392 to move the connecting rod 392 up and down. The rod shaft 397a passes through the receiving rib 397 and the rod connection part 392a to rotate the connecting rod 392.

Thus, the connecting rod 392 can rotate up and down and left and right through the connection member 395, and the connecting rod 392 freely rotates during the opening and closing of the second door 340, so that the shelf 370 can be smoothly folded or unfolded.

Hereinafter, a lower hinge assembly provided to the second door will now be described.

FIG. 43 is an exploded perspective view illustrating an installation structure of the second door. FIG. 44 is a schematic view illustrating a lower hinge assembly when the

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second door is closed. FIG. 45 is a schematic view illustrating the lower hinge assembly when the second door is opened.

Referring to FIGS. 43 to 45, the lower end of the second door 340 is supported by a hinge bracket 53. The hinge bracket 53 is provided to the front surface of the first door 310 to support the second door 340 from the lower side, and is coupled to a lower hinge assembly 54 provided to the second door 340. The lower hinge assembly 54 and the hinge bracket 53 may be formed of a conductive metal.

When the second door 340 is opened, the lower hinge assembly 54 automatically opens the second door 340 through a predetermined angle, and then, prevents the second door 340 from further rotating.

In detail, the lower hinge assembly 54 includes a hinge fixation part 55 fixed to the hinge bracket 53, and a hinge rotation part 56 fixed within the second door 340 and contacting the hinge fixing part 55. The hinge rotation part 56 rotates together with the second door 340, and moves up and down along an upper surface of the hinge fixation part 55.

The hinge fixation part 55 may include an insertion protrusion 551 that is inserted and fixed to the hinge bracket 53, and a lower cam 552 disposed above the insertion protrusion 551. In detail, since the hinge fixation part 55 is fixed to the hinge bracket 53, the hinge fixation part 55 is not affected by the rotation of the second door 340.

In detail, the upper surface of the lower cam 552 includes a first cam surface 552a that is inclined downward, and a second cam surface 552b that is inclined upward from the lower end of the first cam surface 552a. The first cam surface 552a may be continuously connected to the second cam surface 552b to constitute a structure that may be provided continuously in duplicate along the edge of the upper surface of the lower cam 552.

A fixation protrusion 561 may be disposed around the side surface of the hinge rotation part 56. A hinge receiving part 340a is disposed within the second door 340, and the hinge rotation part 56 is installed in the hinge receiving part 340a. A protrusion receiving recess 340b is recessed around the inner surface of the hinge receiving part 340a, and the fixation protrusion 561 is disposed in the protrusion receiving recess 340b. Thus, the hinge rotation part 56 rotates integrally with the second door 340. An upper cam 562 is provided to the lower surface of the hinge rotation part 56. The upper cam 562 is provided with a third cam surface 562a that is inclined downward, and a fourth cam surface 562b that is inclined upward from the lower end of the third cam surface 562a. The third cam surface 562a may be continuously connected to the fourth cam surface 562b to constitute a structure that may be provided continuously in duplicate along the edge of the upper surface of the lower cam 562. The third and fourth cam surfaces 562a and 562b contact the first and second surfaces 552a and 552b in corresponding shapes, respectively.

The upper surface of the hinge rotation part 56 may be supported by an elastic member 563 such as a spring disposed within the hinge receiving part 340a. Thus, the lower surface of the hinge rotation part 56 continually contacts the upper surface of the hinge fixation part 55, and the first and second cam surfaces 552a and 552b of the hinge fixation part 55 and the third cam surface 562a and 562b of the hinge rotation part 56 relatively move contacting each other, according to the rotation of the second door 340.

For example, when the second door 340 is closed, the first cam surface 552a contacts the third cam surface 562a as illustrated in FIG. 44. Since the first cam surface 552a and

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the third cam surface **562a** are inclined downward, when the second door **340** is released, the third cam surface **562a** slips downward along the first cam surface **552a** by the weight of the second door **340**. Thus, the second door **340** is automatically rotated without applying torque to the second door **340**.

When the second door **340** is rotated over a predetermined angle to open the second door **340**, the first cam surface **552a** does not contact the third cam surface **562a** any more, and the second cam surface **552b** contacts the fourth cam surface **562b**. As illustrated in FIG. **45**, since the second cam surface **552b** and the fourth cam surface **562b** are inclined upward in the opening direction, a rotation speed of the second door **340** is gradually decreased.

When the second door **340** rotates through a predetermined angle, for example, about 110° , the second cam surface **552b** completely contacts the fourth cam surface **562b** as illustrated in FIG. **45**. In addition, since the elastic member **563** is sufficiently compressed, the hinge rotation part **56** cannot move upward any more. In this state, the rotation of the second door **340** is stopped or limited.

An angle that limits the opening of the second door **340** may be determined by the curvature of the second cam surface **552b** and the fourth cam surface **562b** and the elasticity of the elastic member **563**, and the second door **340** may be designed to be opened until about 110° , considering the unfolding of the shelf **370** linked with the rotation of the second door **340**.

Hereinafter, an operation of a second door of a refrigerator will now be described according to an embodiment.

When the second door **340** is closed, the shelf **370** is folded to stand vertically and is closely adhered to the protrusion part **342a**. After the shelf **370** is folded, the connection assembly **390** is also closely adhered to the shelf **370**.

In this state, when the latch hook **341** is released to open the second door **340**, the lower hinge assembly **54** operates simultaneously with the releasing of the latch hook **341**, so that the second door **340** automatically rotates.

At this time, the shelf **370** connected through the connection assembly **390** rotates downward and unfolded until the shelf **370** is positioned horizontally. The connection assembly **390** rotates according to the rotation of the shelf **370**. The shelf **370** is slowly moved downward by the damping unit **394**.

The second door **340** is automatically opened by the lower hinge assembly **54** until a predetermined angle, and is stopped when the shelf **370** is positioned horizontally. At this point, the second door **340** is disposed at about 110° , and the second door **340** is gradually decelerated by the lower hinge assembly **54** and stopped just before the shelf **370** is completely unfolded to be positioned horizontally.

When the shelf **370** is completely unfolded, the connection assembly **390** is also positioned horizontally to support the shelf **370**. At this point, the lower surface of the shelf **370** is supported by the lower end of the opening **316**, so that the shelf **370** is maintained in a stable state. After the shelf **370** is completely unfolded, the joint rod **391** of the connection assembly **390** is continually disposed in the end of the cutout part **382a** of the joint member **380**. The lower hinge assembly **54** prevents the second door **340** from being further opened, and thus, the shelf **370** is maintained in a further stable state.

FIG. **46** is a perspective view illustrating the second door. FIG. **47** is an exploded perspective view illustrating the front side of the second door. FIG. **48** is an exploded perspective view illustrating the rear side of the second door. FIG. **49** is

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a cross-sectional view taken along line 7-7' of FIG. **46**. FIG. **50** is a cross-sectional view taken along line 8-8' of FIG. **46**. FIG. **51** is a perspective view illustrating a second door when only a door plate is removed from the second door.

Referring to FIGS. **46** through **51**, the second door **340** includes the door plate **343** that defines the front exterior of the second door **340**, the door case **342** that defines the rear exterior of the second door **340**, cap decors **345** that define the upper and lower surfaces of the second door **340**, and the side decors **346** that define the left and right surfaces of the second door **340**.

In detail, the size of the front surface of the second door **340** is determined according to the door plate **343**. As described above, the door plate **343**, the front surface of the first door **310** and the front surface of the freezer compartment door **20** may have the same material or the same color or the same figure. The door plate **343** may be formed of tempered glass, and the rear surface of the door plate **343** may be provided with a specific pattern or figure. Since the door plate **343** is formed of the tempered glass that is transparent, the pattern or figure can be perceived from the front side of the door plate **343**. The door plate **343** may be adhered to the front surfaces of the cap decors **345** and the front surfaces of the side decors **346** through adhesive members **343b** (refer to FIG. **51**).

A pattern or figure may be formed on the rear surface of the door plate **343** using a following method. In detail, a pattern or figure is printed in a specific shape on the front surface of opaque film that has the same color as that of the front surface of the first door **310**. The film with the printed pattern or figure is attached to the rear surface of the door plate **343**. Since the film is opaque, a heat insulator that fills the rear surface of the door plate **343** is not exposed to the outside. In the related art, a refrigerator door is formed by attaching a separate tempered glass to the front surface of a door cover that is a plastic product through injection molding or a metal plate. However, according to the embodiment, a separate door cover is unnecessary, and the door plate **343** formed of glass performs the two functions. That is, the door plate **343** functions as both the door cover and the tempered glass attached to the front surface of the door cover.

The door case **342**, which defines the rear surface of the second door **340**, may be plastic through injection molding. The door case **342** may be recessed to receive an heat insulator. In detail, the protrusion part **342a** may have a shape corresponding to the opening **316**, and is disposed within the opening **316** when the second door **340** is closed.

The door case **342** may have a gasket recess for receiving the gasket **344**, and the gasket recess is disposed outside the protrusion part **342a**. The gasket **344** extends along the edge of the door case **342** and contacts the outside of the opening **316**.

The latch hook **341** may be installed on the door case **342**, and the upper and lower ends of the door case **342** may be provided respectively with spaces on which the first hinge **52** and the lower hinge assembly **54** are installed. The inside and edge surface of the door case **342** may be provided with a plurality of protrusions or ribs for reinforcing the door case **342**.

Reinforcement members **340c** for reinforcing the second door **340** may be installed on the left and right edges of the door case **342**. The reinforcement members **340c** may be formed of steel, and be elongated up and down. The reinforcement members **340c** installed on the door case **342** prevent torsion or deformation of the second door **340**. The reinforcement members **340c** will be described later in more detail.

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The cap decors **345** define the upper and lower appearances of the second door **340**, and may be formed of plastic through injection molding. The cap decors **345** include an upper cap decor that defines the upper surface of the second door **340**, and a lower cap decor that defines the lower surface of the second door **340**.

A side of the upper cap decor of the cap decors **345** may be provided with the second installation part **340b** on which the second hinge **51** is installed, and a side of the lower cap decor of the cap decors **345** may be provided with a third installation part **345f** on which the lower hinge assembly **54** is installed. The lower cap decor of the cap decors **345** may be provided with a handle part **345g** that is recessed to be held by a user's hand to open the second door **340**.

The cap decors **345** may be coupled to the door case **342** through screws **345h**. To this end, the cap decors **345** may have screw holes **345i** through which the screws **345h** pass, and screw coupling parts **342e** to which the screws **345h** are coupled may be disposed at the door case **342** to correspond to the screw holes **345i**.

The cap decors **345** may include door case coupling parts **345a** installed on the upper and lower ends of the door case **342**, and door plate placement parts **345b** that support the lower and upper surfaces of the door plate **343**. The door case coupling parts **345a** may be coupled to the upper and lower ends of the door case **342**. The door plate placement parts **345b** extend perpendicularly to the door case coupling parts **345a** to the inside of the door case **342**. Thus, the door plate **343** may be coupled to the door case coupling parts **345a** in a manner where the door plate **343** is placed on the door case coupling parts **345a**.

Hereinafter, the cap decors will now be disposed in more detail. In installation structures of the cap decors, the upper cap decor is the same as the lower cap decor, and thus, a description will now be made with respect to the upper cap decor.

The door case coupling part **345a** extends to the door case **342** and may be inserted in an upper border **342f** that is provided to the upper end of the door case **342**. The upper border **342f** may have an insertion recess **342g** in which the door case coupling part **345a** is inserted. The door case coupling part **345a** has a stepped shape, and its rear portion is inserted in the recess **342g** and its front portion is coplanar with the upper border **342f** to define the upper surface of the second door **340**.

The door plate placement part **345b** may extend to the inside of the door case **342** and be closely adhered to the rear surface of the door plate **343**. Movement prevention protrusions **345c** protrude forward from the outer ends of the door plate placement parts **345b**. The movement prevention protrusions **345c** extend in the longitudinal direction of the door case coupling parts **345a** to support and confine the upper and lower ends of the door plate **343**.

The side decors **346** form the left and right surfaces of the second door **340**, and may be formed of a metal such as aluminum. The side decors **346** are installed on both side ends of the door case **342**, and may be coupled to the door case **342** through screws **346e**. The side decors **346** may be formed of plastic through injection molding, and may be coated or colored to have the texture of metal.

The side decors **346** may include door case coupling parts **346a** coupled to both side surfaces of the door case **342**, and door plate placement parts **346b** that perpendicularly extend to the door case coupling parts **346a** to support the door plate **343**. The door plate placement parts **346b** extend toward the inside of the door case **342**, and the rear surface of the door plate **343** is placed on the door plate placement parts **346b**.

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Hereinafter, the side decors will now be described in more detail.

The door case coupling parts **346a** extend rearward, and hooks **346c** may be bent at the rear ends of the door case coupling parts **346a**. The hooks **346c** of the door case coupling parts **346a** engage with side decor coupling recesses **342i** disposed at the left and right ends of the door case **342**. Borders **342h** disposed at the left and right side ends of the door case **342** contact the door case coupling parts **346a** to laterally support the side decors **346**.

The door plate placement parts **346b** extend toward the inside of the door case **342**, and extended ends are bent rearward to prevent the deformation of the side decors **346**.

Movement prevention protrusions **346d** protrude forward from the outer ends of the door plate placement parts **346b**. The movement prevention protrusions **346d** extend in the longitudinal direction of the door case coupling parts **346a** to prevent the left and right movements of the door plate **343**.

Thus, in the second door **340** as illustrated in FIG. **51**, the cap decors **345** are respectively coupled to the upper and lower ends of the door case **342**, and the side decors **346** are respectively coupled to the left and right ends of the door case **342**, and the door plate **343** is placed on the door plate placement parts **345b** and **346b**.

The adhesive members **343b** may be provided respectively to the door plate placement parts **345b** and **346b** contacting the door plate **343**. The adhesive members **343b** may include double-sided adhesive tape or adhesive. Alternatively, the adhesive members **343b** may be applied to the rear surface of the door plate **343**.

When the door plate **343** is adhered to the door plate placement parts **345b** and **346b**, a foaming agent may be filled between the door plate **343** and the door case **342** to form an insulation layer.

Hereinafter, the reinforcement members installed inside the door case will now be described in more detail.

FIG. **52** is an exploded perspective view illustrating a second door coupled with reinforcement members according to an embodiment. FIG. **53** is a cross-sectional view taken along line 9-9' of FIG. **52**.

Referring to FIGS. **52** and **53**, the reinforcement members **340c** may be installed on the left and right sides of the door case **342**. The reinforcement members **340c** may be placed on the front surface of the door case **342** at the edge of the door case **342**, and may be disposed behind the door plate placement parts **346b** of the side decors **346**.

The front and rear ends of the reinforcement member **340c** extend toward the inside of the door case **342**, and are spaced a predetermined distance from each other. Thus, open parts of the reinforcement members **340c** may face the inside of the door case **342**, and an insulator can be uniformly injected to the inside of the reinforcement members **340c**.

In addition, the door plate placement parts **346b** are spaced apart from the reinforcement members **340c**, so that a foaming agent can be uniformly injected to the spaces between the reinforcement members **340c** and the door case **342**. The reinforcement members **340c** are disposed further outside than the portions provided with the screws **346e** for coupling the side decors **346**, so that the reinforcement members **340c** do not interfere with the screws **346e** during the coupling of the screws **346e**.

The reinforcement members **340c** are spaced inward from side ends of the door case **342**, and are spaced apart from the side decor coupling recesses **342i**. The reinforcement member **340c** may be provided in quadruplicate around the door

case 342 as well as the left and right sides of the door case 342, or may be disposed diagonally.

The reinforcement members 340c may be adhered to the front surface of the door case 342 through adhesive. For example, a primer 340d is applied on the bottom surface of the reinforcement member 340c, and then, a double-sided adhesive tape 340e is attached to the bottom surface. A primer 340f is applied on the upper surface of the door case 342. That is, the primers 340d and 340f are attached to the upper and lower surfaces (or front and rear surfaces) of the double-sided adhesive tape 340e.

Hereinafter, assembling of a second door of a refrigerator configured as described above will now be described according to an embodiment.

To assemble the second door 340, a color or figure is formed on the rear surface of the door plate 343. The door case 342 and the cap decors 345 are formed of plastic through injection molding, and the side decors 346 are formed of a metal such as aluminum. The reinforcement members 340c are formed to have a predetermined length.

In detail, the reinforcement members 340c are installed on the inner left and right sides of the door case 342. To this end, the primers 340d and 340f are applied to the reinforcement member 340c and the door case 342, and the reinforcement members 340c are attached to the inner surface of the door case 342 through the double-sided adhesive tape 340e.

The cap decors 345 are coupled to the upper and lower ends of the door case 342. After that, the side decors 346 are coupled to the left and right ends of the door case 342.

In detail, the door case coupling parts 345a are respectively inserted into the upper border 342f and a lower border of the door case 342, and the screws 345h are coupled to fix the cap decors 345 to the door case 342.

The hooks 346c of the door case coupling parts 346a are coupled to the side decor coupling recesses 342i, and then, the screws 346e are coupled to fix the side decors 346 to the door case 342.

After the cap decors 345 and the side decors 346 are coupled to the door case 342, the adhesive members 343b are applied to the door plate placement parts 345b and 346b. Then, the door plate 343 is placed on the door plate placement parts 345b and 346b. Then, the door plate 343 is fixed to the door plate placement parts 345b and 346b through the adhesive members 343b.

The movement prevention protrusions 345c provided to the cap decors 345 and the movement prevention protrusions 346d provided to the side decors 346 support and confine the edge of the door plate 343 to prevent the movement of the door plate 343.

After the door plate 343 is installed, a foaming agent is injected between the door plate 343 and the door case 342 to form an insulation layer within the second door 340. When the injecting of the foaming agent is completed, the assembling of the second door 340 is completed.

Various structures including the gasket 344 to be installed on the door case 342, the latch hook 341, and the lower hinge assembly 54 may be attached just after the door plate 343 is formed, or after or before the foaming agent is injected.

FIG. 54 is an exploded perspective view illustrating the front side of the second door. FIG. 55 is an exploded perspective view illustrating the rear side of the second door. FIG. 56 is a perspective view illustrating the second door installed on a jig.

Referring to FIGS. 54 through 56, as described above, the second door 340 may include the door plate 343 that forms the frontal exterior of the second door 340, the door case 342

that forms the rear exterior of the second door 340, the cap decors 345 that form the upper and lower surfaces of the second door 340, and the side decor 346 that forms the left and right surfaces of the second door 340.

In detail, a foaming agent injection part 342j is disposed at a portion of the protrusion part 342a provided to the door case 342. An ingate 342k may be disposed in the approximately center of the foaming agent injection part 342j. The ingate 342k is a hole through which a foaming agent 84 is injected to form the insulation layer within the second door 340.

The foaming agent injection part 342j may be disposed at a position spaced upward from the lower end of the protrusion part 342a. In detail, the foaming agent injection part 342j may be disposed at a position corresponding to about one fourth to about one third the length of the second door 340 from the lower end of the second door 340. Thus, the ingate 342k is disposed at a position spaced downward from a horizontal cross-section that bisects the second door 340.

When the foaming agent 84 is injected into the second door 340, the lower end of the second door 340 is moved upward to be inclined at an angle ranging from about 4° to about 6°. Thus, during a foaming process, the ingate 342k is disposed higher than the horizontal cross-section that bisects the second door 340. Accordingly, the foaming agent 84 can be uniformly introduced into the second door 340.

In detail, the second door 340 is thinner than a typical refrigerator door, and the length and the lateral width of the second door 340 are great relative to the thickness of the second door 340. Thus, when a typical method is used to inject a foaming agent into the second door 340, since the inner space of the second door 340 is thin and wide, the foaming agent 84 may unevenly spread.

However, when the second door 340 is inclined and the foaming agent 84 is injected through the ingate 342k, the foaming agent 84 can be introduced down to the upper end of the second door 340 along an inclined surface in the second door 340, and simultaneously, the foaming agent 84 can be uniformly introduced to other regions in the second door 340.

To this end, the second door 340 may be installed on a jig 80 that is inclined at an angle ranging from about 4° to about 6° from the ground. Alternatively, the jig 80 on which the second door 340 is installed is disposed horizontally, and the inner space of the jig 80 may be inclined.

When an inclination angle of the second door 340 is less than about 4°, it may be difficult to inject the foaming agent 84 down to the upper end of the second door 340. When the inclination angle of the second door 340 is great than about 6°, it may be difficult to inject the foaming agent 84 up to the end of the second door 340 spaced upward from the horizontal cross-section, that is, up to the lower end of the second door 340. Moreover, it may be difficult to move and assemble the jig 80.

When the jig 80 is inclined in the range from about 4° to about 6°, if the ingate 342k is disposed higher, a foaming agent is hardened before arriving at the upper end of the second door 340, so that an insulation layer may not be formed in a predetermined region. If the ingate 342k is disposed lower, the foaming agent 84 does not arrive at the lower end of the second door 340, that is, the upper most end within the jig 80, so that an insulation layer may not be formed in a predetermined region.

The foaming agent injection part 342j having the ingate 342k may be provided with an injection part cover 3421 that covers the foaming agent injection part 342j. The foaming agent injection part 342j is provided with cover coupling

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parts 342m to install the injection part cover 342i to the foaming agent injection part 342j. The injection part cover 342i installed on the foaming agent injection part 342j may be coplanar with the outer surface of the protrusion part 342a.

Hereinafter, assembling of a second door of a refrigerator configured as described above will now be described according to an embodiment.

To assemble the second door 340, the door plate 343 is formed, and then, a film having a pattern or figure and a background color that is the same as that of the front part of the first door 310 is attached to the rear surface of the door plate 343. The door case 342 and the cap decors 345 are formed of plastic through injection molding, and the side decors 346 are formed of a metal such as aluminum.

After the door case 342, the cap decors 345, and the side decors 346 are formed, the upper and lower ends of the door case 342 formed through injection molding are coupled with the cap decors 345 formed through injection molding. After that, the side decors 346 are coupled to the left and right ends of the door case 342.

After the cap decors 345 and the side decors 346 are coupled to the door case 342, the door plate 343 is installed on the cap decors 345 and the side decors 346. Adhesive may be applied on the cap decors 345 and the side decors 346 or the door plate 343. The door plate 343 is fixed to the cap decors 345 and the side decors 346 through the adhesive to form the frontal exterior of the second door 340. The cap decors 345 and the side decors 346 are provided with discrete fixing structures such as a catching protrusion to prevent the movement of the door plate 343.

After the door plate 343 is installed, the second door 340 is installed on the jig 80. The jig 80 is a fixture for fixing the second door 340 when the foaming agent 84 is injected, and includes an upper jig 81 and a lower jig 82. The door plate 343 and the door case 342 are placed on the upper jig 81 and the lower jig 82, respectively.

The jig 80 may have a corresponding shape to the exterior of the second door 340, and be inclined at a predetermined angle from the ground. Thus, the second door 340 is inclined when being installed on the jig 80.

After the second door 340 is installed to be inclined within the jig 80, the jig 80 is closed. The foaming agent 84 is injected to the ingate 342k through an injection nozzle 83 provided to a side of the jig 80.

At this point, as illustrated in FIG. 58, the foaming agent 84 flows down along the inclined surface of the door plate 343. Then, the second door 340 is filled with the foaming agent 84 from the lowest region. At this point, the foaming agent 84 is provided up to a higher region than the ingate 342k by the pressure of the foaming agent 84 injected through the ingate 342k. As a set time is elapsed, the interior of the second door 340 is entirely and uniformly filled with the foaming agent 84 to form an insulation layer.

Various structures including the gasket 344 to be installed on the door case 342, the latch hook 341, and the lower hinge assembly 54 may be attached just after the door plate 343 is formed, or after or before the foaming agent 84 is injected.

An injection state of the foaming agent 84 may be varied according to inclination angles of the second door 340, which will now be described with reference to the accompanying drawings.

FIGS. 57 to 61 are graphs illustrating filling states of a foaming agent according angles of the jig. Referring to FIGS. 57 to 61, a simulation is performed when the ingate has an injection diameter of 18 mm, a total amount of the foaming agent to be injected is 1100 g, an injection speed of

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the foaming agent is 0.7856 msec, a discharge amount of the foaming agent per second is 280 g/sec, and a discharge time of the foaming agent is 3.93 sec. Under these conditions, the angle of the second door 340 is varied.

Referring to FIGS. 57 to 61, when the second door 340 is not inclined and disposed horizontally, the foaming agent 84 spreads with substantially the same radius about the ingate 342k as illustrated in FIG. 57. However, in this case, since the ingate 342k is disposed in the lower portion of the second door 340, the foaming agent 84 is insufficiently supplied to the upper end of the second door 340, and is unevenly distributed through a wide region. In other words, the foaming agent 84 may be collected only to the region adjacent to the ingate 342k, and the foaming agent 84 may be insufficiently injected to the upper and lower ends of the second door 340.

When the second door 340 is inclined at about 10° from the ground, the foaming agent 84 is mainly supplied to the upper end of the second door 340 as illustrated in FIG. 58, and is partially supplied to the lower end of the second door 340. At this point, the foaming agent 84 is uniformly distributed on the wide surface of the second door 340, has a uniform thickness as a whole. When the foaming agent 84 is further injected, the interior of the second door 340 is uniformly filled with the foaming agent 84.

When the second door 340 is inclined at about 20° from the ground, the most part of the foaming agent 84 is supplied to the upper end of the second door 340 as illustrated in FIG. 59. At this point, since the foaming agent 84 is almost not injected to the lower end of the second door 340, the foaming agent 84 is unevenly injected to the interior of the second door 340.

When the second door 340 is inclined at about 30° from the ground, the foaming agent 84 flows down to the upper end of the second door 340 as illustrated in FIG. 60, and is not injected to the lower end of the second door 340. Thus, in this state, a portion of the lower end of the second door 340 may not be filled with the foaming agent 84.

When the second door 340 is inclined at about 45° from the ground, the foaming agent 84 flows down to the upper end of the second door 340 as illustrated in FIG. 61. Furthermore, the foaming agent 84 flowing at high speed may be branched into several parts. Accordingly, an insulation layer may have an uneven thickness even in the upper end of the second door 340. Moreover, the foaming agent 84 may be hardened in advance in a region to suppress the movement of the foaming agent 84, so that the foaming agent 84 may be unevenly supplied.

As a result under the above described conditions, it was found that a preferable inclination angle of the second door 340 is about 10° or less when the foaming agent 84 is injected. In more detail, a preferable inclination angle of the second door 340 may range from about 4° to about 6°.

FIG. 62 is an exploded perspective view illustrating a refrigerator with a removed second door according to an embodiment. FIG. 63 is a graph illustrating hardness variations of gaskets formed of different materials according to a temperature variation according to an embodiment.

Since the refrigerator illustrated in FIG. 62 is described in the previous embodiments, a description thereof will be omitted.

In FIG. 63, a horizontal axis denotes temperature, and a vertical axis denotes the Shore hardness.

Referring to FIG. 63, a hardness variation of a gasket formed of silicone according to a temperature variation is even smaller than that of a gasket formed of polyvinyl chloride (PVC).

Specifically, the hardness variation of a gasket formed of silicone **45** is disposed substantially within 1 to 2 in a range from -20°C . to 60°C . Thus, when the gasket **344** is formed of the silicone **45**, the hardness variation of the gasket **344** is very small even while temperature varies, so that the resilient force of the gasket **344** almost not varies while the temperature varies. Thus, the space between the first door **310** and the second door **340** can be effectively sealed. Especially, even at a low temperature, the gasket **344** is closely adhered with a predetermined amount of elastic force to the first door **310** to prevent the leakage of cool air.

Hereinafter, the structure of the second door **340** will now be described in more detail with reference to the accompanying drawings.

FIG. **64** is an exploded perspective view illustrating the front side of the second door. FIG. **65** is a rear view illustrating a second door in which a ground wire is disposed.

Since the second door illustrated in FIG. **64** is described with reference to FIGS. **47** and **54**, a description thereof will be omitted here except for a ground wire **347** that is disposed in the second door.

Referring to FIGS. **64** and **65**, the door case **342** may be formed of plastic, and the door plate **343** may be formed of tempered glass or transparent plastic.

In detail, an insulator may be disposed between the door case **342** and the door plate **343**. The insulator may be formed by filling the door case **342** and the door plate **343** with a foaming agent. Alternatively, the insulator (e.g., a vacuum insulator) disposed between the door case **342** and the door plate **343** may be removable when the second door **340** is assembled.

The lower hinge assembly **54** is formed of metal to be installed on the door case **342** as described above. When the lower hinge assembly **54** contacts the door case **342**, the lower hinge assembly **54** may contact the side decor **346** that is formed of metal. That is, after the second door **340** is assembled, the lower hinge assembly **54** contacts the side decor **346** to allow the movement of electric charges.

The cap decors **345** may be formed of plastic or metal such as aluminum. The cap decor **345** that forms the upper surface of the second door **340** is provided with a hinge hole that is shaft-coupled to the second hinge **51**, and the cap decor **345** that forms the lower surface of the second door **340** is provided with a hinge hole for shaft-coupling the hinge bracket **53** to the lower hinge assembly **54**.

The side decors **346** may be formed of a metal such as aluminum, and constitute the exterior of the second door **340**. The ground wire **347** may be disposed between the side decors **346**. The ground wire **347** is used to discharge an electric current, which may occur while the second door **340** is used, to the outside of the second door **340**, and connects the side decors **346** to each other.

The side decors **346** and both ends of the ground wire **347** may be adhered to each other through tape, or coupled through a coupling member such as screws, or connected through an engagement structure such as a clip, but the present disclosure is not limited thereto.

For example, referring to FIG. **64**, the ends of the ground wire **347** may be provided with connection parts **347a** having clip shapes to be fitted on the protruding ends of the side decors **346**. Thus, the ground wire **347** can be connected to the side decors **346** just by fitting the connection parts **347a** respectively on the side decors **346** without an additional coupling member.

Thus, static electricity remaining at one of the side decors **346** can move the other side decor **346** through the ground wire **347**, and be discharged to the outside through the second door **340**.

Hereinafter, static electricity occurring at the second door **340** and a current flow due to the static electricity will now be described in detail.

FIGS. **66A** and **66B** are schematic views illustrating static electricity occurring at the second door.

Referring to FIGS. **66A** and **66B**, electrons do not actively migrate until the second door **340** is opened several times. As illustrated in FIG. **66A**, a front case **314** (corresponding to the second part **312** in FIG. **4**) of the first door **310** and the gasket **344** are electrically neutral to be stable.

In this state, although a user holds the second door **340** to open or close the second door **340**, static electricity does not occur since a residual charge does not exist. Thus, the user can comfortably use the second door **340**.

When the second door **340** is frequently opened and closed, the surface of the gasket **344** repeatedly contacts and separates from the surface of the front case **314** of the first door **310**. Especially, as the frequency of the contact and separation is increased, the amount of static electricity increases. Thus, since a portion of the gasket **344**, which is distant from the rotation shaft of the second door **340**, has a large radius of gyration, the contact and separation occur clearly in the portion of the gasket **344**, but the contact and separation occur unclearly in a portion of the gasket **344** near the rotation shaft. Thus, the amount of static electricity is relatively large at the front case **314** and the distant portion of the gasket **344** from the rotation shaft.

In detail, when the second door **340** is repeatedly opened and closed, the contact and separation repeatedly occur between the gasket **344** and the surface of the front case **314**, so that electrons actively migrate. That is, when electrons of the first door **310** migrate to the gasket **344**, the electrons are accumulated in the gasket **344**, and thus, the first door **310** is charged positively, and the second door **340** is charged negatively.

As such, since the electrons accumulated in the gasket **344** also migrate to the second door **340** provided with the gasket **344**, when a user holds the second door **340**, static electricity occurs as illustrated in FIG. **66B**.

Especially, the distant side decor **346** from the rotation shaft of the second door **340** is easily touched by a user's hand while the second door **340** rotates. Moreover, since the side decor **346** is adjacent to the gasket **344**, electrons easily migrate. In addition, since the side decor **346** is formed of a metal such as aluminum, when the negatively charged side decor **346** is touched by a user's hand, static electricity may cause a spark.

Thus, when the side decors **346** are connected through the ground wire **347** as illustrated in FIG. **65**, electrons (charges) remaining in the distant side decor **346** from the rotation shaft of the second door **340** can migrate to the adjacent side decor **346** to the second door **340**.

The second door **340** is shaft-coupled to the hinge bracket **53** that is formed of metal, and the adjacent side decor **346** to the rotation shaft of the second door **340** contacts the lower hinge assembly **54**. In addition, the lower hinge assembly **54** is coupled to the hinge bracket **53**, and thus, electrons remaining in the second door **340** are induced to migrate to the first door **310** through the adjacent side decor **346**, the lower hinge assembly **54**, and the hinge bracket **53**.

That is, static electricity occurring at one of the side decors **346** can migrate to the other side decor **346** through the ground wire **347**. Since the adjacent side decor **346** to the

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rotation shaft of the second door 340 contacts the lower hinge assembly 54, and the lower hinge assembly 54 is connected to the hinge bracket 53, remaining charges can be induced to the first door 310 sequentially. Thus, even when a user touches the distant side decor 346 from the rotation shaft to rotate the second door 340, static electricity does not occur.

Charges induced through the second door 340 are disappeared at the first door 310, or are guided to a ground wire 315 disposed within the first door 310, and then, are discharged through the cabinet 10 or an outer ground.

Hereinafter, various structures for transmitting a current induced to the first door 310 to the outside will now be described according to embodiments. In the following embodiments, a description of the same parts of the second door 340 as those of the previous embodiments will be omitted, and like reference numerals denote like elements.

FIG. 67 is a perspective view illustrating a refrigerator including a second door is opened according to an embodiment.

Referring to FIG. 67, the second door 340 is rotatably connected to the first door 310 through the second hinge 51.

The side decors 346 may form the left and right surfaces of the second door 340, and the cap decors 345 may form the upper and lower surfaces of the second door 340. The cap decors 345 may be formed of a metal such as aluminum.

The ground wire 347 may be disposed within the second door 340 to connect the side decors 346 to each other. The second hinge 51 may contact the side decor 346.

Thus, charges induced to the side decor 346 through the ground wire 347 can be induced to the first door 310 sequentially through the cap decor 345 coupled to the upper end of the second door 340 and through the second hinge 51. Then, the charges are discharged to the cabinet 10 through the first hinge 52 connecting the first door 310 to the cabinet 10.

If necessary, a sub ground wire 348 may be provided, an end of which is connected to the adjacent side decor 346 to the rotation shaft of the second door 340. The sub ground wire 348 may be connected to a side of the cap decor 345, or be guided to the outside through the second hinge 51 and be connected to the cabinet 10.

FIG. 68 is a perspective view illustrating a refrigerator including a second door according to another embodiment.

Referring to FIG. 68, the upper and lower ends of the second door 340 are rotatably coupled to the first door 310 through the second hinge 51, the lower hinge assembly 54, and the hinge bracket 53.

The side decors 346 may form the left and right surfaces of the second door 340, and the cap decors 345 may form the upper and lower surfaces of the second door 340. The ground wire 347 may be disposed within the second door 340 to connect the side decors 346 to each other.

The ground wire 315 may be disposed within the first door 310, and an end of the ground wire 315 may be connected to a side of the hinge bracket 53 within the first door 310. The ground wire 315 may be indirectly connected to the hinge bracket 53 through a coupling member that couples the hinge bracket 53 to the first door 310. The other end of the ground wire 315 disposed within the first door 310 is guided to the outside through the first hinge 52, and thus, is connected to a side of the cabinet 10.

Thus, charges remaining in the second door 340 are induced to migrate through the ground wire 347 to the adjacent side decor 346 to the rotation shaft of the second

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door 340. The charges induced to the side decor 346 are induced sequentially to the lower hinge assembly 54 and the hinge bracket 53.

The charges induced to the hinge bracket 53 may be discharged to the cabinet 10 or the outside of the refrigerator 1 through the ground wire 315 that is connected to the hinge bracket 53 and disposed within the first door 310.

Instead of guiding the ground wire 315 disposed within the first door 310 to the outside through the first hinge 52, the ground wire 315 may be extended downward to contact the cabinet 10 through a hinge bracket (not shown) that supports the first door 310 from the lower side.

FIG. 69 is a perspective view illustrating a refrigerator including a second door according to another embodiment.

Referring to FIG. 69, the second door 340 is rotatably connected to the first door 310 through the second hinge 51 and the hinge bracket 53.

The side decors 346 may form the left and right surfaces of the second door 340, and the cap decors 345 may form the upper and lower surfaces of the second door 340. At least one of the cap decors 345 provided to the upper and lower portions of the second door 340 may electrically connect the side decors 346 to each other.

In detail, at least one portion of the cap decor 345 forming the lower surface of the second door 340 may be formed of a metal. Thus, when the cap decor 345 is installed, the ends of the cap decor 345 may contact the lower ends of the side decors 346, respectively. Thus, the side decors 346 are electrically connected to each other through the cap decor 345. To this end, the whole cap decor 345 may be formed of a metal, or a portion thereof may be formed of a metal. For example, when the cap decor 345 is longitudinally bisected into upper and lower portions, one of the upper and lower portions may be formed of a metal, and the other may be formed of a non-metal. Thus, although the whole cap decor 345 is not formed of a metal, the side decors 346 can be electrically connected.

Alternatively, when the whole cap decor 345 is formed of plastic, the upper or lower edge of the cap decor 345 may be covered with a conductive contact 345a for connecting the side decors 346. In detail, the contact 345a may include a metal plate or be formed of the same material as that of the ground wire 347, and extend horizontally along the cap decor 345. When being installed, the cap decor 345 may contact the side decors 346.

Thus, charges remaining in the second door 340 or in the side decor 346 may be induced to migrate through the contact 345a of the cap decor 345 to the adjacent side decor 346 to the rotation shaft of the second door 340, and then, be induced into the first door 310 through the second hinge 51 or the lower hinge assembly 54 and the hinge bracket 53. Then, the charges may be discharged to the cabinet 10 or to the outside of the refrigerator 1 through a ground structure in the first door 310.

FIG. 70 is a perspective view illustrating a refrigerator when a second door is opened, according to an embodiment. FIG. 71 is a partial front view illustrating a first door according to an embodiment. FIG. 72 is a rear view illustrating a second door according to an embodiment.

Referring to FIGS. 70 to 72, the refrigerator 1 has the same configuration as that of the previous embodiments except that an inclined surface 316a is formed on the inner border of the opening 316 of the first door 310 and the gasket 344 is closely adhered to the inclined surface 316a, which will now be described in more detail.

The first door 310 may include the first part 311 at the lower side of the grip part 313, and the second part 312 at

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the upper side of the grip part 313. The first part 311 and the second part 312 may be stepped from each other, and the second part 312 may be lower than the first part 311. The second door 340 may be installed on the second part 312. When the second door 340 is closed, the front surface of the first part 311 may be coplanar with the front surface of the second door 340.

The second part 312 may be constituted by the front case 314 formed of plastic, and the front case 314 may be provided with the opening 316. The inclined surface 316a may be disposed around the opening 316. The inclination of the inclined surface 316a is different from an inclination around the protrusion part 342a to primarily prevent the leakage of cool air. This will be described in more detail with reference to FIG. 73.

When the second door 340 is closed, the gasket 344 surrounding the rear surface of the second door 340 contacts the front end of the inclined surface 316a. The gasket 344 extends along the bottom edge of the protrusion part 342a. That is, the gasket 344 may extend along the boundary between the protrusion part 342a and the rear surface of the second door 340. Thus, when the second door 340 is closed, the gasket 344 is closely adhered to the inclined surface 316a to secondarily prevent the leakage of cool air.

Hereinafter, opening and closing of a second door of a refrigerator door configured as described above will now be described in detail with reference to the accompanying drawings according to an embodiment.

FIG. 73 is a cross-sectional view illustrating a refrigerator compartment door when the second door is opened, according to an embodiment. FIG. 74 is a cross-sectional view illustrating the refrigerator compartment door when the second door is closed.

Referring to FIGS. 73 and 74, when the second door 340 is opened, the gasket 344 is spaced apart from the inner border of the opening 316. In this state, a user further rotates the second door 340 to take out food from the storing device 40 through the opening 316 or put food into the storing device 40.

When the second door 340 is rotated and closed, the protrusion part 342a of the second door 340 is inserted to the inside of the opening 316. Then, the gasket 344 contacts the inclined surface 316a of the opening 316.

The inclination angle of the inclined surface 316a is different from that of the edge of the protrusion part 342a. In detail, from the inner edge of the opening 316 to the center thereof (from the upper end to the lower end in FIG. 73), the inclined surface 316a is inclined to come closer to the edge of the protrusion part 342a.

Even when the second door 340 is completely closed, the edge of the protrusion part 342a is spaced apart from the inclined surface 316a to receive the gasket 344. Then, the rear surface of the second door 340 is disposed nearer to the first part 311 of the first door 310 to more effectively prevent the leakage of cool air. If the gasket 344 is disposed between the rear surface of the second door 340 and the first part 311 of the first door 310, the first door 310 is spaced apart from the second door 340 by the thickness of the gasket 344.

As such, since the gasket 344 is disposed around the bottom edge of the protrusion part 342a such that the gasket 344 is closely adhered to the inclined surface 316a, the rear surface of the second door 340 can be disposed nearer to the front surface of the first door 310. As a result, the possibility that cool air can be heat-exchanged with outside air is further decreased.

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FIG. 75 is a perspective view illustrating a refrigerator compartment door when a second door is opened, according to an embodiment.

Referring to FIG. 75, the front surface of the first door 310, particularly, the front surface of the front case 314 corresponding to the outer edge of the opening 316 is provided with a gasket receiving part 314b. The gasket receiving part 314b extends in a closed curve around the opening 316. The gasket receiving part 314b may have a size corresponding to a gasket 710 of the second door 340 to receive the gasket 710 that will be described later.

The gasket 710 may be disposed around the protrusion part 342a. When the second door 340 is closed, the gasket 710 is closely adhered to the gasket receiving part 314b to prevent the leakage of cool air. The gasket 710 may be formed of rubber, silicone, or synthetic resin.

Hereinafter, the gasket and the first door contacting the gasket will now be described in more detail with reference to the accompanying drawings.

FIG. 76 is a cross-sectional view illustrating a refrigerator compartment door according to an embodiment.

Referring to FIG. 76, a gasket installation part 342b is disposed in the rear surface of the second door 340. A fixing part 711 of the gasket 710 is inserted and fixed to the gasket installation part 342b, and the gasket installation part 342b is disposed around the protrusion part 342a.

The gasket 710 may include the fixing part 711 inserted in the gasket installation part 342b, a chamber part 712 that is hollow, and a magnetic part 713 that includes a permanent magnet 714 therein. In detail, the fixing part 711 may be inserted in the gasket installation part 342b. The chamber part 712 extends from the fixing part 711 and has an inner space, so that the gasket 710 can be deformed by pressure. Thus, the gasket 710 can absorb shock and improve sealing performance when the second door 340 is opened and closed. The magnetic part 713 is configured to receive the permanent magnet 714. The magnetic part 713 may be disposed at an end of the gasket 710, and directly contact the front surface of the first door 310 when the second door 340 is closed. Since the magnetic part 713 may have a shape corresponding to the gasket receiving part 314b of the first door 310, when the second door 340 is closed, the magnetic part 713 can be inserted in the gasket receiving part 314b.

An attachment member 720 is disposed in the first door 310 to closely adhere the gasket 710. The attachment member 720 may be formed of a metal to attach the permanent magnet 714 using magnetic force, and have a plate shape with a predetermined width. The attachment member 720 may be formed of high strength steel around the opening 316. Thus, the attachment member 720 reinforces the upper portion of the first door 310, that is, the portion of the first door 310 provided with the opening 316 to prevent the deformation of the first door 310.

The attachment member 720 may be embedded in the first door 310 corresponding to the rear surface of the gasket receiving part 314b, and thus, may be invisible from the outside. The attachment member 720 may be a metal member that continuously extends along the gasket receiving part 314b. Alternatively, the attachment member 720 may include a plurality of plates that are spaced apart from each other along the gasket receiving part 314b. The attachment member 720 may be bent to surround the rear surface of the gasket receiving part 314b.

Hereinafter, opening and closing of a second door of a refrigerator door configured as described above will now be described in detail.

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First, when a user closes the second door 340, the latch hook 341 is inserted into the latch slot 317 and confined to the locking device 60. Thus, the second door 340 can be confined to the first door 310 and be maintained in the closing state.

When the second door 340 is closed, the gasket 710 is closely adhered to the first door 310 to prevent cool air from leaking out of the second storage compartment 405. At this point, the magnetic part 713 of the gasket 710 installed on the second door 340 is inserted into the gasket receiving part 314b. Then, magnetic force closely adheres the magnetic part 713 of the gasket 710 to the attachment member 720 with the front case 314 of the first door 310 therebetween. The gasket receiving part 314b may completely receive the magnetic part 713. When the second door 340 is completely closed, the chamber part 712 is compressed.

In this state, since the most part of the gasket 710 is inserted in the gasket receiving part 314b, the second door 340 can be securely and closely adhered to the first door 310. Thus, since the distance between the first door 310 and the second door 340 is minimized, when the second door 340 is closed, the first door 310 and the second door 340 provide a more improved sense of unity.

A refrigerator according to the present disclosure may be described according to various other embodiments than the previous ones. Hereinafter, a refrigerator will now be described with reference to the accompanying drawings according to another embodiment.

In the current embodiment, a gasket is provided to the first door, and an attachment member is provided to the second door. Thus, in the current embodiment, the rest parts except for the gasket and the attachment member are the same as those of the previous embodiments, a description thereof will be omitted, and like reference numeral denote like elements.

FIG. 77 is a perspective view illustrating a refrigerator when a second door is opened according to an embodiment. FIG. 78 is a cross-sectional view illustrating a refrigerator compartment door according to an embodiment.

Referring to FIGS. 77 and 78, a gasket 730 is disposed around the opening 316 of the first door 310.

The gasket 730 is the same as the gasket illustrated in FIGS. 75 and 76, and includes a fixing part 731, a chamber part 732 that is integrally formed with the fixing part 731 and is hollow, and a magnetic part 733 that includes a permanent magnet 734 therein. Since the gasket 730 is the same as the gasket illustrated in FIGS. 75 and 76, a description thereof will be omitted. However, when the second door 340 is closed, the magnetic part 733 directly contacts the rear surface of the second door 340. The magnetic part 733 may be directly or indirectly adhered to an attachment member 740 provided to the second door 340.

The attachment member 740 may be disposed on the rear surface or the inside of the second door 340 corresponding to the edge of the protrusion part 342a. In detail, the attachment member 740 may contact the rear surface of the second door 340 within the second door 340. Thus, when the second door 340 is closed, the magnetic part 733 of the gasket 730 is closely adhered to the attachment member 740 on the rear surface of the second door 340.

The attachment member 740 may have a plate shape with a predetermined width, or have a tetragonal frame shape. Alternatively, the attachment member 740 has a bent frame shape to prevent the deformation of the second door 340 and reinforce the second door 340. To this end, the attachment member 740 may be disposed at the edge of the rear surface of the second door 340 and be spaced apart from the

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protrusion part 342a, and the gasket 710 may be disposed on the first door 310 to correspond to the attachment member 740.

A refrigerator according to the present disclosure may be described according to various other embodiments than the previous ones. Hereinafter, a refrigerator will now be described with reference to the accompanying drawings according to another embodiment.

In the current embodiment, a magnetic member is provided to the first door, and an attachment member is provided to the second door. Thus, in the current embodiment, the rest parts except for the magnetic member and the attachment member are the same as those of the previous embodiments, a description thereof will be omitted, and like reference numeral denote like elements.

FIG. 79 is a perspective view illustrating a refrigerator compartment door when a second door is opened according to an embodiment.

Referring to FIG. 79, magnetic members 750 may be disposed inside the first door 310. The magnetic members 750 may include a permanent magnet, and are disposed outside the opening 316. The magnetic members 750 may be closely adhered to the front surface of the first door 310, and thus, can be closely adhered to attachment members 760 by magnetic force when the second door 340 is closed.

The magnetic members 750 may be disposed along the edge of the opening 316, or be disposed at a side of the opening 316. Alternatively, the magnetic members 750 may be disposed at the upper and lower sides of the locking device 60, respectively. For example, as illustrated in FIG. 79, the magnetic members 750 may be disposed in the first door 310 at the left side of the opening 316. The attachment members 760 may be disposed on the rear surface of the second door 340 to correspond to the magnetic members 750. Accordingly, magnetic force between the magnetic members 750 and the attachment members 760 more stably couples the latch hook 341 with the locking device 60. Alternatively, the position of the magnetic members 750 and the position of the attachment members 760 may be changed with each other. That is, the magnetic members 750 may be provided to the second door 340, and the attachment members 760 may be provided to the first door 310.

The attachment members 760 may be disposed outside the protrusion part 342a, and may be disposed at a corresponding position to the position of the magnetic members 750. That is, the gasket 344 may be disposed between the bottom of the protrusion part 342a and the attachment members 760. Thus, when the second door 340 is closed, magnetic force closely adheres the magnetic members 750 to the attachment members 760, so that the gasket 344 can be closely adhered to the first door 310.

The attachment members 760 may have a predetermined cross-section or a bent frame shape, and is disposed inside the second door 340 to prevent the deformation of the second door 340 and reinforce the second door 340.

FIG. 80 is a perspective view illustrating a refrigerator when a second door is opened, according to an embodiment. FIG. 81 is an exploded perspective view illustrating the second door.

Referring to FIGS. 80 to 81, as described according to the previous embodiments, the exterior of the refrigerator 1 may be formed by the cabinet 10 and the doors 20 and 30. The cabinet 10 forms a storage space, and the doors 20 and 30 open and close the storage space. The freezer compartment door 20 may be constituted by a single door, and the refrigerator compartment door 30 may be constituted by the first door 310 and the second door 340.

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The front surface of the refrigerator compartment door **30** and the front surface of the freezer compartment door **20** are provided with the grip part **313** to be held for opening and closing the refrigerator compartment door **30** and the freezer compartment door **20**. The grip part **313** has a pocket shape, and extends horizontally. The grip part **313** is disposed at a constant height on the refrigerator compartment door **30** and the freezer compartment door **20**, and extends in the same line from an outer end of the refrigerator compartment door **30** to an outer end of the freezer compartment door **20**.

The grip part **313** may be disposed at a portion that can be easily held by a user, and be disposed in the middle of the vertical height of the freezer compartment door **20** and the refrigerator compartment door **30**. A portion of the grip part **313** provided to the refrigerator compartment door **30** may be disposed in the boundary between the first door **310** and the second door **340** to be described later.

A door basket **342f** may be removably attached to the rear surface of the second door **340**. The door basket **342f** may be installed on the protrusion part **342a**, and a region provided with the door basket **342f** may be provided with a recess **342g**. Basket installation parts **342e** to which the door basket **342f** is removably attached may be disposed at the left and right sides of the protrusion part **342a**. Thus, both sides of the door basket **342f** and the basket installation parts **342e** may have shapes to engage with each other.

When the second door **340** is closed, the door basket **342f** may be inserted in the opening **316**. When the second door **340** is closed, the door basket **342f** does not interfere with structures in the storing device **40**. For example, when the second door **340** is closed, the rear surface of the door basket **342f** and the rear surface of the first door **310** corresponding to the region provided with the storing device **40** may be disposed in the same vertical surface. That is, the door basket **342f** may have a back and forth width not to go into the storing device **40**.

Then, when the second door **340** is closed, the rear surface of the door basket **342f** is disposed outside the storing device **40** to prevent the interference with food stored in the storing device **40** or baskets. Alternatively, when the second door **340** is closed, the door basket **342f** may be disposed between the baskets within the storing device **40**.

As described above, the latch hook **341** may be disposed on the rear surface of the second door **340** corresponding to the locking device **60** such that the latch hook **341** is coupled with the locking device **60** according to the rotation of the second door **340**.

In detail, the hook fixing part **341a** is fixed to a base plate **341c** that is a separate member. The base plate **341c** is coupled to a hook installation recess **342h** in the rear surface of the second door **340**. Accordingly, the latch hook **341** is fixed to the rear surface of the second door **340**.

The hook installation recess **342h** is recessed in the door case **342** that forms the rear surface of the second door **340**, so that the base plate **341c** is coplanar with the door case **342**. In detail, the base plate **341c** may have a shape corresponding to the hook installation recess **342h**. The front surface of the base plate **341c** may have holes with shapes corresponding to fixing protrusions of the hook fixing part **341a**. Screws passing through the holes are inserted from the rear side of the base plate **341c** into the fixing protrusions, so that the latch hook **341** can be fixed to the base plate **341c**.

Screws inserted from the front side of the base plate **341c** fix the base plate **341c**, coupled with the latch hook **341**, to the hook installation recess **342h**. That is, the latch hook **341** is coupled to the base plate **341c**, and then, the base plate **341c** is coupled to the hook installation recess **342h**.

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This coupling structure will now be described in more detail.

In detail, when a shock or load is applied to the latch hook **341**, the latch hook **341** or a portion of the second door **340** provided with the latch hook **341** may be broken. In the current embodiment, instead of directly coupling the latch hook **341** to the door case **342**, the latch hook **341** is indirectly fixed to the door case **342** through the base plate **341c**. Thus, when the latch hook **341** is broken, the possibility that the door case **342** is also broken is decreased. Only the latch hook **341** may be replaced by removing the latch hook **341** from the base plate **341c**, or both the latch hook **341** and the base plate **341c** may be replaced. Then, it is unnecessary to replace the door case **342**, and thus, the repairing costs can be reduced.

Hereinafter, a coupling structure of the first and second doors will now be described in detail with reference to the accompanying drawings.

FIG. **82** is an exploded perspective view illustrating the refrigerator compartment door with the second door and the lower hinge. FIG. **83** is a partial cut-away perspective view illustrating the refrigerator compartment door coupled with the second door.

Referring to FIGS. **82** and **83**, the upper end of the second door **340** is supported by the second hinge **51**, and the lower end of the second door **340** is rotatably installed on the first door **310** through a lower hinge assembly **57**. The lower hinge assembly **57** according to the current embodiment is different in configuration from the above-described lower hinge assembly **54**.

The lower hinge assembly **57** may include a hinge member **571** fixed to the second door **340**, a hinge stopper **572** coupled to the hinge member **571**, a damping member **574** installed on the first door **310** and coupled with a rotation shaft **571b** of the hinge member **571**, and a confinement member **573** installed on the first door **310** to limit a rotation angle of the second door **340**.

In detail, the hinge member **571** may be fixed to a hinge installation part **571a** provided to the lower end of the second door **340**. Then, the hinge member **571** is fixed to the second door **340**, and thus, can be rotated with the second door **340**. The rotation shaft **571b** as the rotation center of the second door **340** passes through the confinement member **573** and is shaft-coupled to the damping member **574**.

The hinge stopper **572** is coupled to the lower surface of the hinge member **571** through a coupling member. The hinge stopper **572** may be integrally formed with the hinge member **571**. The hinge stopper **572** may include a confinement protrusion **572a** that protrudes downward. The confinement protrusion **572a** passes through a portion of the confinement member **573**. The confinement protrusion **572a** rotates together with the second door **340**, and interferes with a portion of the confinement member **573** to limit the opening of the second door **340** at a predetermined angle.

The damping member **574** is fixed to the first door **310**. The damping member **574** is shaft-coupled to the hinge member **571**, and a structure may be disposed within the damping member **574** to decelerate the rotation of the hinge member **571**. The damping member **574** may be configured such that the second door **340** automatically rotate until a predetermined angle and is decelerated over the predetermined angle. The above-described structure within the damping member **574** is similar to that of the lower hinge assembly **54** according to the previous embodiments, and a detailed description thereof will be omitted.

The damping member **574** is installed on a grip part decor **575** provided to the first door **310**. The grip part decor **575**

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is installed on the front surface of the first door 310 provided to the grip part 313. That is, the grip part decor 575 is installed on a portion that defines the space between the lower end of the second door 340 and the upper end of the first part 311 of the first door 310. The grip part decor 575 may be additionally provided to the freezer compartment door 20.

The grip part decor 575 may include a thin recess part 575a that is disposed at the opposite side to the rotation shaft of the first door 310, and a thick support part 575b that is disposed at an adjacent side to the rotation shaft. Thus, the grip part 313 provided to the recess part 575a can be held by a user to open the first door 310. The damping member 574 and the confinement member 573 may be installed on the support part 575b.

The confinement member 573 is installed on the upper surface of the support part 575b. The confinement member 573 limits the rotation of the second door 340, and confines the damping member 574.

In detail, the confinement member 573 is fixed to the upper surface of the support part 575b through a screw, and shields the damping member 574 from the upper side when the confinement member 573 is installed on the first door 310. The confinement member 573 has a rotation shaft insertion hole 573a through which a rotation shaft 574a of the damping member 574 is exposed. In more detail, the rotation shaft 571b of the hinge member 571 passes through the rotation shaft insertion hole 573a, and the rotation shaft 574a of the damping member 574 passes through the rotation shaft insertion hole 573a and is inserted into the rotation shaft 571b.

Hereinafter, the opening and closing of the second door will now be described with reference to the accompanying drawings.

FIG. 84 is a front view illustrating the refrigerator when the second door is closed. FIG. 85 is a bottom view illustrating a portion of the second door with the lower hinge assembly when the second door is closed.

Referring to FIGS. 84 and 85, the confinement member 573 may have the rotation shaft insertion hole 573a and a confinement protrusion receiving part 573b that receives the confinement protrusion 572a.

In detail, the confinement protrusion receiving part 573b extends along a moving path of the confinement protrusion 572a when the confinement protrusion 572a moves according to the rotation of the second door 340. Thus, when the second door 340 rotates, the confinement protrusion 572a moves within the confinement protrusion receiving part 573b. In detail, while the second door 340 rotates, the confinement protrusion 572a revolves around the rotation shaft 571b.

When the second door 340 is completely closed and opened at a predetermined angle, the confinement protrusion receiving part 573b limits the movement of the confinement protrusion 572a to confine the second door 340.

In detail, the confinement protrusion receiving part 573b has a predetermined curvature, and an end thereof contacts the confinement protrusion 572a when the second door 340 is closed as illustrated in FIG. 85.

FIG. 86 is a front view illustrating the refrigerator when the second door is opened. FIG. 87 is a bottom view illustrating a portion of the second door with the lower hinge assembly when the second door is opened.

Referring to FIGS. 86 and 87, the other end of the confinement protrusion receiving part 573b contacts the confinement protrusion 572a when the second door 340 is opened at a predetermined angle (about 100° to 130°). Thus,

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when the second door 340 is opened at the predetermined angle, the confinement protrusion 572a interferes with the confinement protrusion receiving part 573b to stop the confinement protrusion 572a and limit the rotation of the second door 340.

As such, the rotation angle of the second door 340 is limited by the lower hinge assembly 57 to prevent the leakage of cool air due to an excessive opening of the second door 340. In addition, a collision of the second door 340 with furniture adjacent to the refrigerator 1 can be prevented.

Furthermore, structures that limit the rotation of the second door 340 are not exposed to the outside, thereby preventing, for example, an accident that a user's finger is caught to the structures.

The terms "first", "second", "A", "B", "(a)", and "(b)" can be selectively or exchangeably used for the members. These terms are used only to differentiate one member, component, region, layer, or portion from another one, and the intrinsic qualities, orders or sequences of the members are not limited by these terms. It will be understood that when an element is referred to as being "coupled to", "combined with", or "connected to" another element, it can be directly coupled to, combined with, or connected to the other element or intervening elements may also be present.

Although embodiments have been described with reference to a number of illustrative embodiments thereof, it should be understood that numerous other modifications and embodiments can be devised by those skilled in the art that will fall within the spirit and scope of the principles of this disclosure. More particularly, various variations and modifications are possible in the component parts and/or arrangements of the subject combination arrangement within the scope of the disclosure, the drawings and the appended claims. In addition to variations and modifications in the component parts and/or arrangements, alternative uses will also be apparent to those skilled in the art.

The invention claimed is:

[1. A refrigerator comprising: a cabinet; a first storage compartment within the cabinet; a first door having an upper surface, a lower surface, a first side surface, and a second side surface, the first door rotatably configured to open and close at least a portion of the first storage compartment; a storing device that is coupled to the first door and that defines a second storage compartment, the second storage compartment being disposed in the first storage compartment when the first door is oriented in a closed position and the second storage compartment being configured to move with the first door when the first door rotates between opened and closed positions; a second door having an upper surface, a lower surface, a first side surface, and a second side surface, the second door rotatably mounted to an upper portion of the first door, that is configured to open and close the second storage compartment in a same direction as a rotation direction of the first door, and that is configured to enable access to the second storage compartment when the first door is oriented in a closed position and the second door is oriented in an open position; a first hinge connecting the upper surface of the first door to an upper surface of the cabinet; a second hinge connecting the upper surface of the second door to the upper surface of the first door; a locking unit configured to lock the second door to the first door; and a release member configured to receive a user input, wherein the locking unit is configured to release the second door from the first door based on the release member receiving the user input, and wherein the locking unit also is configured to release the second door from the first door based on a pressing force applied to a front surface of the second door

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at a location spaced apart from the release member or based on a touch of the user input; wherein the second door, on the upper portion of the first door, is positioned above a lower portion of the first door in a position at which the front surface of the second door is generally coplanar with a front surface of the lower portion of the first door when the second door is oriented in a closed position; and wherein when the second door is oriented in the closed position, the first side surfaces of the first door and the second door are substantially coplanar, the second side surfaces of the first door and the second door are substantially coplanar, and the upper surfaces of the first door and second door are substantially coplanar.]

[2. The refrigerator according to claim 1, wherein the locking unit comprises:

- a latch hook provided to the second door;
- a latch cam provided to the first door and configured to catch a portion of the latch hook; and
- a stopper provided to the first door and configured to limit rotation of the latch cam.]

[3. The refrigerator according to claim 2, wherein the release member comprises:

- a first member provided to the second door; and
- a second member that is provided to the first door and that links with the first member.]

[4. The refrigerator according to claim 3, wherein the first member comprises:

- an operation button configured to be pressed by a user; and
- a push rod positioned behind the operation button, the push rod being configured to move together with the operation button, and
- the second member comprises a latch rod that is pressed by the push rod.]

[5. The refrigerator according to claim 4, further comprising an elastic member that is wound around an outer circumferential surface of the push rod to return the push rod to an original position of the push rod when pressure on the operation button is released.]

[6. The refrigerator according to claim 4, further comprising an elastic member that is wound around an outer circumferential surface of the latch rod to return the latch rod to an original position of the latch rod when pressure on the operation button is released.]

[7. The refrigerator according to claim 3, wherein the first member operates the second member and, based on the first member operating the second member, the second member pushes the stopper in a direction in which the stopper is removed from the latch cam.]

[8. The refrigerator according to claim 3, wherein the first member comprises an input member that is positioned on the front surface of the second door and that is configured to receive input of an operation command of the release member, and

- the second member comprises an actuator that is operated according to an electrical signal based on input received by the input member.]

[9. The refrigerator according to claim 2, further comprising an elastic member that is provided to a rotation shaft of the latch cam and configured to rotate the latch cam to an original position of the latch cam.]

[10. The refrigerator according to claim 2, further comprising an elastic member having a first end connected to the stopper and a second end connected to the first door, the elastic member being configured to return the stopper to an original position of the stopper.]

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11. A refrigerator comprising:

a cabinet having a front surface that defines an access opening;

a first storage region within the cabinet;

a first door having an upper facing surface, a lower facing surface, a first side surface, and a second side surface, the first door rotatably configured to open and close at least a portion of the first storage region, a portion of a rear side of the first door being configured to contact the front surface of the cabinet when the first door is oriented in a closed position;

a second storage region disposed in the first door and configured to move with the first door when the first door rotates between opened and closed positions, a portion of the second storage region being disposed in the first storage region when the first door is oriented in the closed position;

a second door having an upper facing surface, a lower facing surface, a first side surface, and a second side surface, the second door being (i) rotatably mounted to the first door, (ii) configured to open and close the second storage region in a same direction as a rotation direction of the first door, (iii) disposed at a front side of the first door when the first door and the second door are oriented in a closed position, and (iv) configured to enable access to the second storage region when the first door is oriented in the closed position and the second door is oriented in the open position;

a first hinge connecting the upper facing surface of the first door to an upper facing surface of the cabinet, the first hinge having a first hinge shaft that is inserted into the first door at a position closer to the first side surface of the first door than the second side surface of the first door; and

a second hinge connecting the upper facing surface of the second door to the upper facing surface of the first door, the second hinge having a second hinge shaft that is inserted into the second door at a position that is closer to the first side surface of the second door than the second side surface of the second door,

wherein a first thickness of the first side surface of the first door in a front to rear direction is greater than a second thickness of the first side surface of the second door in the front to rear direction,

wherein the first hinge shaft is located at a position closer to the front surface of the first door than a rear surface of the first door, and

wherein when the second door is oriented in the closed position, the first side surfaces of the first door and the second door are substantially coplanar and portions of the upper facing surfaces of the first door and second door on which the first hinge shaft and the second hinge shaft are respectively located are substantially coplanar.

12. The refrigerator according to claim 11, further comprising one or more baskets provided in the second storage region.

13. The refrigerator according to claim 11, further comprising one or more shelves provided in the second storage region.

14. The refrigerator according to claim 11, further comprising a frame that covers a rear surface of the first door.

15. The refrigerator according to claim 11, wherein a sealer is provided at a rear surface of the first door.

16. The refrigerator according to claim 11, wherein when the first and second doors are oriented in closed positions, a distance between the front surface of the first door and a

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rear surface of the second door is less than a distance between the front surface of the cabinet and a rear surface of the first door.

17. The refrigerator according to claim 11, wherein when the second door is oriented in the closed position, the first hinge shaft is located at a position closer to the rear surface of the second door than the rear surface of the first door.

18. The refrigerator according to claim 11, wherein the second hinge shaft is located closer to a rear edge of the first side surface of the second door than to a front edge of the first side surface of the second door.

19. The refrigerator according to claim 11, wherein a first diameter of the first hinge shaft is greater than a second diameter of the second hinge shaft.

20. The refrigerator according to claim 11, wherein the first hinge includes a first extension part that connects to the first hinge shaft, and the second hinge includes a second extension part that connects to the second hinge shaft.

21. The refrigerator according to claim 20, wherein the first extension part is positioned vertically higher than the second extension part.

22. The refrigerator according to claim 20, wherein the first extension part of the first hinge is exposed from a top side of the refrigerator.

23. The refrigerator according to claim 20, wherein the second extension part of the second hinge is exposed from a top side of the refrigerator.

24. The refrigerator according to claim 20, wherein a recess portion is provided on an upper portion of the second door, and the recess portion has the upper facing surface on which the second hinge shaft is located, and

a portion of the second extension part of the second hinge is placed in the recess portion.

25. The refrigerator according to claim 20, wherein the first hinge further includes a first coupling part fixed to the upper facing surface of the cabinet,

wherein the second hinge further includes a second coupling part fixed to the upper facing surface of the first door, and

wherein the first hinge shaft is disposed between the first side surface of the first door and the second coupling part in a direction from the first side surface of the first door to the second side surface of the first door.

26. The refrigerator according to claim 25, wherein the second extension part having a first portion extending from the second hinge shaft in a direction from the first side surface of the second door the second side surface of the second door and a second portion connecting the first portion to the second coupling part.

27. The refrigerator according to claim 25, wherein a first distance between a first hinge axis of the first hinge shaft and the first side surface of the first door is greater than a second

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distance between a second hinge axis of the second hinge shaft and the first side surface of the second door.

28. The refrigerator according to claim 11, wherein the first hinge is mounted to the first door at an upper mounting surface of the first door that is positioned vertically below an uppermost portion of the first door.

29. The refrigerator according to claim 11, wherein the second hinge is mounted to the second door at an upper mounting surface of the second door that is positioned vertically below an uppermost portion of the second door.

30. The refrigerator according to claim 11, wherein the first hinge is mounted to the first door at an upper mounting surface of the first door that is positioned vertically below an uppermost portion of the first door, and

wherein the second hinge is mounted to the second door at an upper mounting surface of the second door that is positioned vertically below an uppermost portion of the second door.

31. The refrigerator according to claim 30, wherein the first door includes a first downwardly stepped portion from the uppermost portion of the first door, and the second door includes a second downwardly stepped portion from the uppermost portion of the second door, and

wherein the first hinge is mounted to the first door at the first stepped portion, and the second hinge is mounted to the second door at the second stepped portion.

32. The refrigerator according to claim 11, wherein the front surface of the second door extends vertically higher than first and second hinges to thereby shield the first and second hinges from being exposed from a front side of the refrigerator.

33. The refrigerator according to claim 11, wherein the upper facing surfaces of the first door and second door are positioned vertically higher than the upper facing surface of the cabinet.

34. The refrigerator according to claim 11, wherein a first distance between a first hinge axis of the first hinge shaft and the first side surface of the first door is greater than a second distance between a second hinge axis of the second hinge shaft and the first side surface of the second door.

35. The refrigerator according to claim 11, wherein when the second door is oriented in the closed position, the first side surfaces of the first door and the second door are substantially coplanar.

36. The refrigerator according to claim 35, wherein the second side surfaces of the first door and the second door are substantially coplanar.

37. The refrigerator according to claim 35, wherein the upper facing surface of the first door is oriented parallel to the upper facing surface of the second door.

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