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(54) **HOT-WATER SUPPLY UNIT**

(57) Provided is a hot-water supply unit (100), comprising: a housing (200); a tank (300); thermal insulator (400) substantially surrounding the tank; a heating mechanism (700) disposed within a machine space (110) formed by the housing and positioned above the thermal insulator; an electric component unit (800) disposed within the machine space and having a component box (810, 820) accommodating an electric component. The housing and the thermal insulator form a clearance space

(120) extending at least from the lower end of the thermal insulator to the upper end of the thermal insulator. The housing defines a first housing opening (242), and is configured such that the clearance space communicates with the outside of the housing via the first housing opening. The component box is configured such that the inside of the component box communicates with the outside of the housing via the first housing opening.

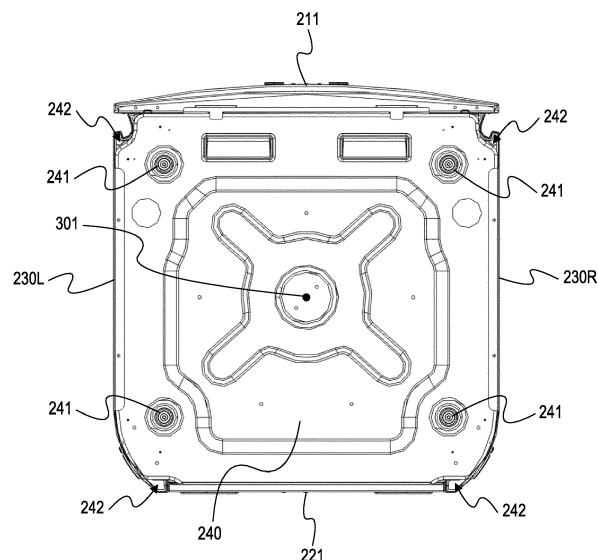


Fig. 6

Description

Field of the Invention

[0001] The present invention relates to a hot-water supply unit having an electric component unit configured to operate a heating mechanism for heating up water stored in a tank.

Background

[0002] Hot-water supply units are usually each provided with an electric component unit configured to operate a heating mechanism for heating up water stored in a tank. The temperature of the electric component unit tends to become high since high-heat-generating electric components are accommodated in a component box.

[0003] CN 104930702 A discloses a hot-water supply unit in which a heating mechanism and an electric component are arranged above a water tank and which has a configuration for ventilating the electric component unit. The hot-water supply unit has a housing accommodating the water tank, the heating mechanism and the electric component unit, and the side faces of the housing is formed with a plurality of gratings at a position close to the electric component unit. CN 104930702 A also discloses to provide a fan assembly so as to promote the ventilation through the gratings. Thereby, the electric component unit can be cooled by outer air.

[0004] However, providing the fan assembly causes an increase in the volume of the unit. Meanwhile, but for the fan assembly, the air flow through the gratings is not assured, and the electric component unit cannot necessarily be efficiently cooled.

Summary

[0005] The object of the present invention is to provide a hot-water supply unit that can efficiently cool the electric component unit without causing an increase in the volume of the hot-water supply unit.

[0006] A first aspect of the present invention provides a hot-water supply unit comprising: a hot-water supply unit, comprising: a housing, a tank disposed within the housing, and configured to store water; thermal insulator substantially surrounding the tank within the housing; a heating mechanism disposed within a machine space, and configured to heat up the water stored in the tank, the machine space being formed by the housing within the housing and being positioned above the thermal insulator; an electric component unit disposed within the machine space, and having at least one electric component configured to operate at least a part of the heating mechanism and a component box accommodating the electric component; and wherein: the housing and the thermal insulator form a clearance space extending at least from the lower end of the thermal insulator to the upper end of the thermal insulator; the housing defines

a first housing opening, and is configured such that the clearance space communicates with the outside of the housing via the first housing opening; and the component box is configured such that the inside of the component box communicates with the outside of the housing via the first housing opening.

[0007] With the above configuration, the clearance space between the housing and the thermal insulator serves as at least a part of a continuous air passage from outside of the housing to the electric component unit. Thus, the clearance space can be utilized as a vent shaft for ventilation of the electric component unit. In addition, the electric component unit is positioned above the tank and the thermal insulator within the housing, and thus the clearance space extends below the electric component unit. Thereby, the clearance space can exhibit a chimney effect to promote the ventilation. Forming such a clearance space has a further advantageous effect of reducing the volume of the thermal insulator. When the clearance space is already formed, the above configuration can be obtained with small-scale structural modifications such as forming apertures on the bottom part of the housing and the component box. Accordingly, a hot-water supply unit can efficiently cool its electric component unit without causing an increase in the volume and/or an area size of the hot-water supply unit and with a simple structure.

[0008] According to a preferred embodiment of the hot-water supply unit mentioned above, the housing defines a second housing opening, and configured such that the machine space communicates with outside of the housing via the second housing opening; and the component box is configured such that the inside of the component box communicates with the outside of the housing via the second housing opening.

[0009] With the above configuration, the above-mentioned air passage opens to the outside of the housing at least at two openings. The ventilation of the electric component is thereby enhanced. For obtaining such a configuration, mere small-scale structural modification, such as further providing an aperture on the top part of the housing, is required.

[0010] According to another preferred embodiment of the hot-water supply unit with the second housing opening mentioned above, the first housing opening is formed in a position lower than the position of the electric component unit; and the second housing opening is formed in a position higher than or equal to the position of the electric component unit.

[0011] With the above configuration, the above-mentioned air passage opens to the outside of the housing at the lower position and the higher or the same height position with respect to the electric component unit. Thereby, the chimney effect is further promoted. It should be noted that the term "the position of the electric component unit" may be applied to the position of any part of the electric component unit.

[0012] According to another preferred embodiment of

any one of the hot-water supply units with the second housing opening mentioned above, the second housing opening is formed at least in the top face of the housing.

[0013] With the above configuration, the number or the area of the second housing opening in the side faces of the housing can be reduced, even to zero. Thereby, the structure of the side faces of the housing can be made simple. In addition, the chimney effect is further promoted.

[0014] According to another preferred embodiment of any one of the hot-water supply units mentioned above, the first housing opening is formed at least in the bottom face of the housing.

[0015] With the above configuration, the number or the area of the first housing opening in the side faces of the housing can be reduced, even to zero. Thereby, the structure of the side faces of the housing can be made simple. In addition, the chimney effect is further promoted.

[0016] According to another preferred embodiment of any one of the hot-water supply units mentioned above, the housing includes a bottom plate provided with at least one leg extending downward; and the bottom plate defines the first housing opening with which the clearance space ends on the bottom plate.

[0017] With the above configuration, a clearance gap is formed between the bottom plate of the hot-water supply unit and the installation surface on which the hot-water supply unit is installed, and the first housing opening is formed in the bottom plate. In other words, the clearance space is open to the clearance gap. Thereby, it is possible to introduce an air into the clearance space with a simple structure.

[0018] According to another preferred embodiment of any one of the hot-water supply units mentioned above, the component box defines a first box opening via which the inside of the component box communicates with a box outside space, the box outside space being a part of the machine space and being outside of the component box.

[0019] With the above configuration, the box outside space can be utilized as a part of the above-mentioned continuous air passage. In addition, the box outside space can be ventilated as with the inside of the component box.

[0020] According to another preferred embodiment of any one of the hot-water supply units with the first box opening mentioned above, the clearance space communicates with the box outside space.

[0021] With the above configuration, the inside of the component box communicates with the first housing opening by utilizing the box outside space. Thus, a connection between the inside of the component box and the outside of the housing via the first housing opening can be achieved with a simple structure.

[0022] According to another preferred embodiment of any one of the hot-water supply units with the second housing opening mentioned above, the component box defines a first box opening via which the inside of the

component box communicates with a box outside space, the box outside space being a part of the machine space and being outside of the component box; and the second housing opening communicates with the box outside space.

[0023] With the above configuration, the inside of the component box communicates with the second housing opening by utilizing the box outside space. Thus, a connection between the inside of the component box and the outside of the housing via the second housing opening can be achieved with a simple structure.

[0024] According to another preferred embodiment of any one of the hot-water supply units mentioned above, the component box defines a second box opening via which inside of the component box communicates with the clearance space.

[0025] With the above configuration, a connection between the inside of the component box and the outside of the housing via the first housing opening can be achieved with a simple structure.

[0026] According to another preferred embodiment of any one of the hot-water supply units mentioned above, at least a part of the component box forms a part of the housing, and defines the second housing opening.

[0027] With the above configuration, the inside of the component box directly communicates with the outside of the housing via the second housing opening. Thus, the connection between the inside of the component box and the outside of the housing via the second housing opening can be achieved with a simple structure. Moreover, since the inside of the component box is close to the outside of the housing, the ventilation of the electric component is further enhanced.

[0028] According to another preferred embodiment of any one of the hot-water supply units mentioned above, the hot-water supply unit further comprises: a main frame disposed within the housing, and supporting the heating mechanism and the electric component unit; and a support plate disposed within the housing between the thermal insulator and the main frame to support the main frame with respect to the thermal insulator, wherein: the support plate defines a plate opening via which the clearance space communicates with the machine space.

[0029] With the above configuration, the hot-water supply unit can stabilize the heating mechanism and the electric component unit within the machine space with a simple structure. In addition, although the support plate forms the machine space together with the housing, the machine space can communicate with the clearance space via the plate opening. Thus, even in a case where the support plate is provided, the above-mentioned air passage can be achieved.

[0030] According to another preferred embodiment of any one of the hot-water supply units mentioned above, the electric component includes a transformer.

[0031] The transformer for an auxiliary heater or the like tends to generate a lot of heat. Thus, with the above configuration, it is possible to supply the ventilation air to

the part of greatest need for cooling.

[0032] According to another preferred embodiment of any one of the hot-water supply units mentioned above, the housing has a polygonal prism form; and the clearance space is formed along at least one of the inner corners of the housing.

[0033] With the above configuration, it is only necessary that the first housing opening is disposed at the corner part of the housing where the clearance space is formed. Thus, the arrangement of the first housing opening can be easily designed.

[0034] According to another preferred embodiment of any one of the hot-water supply units with the polygonal prism form mentioned above, the polygonal prism form is a right prism form.

[0035] While the right prism form allows components to be effectively and compactly arranged within the housing, such a dense arrangement of the components could raise a problem how to ventilate the component box. In this regard, the above configuration can utilize the clearance space between the insulator and the housing for ventilation of the electric component. Hence, with the above configuration, a compact and reliable hot-water supply unit can be achieved.

Brief Description of the Drawings

[0036]

Fig. 1 is a top front perspective view of a hot-water supply unit according to an embodiment of the present invention.

Fig. 2 is a bottom rear perspective view of the hot-water supply unit according to the present embodiment.

Fig. 3 is a right side view of the hot-water supply unit in a use state according to the present embodiment, with a right side plate removed.

Fig. 4 is a vertical cross sectional view of the hot-water supply unit according to the present embodiment.

Fig. 5 is a horizontal cross sectional view of the hot-water supply unit according to the present embodiment.

Fig. 6 is a bottom plan view of the hot-water supply unit according to the present embodiment.

Fig. 7 is a top perspective view of a support plate according to the present embodiment.

Fig. 8 is a bottom perspective view of the support plate according to the present embodiment.

Fig. 9 is a front perspective view of a main frame according to the present embodiment, along with the support plate, a rear upper plate and an electric component unit.

Fig. 10 is a perspective view of a front upper plate in a detached state, according to the present embodiment.

Fig. 11 is a perspective view of a second housing opening and a peripheral part thereof, according to the present embodiment.

Fig. 12 is a front perspective view of the upper part of the hot-water supply unit according to the present embodiment, with the front upper plate, a top front plate and the electric component unit removed.

Fig. 13 is a perspective view of the electric component unit according to the present embodiment.

Fig. 14 is a perspective view of the main frame according to the present embodiment.

Fig. 15 is a front perspective view of the upper part of the hot-water supply unit according to the present embodiment, with the front upper plate and the top front plate removed.

Fig. 16 is a front perspective view of the upper part of the hot-water supply unit according to the present embodiment, with an upper component box positioned outside of the housing.

Fig. 17 is a flowchart of a maintenance process of the hot-water supply unit according to the present embodiment.

Detailed Description of Preferred Embodiment

[0037] A preferred embodiment of a hot-water supply unit according to the present invention will be described with reference to the drawings.

Outline of Hot-Water Supply Unit

[0038] Fig. 1 is a top front perspective view of a hot-water supply unit according to the present embodiment. Fig. 2 is a bottom rear perspective view of the hot-water supply unit.

[0039] The hot-water supply unit 100 may constitute both a part of a heat pump system and a part of a hot-water supply system for domestic water (not shown). The hot-water supply system includes a hot-water destination, such as a floor heater and a faucet, and configured to supply the generated hot water to the hot-water destination. The hot-water supply unit 100 is configured to generate hot water to be used in the hot-water supply

system by transferring heat supplied from the heat pump system to water.

[0040] The hot-water supply unit 100 has a housing 200 which accommodates most of the rest part of the hot-water supply unit 100. The housing 200 has a substantially right prism form.

[0041] The housing 200 includes a front side plate 210, a rear side plate 220, a right side plate 230R, a left side plate 230L, a bottom plate 240 and a top plate 250. Each of the front side plate 210, the rear side plate 220, the right side plate 230R and the left side plate 230L (hereinafter referred to as "the four side plates") extends in a substantially vertical direction in a use state of the hot-water supply unit 100 (hereinafter referred to as "the use state"). Each of the bottom plate 240 and the top plate 250 extends in a substantially horizontal direction in the use state. Each of the four side plates, the bottom plate 240 and the top plate 250 (hereinafter referred to as "the housing plates") has a substantially flat shape. Each of the housing plates may be mainly made of a steel plate.

[0042] In this embodiment, the terms related to directions are interpreted as follows, unless otherwise specified. The terms indicating linear directions are the linear directions in the use state and seen from a direction facing the front side plate 210. The right direction when seen from a direction facing the front side plate 210 may be set as an X-axis direction. The depth direction when seen from a direction facing the front side plate 210 may be set as a Y-axis direction. The upward vertical direction when seen from a direction facing the front side plate 210 may be set as a Z-axis direction.

[0043] The front side plate 210 is arranged on the front side of the hot-water supply unit 100. The front side plate 210 may have a horizontal cross section curved outward (frontward) in the X-Y plane (in a horizontal plane). The front side plate 210 includes a front lower plate 211 and a front upper plate 212 which are continuously arranged flush with each other. The front upper plate 212 is arranged above the front lower plate 211. The front upper plate 212 includes a user interface 213. The user interface may include a display device, operation buttons or the like. The front upper plate 212 is preferably made from resin. Thereby, the appearance of the hot-water supply unit 100 can be enhanced.

[0044] The rear side plate 220 is arranged on the opposite side of the hot-water supply unit 100 with respect to the front side plate 210, i.e. on the back side of the hot-water supply unit 100. The rear side plate 220 may include a rear lower plate 221 and a rear upper plate 222 which are arranged flush with each other. The rear upper plate 222 is arranged above the rear lower plate 221.

[0045] The right side plate 230R is arranged on the right side of the hot-water supply unit 100. The right side plate 230R preferably connects the right ends of the front side plate 210 and the rear side plate 220. The left side plate 230L is arranged on the left side of the hot-water supply unit 100. The left side plate 230L preferably connects the left ends of the front side plate 210 and the rear

side plate 220.

[0046] The four side plates have substantially the same height. Thus, the upper ends of the four side plates forms an upper horizontal rectangular-like frame, and the lower ends of the four side plates forms a lower horizontal rectangular-like frame.

[0047] The bottom plate 240 is arranged at the bottom of the hot-water supply unit 100. The bottom plate 240 has a rectangular-like shape with four main edges. The bottom plate 240 may have an outer shape corresponding to the lower horizontal rectangular-like frame of the four side plates. The four main edges of the bottom plate 240 may be connected to the lower ends of the four side plates, respectively. The bottom plate 240 is provided with four legs 241 each extending downward.

[0048] The top plate 250 is arranged at the top of the hot-water supply unit 100. The top plate 250 has a rectangular-like shape with four main edges. The top plate 250 may have an outer shape corresponding to the upper horizontal rectangular-like frame of the four side plates. The three among the four main edges of the top plate 250 may be connected to the upper ends of the rear side plate 220, right side plate 230R and left side plate 230L, respectively. The top plate 250 includes a top rear plate 251, a top front plate 252, and a top main plate 253 which are arranged flush with each other. The top rear plate 251 is arranged on the rear side, the top front plate 252 is arranged on the front side, and the top main plate 253 is arranged between the top rear plate 251 and the top front plate 252. However, some or all of them may be integrated as a single plate.

[0049] As detailed later, at least the front upper plate 212 among the housing plates is configured to be easily removable from the rest part of the hot-water supply unit 100.

Internal Configuration of Hot-Water Supply Unit

[0050] Fig. 3 is a right side view of the hot-water supply unit in the use state, with the right side plate 230R removed and some parts omitted.

[0051] The hot-water supply unit 100 is installed on an installation surface S which is a substantially horizontal plane such that the bottom plate 240 faces the installation surface S. Since the legs 241 are in contact with the installation surface S, a clearance gap is formed between the bottom plate 240 and the installation surface S.

[0052] The hot-water supply unit 100 includes a tank 300 (not shown in Fig. 3, see Fig. 4), a thermal insulator 400, a support plate 500, a main frame 600, a heating mechanism 700 and an electric component unit 800.

[0053] The tank 300 and the thermal insulator 400 are positioned at the lower inside of the housing 200. In the hot-water supply unit 100, a machine space 110 is formed above the thermal insulator 400 and tank 300 by the housing 200. Thus, the machine space 110 is positioned at the upper inside of the housing 200. The main frame 600 is disposed within the machine space 110 to support

the heating mechanism 700 and the electric component unit 800 substantially within the main frame 600. In other words, the heating mechanism 700 and the electric component unit 800 are disposed in the machine space 110 above the thermal insulator 400. The support plate 500 is disposed at between the thermal insulator 400 and the main frame 600. The support plate 500 supports the main frame 600 with respect to the thermal insulator 400.

[0054] The tank 300 is configured to store water. The tank 300 may include a heating medium pipe configured to flow heating medium and perform a heat exchange between the heating medium and the stored water. The heating medium may be water or refrigerant.

[0055] The thermal insulator 400 is made of a material with high thermal insulating properties, and substantially surrounding the tank 300. The thermal insulator 400 has a substantially even thickness around the tank 300 such that the amount of foam filler is minimized while ensuring a desired thermal insulation performance. Consequently, as detailed later, four clearance spaces are formed between the housing 200 and the thermal insulator 400 along the four inner corners of the housing 200, respectively.

[0056] The support plate 500 lies on or over the top of the thermal insulator 400. The support plate 500 may be disposed on the thermal insulator 400. The support plate 500 supports the main frame 600 from below. The support plate 500 is hard enough to stabilize the position of the main frame 600 which supports the heating mechanism 700 and the electric component unit 800.

[0057] The heating mechanism 700 is configured to heat up the water stored in the tank 300. The heating mechanism 700 may be configured to heat up the heating medium mentioned above by transferring heat supplied from the heat pump system to the heating medium by a heat exchanger. The heating mechanism 700 may be configured to circulate the heating medium between the heating medium pipe of the tank 300 and the heat exchanger by a circulation pump. The heating mechanism 700 also may include an auxiliary heater for supplementarily heating up the water or the heating medium.

[0058] The electric component unit 800 is configured to electrically operate the heating mechanism 700. The electric component unit 800 has a plurality of electric components configured to operate at least a part of the heating mechanism 700, and two component boxes accommodating the electric components.

[0059] As shown in Fig. 3, the front upper plate 212 (a removable side plate) covers at least a part of the machine space 110. Thus, the machine space 110 becomes open to the outside (hereinafter simply referred to as "the outside") of the housing 200 when the front upper plate 212 is removed. The heating mechanism 700 is positioned rearward of the electric component unit 800 with respect to the front upper plate 212.

[0060] Fig. 4 is a vertical cross sectional view of the hot-water supply unit 100 when cut by a plane extending in parallel to the Y-Z plane and passing the centre of the

tank 300, with some parts (particularly the heating mechanism 700) omitted.

[0061] The tank 300 has a tubular shape with a principal axis 301 extending in the substantially vertical direction. Although the tank 300 may be partially connected to the bottom plate 240 at the bottom of the tank 300 and to the support plate 500 at the top of the tank 300, there are clearances between the tank 300 and both the bottom plate 240 and the support plate 500. Also, there is a clearance between the tank 300 and each of the four side plates.

[0062] The thermal insulator 400 surrounds substantially all over the outside surface of the tank 300 from the bottom to the top so as to fill most of the above clearances. The thermal insulator 400 may be adhered to the bottom plate 240, the tank 300 and the support plate 500. It is preferable that the material of the thermal insulator 400 is hard enough to stabilize the positions of the tank 400 and the support plate 500 with respect to the bottom plate 240 in the use state.

[0063] Such a configuration of the thermal insulator 400 can be achieved by a production process of, for instance, defining a space by the tank 300, the bottom plate 240, the support plate 500 and one or a plurality of dies arranged around the tank 300, foaming a foam filler such as urethane within the defined space, drying the foam filler, and then removing the dies.

[0064] With the above configuration, the bottom plate 240, the tank 400, the thermal insulator 400, the support plate 500, the main frame 600, the heating mechanism 700 and the electric component unit 800 form a solid column-like structure as a whole. Each part of the housing 200 other than the bottom plate 240 may be detachably attached to this solid column-like structure by hanging fixing or the like.

[0065] The component boxes of the electric component unit 800 occupy mere a part of the machine space 100. Thus, a space (hereinafter referred to as "the box outside space") 111 which is a part of the machine space 100 and is outside of any one of the component boxes is formed within the housing 200. The heating mechanism 700 is disposed in the box outside space 111.

[0066] The hot-water supply unit 100 has a plurality of connection elements 831 on the outer surface of the component boxes. Each of the connection elements 831 may be connected to one of the component boxes and the heating mechanism 700. The electric component unit 800 performs the operation of the heating mechanism 700 via the connection elements 831 and cables (not shown) connected to the connection elements 831. Each of the connection elements 831 connecting the upper component box 820 with the heating mechanism 700 is preferably detachable from at least one of the upper component box 820 and the heating mechanism 700.

[0067] The temperature of the electric component unit 800 tends to become high. In this regard, the hot-water supply unit 100 includes a structure for ventilation of the electric component unit 800. More specifically, the hot-

water supply unit 100 forms continuous air passages from outside of the housing 200 to the electric component unit 800 by utilizing the above-mentioned clearance spaces between the housing 200 and the thermal insulator 400.

[0068] In addition, it is desirable that at least a part of the electric component unit 800 can be easily removed out from the housing 200 in light of the maintainability of the heating mechanism 700 (see Fig. 3). In this regard, the hot-water supply unit 100 includes a unique structure for maintenance. More specifically, the electric component unit 800 is configured to be separated into two parts in the vertical direction, and the upper part is configured to be removed out.

Structure for Ventilation

[0069] Fig. 5 is a horizontal cross sectional view of the hot-water supply unit 100 when cut by a plane extending in parallel to the X-Y plane and passing the centre part of the tank 300, with some parts omitted, and when viewed from the lower side.

[0070] The cross section of the outer surface (hereinafter referred to as "the insulator outer surface") 401 of the thermal insulator 400 has a circle-like shape. On the other hand, the cross section of the inner surface (hereinafter referred to as "the housing inner surface") 261 of the four side plates (the housing 200) has a rectangular-like shape. Consequently, the four clearance spaces 121 are formed between the housing 200 and the thermal insulator 400 along the four inner corners of the four side plates (the housing 200), respectively.

[0071] The tank 300 has a tubular shape, and the thermal insulator 400 has substantially even thickness around the tank 300. Thus, each of the clearance spaces 121 extends at least from the lower end of the thermal insulator to the upper end of the thermal insulator. In other words, each of the clearance spaces 121 ends on the bottom plate 240 at the bottom of the clearance space 121, and ends on the support plate 500 at the top of the clearance space 121. The insulator outer surface 401 preferably has four planes respectively in contact with the four side plates, respectively. In this case, the clearance spaces 121 is formed between each pair of the adjacent planes.

[0072] As detailed later, the support plate 500 defines plate openings 501 at positions corresponding to the positions of the clearance spaces 121 in top plan view, i.e. at the four inner corners of the housing 200 (the four side plates). Thus, the upper parts of the clearance spaces 121 end at the plate openings 501, respectively.

[0073] With regard to the lower parts of the clearance spaces 121, the housing 200 defines first housing openings via which the clearance spaces 121 communicates with the outside, respectively. The first housing openings are formed in the bottom plate 240 (see Figs. 2 to 4).

[0074] Fig. 6 is a bottom plan view of the hot-water supply unit 100.

[0075] The bottom plate 240 has the rectangular-like outer shape along the above-mentioned lower horizontal rectangular-like frame of the four side plates. Meanwhile, the bottom plate 240 forms one or a plurality of first housing openings 242 at each of the four corners of the bottom plate 240, respectively. As mentioned above, each of the clearance spaces 121 (see Fig. 5) extends along the corner of the housing 200 to reach the bottom plate 240. Thus, the lower part of each clearance spaces 121 ends at the corresponding first housing opening 242.

[0076] Each the first housing opening 242 may be a notch recessed from the corresponding inner corner of the lower horizontal rectangular-like frame of the four side plates, or an aperture defined by the bottom plate 240.

[0077] The four legs 241 are preferably disposed near the four corners of the bottom plate 240, respectively, to form the above-mentioned clearance gap between the bottom plate 240 and the installation surface S (see Fig. 3). Thus, the clearance spaces 121 communicate with the outside via the first housing openings 242.

[0078] The thermal insulator 400 may be formed such that the bottom part of the thermal insulator 400 extends outward along the bottom plate 240 such that the tank 300 and the thermal insulator 400 are more stabilized on the bottom plate 240. In this case, the thermal insulator 400 needs to be formed not to close the first housing openings 242.

[0079] As mentioned above, the upper parts of the clearance spaces 121 end at the plate openings 501, respectively. The hot-water supply unit 100 is configured such that each clearance space 121 communicates with the box outside space 111 (see Fig. 4) through the plate openings 501 of the support plate 500.

[0080] Fig. 7 is a top perspective view of the support plate 500. Fig. 8 is a bottom perspective view of the support plate 500.

[0081] The support plate 500 preferably includes an upper plate part 510 and a lower plate part 520. The centre of the upper plate part 510 and the centre of the lower plate part 520 may be substantially aligned with the principal axis 301 (see Figs.4-6).

[0082] The upper plate part 510 has a substantially rectangular-like shape extending in a substantially horizontal plane. Each of the four main edges of the upper plate part 510 extends along the depth direction (i.e. the Y-axis direction) or the width direction (i.e. the X-axis direction). The lower plate part 520 has a substantially rectangular-like shape extending in a substantially horizontal plane and with the four main corners chamfered. Each of the four main edges of the lower plate part 520 also extends along the depth direction or the width direction.

[0083] The upper plate part 510 is smaller than the lower plate part 520 in both length and width (in sizes in the depth direction and the width direction). Thus, the lower plate part 520 extends outward with respect to the upper plate part 510 in a horizontal plane. Each one of the four main corners of the upper plate part 510 may protrude from the corresponding chamfered corner part

of the lower plate part 520 in a horizontal plane. Yet, each main corner of the upper plate part 510 is recessed with respect to any one of the extended lines of the four main edges of the lower plate part 520.

[0084] The upper plate part 510 may include a wall part 511 defining a drain receiving part 512 with a square-like shape therein. The upper plate part 510 may also include a drain discharge port 513 in the drain receiving part 512, for instance, at one of the four corners thereof. In this case, it is preferable that the surface of the drain receiving part 512 is slightly slanted downward towards the drain discharge port 513 with respect to a horizontal plane.

[0085] A plate convex part 514 which extends in parallel to the outer shape of the top part of tank 300 (see Fig. 4) may be formed in the middle of the drain receiving part 512. The upper plate part 510 is formed with plate apertures 515 corresponding to pipe ends (not shown) which protrudes from the tank 300 and are connected to the heating mechanism 700 (see Fig. 3).

[0086] The upper plate part 510 may further include a right frame receiving part 516R disposed on the right side of and outside of the drain receiving part 512, and a left frame receiving part 516L disposed on the left side of and outside of the drain receiving part 512. Each of the right frame receiving part 516R and the left frame receiving part 516L may include a plurality of ribs with the same height. Each rib may be connected to both the wall part 511 and the upper surface of the lower plate part 520. Each of the right frame receiving part 516R and the left frame receiving part 516L may also include screw holes.

[0087] The lower plate part 520 may include four extending parts 521 extending outward with respect to the upper plate part 510 in a horizontal plane, and a reinforcing member 522 extending downward and edging the outline of the lower plate part 520. The lower plate part 520 may have a substantially octagon shape.

[0088] The support plate 500 is configured such that the four main edges of the lower plate part 520 are in contact with the inner surfaces of the four side plates of the housing 200, respectively. Even in this case, each main corner of the upper plate part 510 is spaced from the housing inner surface 261 (see Fig. 5). Thus, the four plate openings 501 (see Fig. 5) are formed at the four inner corners of the four side plates. Each plate opening 501 is defined by the housing inner surface 261 (see Fig. 5) and one of the four main corner parts of the support plate 500.

[0089] The support plate 500 may be made of acrylonitrile-butadiene-styrene resin (ABS resin) or the like. It is preferable that a material having a good adherence property with the material of the thermal insulator 400 is used for the support plate 500.

[0090] As mentioned above, the support plate 500 supports the main frame 600. The main frame 600 is set onto and fixed to the right frame receiving part 516R and the left frame receiving part 516L, for instance.

[0091] Fig. 9 is a front perspective view of the main frame 600 along with the support plate 500, the rear upper

plate 222 and the electric component unit 800.

[0092] The main frame 600 has a right frame 610R and a left frame 610L. Each of the right frame 610R and the left frame 610L is preferably a rectangular-like frame made of one or a plurality of metal angle bars. The right frame 610R and the left frame 610L are fixed to the right frame receiving part 516R and the left frame receiving part 516L (see Fig. 7) by screw fixing or the like so as to stand on the support plate 500, respectively. In this state, the right frame 610R and the left frame 610L are arranged substantially in parallel to each other, and substantially plane-symmetrical to each other about a plane (hereinafter referred to as "the centre Y-Z plane") in parallel to the Y-Z plane and passing the centre of the hot-water supply unit 100. The right end and the left end of the rear upper plate 222 may be fixed to the rear ends of the right frame 610R and the left frame 610L by screw fixing or the like, respectively.

[0093] The main frame 600 is substantially the same as the upper plate part 510 of the support plate 500 in size in a horizontal plane. Thus, the main frame 600 is spaced from the four side plates of the housing 200. Moreover, the main frame 600 is positioned above the upper plate part 510 of the support plate 500. Thus, the main frame 600 is also spaced from the lower plate part 520 of the support plate 500. Hence, the machine space 110 communicates with the clearance spaces 121 via the plate openings 501 (see Fig. 5), respectively.

[0094] The electric component unit 800 has a lower component box 810 accommodating at least one of the above-mentioned electric components, and an upper component box 820 accommodating at least another of the electric components. Each of the lower component box 810 and the upper component box 820 has a substantially cuboid shape. For each of the lower component box 810 and the upper component box 820, the length in the depth direction may be less than the length in the width direction and the length in the height direction (i.e. the Z-axis direction). The electric component difficult to be provided with the detachable connection element 831 or is relatively heavy, such as a transformer for the above-mentioned auxiliary heater, is preferably accommodated in the lower component box 810.

[0095] The lower component box 810 is disposed at a lower front position of the inner space of the main frame 600. Here, the inner space of the main frame 600 means a space defined by the right frame 610R and the left frame 610L therebetween. The lower component box 810 is fixed to the main frame 600.

[0096] The upper component box 820 is disposed at an upper front position of the inner space of the main frame 600. The upper component box 820 is positioned right above the lower component box 810. The upper component box 820 is attached to the main frame 600 in a detachable manner as detailed later.

[0097] The lower component box 810 and the upper component box 820 are arranged such that the front side surfaces thereof are substantially flush with the front side

surface of the main frame 600. In addition, the upper component box 820 is arranged such that the top surface thereof is substantially flush with the top surface of the main frame 600.

[0098] Each of the lower component box 810 and the upper component box 820 defines one or a plurality of front box openings 832 (a first box opening) and one or a plurality of side box openings 833 (a first box opening or a second box opening).

[0099] The front box openings 832 are formed on the front side surfaces of the lower component box 810 and the upper component box 820. Each front box opening 832 may be a slit extending horizontally and provided with an eave extending outward and downward from the upper edge of the slit. It is preferable that the front box openings 832 are formed in the substantially entire range of the lower component box 810 and the upper component box 820 in the width direction. It is also preferable that the front box openings 832 are formed in the substantially entire range of the lower component box 810 and the upper component box 820 in the height direction.

[0100] The side box openings 833 are formed on the both lateral sides of the lower component box 810 and the upper component box 820. Each side box opening 833 may be a slit extending horizontally. It is preferable that the side box openings 833 are formed in the substantially entire range of the lower component box 810 and the upper component box 820 in the depth direction. It is also preferable that the side box openings 833 are formed in the substantially entire range of the lower component box 810 and the upper component box 820 in the height direction.

[0101] Both the front box openings 832 and the side box openings 833 are spaced from the housing inner surface 261 (see Fig. 5), and not covered by the main frame 600 and other elements in the box outside space 111. Thus, each of the insides of the lower component box 810 and the upper component box 820 communicates with the box outside space 111 via each of the front box openings 832 and the side box openings 833.

[0102] As mentioned above, the clearance spaces 121 communicate with the box outside space 111. Hence, the inside of each of the lower component box 810 and the upper component box 820 communicates with the outside via the side box openings 833, the box outside space 111, the plate openings 501, the clearance spaces 121 and the first housing openings 242 (see Figs. 5 and 6).

[0103] In addition to the first housing openings 242, the housing 200 defines a second housing opening via which the box outside space 111 communicates with the outside. The second housing opening is preferably formed in the top face of the housing 200. Here, the second housing opening is defined by the front upper plate 212 (see Figs. 1, 3 and 4).

[0104] Fig. 10 is a perspective view of the front upper plate 212 in a detached state.

[0105] The front upper plate 212 has a plate part 214,

a user interface box 215 and an attachment frame 216. The plate part 214 forms the front outer surface of the front upper plate 212. The user interface box 215 is disposed on the back side of the plate part 214 at a position corresponding to the user interface 213 (see Fig. 1). The user interface box 215 is configured to communicate with the electric component unit 800 by wireless communication or the like. The user interface box 215 is configured to accept a manual operation from a user and/or provide information to the user through the user interface 213.

[0106] The user interface box 215 may include an arithmetic circuit such as a CPU (Central Processing Unit), a work memory used by the CPU, such as a RAM (Random Access Memory), and a recording medium storing control programs and information used by the CPU, such as a ROM (Read Only Memory), although they are not shown. It is preferable that the user interface box 215 has a waterproof structure.

[0107] The attachment frame 216 is arranged on the back side of the plate part 214 along the four main edges of the plate part 214, and extending backward from the plate part 214.

[0108] The attachment frame 216 preferably forms two claw parts 217 in the top part of the attachment frame 216 at different positions in the width direction. The claw parts 217 are configured to engage with two snap locks detailed later which are arranged on the top plate 250 (see Fig. 1), respectively. The front upper plate 212 is attached to the frame 600 by engagement of the claw parts 217 and the snap locks.

[0109] The front upper plate 212 preferably provided with one or more of engaging projection in the bottom face thereof which are fitted into corresponding engaging holes provided in the top face of the front lower plate 211.

[0110] The attachment frame 216 is configured such that the most part of the edge of the attachment frame 216 is in contact with the front surface of the main frame 600 and the electric component unit 800 (see Fig. 9) when the attachment frame 216 is attached to the main frame 600. Meanwhile, the attachment frame 216 forms one or a plurality of second housing opening 218 in a part of the attachment frame 216. The second housing opening 218 may be a notch of the attachment frame 216 or an aperture defined by the attachment frame 216. The second housing opening 218 is preferably arranged in the top part of the attachment frame 216.

[0111] Fig. 11 is a perspective view of the second housing opening 218 and the peripheral part thereof in the use state.

[0112] The top front plate 252 is preferably provided with two snap locks 821 on the front edge thereof at different positions in the width direction. The snap locks 821 are disposed at the positions corresponding to the positions of the claw parts 217 of the front upper plate 212. The front upper plate 212 is attached to the rest part of the hot-water supply unit 100 by snapping the snap locks 821 while hooking the claw parts 217 on the snap locks 821, respectively.

[0113] Although the front side plate 210 defines the box outside space 111 (see Fig. 4), the box outside space 111 opens to the outside via the second housing opening 218.

[0114] As mentioned above, each of the insides of the lower component box 810 and the upper component box 820 communicates with the box outside space 111 via the front box openings 832. Hence, the inside of each of the lower component box 810 and the upper component box 820 communicates with the outside via the front box openings 832, the box outside space 111 and the second housing opening 218.

[0115] With the above-mentioned configuration, a continuous air passage running from the first housing opening 242 through the electric component unit 800 to the second housing opening 218 is formed. Thereby, a natural ventilation of the electric component unit 800 is performed to cool the electric component unit 800.

[0116] Moreover, each first housing opening 242 is located lower than the position of the electric component unit 800, and the second housing opening 218 is in a position higher than the position of the electric component unit 800. Thereby, the chimney effect of the air passage can be promoted to efficiently ventilate the electric component unit 800.

[0117] Furthermore, the clearance spaces 121 between the housing 200 and the thermal insulator 400 and the machine space 110 are utilized to form the air passage. Thereby, the efficient ventilation of the electric component unit 800 can be achieved without causing an increase in the volume of the hot-water supply unit 100.

Structure for Maintenance

[0118] Fig. 12 is a front perspective view of the upper part of the hot-water supply unit 100 with the front upper plate 212, the top front plate 252 and the electric component unit 800 removed.

[0119] The hot-water supply unit 100 forms an inspection opening 262 in the housing 200. The inspection opening 262 is defined, for instance, by the top edge of the front lower plate 211, the front edge of the top plate 250, and the front edges of the main frame 600 which are facing to each other. The inspection opening 262 leads to the machine space 110. The front upper plate 212 is configured to cover at least a part of the inspection opening 262. The front upper plate 212 is preferably configured to cover all the front side of the inspection opening 262.

[0120] Incidentally, the whole or a part of the top plate 250 (see Fig. 1) may be detachably attached to the main frame 600. For instance, the top front plate 252 is detachably attached to the main frame 600 and the top main plate 253 (see Fig. 11), and removed along with the front upper plate 212 when the maintenance process is performed. In this case, the top opening of the frame which has been covered by the top front plate 252 can be deemed as a part of the inspection opening 262.

[0121] The upper component box 820 (see Fig. 9) is configured such that the upper component box 820 can be pulled out from the machine space 110 through the inspection opening 262. In other words, the upper component box is configured to be switched between a normal state (a first state) of being positioned on the lower component box 810 (see Fig. 9) within the housing 200 and a maintenance state (a second state) of being positioned outside of the housing 200.

[0122] Fig. 13 is a perspective view of the electric component unit 800.

[0123] As mentioned above, the lower component box 810 is fixed to the main frame 600. The top face of the lower component box 810 and the bottom face of the upper component box 820 are configured to fit to each other. The upper component box 820 preferably has a box fitting member 822 configured to position the upper component box 820 on the lower component box 810. The box fitting member 822 may be an angled bar which is disposed at the front bottom edge of the upper component box 820 such that the inner corner of the box fitting member 822 fits with the front top edge of the lower component box 810.

[0124] The upper component box 820 has a right upper hook member 823R and a left upper hook member 823L. The right upper hook member 823R is disposed at the upper end of the back right edge of the upper component box 820. The left upper hook member 823L is disposed at the upper end of the back left edge of the upper component box 820. Thus, the right upper hook member 823R and the left upper hook member 823L are disposed at positions which are close to the upper part of the right frame 610R and the upper part of the left frame 610L of the main frame 600, respectively (see Fig. 9).

[0125] Each of the right upper hook member 823R and the left upper hook member 823L preferably includes a plate member extending backward and a projection member protruding from the plate member outward in the width direction. The projection member preferably has an enlarged part on the distal part thereof. It is preferable that the distance between the surface of the plate member of the right upper hook member 823R which faces the right frame 610R and the surface of the plate member of the left upper hook member 823L which faces the left frame 610L is slightly smaller than or equal to the distance between the right frame 610R and the left frame 610L.

[0126] The upper component box 820 further has a right lower hook member 824R and a left lower hook member 824L. The right lower hook member 824R is disposed at the lower end of the front right edge of the upper component box 820. The left lower hook member 824L is disposed at the lower end of the front left edge of the upper component box 820. Thus, the right lower hook member 824R and the left lower hook member 824L are disposed at positions which are close to the front part of the right frame 610R and the front part of the left frame 610L of the main frame 600, respectively (see Fig. 9).

[0127] Each of the right lower hook member 824R and the left lower hook member 824L preferably includes a plate member slightly extending frontward and a projection member protruding from the plate member outward in the width direction. The projection member preferably has an enlarged part on the distal part thereof.

[0128] It is preferable that the distance between the surface of the plate member of the right lower hook member 824R which faces the right frame 610R and the surface of the plate member of the left lower hook member 824L which faces the left frame 610L is substantially the same as the above-mentioned distance between the plate members of the right upper hook member 823R and the left upper hook member 823L. It is also preferable that the projection members of the right upper hook member 823R and the right lower hook member 824R have substantially the same size and shape, and the projection members of the left upper hook member 823L and the left lower hook member 824L have substantially the same size and shape.

[0129] Fig. 14 is a perspective view of the main frame 600.

[0130] The right frame 610R defines a right upper groove 611 R, and the left frame 610L defines a left upper groove 611 L.

[0131] The right upper groove 611 R is a groove formed on the inner face of the right frame 610R at a position corresponding to the position of the right upper hook member 823R in the use state. More specifically, the right upper groove 611 R extends from the middle of the upper part of the right frame 610R to the top face of the right frame 610R. The upper end of the right upper groove 611 R is open to the outside at least when the front upper plate 212 is removed. This may be achieved by the removal of the top front plate 252 or the clearance between the top plate 250 and the upper part of the right frame 610R (see Figs. 11 and 12). The width of the right upper groove 611 R in the Y-Z plane is slightly greater than or equal to the width of the projection member of the right upper hook member 823R in the Y-Z plane.

[0132] The position of the lower end of the right upper groove 611 R corresponds to the position of the projection member of the right upper hook member 823R in the use state. The right upper groove 611 R is slanted frontward with respect to the position of the lower end of the right upper groove 611 R. Thus, the right upper groove 611 R is configured so as to receive the right upper hook member 823R and stabilize the position of the right upper hook member 823R.

[0133] In the case the projection member of the right upper hook member 823R has the enlarged part on the distal part thereof, the part of the right upper groove 611 R which is at the inner face of the right frame 610R is preferably narrower than the other part of the right upper groove 611 R. Thereby, the movement of the right upper hook member 823R in the width direction is effectively restricted.

[0134] The left upper groove 611 L and the left upper

hook member 823L (see Fig. 13) are substantially plane-symmetrical to the right upper groove 611 R and the right upper hook member 823R, respectively, about the centre Y-Z plane. Thus, the left upper groove 611 L is also configured so as to receive the left upper hook member 823L and stabilize the position thereof.

[0135] Moreover, the distance between the ends of the projection members of the right upper hook member 823R and the left upper hook member 823L is slightly smaller than or equal to the distance between the bottom surfaces of the right upper groove 611 R and the left upper groove 611 L in the width direction.

[0136] Thus, the right upper hook member 823R and the left upper hook member 823L can be fitted into and removed from the right upper groove 611 R and the left upper groove 611 L via the upper ends thereof, respectively.

[0137] In addition to the right upper groove 611 R and the left upper groove 611 L, the right frame 610R and the left frame 610L define a right lower groove 612R and a left lower groove 612L, respectively. The right lower groove 612R and the left lower groove 612L (see Fig. 14) are formed at positions which are lower than the right upper groove 611 R and the left upper groove 611 L.

[0138] The right lower groove 612R is a groove formed on the inner face of the right frame 610R at a position corresponding to the position of the right lower hook member 824R (see Fig. 13) in the use state. More specifically, the right lower groove 612R extends from the middle of the front part of the right frame 610R to the front face of the right frame 610R. The front end of the right lower groove 612R is open to the outside at least when the front lower plate 212 is removed.

[0139] The width in the Y-Z plane, the length in the Y-Z plane, the slant angle in the Y-Z plane, and the depth in the width direction (in the X-axis direction) of the right lower groove 612R are substantially the same as those of the right upper groove 611R, respectively. In other words, the right lower groove 612R and the right upper groove 611 R have substantially the same shape and extend substantially in parallel.

[0140] The position of the lower end of the right lower groove 612R corresponds to the position of the projection member of the right lower hook member 824R in the use state. Thus, the right lower groove 612R is configured so as to receive the right lower hook member 824R and stabilize the position of the right lower hook member 824R.

[0141] The left lower groove 612L and the left lower hook member 824L (see Fig. 13) are substantially plane-symmetrical to the right lower groove 612R and the right lower hook member 824R, respectively, about the centre Y-Z plane. Thus, the left lower groove 612L is also configured so as to receive the left lower hook member 824L and stabilize the position thereof.

[0142] Moreover, the distance between the ends of the projection members of the right lower hook member 824R and the left lower hook member 824L is slightly smaller

than or equal to the distance between the bottom surfaces of the right lower groove 612R and the left lower groove 612L in the width direction.

[0143] Thus, the right lower hook member 824R and the left lower hook member 824L can be fitted into and removed from the right lower groove 612R and the left lower groove 612L via the front ends thereof, respectively.

[0144] Furthermore, the right upper groove 611 R, the left upper groove 611 L, the right lower groove 612R and the left lower groove 612L extend substantially in parallel. Thus, the upper component box 820 can be detached from and attached to the main frame 600 while kept in the same attitude as being in the normal state.

[0145] As mentioned above, the top face of the lower component box 810 and the bottom face of the upper component box 820 are configured to fit to each other. Thus, the position (hereinafter referred to as "the normal position") of the upper component box 820 in the normal state is stabilized by the engagement of the right upper hook member 823R and the right upper groove 611 R, the engagement of the left upper hook member 823L and the left upper groove 611 L, the engagement of the right lower hook member 824R and the right lower groove 612R, the engagement of the left lower hook member 824L and the left lower groove 612L, and the contact of the upper component box 820 with the lower component box 810. This positioning may be enhanced by the above-mentioned box fitting member 822 (see Fig. 13).

[0146] Fig. 15 is a front perspective view of the upper part of the hot-water supply unit 100 with the front upper plate 212 and the top front plate 252 removed.

[0147] When the front upper plate 212 is removed, the upper component box 820 in the normal state is exposed to the outside. The height of the electric component unit 800 may be greater than the height of the inspection opening 262 or the front upper plate 212. Meanwhile, the position of the lower end of the upper component box 820 in the normal state is higher than or equal to the position of the lower end of the inspection opening 262, i.e. the upper end of the front lower plate 211. In other words, the upper component box 820 is smaller than or equal to the size of the inspection opening 262.

[0148] As mentioned above, the right upper hook member 823R, the left upper hook member 823L, the right lower hook member 824R and the left lower hook member 824L can be fitted into and removed from the right upper groove 611 R, the left upper groove 611 L, the right lower groove 612R and the left lower groove 612L, respectively (see Figs. 13 and 14). The connection of the upper component box 820 with the heating mechanism 700 is detachable by the above-mentioned connection elements 831 (see Fig. 4).

[0149] Hence, the upper component box 820 can be easily pulled out from the machine space 110 through the inspection opening 262, just by removing the front upper plate 212 and pulling the upper component box 820 frontward while lifting it up. If the top front plate 252

(see Figs. 1 and 11) is further removed, the upper component box 820 can be pulled out more easily.

[0150] Particularly in the case where a heavy electric system is disposed in the lower component box 810, a light electric system is disposed in the upper component box 820, and the front lower plate 211 is made from steel, it is preferable that the height of the electric component unit 800 is greater than the height of the front upper plate 212. With such a configuration, at least a part of the electric component unit 800 is covered not by the front upper plate 212 (see Fig. 3) but by the front lower plate 211. In other words, the area of the front upper plate 212 which is close to the lower component box 810 can be made small to reduce the effects of the heat from the lower component box 810 on the front upper plate 212. Thereby, the flexibility in design of the front upper plate 212 from the perspective of security can be improved. For instance, a low heat resistant material can be used for the front upper plate 212.

[0151] The hot-water supply unit 100 is also configured to hold the pulled-out upper component box 820 at a position close to the inspection opening 262.

[0152] As mentioned above, the right lower groove 612R and left lower groove 612L have substantially the same shape as the right upper groove 611 R and left upper groove 611 L. Thus, the right lower groove 612R and left lower groove 612L are also configured so as to receive the right upper hook member 823R and the left upper hook member 823L, and stabilize the positions of the right upper hook member 823R and the left upper hook member 823L, respectively. Hence, the right upper hook member 823R and the left upper hook member 823L can be fitted into and removed from the right lower groove 612R and the left lower groove 612L via the front ends thereof, respectively.

[0153] The right lower groove 612R and the left lower groove 612L are formed slightly higher than the top face of the lower component box 810. The positions of the lower ends of the right lower groove 612R and the left lower groove 612L correspond to the positions of the projection members of the right upper hook member 823R and the left upper hook member 823L in a state where the upper component box 820 is disposed at a predetermined position outside of the housing 200. The predetermined position is a position lower than the normal position. The predetermined position is preferably the position in which the top surface of the upper component box 820 is close to the top surface of the lower component box 810.

[0154] Thus, the position (hereinafter referred to as "the maintenance position") of the upper component box 820 in the maintenance state is achieved by the engagement of the right upper hook member 823R and the right lower groove 612R, the engagement of the left upper hook member 823L and the left lower groove 612L.

[0155] Fig. 16 is a front perspective view of the upper part of the hot-water supply unit 100 with the upper component box 820 positioned outside of the housing.

[0156] The upper component box 820 is hanged from the right lower groove 612R and the left lower groove 612L, i.e. the front lower part of the main frame 600. In this state, the upper component box 820 is exerted with a rotation force by gravity about an axis line connecting the right lower groove 612R and the left lower groove 612L. Yet, at least the front lower plate 211 restrain the rotation of the upper component box 820 at the front surface the front lower plate 211.

[0157] The right lower groove 612R and the left lower groove 612L are preferably configured such that the distance in the depth direction between the centre of the outer surface of the front lower plate 211 and each of the lower ends of the right lower groove 612R and the left lower groove 612L is substantially equal to the distance in the depth direction between the back surface of the upper component box 820 and each of the projection members of the right upper hook member 823R and the left upper hook member 823L (see Fig. 13) in the normal state.

[0158] Thereby, the back surface of the upper component box 820 contacts with the outer surface of the front lower plate 211 in a state where the back surface of the upper component box 820 is substantially parallel to the outer surface of the front lower plate 211. Hence, the upper component box 820 can be movably supported outside of the housing 200 such that the upper component box 820 in the normal state and the upper component box 820 in the maintenance state are substantially parallel.

[0159] It can be said that the right upper hook member 823R, the left upper hook member 823L, the right lower groove 612R, the left lower groove 612L, and the front lower plate 211 are stabilizing members configured to stabilize the upper component box 200 at the maintenance state with respect to the housing 200.

[0160] With the above configuration, the upper component box 820 can be switched between the normal state and the maintenance state through the inspection opening 262.

[0161] Moreover, the upper component box 820 can be hold at a position close to the inspection opening 262 and in the same attitude as being in the normal state.

[0162] Incidentally, it is also preferable that the heating mechanism 700 itself has a configuration with which elements of the heating mechanism 700 are easy to observe and maintain from the inspection opening 262 side.

[0163] The heating mechanism 700 may be configured such that the overlaps between the elements are minimized when viewed from the inspection opening 262 side (the front and/or the above of the housing 200). In particular, it is preferable that the elements with high maintenance frequency are not overlapped by the other element. In the case where such an overlap is inevitable, it is preferable that an element smaller than the other element is positioned on the front side and/or the upper side of the other element. The elements with high maintenance frequency may include a filter configured to re-

move impure substances in the heating medium pipe, a flow sensor configured to detect the state of the heating medium, the pump configured to circulate the heating medium, and a three-way valve configured to change the flow path of the heating medium, and so forth.

[0164] Fig. 17 is a flowchart of a maintenance process of the hot-water supply unit 100. The maintenance process is performed by a maintenance person, for instance.

[0165] Firstly, the front upper plate 212 is removed from the rest part of the hot-water supply unit 100 (S1000). As a result, the upper component box 820 becomes exposed to the outside through the inspection opening 262 (see Fig. 15). The front upper plate 212 may be removed by loosening the snap locks 821 from the claw parts 217 (see Fig. 11), slightly lifting the front upper plate 212 while drawing out the engaging projection of the front upper plate 212 from the engaging holes of the front lower plate 211, pulling the front upper plate 212 frontward, and putting down the front upper plate 212 onto the floor near the hot-water supply unit 100.

[0166] The upper component box 820 is drawn out of the housing 200 through the inspection opening 262 (S2000), and then the right upper hook member 823R and the left upper hook member 823L are attached to the right lower groove 612R and the left lower groove 612L, respectively (S3000). The connection elements 831 may be disconnected from the upper component box 820 or the heating mechanism 700.

[0167] Thus, the state of the upper component box 820 is switched from the normal state where the upper component box 820 is positioned on the lower component box 810 within the housing 200 to the maintenance state where the upper component box 820 is positioned outside of the housing 200, and the heating mechanism 700 becomes accessible through the inspection opening 262.

[0168] Yet, in a case where each of the connection elements 831 is made of a flexible material and has a length long enough to maintain the connection with both the upper component box 820 and the heating mechanism 700 when upper component box is in the maintenance state, the connection elements 831 do not necessarily need to be disconnected. In such a case, the state of the upper component box 820 may be switched from the normal state to the maintenance state while maintaining the connection of each of the connection elements 831 with both the upper component box 820 and the heating mechanism 700.

[0169] After the maintenance work of the heating mechanism 700 is performed (S4000), the right upper hook member 823R and the left upper hook member 823L are detached from the right lower groove 612R and the left lower groove 612L, respectively (S5000), and then the upper component box 820 is fitted into the housing 200 through the inspection opening 262 (S6000). The right upper hook member 823R and the left upper hook member 823L may be attached to the right upper groove 611 R and the left upper groove 611 L, respectively. The right lower hook member 824R and the left lower hook

member 824L may also be attached to the right lower groove 612R and the left lower groove 612L, respectively. The connection elements 831 may be reconnected to the upper component box 820 and/or the heating mechanism 700. As a result, the upper component box 820 is switched from the maintenance state to the normal state.

[0170] Lastly, the front upper plate 212 is reattached to the rest part of the hot-water supply unit 100 (S7000). Thus, the hot-water supply unit 100 becomes to be in the use state.

[0171] Hence, the maintenance person can easily remove out the upper component box 820 from the housing 200 and put the upper component box 820 in a position which is close to the original position but does not overlap at least a part of the inspection opening 262. Thereby, the maintainability of the heating mechanism 700 is improved even in a case the electric component unit 800 is vertically long to be greater than the inspection opening 262 in height. The installation area of the hot-water supply unit 200 can be reduced by the vertically long shape of the electric component unit 800. Hence, it is possible to strike a balance of minimizing the installation area of the hot-water supply unit 100 and improving the maintainability of the heating mechanism 700.

Advantageous Effect

[0172] As described above, the hot-water supply unit 100 according to the present embodiment is configured such that the inside of the component box 800 communicates with the outside via the clearance space 121 formed by the housing 200 and the thermal insulator 400 and the first housing opening 242 defined by the housing 200. With this configuration, it is possible to efficiently cool the electric component unit without causing an increase in the volume of the hot-water supply unit.

[0173] Moreover, the hot-water supply unit 100 according to the present embodiment is configured such that the upper component box 820 can be switched between a first state of being positioned on the lower component box 810 within the housing 200 and a second state of being positioned outside of the housing 200. With this configuration, it is possible to strike a balance of minimizing the installation area of the hot-water supply unit 100 and improving the maintainability of the heating mechanism 700.

Variations

[0174] The configuration of the hot-water supply unit according to the present embodiment explained above may be modified. Some examples of such modifications are mentioned below. The each of modification examples may be combined with one or more of the other modification examples.

[0175] Number, shape and position of each of the first housing opening and the second housing opening are not limited to the above-mentioned number, shape and

position. For instance, any one of the first housing opening and the second housing opening may be formed in one of the four side plates, and the second housing opening may be formed in the top plate. In a case where the top plate is not provided, the upper ends of the four side plates may define the second housing opening. The first housing opening may be formed in the lower corner part or the side edge part of the side plate.

[0176] The second housing opening does not necessarily need to be formed, particularly in a case where the average or minimum sectional area of the air passage from the first housing opening to the inside of the electric component unit is relatively large with respect to the length of the air passage.

[0177] Number, shape and position of the clearance space communicating with the inside of the component box are not limited to the above-mentioned number, shape and position. The outer shape of the clearance space may be a substantially straight-cylindrical shape, a spiral-cylindrical shape or the like. Alternatively, the clearance space may be formed around substantially the entire circumference of the thermal insulator.

[0178] Number, shape and position of the first box opening via which the inside of the component box communicates with a box outside space and the second box opening via which inside of the component box communicates with the clearance space are not limited to the above-mentioned number, shape and position. The first box opening and the second box opening may be the same opening or different openings. Any one of the first box opening and the second box opening may be formed in the top face or the bottom face of the component box. Any one of the first box opening and the second box may be punch hole formed in the component box.

[0179] Particularly in a case where the clearance space reaches the component box, the second box opening may be directly open to the clearance space. In addition, in a case where at least a part of the component box forms a part of the housing, the part of the component box may define the second housing opening. In any one of these cases, the first box opening is not necessarily required.

[0180] The hot-water supply unit may be provided with a fan assembly in at least one of the air passage from the first housing opening to the inside of the electric component unit and the air passage from the inside of the electric component unit to the second housing opening. Thereby, the ventilation of the electric component unit.

[0181] Position and configuration of each of the heating mechanism and the electric component unit are not limited to the above-mentioned and configuration. The electric component unit may be arranged along the side plate other than the front side plate, for instance. An inspection opening formed in the housing and leading to the machine space and a removable side plate which covers the inspection opening may be arranged on the side where the electric component unit is arranged. At least the upper component box may have an opening in a side

surface facing to the removable side plate when the upper component box is in the first state. The lower component box and the upper component box may be configured as a single component box.

[0182] Number, shape and position of each of the parts of the hot-water supply unit 100, including the leg, the claw part, the snap lock, the engaging projection, engaging hole, the upper groove, the lower groove, the upper hook member, the lower hook member and the box fitting member, are not limited to the above-mentioned number, shape and position. More specifically, each of the leg, the claw part, the snap lock, the engaging projection, engaging hole, the upper groove, the lower groove, the upper hook member, the lower hook member and the box fitting member is not necessarily required.

[0183] The specific configuration of the stabilizing member is not limited to the above-mentioned configuration.

[0184] For instance, a hole may be formed in the top face of the lower component box 810, and a hook member extending backward and configured to engage with the hole when the upper component box 820 is in the maintenance state may be disposed at the rear top edge of the upper component box 820. Thereby, the upper component box 820 can be hanged from the hole of the lower component box 810 just by inserting the end of the hook member into the hole. The hole may be formed in the other part of the lower component box 810, such as the front face thereof. The hook member also may be disposed at the other part of the hook member, such as the back face thereof. A plurality of set of the hole and the hook member may be provided.

[0185] The hook member may be configured such that the length in the depth direction and/or the angle in the Y-Z plane are adjustable. More specifically, the hook member may be converted to a form for engaging with the above-mentioned engaging holes provided in the top face of the front lower plate 211. In this case, the engaging holes of the front lower plate 211 may also be used for hanging and stabilizing the upper component box 820 at the maintenance position.

[0186] The specific configuration of the support plate is not limited to the above configuration. For instance, the support plate may be formed thicker and made of the same material as the thermal insulator. The support plate may be configured to be in contact with the housing only at two opposite plate side surfaces, or not be in contact with the housing. The support plate may have a flat shape instead of the convex and/or concave shape.

[0187] The hot-water supply unit does not necessarily need to be provided with the support plate. The main frame may be arranged so as to extend from the bottom part of the housing to the top part of the housing.

[0188] The specific configuration of the heating mechanism is not limited to the above configuration. For instance, the heating mechanism may include a compressor, a pump or the like of the heat pump system.

[0189] The specific configuration of each of the tank

and the thermal insulator is not limited to the above configuration. For instance, the tank may have a column shape, a cuboid shape and so forth.

[0190] The specific configuration of the housing is not limited to the above configuration. For instance, the front lower plate and the upper plate may be integrated as a single plate. The rear lower plate and the rear upper plate may be integrated as a single plate. A part of the housing, e.g. the top plate, may be omitted. Two or more of the four side plates may be integrated as a single unit. Although it is preferable that the housing has a polygonal prism form, the housing also may have a cylindrical shape, a shape with three flat side faces and one curved face, and so on.

[0191] The specific configuration for detachably attaching the side plate to the main frame is not limited to the above configuration. For instance, side plate may be fixed to the main frame by other fixing means, such as screw fixing, magnetic fixing, side clamping, snap locking, or the like.

[0192] While only selected embodiments have been chosen to illustrate the present invention, it will be apparent to those skilled in the art from this disclosure that various changes and modifications can be made herein without departing from the scope of the invention as defined in the appended claims. For example, unless specifically stated otherwise, the size, shape, location or orientation of the various components can be changed as needed and/or desired so long as the changes do not substantially affect their intended function. Unless specifically stated otherwise, components that are shown directly connected or contacting each other can have intermediate structures disposed between them so long as the changes do not substantially affect their intended function. The functions of one element can be performed by two, and vice versa unless specifically stated otherwise. The structures and functions of one embodiment can be adopted in another embodiment. It is not necessary for all advantages to be present in a particular embodiment at the same time. Thus, the foregoing descriptions of the embodiments according to the present invention are provided for illustration only.

Reference list

[0193]

100:	Hot-Water Supply Unit
110:	Machine Space
111:	Box Outside Space
120:	Clearance Space
200:	Housing
210:	Front Side Plate
211:	Front Lower Plate
212:	Front Upper Plate
213:	User Interface
214:	Plate Part
215:	User Interface Box

216: Attachment Frame
 217: Claw Parts
 218: Second Housing Opening
 220: Rear Side Plate
 221: Rear Lower Plate
 222: Rear Upper Plate
 230R: Right Side Plate
 230L: Left Side Plate
 240: Bottom Plate
 241: Leg
 242: First Housing Opening
 250: Top Plate
 251: Top Rear Plate
 252: Top Front Plate
 253: Top Main Plate
 261: Housing Inner Surface
 262: Inspection Opening
 300: Tank
 301: Principal Axis
 400: Thermal Insulator
 401: Insulator Outer Surface
 500: Support Plate
 501: Plate Opening
 510: Upper Plate Part
 511: Wall Part
 512: Drain Receiving Part
 513: Drain Discharge Port
 514: Plate Convex Part
 515: Plate Aperture
 516R: Right Frame Receiving Part
 516L: Left Frame Receiving Part
 520: Lower Plate Part
 521: Extending Part
 522: Reinforcing Member
 600: Main Frame
 610R: Right Frame
 610L: Left Frame
 611R: Right Upper Groove
 611L: Left Upper Groove
 612R: Right Lower Groove
 612L: Left Lower Groove
 700: Heating Mechanism
 800: Electric Component Unit
 810: Lower Component Box
 820: Upper Component Box
 821: Snap Lock
 822: Box Fitting Member
 823R: Right Upper Hook Member
 823L: Left Upper Hook Member
 824R: Right Lower Hook Member
 824L: Left Lower Hook Member
 831: Connection Element
 832: Front Box Opening
 833: Side Box Opening

Claims

1. A hot-water supply unit, comprising:

5 a housing,
 a tank disposed within the housing, and configured to store water;
 thermal insulator substantially surrounding the tank within the housing;
 10 a heating mechanism disposed within a machine space, and configured to heat up the water stored in the tank, the machine space being formed by the housing within the housing and being positioned above the thermal insulator;
 15 an electric component unit disposed within the machine space, and having at least one electric component configured to operate at least a part of the heating mechanism and a component box accommodating the electric component, wherein:

20 the housing and the thermal insulator form a clearance space extending at least from the lower end of the thermal insulator to the upper end of the thermal insulator;
 25 the housing defines a first housing opening, and is configured such that the clearance space communicates with the outside of the housing via the first housing opening; and
 30 the component box is configured such that the inside of the component box communicates with the outside of the housing via the first housing opening.

35 2. The hot-water supply unit according to claim 1, wherein:

40 the housing defines a second housing opening, and configured such that the machine space communicates with outside of the housing via the second housing opening; and
 the component box is configured such that the inside of the component box communicates with the outside of the housing via the second housing opening.

45 3. The hot-water supply unit according to claim 2, wherein:

50 the first housing opening is formed in a position lower than the position of the electric component unit; and
 the second housing opening is formed in a position higher than or equal to the position of the electric component unit.

55 4. The hot-water supply unit according to claim 2 or 3, wherein:

- the second housing opening is formed at least in the top face of the housing.
5. The hot-water supply unit according to any one of claims 1 to 4, wherein: 5
- the first housing opening is formed at least in the bottom face of the housing.
6. The hot-water supply unit according to any one of claims 1 to 5, wherein: 10
- the housing includes a bottom plate provided with at least one leg extending downward; and the bottom plate defines the first housing opening with which the clearance space ends on the bottom plate. 15
7. The hot-water supply unit according to any one of claims 1 to 6, wherein: 20
- the component box defines a first box opening via which the inside of the component box communicates with a box outside space, the box outside space being a part of the machine space and being outside of the component box. 25
8. The hot-water supply unit according to claim 7, wherein: 30
- the clearance space communicates with the box outside space.
9. The hot-water supply unit according to claim 2 to 4, wherein: 35
- the component box defines a first box opening via which the inside of the component box communicates with a box outside space, the box outside space being a part of the machine space and being outside of the component box; and the second housing opening communicates with the box outside space. 40
10. The hot-water supply unit according to any one of claims 1 to 9, wherein: 45
- the component box defines a second box opening via which inside of the component box communicates with the clearance space. 50
11. The hot-water supply unit according to any one of claims 1 to 8 and 10, wherein: 55
- at least a part of the component box forms a part of the housing, and defines the second housing opening.
12. The hot-water supply unit according to any one of claims 1 to 11, further comprising:
- a main frame disposed within the housing, and supporting the heating mechanism and the electric component unit; and
- a support plate disposed within the housing between the thermal insulator and the main frame to support the main frame with respect to the thermal insulator, wherein:
- the support plate defines a plate opening via which the clearance space communicates with the machine space.
13. The hot-water supply unit according to any one of claims 1 to 12, wherein:
- the electric component includes a transformer.
14. The hot-water supply unit according to any one of claims 1 to 13, wherein:
- the housing has a polygonal prism form; and the clearance space is formed along at least one of the inner corners of the housing.
15. The hot-water supply unit according to claim 14, wherein:
- the polygonal prism form is a right prism form.
- Amended claims in accordance with Rule 137(2) EPC.**
1. A hot-water supply unit (100), comprising:
- a housing (200),
- a tank (300) disposed within the housing, and configured to store water;
- thermal insulator (400) substantially surrounding the tank within the housing;
- a heating mechanism (700) disposed within a machine space (110), and configured to heat up the water stored in the tank, the machine space being formed by the housing within the housing and being positioned above the thermal insulator; and
- an electric component unit (800) disposed within the machine space, and having at least one electric component configured to operate at least a part of the heating mechanism and a component box (810, 820) accommodating the electric component,
- characterized in that:**

- the housing and the thermal insulator form a clearance space (120) extending at least from the lower end of the thermal insulator to the upper end of the thermal insulator; the housing defines a first housing opening (242), and is configured such that the clearance space communicates with the outside of the housing via the first housing opening; and the component box is configured such that the inside of the component box communicates with the outside of the housing via the first housing opening.
2. The hot-water supply unit (100) according to claim 1, wherein:
- the housing (200) defines a second housing opening (218), and configured such that the machine space (110) communicates with outside of the housing via the second housing opening; and the component box (810, 820) is configured such that the inside of the component box communicates with the outside of the housing via the second housing opening.
3. The hot-water supply unit (100) according to claim 2, wherein:
- the first housing opening (242) is formed in a position lower than the position of the electric component unit (800); and the second housing opening (218) is formed in a position higher than or equal to the position of the electric component unit.
4. The hot-water supply unit (100) according to claim 2 or 3, wherein:
- the second housing opening (218) is formed at least in the top face of the housing (200).
5. The hot-water supply unit (100) according to any one of claims 1 to 4, wherein:
- the first housing opening (242) is formed at least in the bottom face of the housing (200).
6. The hot-water supply unit (100) according to any one of claims 1 to 5, wherein:
- the housing (200) includes a bottom plate (240) provided with at least one leg (241) extending downward; and the bottom plate defines the first housing opening (242) with which the clearance space (120) ends on the bottom plate.
7. The hot-water supply unit (100) according to any one of claims 1 to 6, wherein:
- the component box (810, 820) defines a first box opening (832, 833) via which the inside of the component box communicates with a box outside space (111), the box outside space being a part of the machine space (110) and being outside of the component box.
8. The hot-water supply unit (100) according to claim 7, wherein:
- the clearance space (120) communicates with the box outside space (111).
9. The hot-water supply unit (100) according to claim 2 to 4, wherein:
- the component box (810, 820) defines a first box opening (832, 833) via which the inside of the component box communicates with a box outside space (111), the box outside space being a part of the machine space (110) and being outside of the component box; and the second housing opening (218) communicates with the box outside space.
10. The hot-water supply unit (100) according to any one of claims 1 to 9, wherein:
- the component box (810, 820) defines a second box opening (833) via which inside of the component box communicates with the clearance space (120).
11. The hot-water supply unit (100) according to any one of claims 1 to 8 and 10, wherein:
- at least a part of the component box (810, 820) forms a part of the housing (200), and defines the second housing opening (218).
12. The hot-water supply unit (100) according to any one of claims 1 to 11, further comprising:
- a main frame (600) disposed within the housing (200), and supporting the heating mechanism (700) and the electric component unit (800); and a support plate (500) disposed within the housing between the thermal insulator (400) and the main frame to support the main frame with respect to the thermal insulator, wherein:
- the support plate defines a plate opening (501) via which the clearance space (120) communicates with the machine space (110).
13. The hot-water supply unit (100) according to any one of claims 1 to 12, wherein:
- the electric component includes a transformer.
14. The hot-water supply unit (100) according to any one of claims 1 to 13, wherein:

the housing (200) has a polygonal prism form;
and
the clearance space (120) is formed along at
least one of the inner corners of the housing.

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15. The hot-water supply unit (100) according to claim
14, wherein:
the polygonal prism form is a right prism form.

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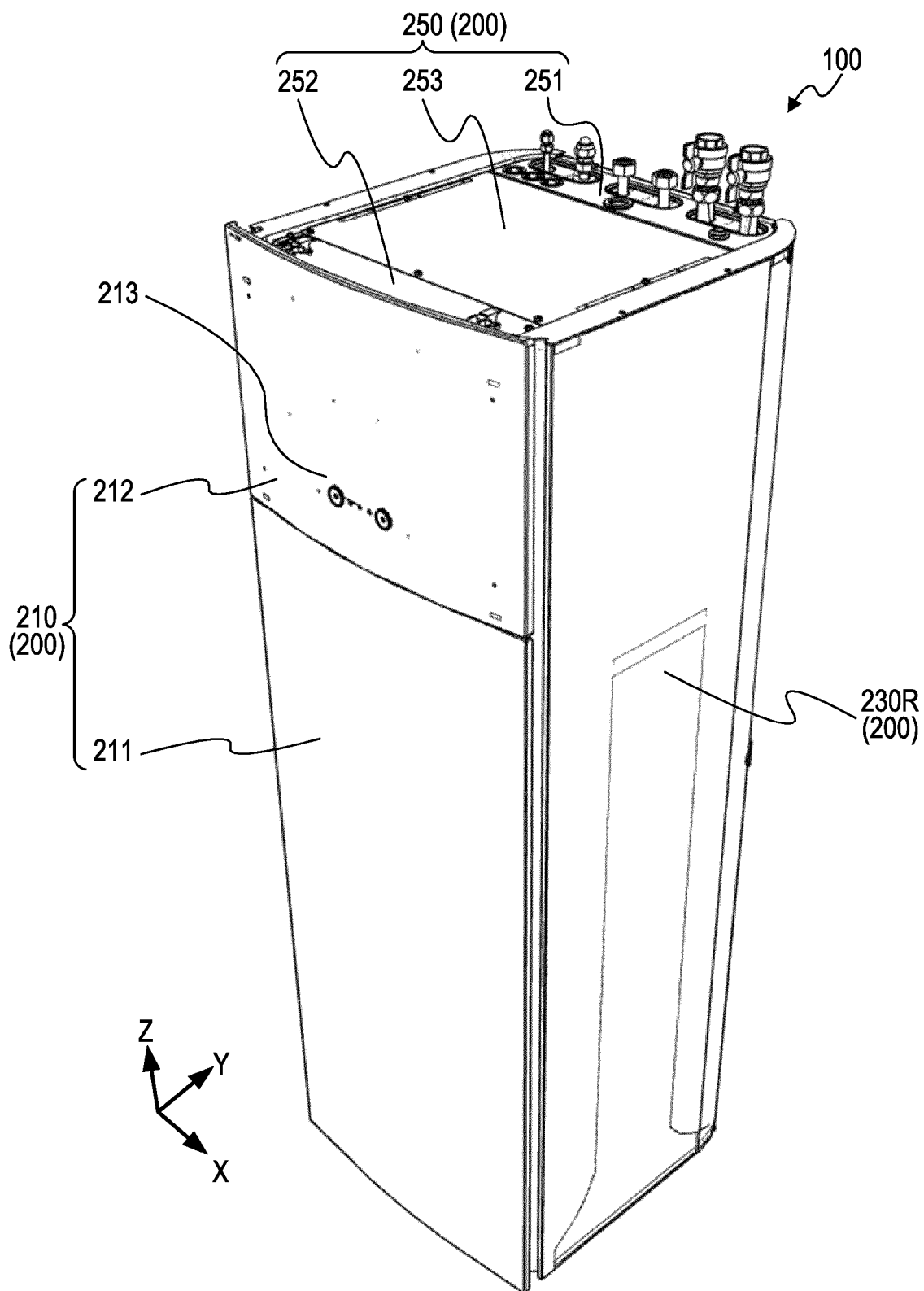


Fig. 1

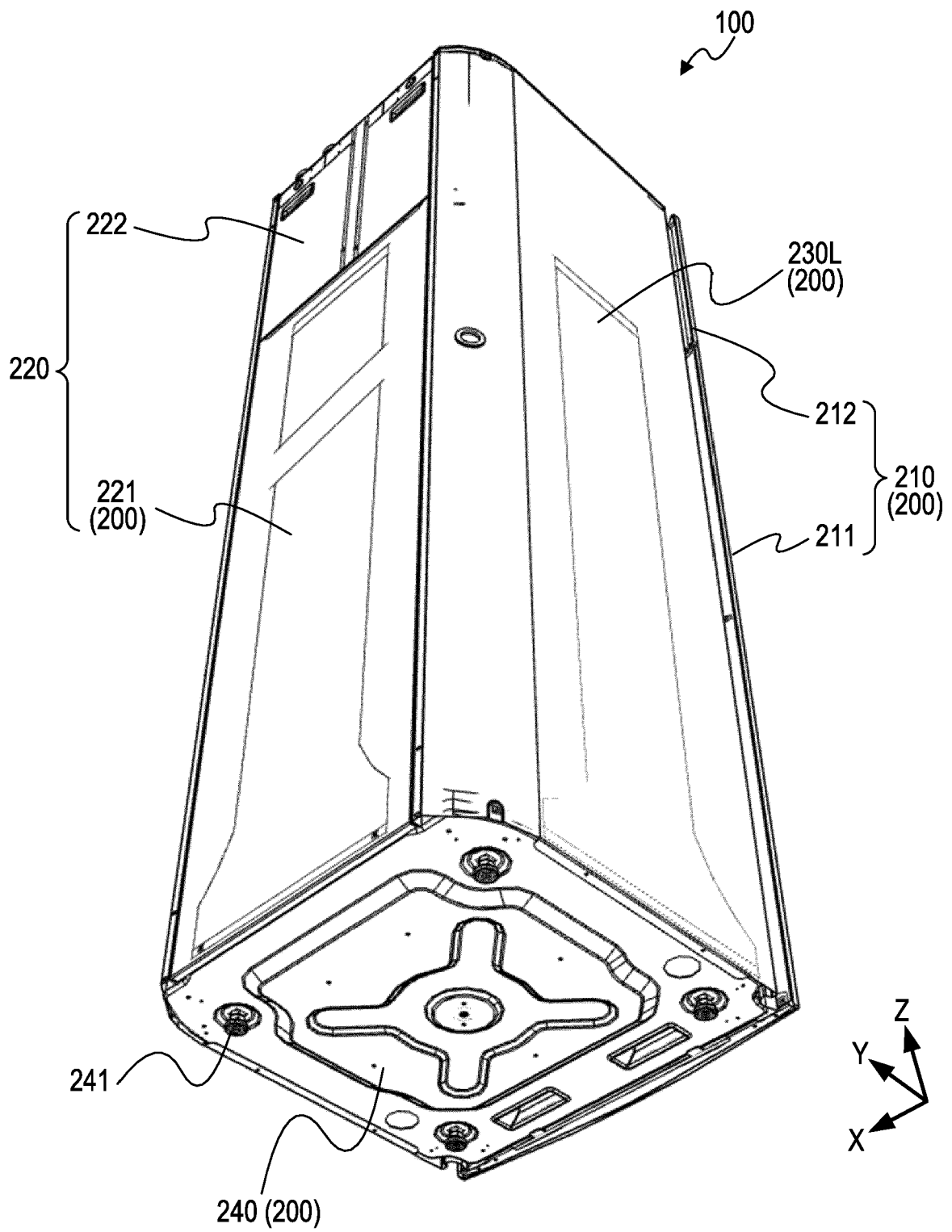


Fig. 2

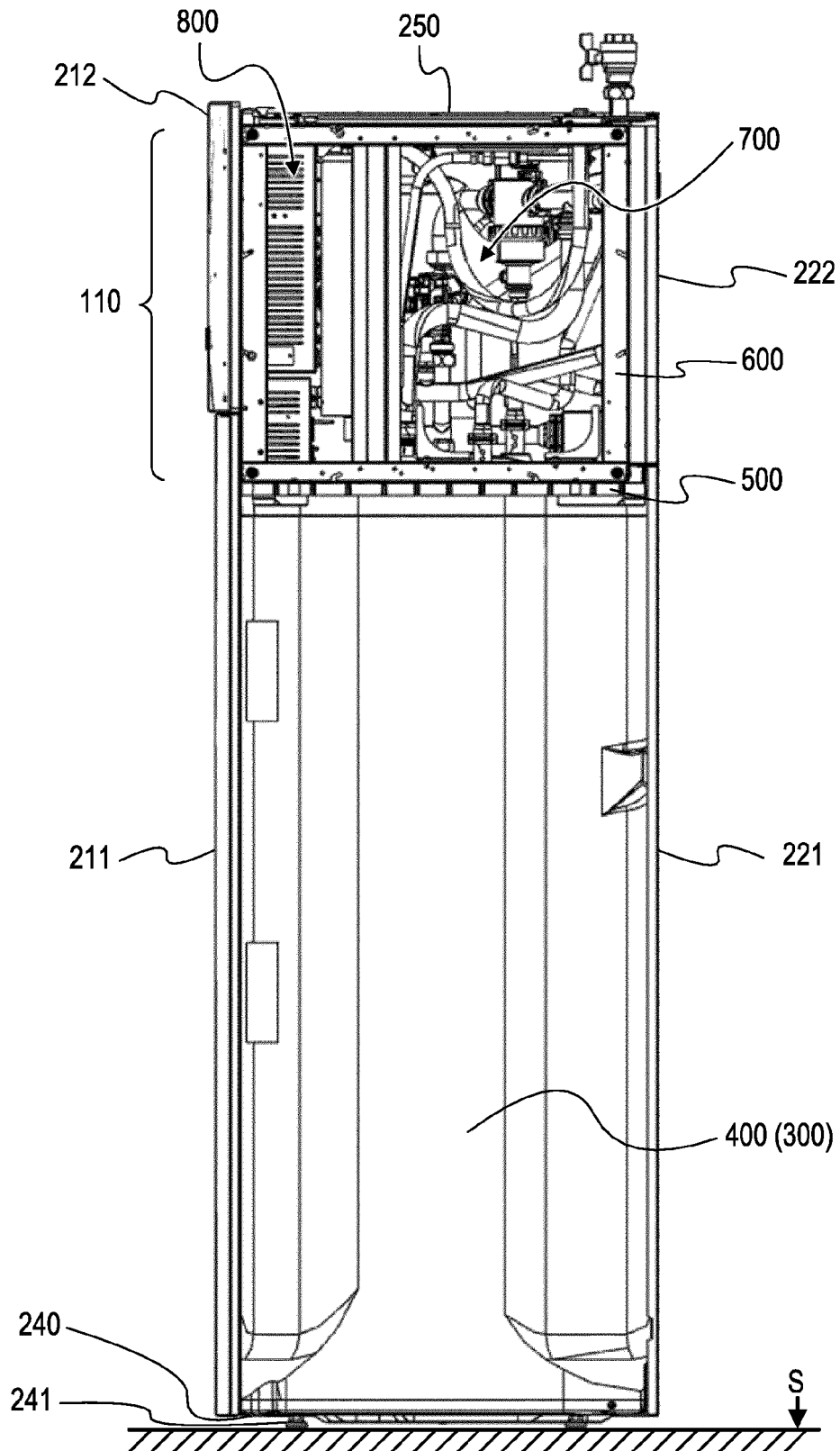


Fig. 3

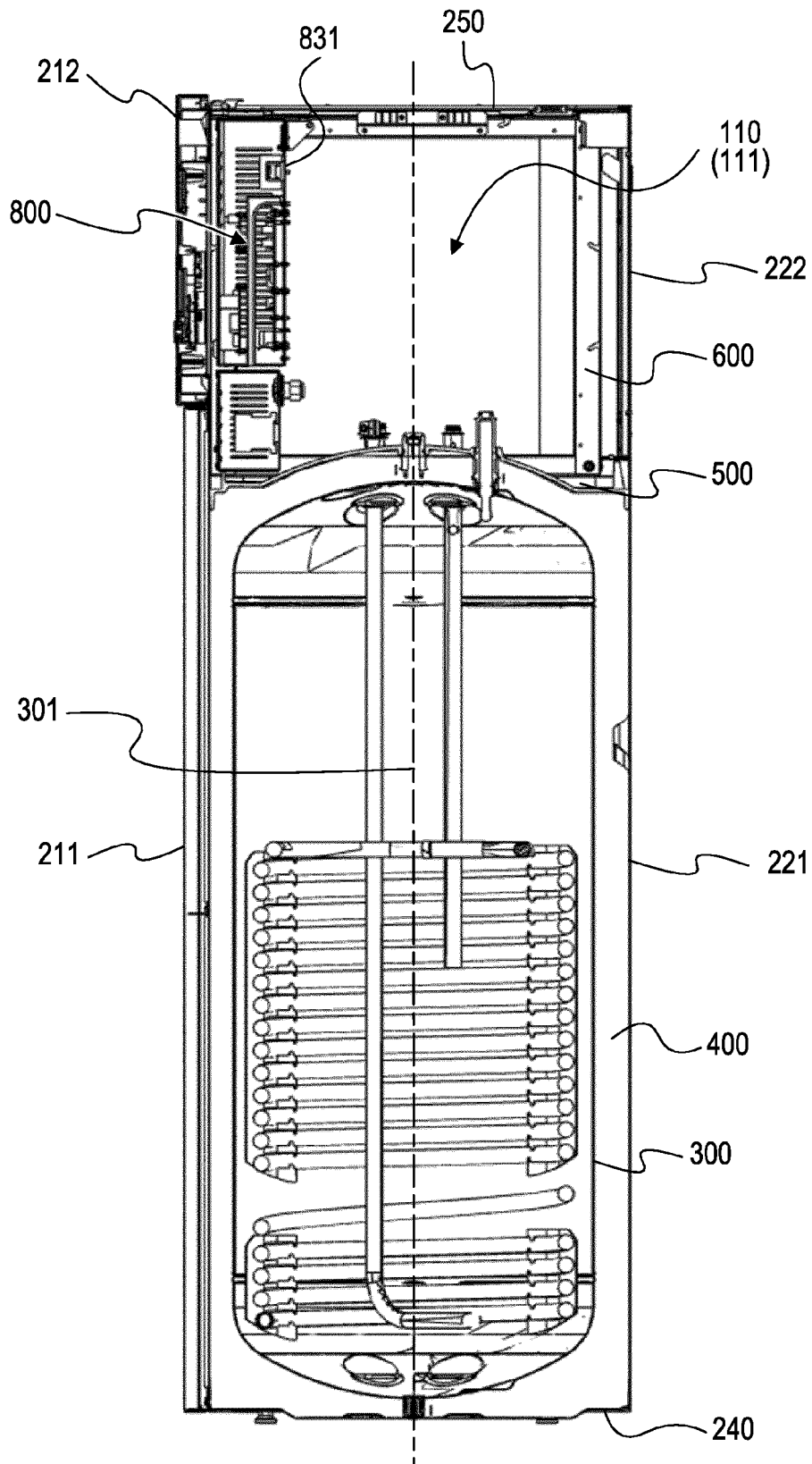


Fig. 4

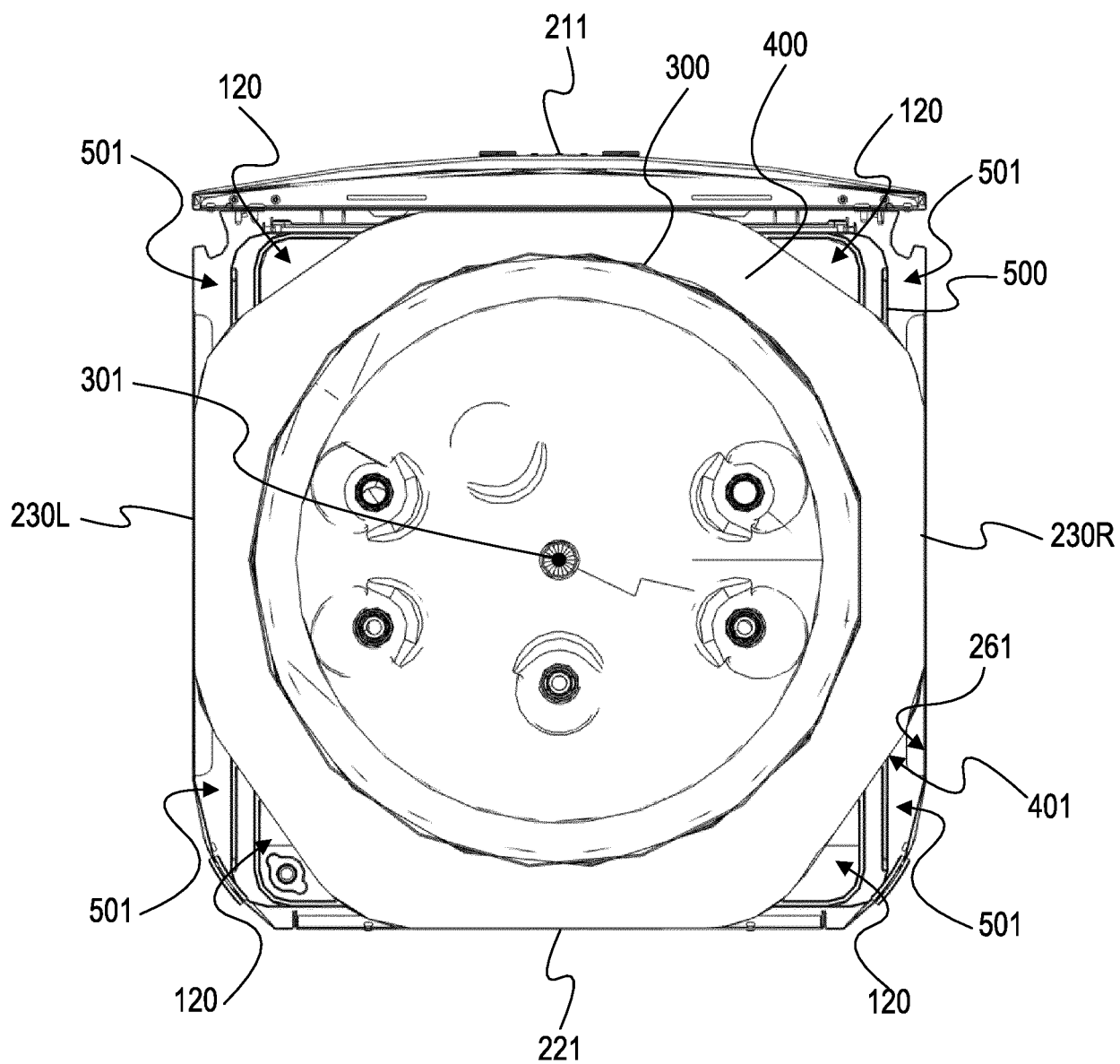


Fig. 5

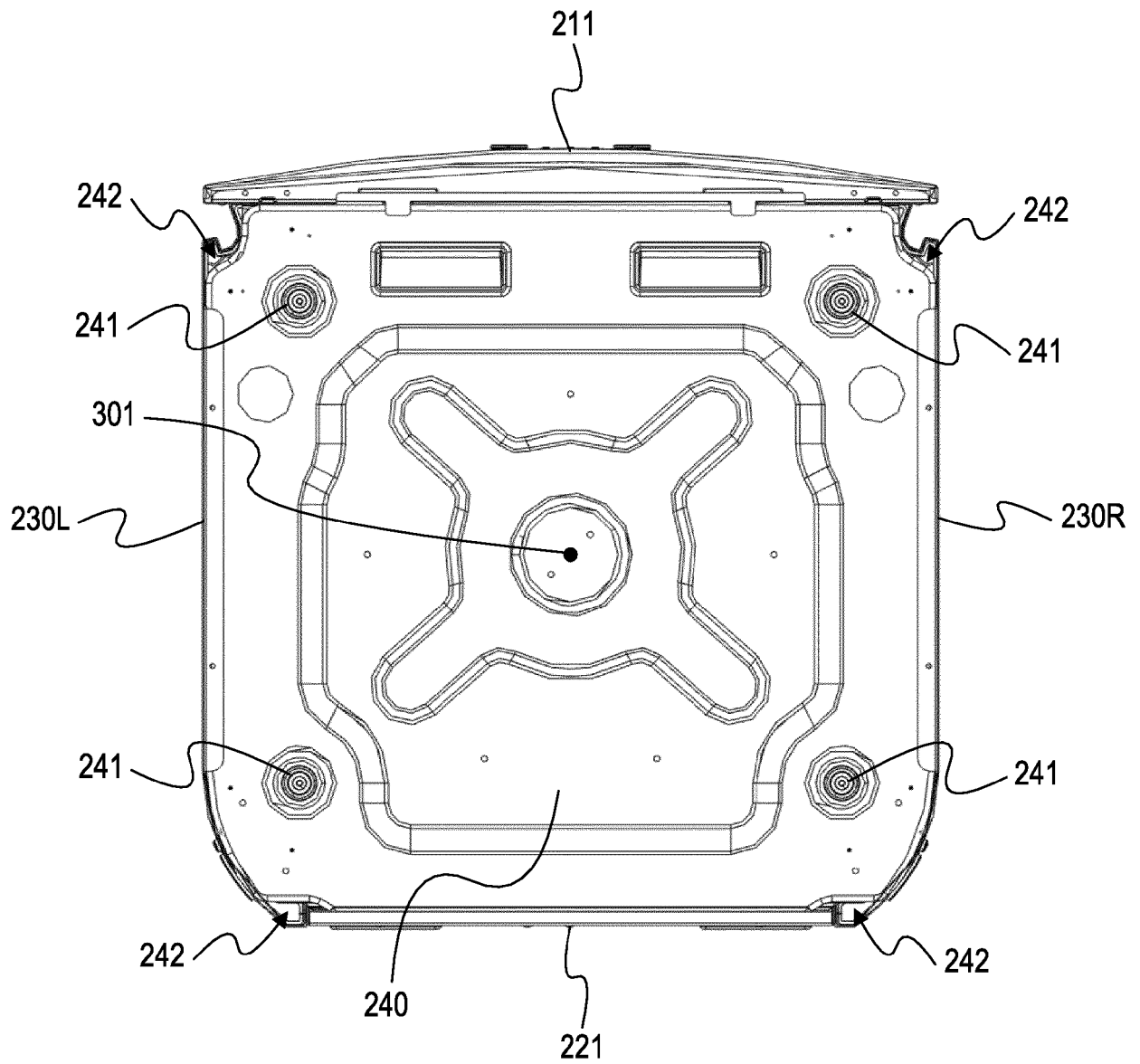


Fig. 6

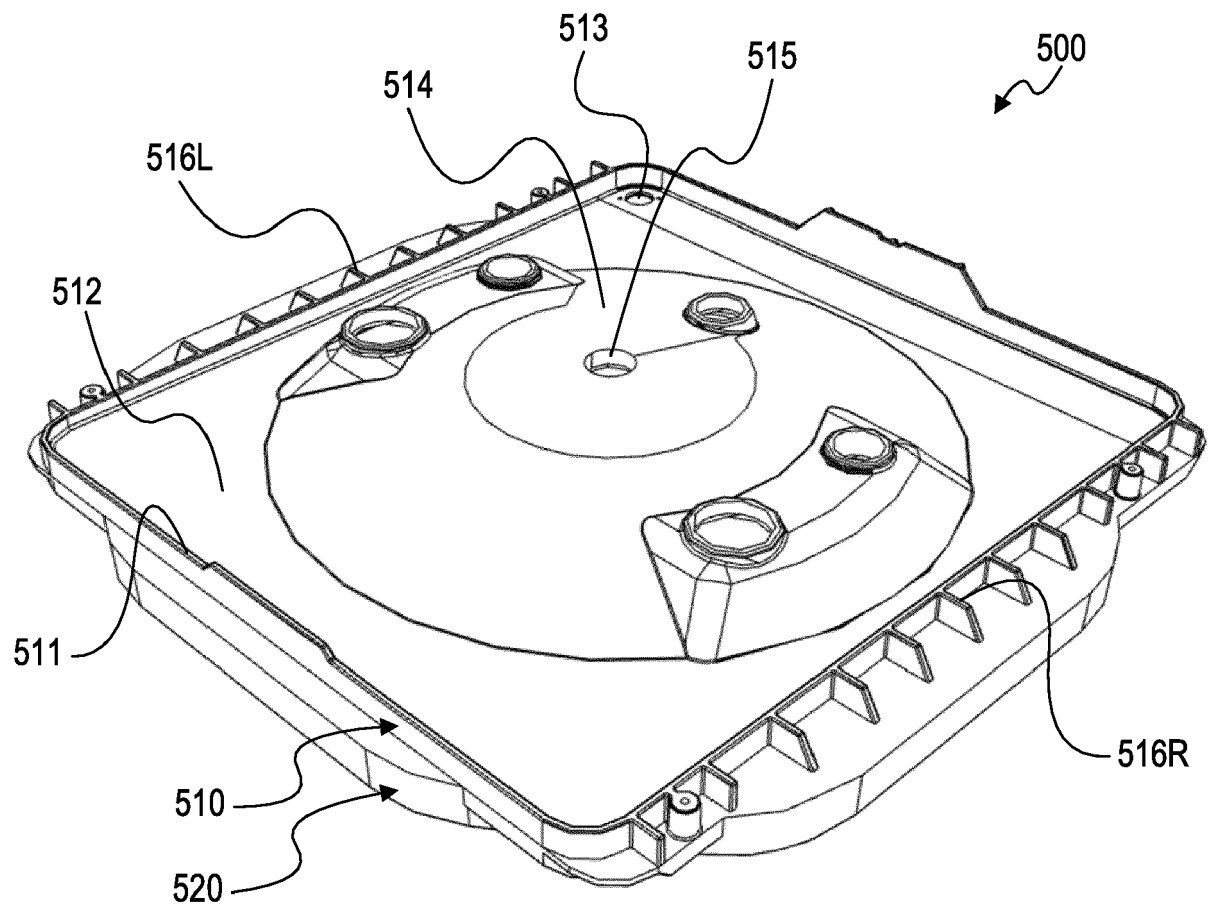


Fig. 7

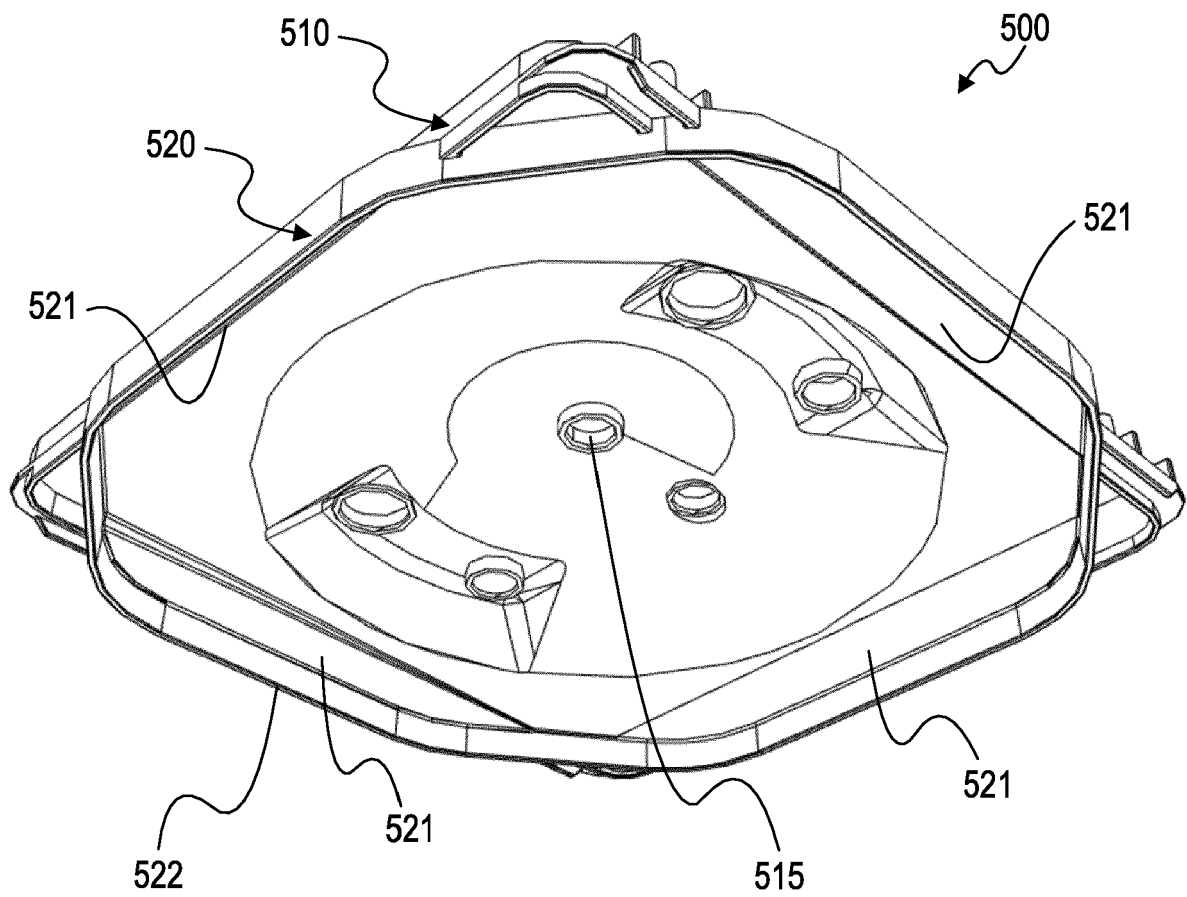


Fig. 8

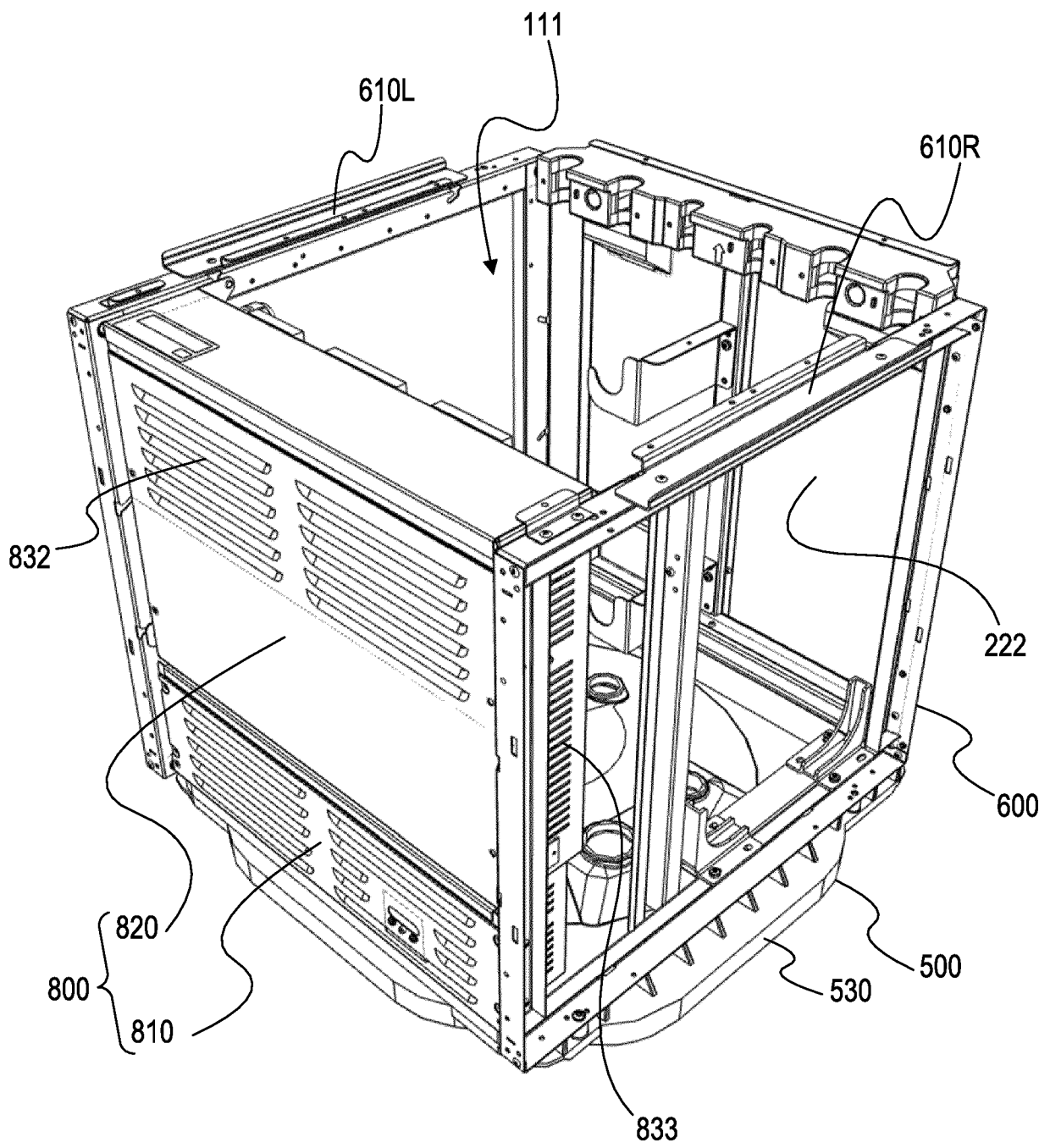


Fig. 9

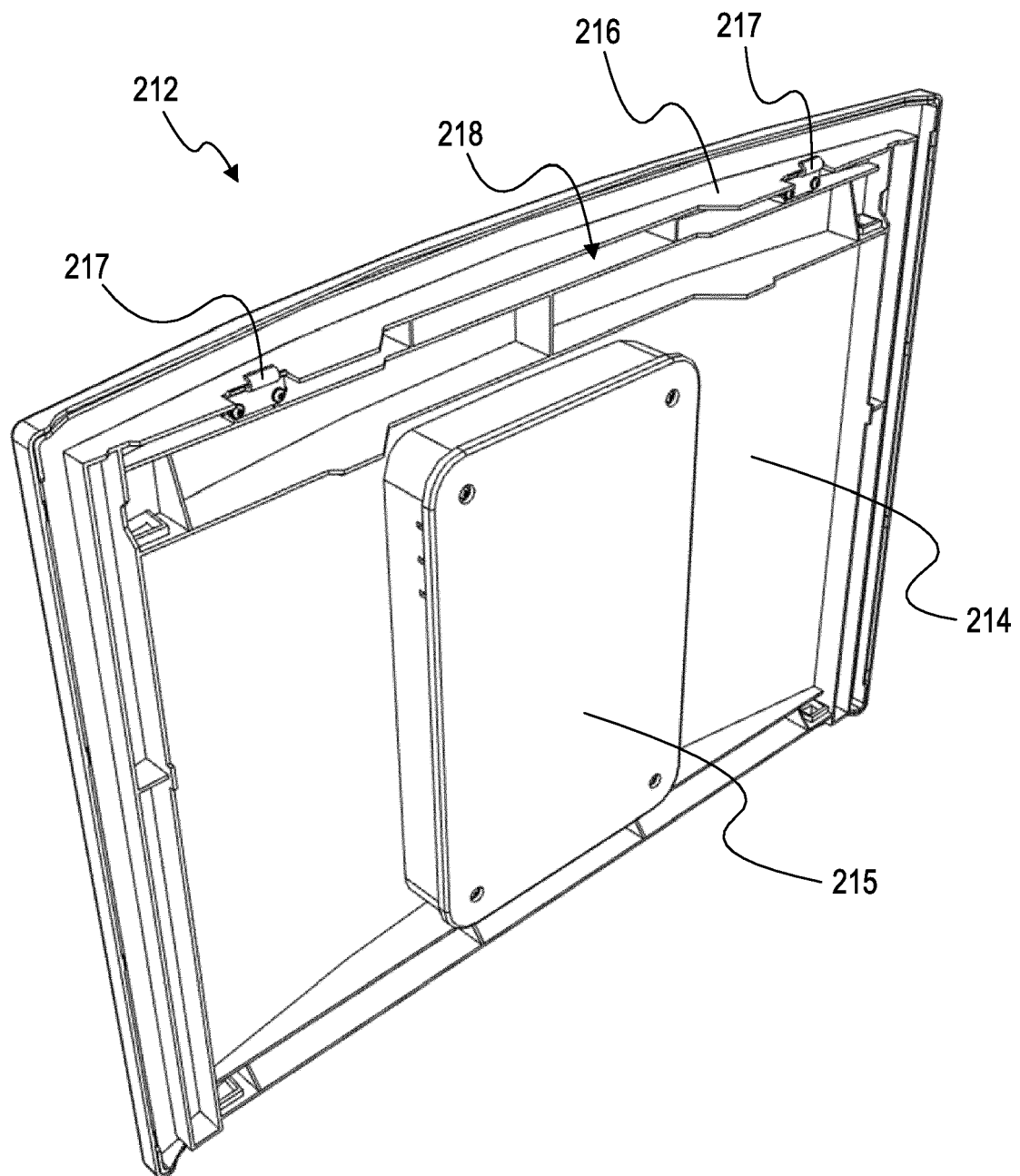


Fig. 10

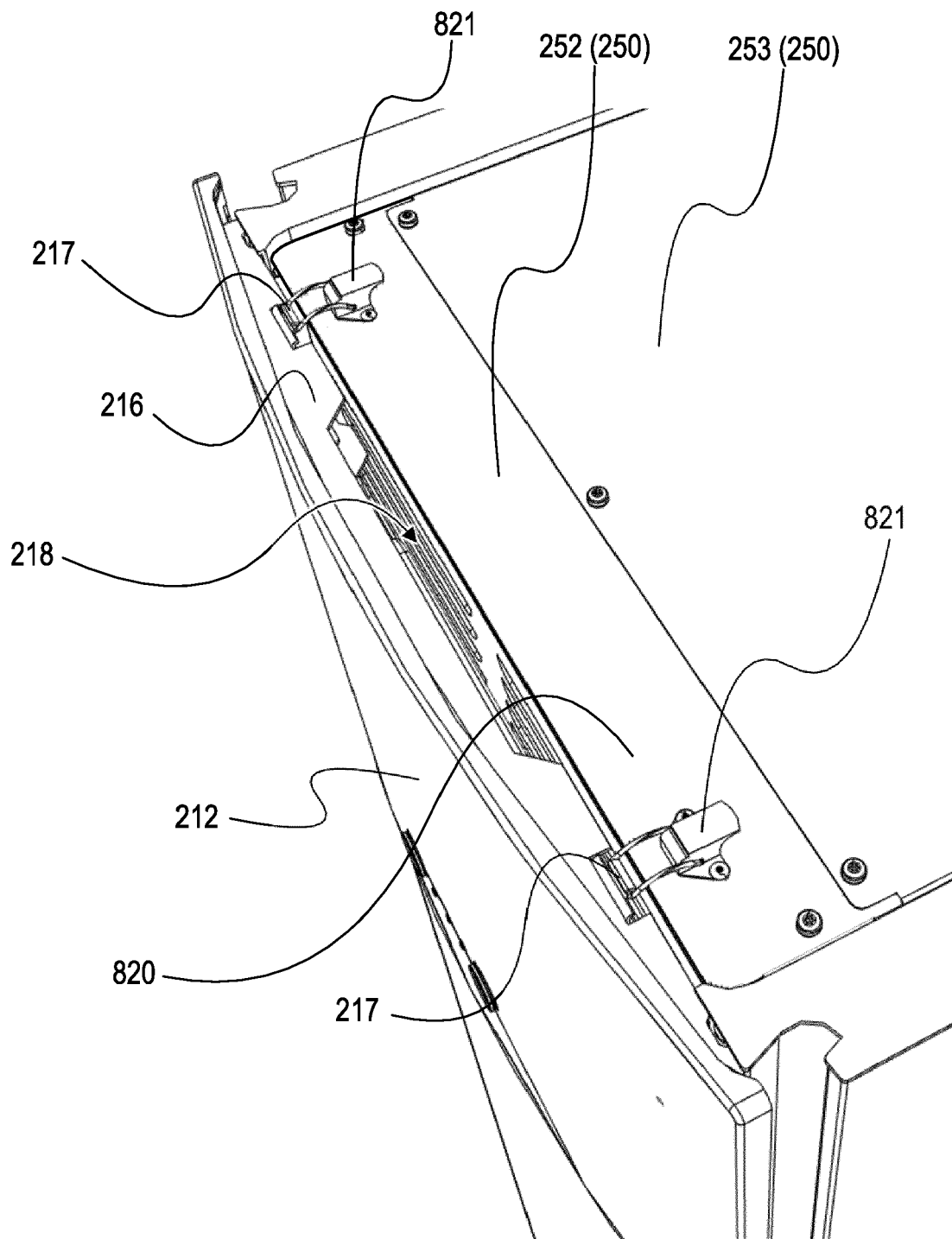


Fig. 11

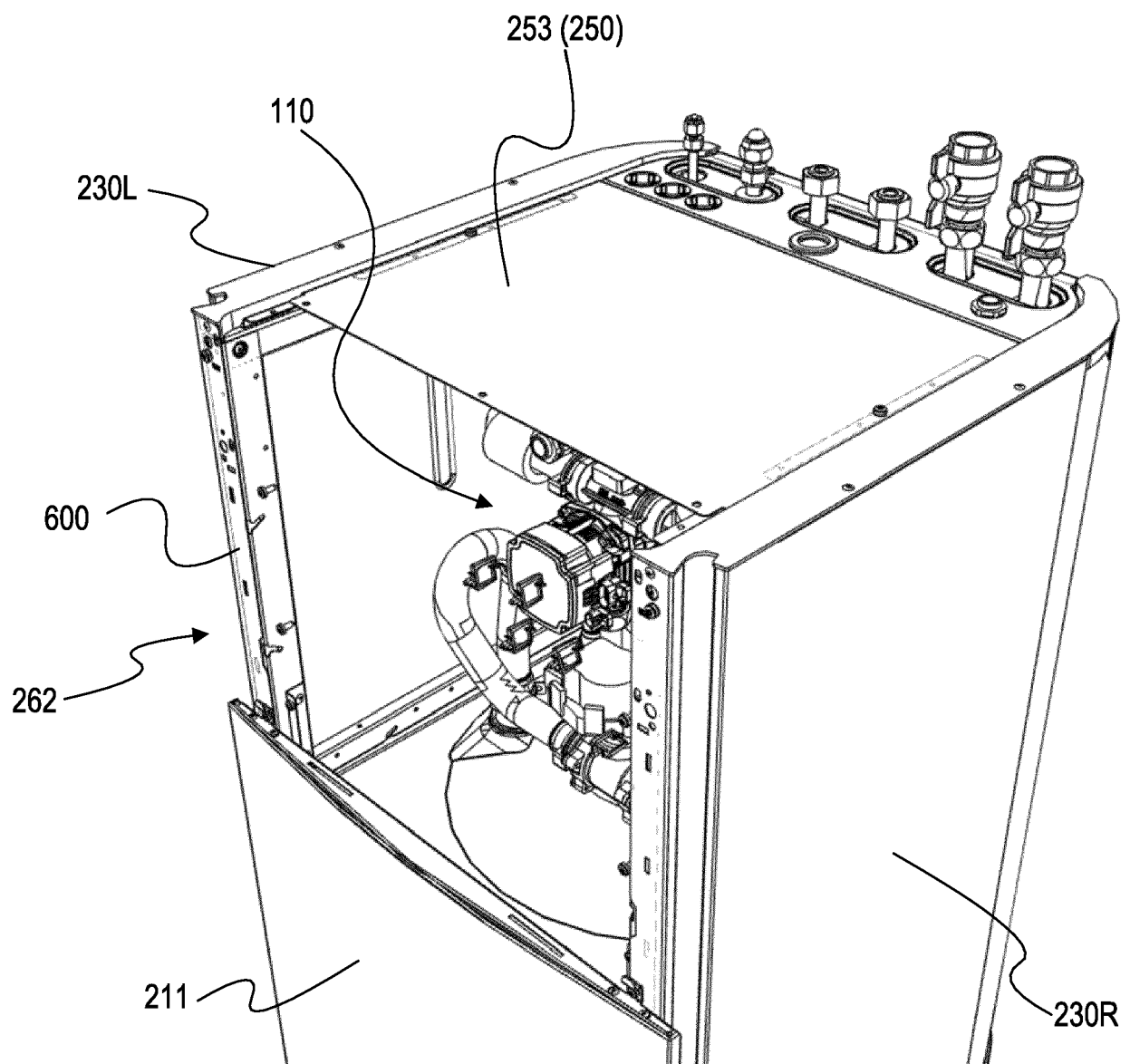


Fig. 12

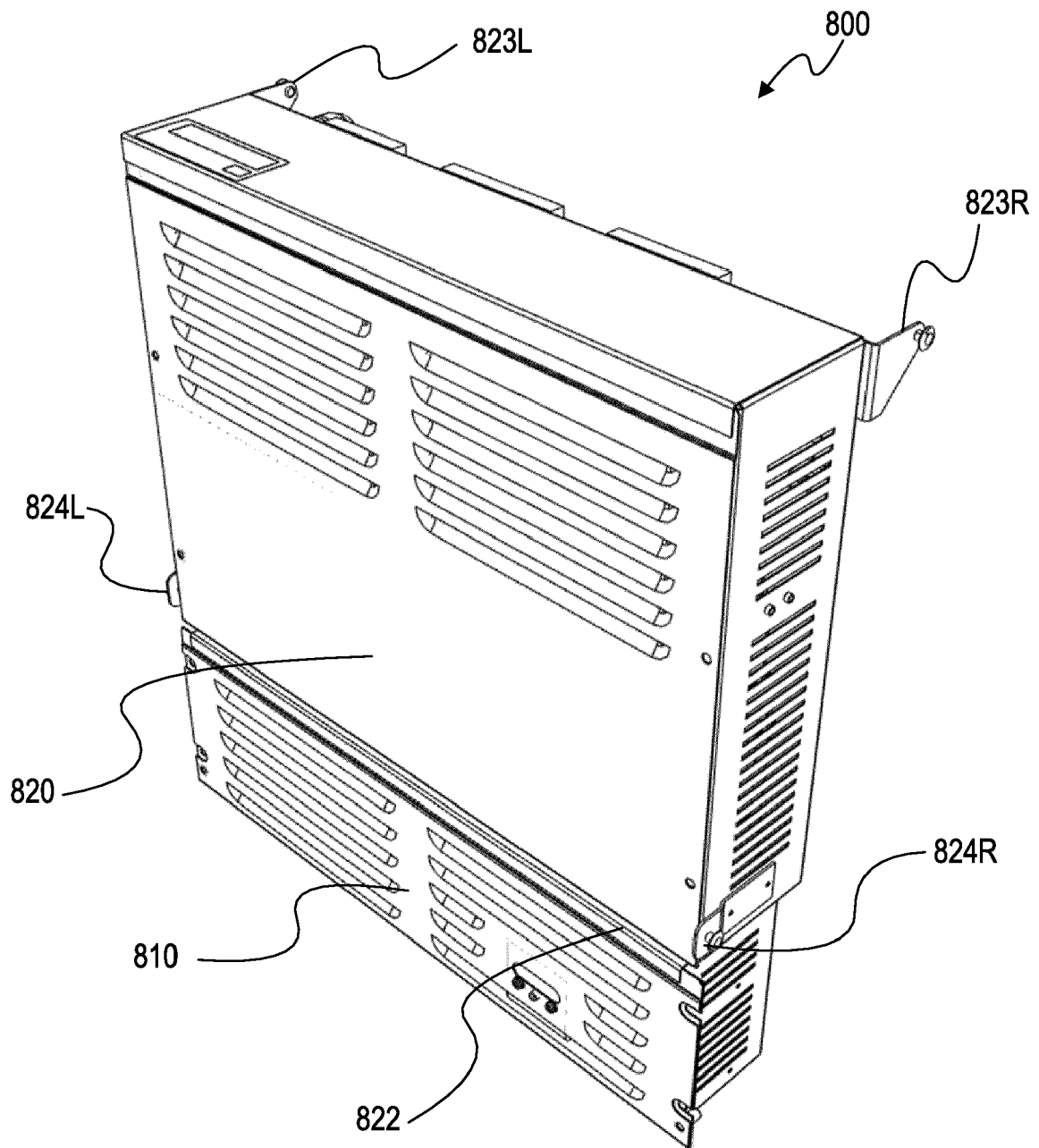


Fig. 13

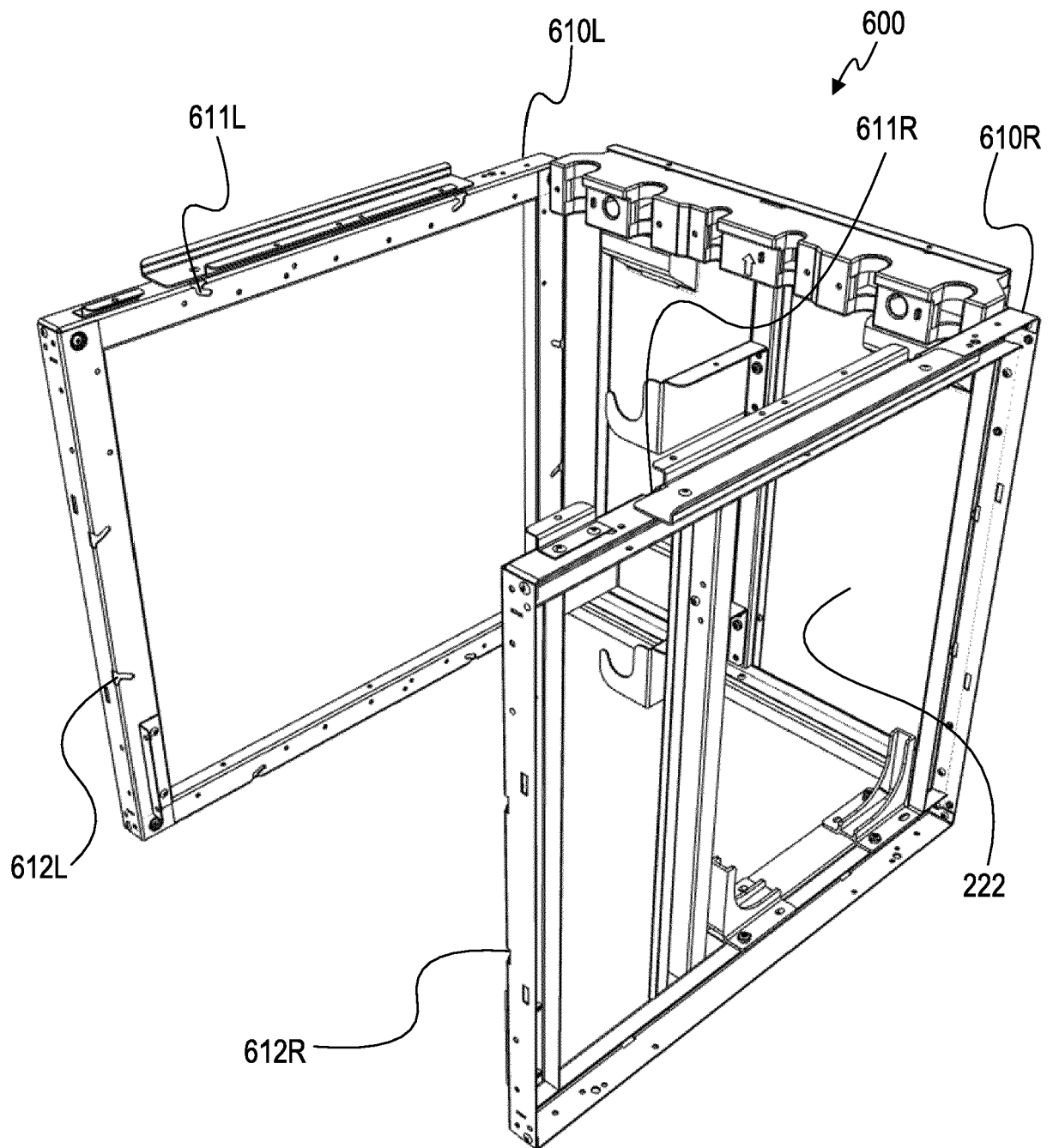


Fig. 14

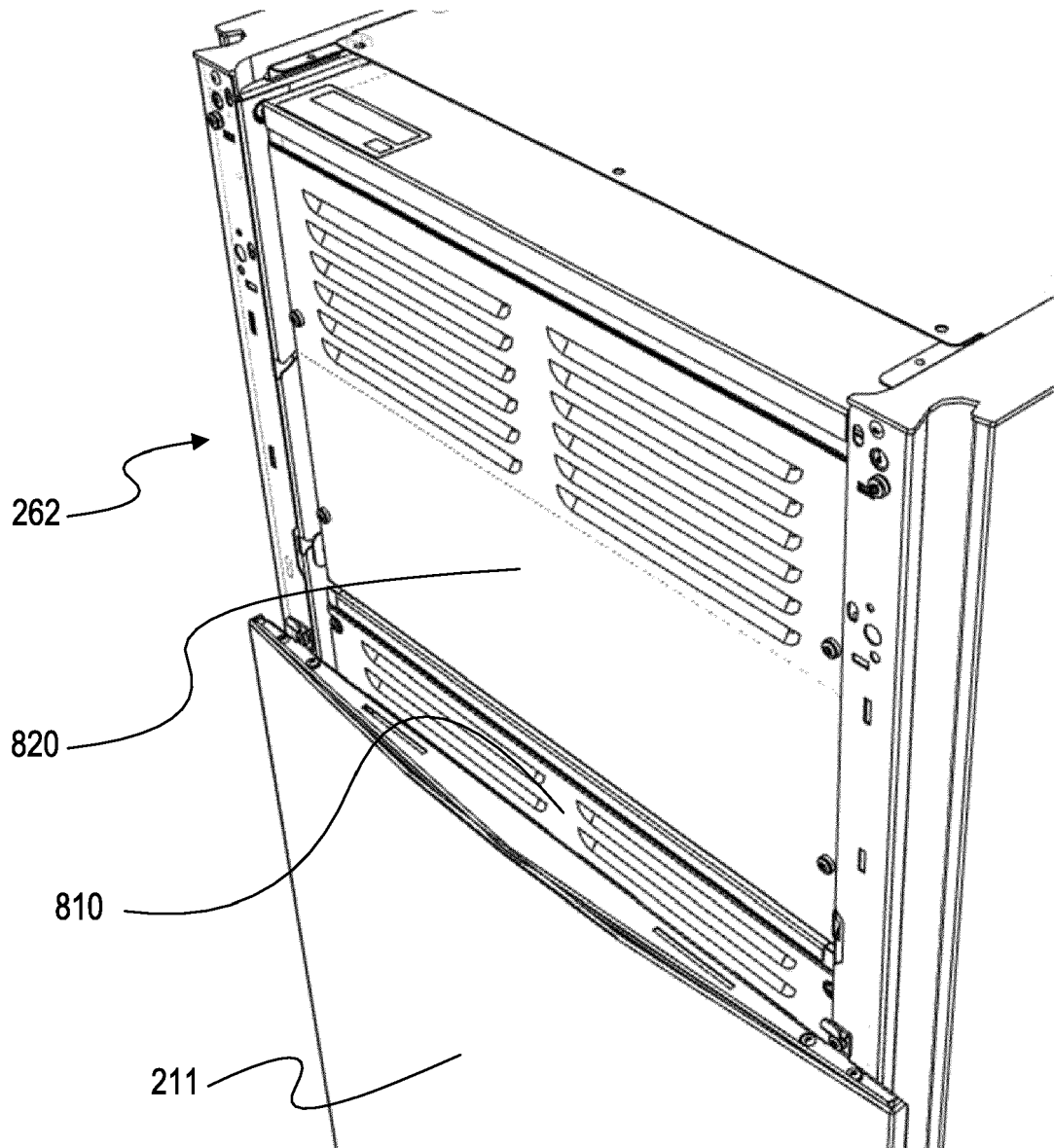


Fig. 15

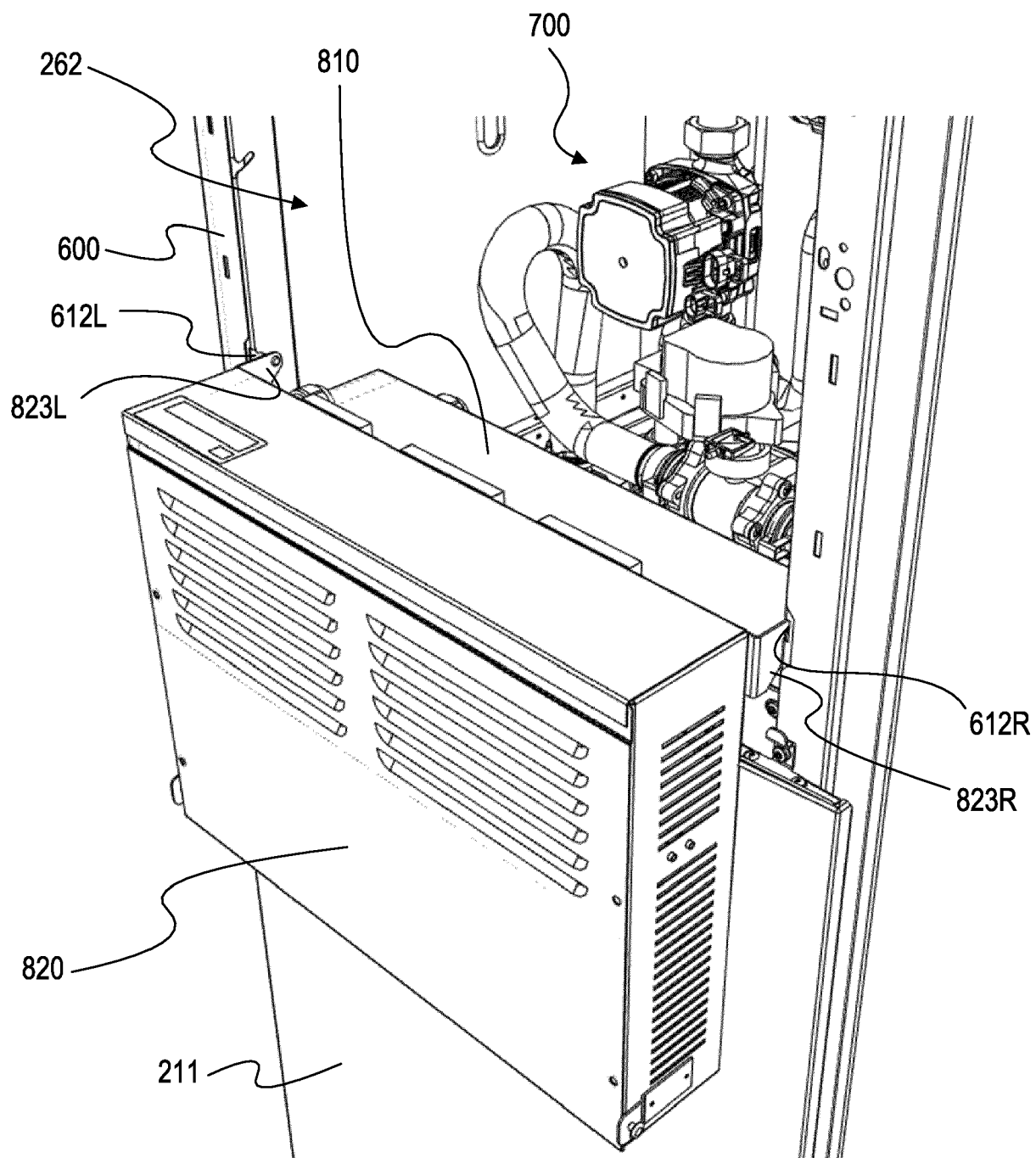


Fig. 16

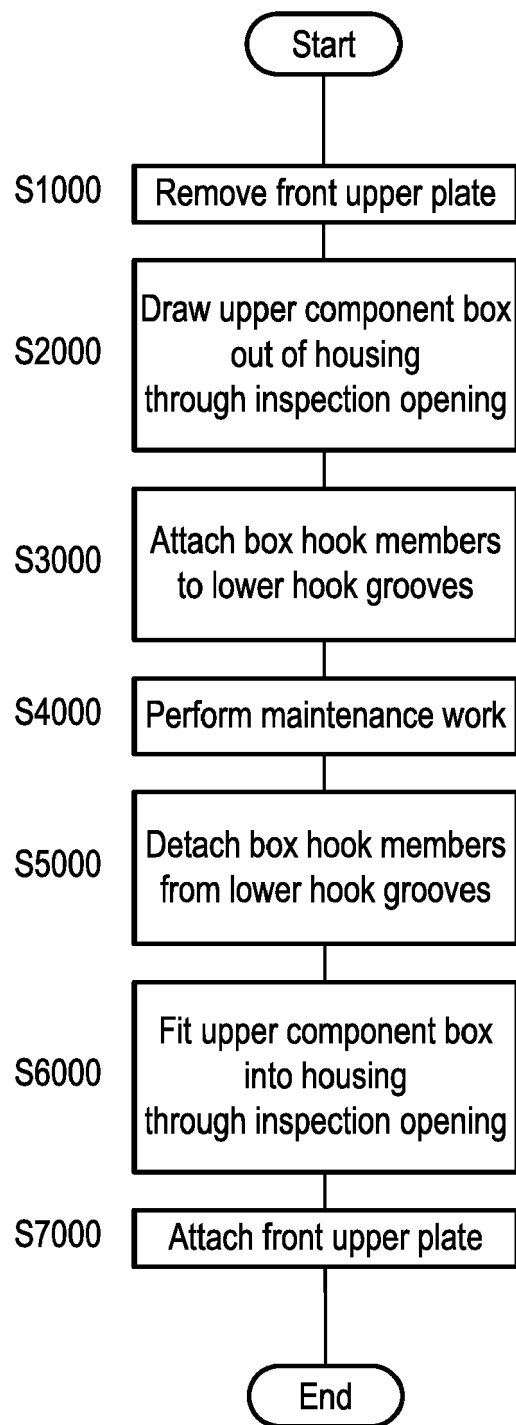


Fig. 17



EUROPEAN SEARCH REPORT

 Application Number
 EP 17 19 3820

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The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 23 March 2018	Examiner Schwaiger, Bernd
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

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**ANNEX TO THE EUROPEAN SEARCH REPORT
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5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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