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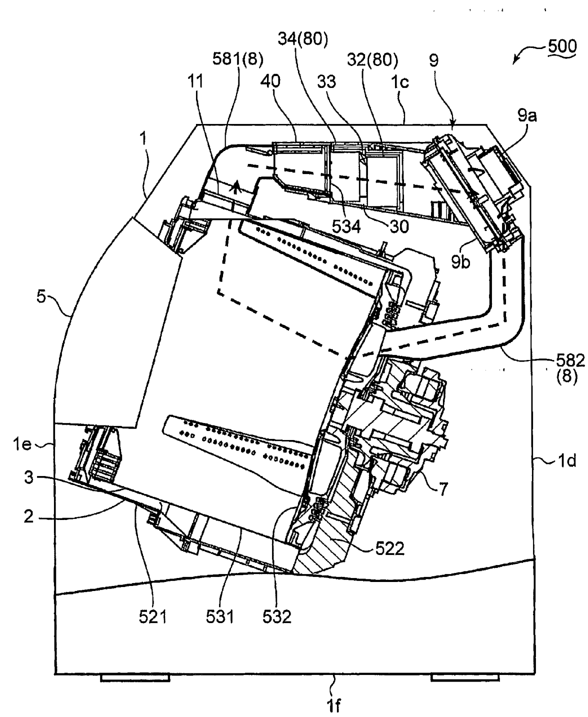
(54) Drying machine and washing machine comprising a drying machine

(57) A drying machine (500) including a housing (1), an outer vessel (2) supported in the housing (1), a rotatable storage (3) mounted in the outer vessel (2) and configured to accommodate clothing, a heat pump device (30) configured to dry the clothing in the storage (3), a supporting member (61, 63) configured to support the heat pump device (30), and a first fixing member (70) configured to fix the heat pump device (30) to the supporting member (61, 63), wherein the heat pump device (30) disposed in an upper space formed above the outer vessel (2) in the housing (1) includes a compressor (31) configured to compress refrigerant, and the supporting member (61, 63) below the heat pump device (30) is disposed near the compressor (31).

FIG.1



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Description

Technical Field

[0001] The present invention relates to a drying machine and a washing machine comprising a drying machine which are provided with a heat pump device. The washing machine which comprises a drying machine and which can work as a washing machine and/or a drying machine is called in the following "washing and drying machine".

Background Art

[0002] A drying machine such as a drum-type washing and drying machine for drying clothing typically comprises a heat pump mechanism. The heat pump mechanism may dry the clothing with less power consumption than a device using a heater. In addition, the heat pump mechanism may dehumidify dry air after drying the clothing without cooling water and recover heat from the dry air. Accordingly, the heat pump mechanism is advantageous in terms of water saving and power saving in comparison to a device configured to dry clothing with a heater (refer to Japanese Patent Application Publication No. 2006-110394).

[0003] A heat pump mechanism generally comprises a compressor configured to compress refrigerant, a heat exchanger configured to exchange heat with the dry air for drying the clothing, and a circulation tube configured to define a circulation path of the refrigerant between the compressor and the heat exchanger. The heat exchanger generally comprises a dehumidifier configured to dehumidify the dry air, and a heater configured to heat the dry air.

[0004] Fig. 14 schematically shows a conventional washing and drying machine. The conventional washing and drying machine is now described with reference to Fig. 14.

[0005] The conventional drum-type washing and drying machine 600 comprises a housing 100, and a washing drum 102 disposed in the housing 100. The washing drum 102 includes a water tank configured to store wash water, and a rotating drum configured to rotate in the water tank. In the following description, an internal space of the housing 100 below the washing drum 102 is referred to as a lower space, and the internal space of the housing 100 above the washing drum 102 is referred to as an upper space.

[0006] The washing and drying machine 600 further comprises a heat pump mechanism 130 disposed in the lower space, a circulatory ventilation flue 108 configured to connect the washing drum 102 to the heat pump mechanism 130, and a filter 140 configured to trap lint (dust components) such as waste thread, which is generated during a process of drying the clothing. The filter 140 is mounted on the circulatory ventilation flue 108. The washing and drying machine 600 further comprises an air blower 109 mounted on the circulatory ventilation flue 108. The air blower 109 blows the dry air in the circulatory ventilation flue 108.

[0007] The dry air is discharged from an upper part of the washing drum 102, and thereafter passes through the filter 140. After a dust removal process by the filter 140, the dry air is sent to the heat pump mechanism 130 by the air blower 109. The heat pump mechanism 130 comprises a heat exchanger configured to exchange heat with the dry air. The heat exchanger dehumidifies and heats the dry air. The dry air thereafter flows into the washing drum 102.

[0008] Various components are disposed around the washing drum 102 in the housing 100. The air blower 109 is disposed, for example, in the upper space.

[0009] Fig. 15 is a cross-sectional view schematically showing a support structure configured to support the components disposed in the upper space of the housing 100. The support structure used for the components disposed in the upper space is now described with reference to Fig. 15.

[0010] Fig. 15 shows a component 150 disposed in the upper space, and a supporting member 160 configured to support the component 150. The supporting member 160 is generally disposed above the component 150. A fixing member such as a screw 171 or a helical coil wire screw thread insert 172 is used to fix the supporting member 160 to the component 150.

[0011] The gravity working on the component 150 is applied as tensile force to the screw 171. For example, during the operation where the washing and drying machine 600 is transported or where the washing and drying machine 600 is installed, the screw 171 is subject to the gravity working on the component 150, as well as an inertial force of the components resulting from the transport of the washing and drying machine 600. Accordingly, the screw 171 is loaded by a greater tensile force.

[0012] If the washing and drying machine 600 is accidentally dropped or toppled, the screw 171 is subject to the gravity working on the component 150 and/or the inertial force of the components resulting from the transfer of the washing and drying machine 600, as well as an impact force caused by the dropping or the toppling of the washing and drying machine 600. Accordingly, the screw 171 is subject to even greater tensile force. In particular, when the component 150 is heavier, the screw 171 is subject to much greater tensile force. Accordingly, the screw 171 is likely to be potentially broken.

[0013] In consideration of the transport and the accidental dropping or toppling of the washing and drying machine 600, the heavier components 150 such as the heat pump device 130 are disposed in the lower space but not the upper space.

Disclosure of the Invention

[0014] An object of this invention is to provide an improved drying machine and a washing and drying machine.

[0015] The object of the present invention is solved by the subject-matter of the independent claims. The dependent claims are directed to embodiments of advantage.

Advantages of the invention

[0016] Advantageously, the drying machine or washing machine comprises a support structure to appropriately support a heavier component disposed in an upper space. Advantageously, the drying machine or washing machine has less energy consumption. In the following advantageous embodiments of the invention are disclosed. Features of different embodiments having the same or similar function than features of other embodiments can be exchanged. In particular features of different embodiments can be combined, in particular those which have different functions.

[0017] The feature that the supporting member is disposed near the compressor means in particular that the supporting member is disposed closer to the compressor than to the front side of the housing. The front side is that side which includes an opening (door) for inserting the closing to be dried. The supporting member is in particular disposed closer to the backside which is opposite to the front side of the housing. A distance between the supporting member and the compressor is in particular smaller than 30 cm, 20 cm or 10 cm.

[0018] Preferably at least part of the heat pump device is disposed in the upper space formed above the storage. In particular all of the heat pump device is disposed in the upper space or at least that part of the heat pump is disposed in the upper space which does not include the compressor 31. The storage for the clothing (in the drying machine) can be a rotatable storage or a static storage.

Brief Description of the Drawings

[0019]

Fig. 1 is a cross-sectional view showing a schematic configuration of a drum-type washing and drying machine according to one embodiment.

Fig. 2 is a partial view of a front surface appearance of the drum-type washing and drying machine shown in Fig. 1.

Fig. 3 is a perspective view schematically showing an internal structure of the drum-type washing and drying machine shown in Fig. 1.

Fig. 4 is a schematic plan view of the drum-type washing and drying machine shown in Fig. 1.

Fig. 5 is a cross-sectional view along a line A-A shown in Fig. 4.

Fig. 6 is a schematic plan view of the drum-type washing and drying machine shown in Fig. 1.

Fig. 7 is a schematic perspective view of the drum-type washing and drying machine shown in Fig. 1.

Fig. 8 is a schematic perspective view of components disposed in an upper space of the drum-type washing and drying machine shown in Fig. 1.

Fig. 9 is a perspective view schematically showing an upper configuration of the drum-type washing and drying machine shown in Fig. 1.

Fig. 10 is a perspective view schematically showing a supporting member in the washing and drying machine shown in Fig. 1.

Fig. 11 is a perspective view schematically showing the drum-type washing and drying machine shown in Fig. 1.

Fig. 12 is a perspective view schematically showing another arrangement of the supporting member in the drum-type washing and drying machine shown in Fig. 1.

Fig. 13 is a perspective view schematically showing the drum-type washing and drying machine shown in Fig. 12.

Fig. 14 is a perspective view schematically showing a conventional washing and drying machine configured to dry clothing with a heat pump.

Fig. 15 is a schematic cross-sectional view showing a support structure configured to support components disposed in an upper space formed in a housing of a conventional washing and drying machine for drying clothing with a heat pump.

Description of the Preferred Embodiments

[0020] A drying machine according to one embodiment is now described with reference to the accompanying drawings. In this embodiment, a drum-type washing and drying machine is exemplified as the drying machine. Alternatively, the drying machine may be a different type of washing and drying machines. Furthermore, the drying machine may also be drying equipment without a washing function. Accordingly, detailed structures described below does not in any way limit principles according to this embodiment.

(Overall configuration of drum-type washing and drying machine)

[0021] Fig. 1 is a schematic cross-sectional view of the drum-type washing and drying machine. Fig. 2 is a perspective view partially showing a front surface of the drum-type washing and drying machine. Fig. 3 is a perspective view schematically showing an internal structure of the drum-type washing and drying machine.

[0022] A washing and drying machine 500 comprises a housing 1 including a wall configured to define an internal space for housing various elements (for example, rotating drum 3, water tank 2 and heat pump device 30 described later) for cleaning and drying the clothing. The wall of the housing 1 includes a front wall 1e disposed on the front side, a rear wall 1d disposed opposite to the front wall 1e, a right wall 1a disposed between the front wall 1e and the rear wall 1d, and a left wall 1b disposed opposite to the right wall 1a. The front wall 1e, the rear wall 1d, the right wall 1a and the left wall 1b vertically stand. In this embodiment, at least one of the right wall 1a and the left wall 1b is exemplified as a side wall. Moreover, the right wall 1a is exemplified as a first side wall, and the left wall 1b is exemplified as a second side wall.

[0023] The wall of the housing 1 includes an upper wall 1 c surrounded by upper edges of the front wall 1e, the rear wall 1d, the right wall 1a and the left wall 1b, and a bottom wall If surrounded by lower edges of the front wall 1e, the rear wall 1d, the right wall 1a and the left wall 1b.

[0024] The front wall 1e is formed with an access opening through which the clothing is taken in and out. The washing and drying machine 500 further comprises a door 5 configured to open or close the access opening. The door 5 mounted on the front wall 1e is turned between an open position (refer to Fig. 1) for opening the access opening and a closed position (refer to Fig. 2) for closing the access opening.

[0025] The washing and drying machine 500 further comprises a substantially cylindrical rotating drum 3 disposed in the housing 1. The rotating drum 3 configured to wash and dry the clothing includes a peripheral wall 531 configured to form an opening in communication with the access opening of the front wall 1e, and a bottom wall 532 opposite to the opening formed by the peripheral wall 531. Clothing thrown through the access opening is stored in the rotating drum 3. In this embodiment, the rotating drum 3 is exemplified as a storage.

[0026] The washing and drying machine 500 further comprises an approximately cylindrical water tank 2 disposed in the housing 1. The water tank 2 includes a peripheral wall 521 surrounding the peripheral wall 531 of the rotating drum 3, and a bottom wall 522 along the bottom wall 532 of the rotating drum 3. The water tank 2 internally stores wash water for washing the clothing. In this embodiment, the water tank 2 is exemplified as an outer vessel.

[0027] The washing and drying machine 500 further comprises a water supply pipe (not shown) configured to supply water to the water tank 2. The water supply pipe connected to the water tank 2 includes a water supply valve (not shown). The water supply valve is used for controlling the water supply to the water tank 2. The washing and drying machine 500 further comprises a drainage pipe (not shown) configured to drain water from the water tank 2. The drainage pipe connected to the water tank 2 includes a drain valve (not shown). The drain valve is used for controlling the drainage from the water tank 2.

[0028] An exhaust outlet 11 is formed at an upper part of the peripheral wall 521 of the water tank 2. The dry air after drying the clothing in the rotating drum 3, which is rotatably mounted in the water tank 2, is efficiently discharged from the exhaust outlet 11. In this embodiment, the exhaust outlet 11 is formed above the maximum liquid level of the wash water in the water tank 2/rotating drum 3 so as to prevent the wash water from flowing out from the exhaust outlet 11. If drying apparatuses without washing functions is used as the drying machine, the exhaust outlet 11 may be formed at an arbitrary location on the peripheral wall 531 of the rotating drum 3 or the bottom wall 532.

[0029] As shown in Fig. 3, the washing and drying machine 500 further comprises a damper 523 including an upper end connected to the peripheral wall 521 of the water tank 2 and a lower end connected to the bottom wall 1f of the housing 1. The rotating drum 3 rotates in the water tank 2. The damper 523 configured to support the water tank 2 in the housing 1 absorbs vibration caused by the rotation of the rotating drum 3.

[0030] The washing and drying machine 500 further comprises a drive motor 7 configured to rotate the rotating drum 3. The drive motor 7 is mounted on an outer surface of the bottom wall 522 of the water tank 2. A rotational axis of the rotating drum 3 which is rotated by the drive motor 7 is tilted upward toward the front side.

[0031] The clothing in the rotating drum 3 sometimes causes unbalance of weight in the rotating drum 3 and/or the water tank 2. Consequently, vibration caused by the rotation of the rotating drum 3 is transmitted to the water tank 2. The damper 523 supporting the water tank 2 attenuates the vibration from the water tank 2.

[0032] As described above, the door 5 for opening and closing the access opening of the rotating drum 3 is mounted on the front wall 1e of the housing 1. A user may open the door 5 to put or take out the clothing into or from the rotating drum 3.

[0033] As shown in Fig. 2, the washing and drying machine 500 further comprises an operation panel 4. The operation panel 4 is disposed along an upper edge of the front wall 1e of the housing 1. The operation panel 4 includes various operation keys 541, which are used for operating the washing and drying machine 500, and a display window 542 configured to display various types of information such as operation modes of the washing and drying machine 500.

[0034] The washing and drying machine 500 further comprises a detergent supply unit 10 configured to hold detergent inside the housing 1. The detergent supply unit 10 disposed at the lower left side of the operation panel 4 may be pulled out toward the front side. The detergent supply unit 10 comprises a storage container (not shown) configured to hold the detergent in the housing 1. The storage container may be divided, for example, into a first storage part (not shown) configured to accommodate powder detergent, a second storage part (not shown) configured to accommodate liquid detergent and a third storage part (not shown) configured to house softener.

(Heat Pump Device)

[0035] Fig. 4 is a schematic plan view of the washing and drying machine 500. Fig. 5 is a cross-sectional view along a line A-A shown in Fig. 4. Fig. 6 is a schematic plan view of the washing and drying machine 500. Fig. 7 is a schematic perspective view of the washing and drying machine 500. The heat pump device is now described with reference to Fig. 1, and Figs. 3 to 7.

[0036] The washing and drying machine 500 comprises a heat pump device 30 configured to dry the clothing. The washing and drying machine 500 uses the heat pump device 30 to dehumidify and heat the dry air exhausted from the rotating drum 3.

[0037] As described above, the housing 1 forms an internal space for accommodating various devices such as the rotating drum 3, the water tank 2 and the heat pump device 30. In the following description, a narrow space above the water tank 2 in the internal space of the housing 1 is referred to as an upper space. Moreover, a space below the water tank 2 in the internal space of the housing 1 is referred to as a lower space. The heat pump device 30 and most of the various elements, which form a circulatory path of dry air between the heat pump device 30 and the rotating drum 3, are disposed in the upper space. As shown in Figs. 1 and 7, heavier components (for example, the heat pump device 30) are disposed in the upper space in the housing 1. As described later, the washing and drying machine 500 comprises a support structure configured to appropriately support the heavier components in the upper space. The support structure may appropriately support the heavier components in the upper space even if the washing and drying machine 500 is accidentally dropped or toppled.

[0038] As shown in Fig. 1, the washing and drying machine 500 further comprises a circulatory ventilation flue 8 which communicates the water tank 2 and the heat pump device 30. The circulatory ventilation flue 8 includes an upstream ventilation flue 581 extending upward from the exhaust outlet 11, and a downstream ventilation flue 582 connected to the bottom wall 522 of the water tank 2.

[0039] The washing and drying machine 500 further comprises a filter 40 disposed between the upstream ventilation flue 581 and the heat pump device 30. The filter 40 connected to the upstream ventilation flue 581 removes lint (dust components) in the dry air. The dry air thereafter flows into the heat pump device 30. As described above, the heat pump device 30 dehumidifies and heats the dry air.

[0040] The washing and drying machine 500 further comprises a blower 9 disposed between the heat pump device 30 and the downstream ventilation flue 582. The blower 9 sucks the dry air from the exhaust outlet 11 of the water tank 2 and thereafter re-sends the dry air into the rotating drum 3 through the downstream ventilation flue 582. The dry air sent from the blower 9 is thereby circulated along a circulatory path defined by the circulatory ventilation flue 8.

[0041] As described above, in this embodiment, the various elements (filter 40, heat pump device 30 and blower 9) forming the circulatory path of the dry air between the heat pump device 30 and the rotating drum 3 are intensively disposed in the upper space, which results in less pressure loss and faster circulation of the dry air to achieve sufficient air volume.

[0042] As shown in Figs. 3 to 5, the heat pump device 30 comprises a compressor 31 configured to compress refrigerant, a heat exchanger 80 configured to dry the clothing in the rotating drum 3, and a decompressor 33 including an expansion valve (or capillary tube) to decrease pressure of the pressurized refrigerant. The heat exchanger 80 comprises a heating portion 32 configured to radiate heat of the heated and pressurized refrigerant after the compression by the compressor 31, and a dehumidifier 34 configured to absorb heat from the periphery with the decompressed, low-pressure refrigerant. In this embodiment, the heating portion 32 is exemplified as a radiator, and the dehumidifier 34 is exemplified as a heat absorber.

[0043] As shown in Fig. 3, the heat pump device 30 further comprises a pipe line 20 configured to connect the compressor 31, the heating portion 32 and the dehumidifier 34, which are used for the heat exchanger 80, and the decompressor 33. The refrigerant flowing through the pipe line 20 is circulated among the compressor 31, the heating portion 32, the dehumidifier 34 and the decompressor 33.

[0044] Fig. 3 shows a generatrix G extending from an apex 2a (the uppermost point of the discoid bottom wall 522) of the bottom wall 522 of the water tank 2. The generatrix G is the uppermost one of generatrices representing an outer surface of the peripheral wall 521 of the water tank 2.

[0045] The compressor 31 above the peripheral wall 521 of the water tank 2 is shifted toward the right wall1a with respect to the generatrix G. The compressor 31 includes a bottom surface 31a below the generatrix G. Since the upper space above the peripheral wall 521 of the water tank 2 is beneficially used for mounting the compressor 31, the heat pump device 30 comprising the compressor 31 may be appropriately accommodated in the smaller housing 1. Since the compressor 31 is shifted toward the right wall 1a (or left wall 1b) with respect to the uppermost generatrix G, the heat pump device 30 may be disposed in the upper space without increase in height of the housing 1, which results in downsizing of the washing and drying machine 500.

[0046] The refrigerant flowing through the pipe line 20 in the heating portion 32 exchanges heat with the peripheral air (dry air flowing from the filter 40 into the heating portion 32). Consequently, while the refrigerant is heated and vaporized, moisture in the dry air becomes condensed, so that the moisture in the dry air is consequently removed.

[0047] The vaporized refrigerant flows into the compressor 31. The compressor 31 compresses the refrigerant, which result in the heated and pressurized refrigerant, which thereafter flows into the heating portion 32. In the heating portion 32, the refrigerant exchanges heat with the peripheral (dry air flowing from the dehumidifier

34 into the heating portion 32). Consequently, while the dry air is heated, the refrigerant is cooled and liquefied.

[0048] The decompressor 33 decompresses the liquefied high-pressure refrigerant, which results in low temperature and low pressure of the refrigerant, which flows into the dehumidifier 34 once again.

[0049] As described above, the blower 9 blows the dry air toward the water tank 2 through the downstream ventilation flue 582. The dry air thereafter flows into the rotating drum 3 through the water tank 2. The clothing in the rotating drum 3 is thereby dried.

[0050] As a result of drying the clothing, the dry air contains a larger amount of moisture. As described above, the blower 9 sucks the dry air in the rotating drum 3 from the exhaust outlet 11 of the water tank 2. The dry air thereby reaches the heat pump device 30 via the upstream ventilation flue 581 and the filter 40.

[0051] As described above, the dehumidifier 34 of the heat pump device 30 initially dehumidifies and cools the dry air. Consequently, the moisture in the dry air becomes condensed and is separated from the dry air. The dry air thereafter flows into the heating portion 32. The heating portion 32 heats the dry air as described above. Consequently, the dry air after passing through the heat pump device 30 becomes a higher temperature and a lower humidity. The blower 9 re-sends the heated and less humid dry air to the rotating drum 3.

[0052] The washing and drying machine 500 comprises a fixing member 38 configured to connect the heat pump 30 with the blower 9. As shown in Figs. 4 and 6, the blower 9 fixed to the heat pump device 30 with the fixing member 38 is disposed near the compressor 31. In this embodiment, the blower 9 is disposed between the compressor 31 and the left wall 1b. Since the left space of the compressor 31 shifted toward the right wall 1a with respect to the generatrix G of the peripheral wall 521 of the water tank 2 is beneficially used for installing the blower 9, the blower 9 may appropriately accommodated in the compact housing 1. Arrangement of the heat pump device 30 and the blower 9 aligned between the right wall 1a and the left wall 1b is less likely to require increase in height of the housing 1. Accordingly, the compact washing and drying machine 500 is provided.

[0053] Lint (dust components) is generated from the clothing to be dried in the rotating drum 3. Adhesion and accumulation of the lint to the heat exchanger 80 worsens circulation efficiency of dry air and the heat exchange efficiency of the heat exchanger 80.

[0054] The washing and drying machine 500 comprises a filter 40 disposed at an upstream position of the heat exchanger 80. The filter 40 traps and collects foreign matter such as lint, dust and pollen from the dry air before the dry air passes through the heat exchanger 80 to prevent infiltration of the lint to the heat exchanger 80. The filter 40 mounted on the circulatory ventilation flue 8 in the upper space of the housing 1 is provided near the front wall 1e. Accordingly, a user or a worker trying to remove the lint accumulated in the filter 40 may perform maintenance work while standing near the front wall 1e of the housing 1, which results in more efficient maintenance work for the washing and drying machine 500.

[0055] As shown in Fig. 5, the filter 40 includes a first filter 40A, and a second filter 40B disposed a downstream side of the first filter 40A. The first filter 40A is coarser than the second filter 40B. Accordingly, the second filter 40B traps and collects smaller lint and other foreign matter which are passed through the first filter 40A, which results in less deterioration in heat exchange efficiency of the heat pump device 30 and circulation efficiency of the blower 9, which are caused by the adhesion of lint and other foreign matter. Moreover, the filter 40 is likely to prevent scatter of lint and other foreign matter outside the housing 1, which results in less contamination around the washing and drying machine 500.

[0056] As shown in Fig. 2, an opening 40c is formed on the upper wall 1c of the housing 1. The first filter 40A is attached to and removed from the circulatory ventilation flue 8 through the opening 40c formed near a front edge of the upper wall 1c. Accordingly, the user or the worker may attach or remove the first filter 40A to and from the housing 1 while standing near the front wall 1e of the housing 1, which results in highly efficient maintenance work for the washing and drying machine 500.

[0057] Unlike the first filter 40A, the second filter 40B is fixed to the circulatory ventilation flue 8. Since the first filter 40A removes the lint and other foreign matter in the dry air before the second filter 40B, the second filter 40B less frequently clogs. Moreover, the user or the worker may clean the second filter 40B through the opening 40c formed on the upper wall 1c of the housing 1. Accordingly, less efforts are required to resolve the clogging of the second filter 40B fixed to the circulatory ventilation flue 8.

[0058] The heat exchanger 80 is disposed immediately after the second filter 40B. As described above, the heat exchanger 80 causes flow of the refrigerant heated by the compressor 31. The second filter 40B fixed to the circulatory ventilation flue 8 prevents a user unfamiliar with the maintenance work from easily contacting the heat exchanger 80. In addition, unlike the first filter 40A, since the second filter 40B is fixed to the circulatory ventilation flue 8, position of the second filter 40B is less likely to change, which result in less infiltration of lint into the heat exchanger 80, which is caused by inappropriate installation of the second filter 40B.

[0059] The filter 40 causes pressure loss of dry air. As a result of such pressure loss, velocity distribution of dry air becomes flatter (i.e. flow of the dry air is regulated). As shown in Figs. 4 and 5, the filter 40 is disposed immediately before the heat exchanger 80. Accordingly, the regulated dry air flows into the heat exchanger 80.

[0060] In general, if the circulatory ventilation flue is shortened in order to downsize the washing and drying machine, it becomes more difficult to install a regulation mechanism (for example, a straight pipe) in the circulatory ventilation flue. However, according to this embodiment, since the filter 40 regulates the dry air, it requires shorter flow length to regulate the dry air. The inflow of the regulated dry air to the heat exchanger 80 is less likely to cause local and large change in the heat exchange efficiency, which results in improved heat exchange efficiency of the heat exchanger 80.

[0061] As described above, the filter 40 provided at the upstream position of the heat exchanger 80 regulates the dry air without installation of a ragulation mechanism (for example, a straight pipe) in the circulatory ventilation flue 8. The shorter circulatory ventilation flue 8 may be thereby suitably designed.

[0062] As shown in Figs. 1 and 5, the dehumidifier 34 of the heat exchanger 80 includes an introductory surface 534 into which the dry air flows. The filter 40 is disposed near the introductory surface 534. Accordingly, the dry air regulated with the filter 40 is linearly sent to the dehumidifier 34 disposed immediately after the filter 40.

[0063] As described above, the filter 40 regulates the dry air to decrease a flow rate of the dry air. Since the circulatory ventilation flue 8 hardly inflects the flow direction of the dry air between the filter 40 and the introductory surface 534, the dry air linearly flows into the dehumidifier 34 immediately after the reduction in the flow rate. Consequently, the dry air after passing through the dehumidifier 34 is less likely to locally become a high flow rate, which results in less scatter of the water component condensed at the dehumidifier 34.

[0064] As shown in Fig. 5, the washing and drying machine 500 further comprises a recovery structure 35 configured to recover the water component condensed at the dehumidifier 34. The recovery structure 35 is disposed below the dehumidifier 34. As described above, since the filter 40 hardly causes the scatter of the water component condensed at the dehumidifier 34, the water component may be sufficiently recovered by using the smaller recovery structure 35, which results in downsizing of the washing and drying machine 500.

[0065] A concave part (not shown) is formed on the recovery structure 35. The water component condensed at the dehumidifier 34 seeps into the concave part across a surface of the dehumidifier 34. A range of the concave part may be determined so that the concave part appropriately receives the water component scattered downstream by the dry air.

[0066] As described above, the filter 40 for regulating the dry air decreases the scatter of the water component condensed at the dehumidifier 34. Accordingly, a smaller area of the concave part is acceptable to receive the water component seeping from the dehumidifier 34. Therefore the water component may be appropriately recovered with the smaller recovery structure 35.

[0067] As described above, the water component less scattered by the filter 40 is appropriately recovered with the recovery structure 35. The recovered water component is preferably discharged from the concave part of the recovery structure 35 to the outside of the washing and drying machine 500. For example, the water component may be drained together with the wash water to the drain outlet provided below the housing 1.

[0068] The recovery structure 35 is disposed in the upper space of the housing 1 together with the heat exchanger 80. Accordingly, the water component recovered with the recovery structure 35 is appropriately drained using potential energy. The discharge of the water component from the recovery structure 35 does not require a dedicated discharge system such as a pump, which result in the compact washing and drying machine 500.

[0069] As described above, the filter 40 disposed immediately before the heat exchanger 80 effectively inhibits inflow of lint and other foreign matter into the heat exchanger 80. Nevertheless, as a result of longer usage of the washing and drying machine 500, lint and other foreign matter may become adhered to and/or accumulated in the heat exchanger 80.

[0070] As described above, the heat exchanger 80 is provided at the upper, portion in the housing 1. A worker may remove the first filter 40A through the opening 40c formed on the upper wall 1 c of the housing 1. Subsequently, the worker may remove the second filter 40B from the circulatory ventilation flue 8 with a special tool. The worker may thereby access the heat exchanger 80 to remove the lint and other foreign matter from the heat exchanger 80. The worker may perform the series of operations such as removing the first filter 40A, the second filter 40B and cleaning out lint and other foreign matter from the heat exchanger 80 while standing near the front wall 1e of the housing 1, which results in more efficient maintenance work for the washing and drying machine 500.

(Structure of Filter)

[0071] The structure of the filter 40 is now described with reference to Fig. 5.

[0072] The substantially cylindrical first filter 40A of the filter 40 includes a coarser filter mesh than the filter mesh used as the second filter 40B. The first filter 40A includes a peripheral surface formed with an opening. The opening formed on the peripheral surface of the first filter 40A is used as an inflow portion 41 into which the dry air flows. The dry air discharged from the rotating drum 3 flows into the first filter 40A via the inflow portion 41.

[0073] The second filter 40B fixed at a downstream position of the first filter 40A includes a flat filter mesh.

[0074] The filter 40 comprises a cover part 42 disposed above the first filter 40A. When the first filter 40A is mounted on the washing and drying machine 500, the cover part 42 is fitted into the opening 40c formed on the upper wall 1c of the housing 1. The cover part 42 is preferably formed in a shape so that it can be gripped by a user. When the user tries to mount the first filter 40A, the user may use the cover part 42 as a knob member.

[0075] The substantially cylindrical first filter 40A includes an area L_L which causes considerable pressure loss, and an area L_S which causes less pressure loss. The area L_S existing at the approximate center of the first filter 40A is opposite to the inflow portion 41 and directly collides with the dry air flowing from the inflow portion 41. The area L_L exists above and below the area L_S.

[0076] The dry air flows into the heat exchanger 80 after passing through the cylindrical first filter 40A, which causes the aforementioned pressure loss distribution. As a result of the aforementioned pressure loss, the velocity distribution of the dry air which flows faster in an upper part of the dehumidifier 34 and slower in a lower part of the dehumidifier 34 is obtained. The cylindrical first filter 40A is preferably disposed near the introductory surface 534 of the dehumidifier 34, which results in effectively less scatter of the water component condensed at the dehumidifier 34.

[0077] Droplets of the water component condensed at the dehumidifier 34 are smaller at the upper part of the dehumidifier 34. While the droplets of the water component seep downward, the droplets get mixed with droplets of other water components. Consequently, the droplets of the water component gradually become larger as they seep downward. Accordingly, while larger droplets of the water component become adhered to the lower part of the dehumidifier 34, smaller droplets of the water component become adhered to the upper part of the dehumidifier 34.

[0078] As described above, the velocity of the dry air at the lower part of the dehumidifier 34 is smaller than the velocity of the dry air at the upper part of the dehumidifier 34. Accordingly, the larger droplets of the water component are less likely to be scattered, which results in a narrower scattering range of the water component condensed at the dehumidifier 34. Accordingly, the water component condensed at the dehumidifier 34 may be appropriately recovered with the smaller recovery structure 35.

(Comparison with conventional washing and drying machine)

[0079] The washing and drying machine 500 according to this embodiment comprises, as described above, the heat pump device 30 and the filter 40 fixed to the heat pump device 30. The filter 40 and the heat exchanger 80 of the heat pump device 30 are both disposed in the upper space of the housing 1 (space above the water tank 2). Accordingly, the filter 40 is disposed near the heat exchanger 80.

[0080] The filter 40, the heat exchanger 80 and the blower 9 are disposed in sequence along the flow direction of dry air. The filter 40 regulates the dry air. The regulated dry air flows into the heat exchanger 80. The heat exchanger 80 dehumidifies and heats the dry air. The blower 9 thereafter sends the dry air to the rotating drum 3.

[0081] A conventional washing and drying machine comprises a heat pump device disposed in the lower space of the housing (space below the water tank), and a filter disposed in the upper space of the housing (space above the water tank). The filter, the blower and the heat exchanger are disposed in order along the flow direction of the dry air.

[0082] As described above, in this embodiment, since the filter 40 is disposed near the heat exchanger 80, the dry air is circulated using the shorter circulatory ventilation flue 8 than the circulatory ventilation flue adopted in the aforementioned conventional washing and drying machine, which results in less pressure loss of the dry air flowing in the circulatory ventilation flue 8. The reduction in the pressure loss of dry air leads to less power consumption of the blower 9 to blow the dry air and increases in a flow rate of dry air flowing in the circulatory ventilation flue 8.

[0083] The filter 40 disposed in the shorter circulatory ventilation flue 8 regulates the dry air. The regulation of the dry air improves the heat exchange efficiency of the heat exchanger 80, which results in a more exchange amount of heat, power saving and shorter drying time, in comparison to a conventional washing and drying machine.

(Temperature Detection of Dry Air)

[0084] Temperature detection of the dry air is now described with reference to Fig. 5.

[0085] The washing and drying machine 500 further comprises a first temperature sensor 36 and a second temperature sensor 37. The first temperature sensor 36 and the second temperature sensor 37 are both used for detecting temperature of the dry air in the circulatory ventilation flue 8.

[0086] The first temperature sensor 36 detects the temperature of the dry air flowing between the rotating drum 3 and the heat exchanger 80. The first temperature sensor 36 is disposed between the filter 40 and the dehumidifier 34.

[0087] The second temperature sensor 37 detects the temperature of the dry air between the heat exchanger 80 and the rotating drum 3. The second temperature sensor 37 is disposed immediately after the blower 9.

[0088] The first temperature sensor 36 detects the temperature of the dry air before the dry air is dehumidified and heated by the heat exchanger 80. The second temperature sensor 37 detects the temperature of the dry air after the dry air is dehumidified and heated by the heat exchanger 80. The output signals of the first temperature sensor 36 and the second temperature sensor 37 are used for controlling the heat pump device 30.

[0089] The first temperature sensor 36 between the filter 40 and the heat exchanger 80 is provided near the area L_L where the pressure loss of the substantially cylindrical first filter 40A becomes larger (an upper portion or a lower portion of the first filter 40A). In the first filter 40A, lint and other foreign matter is less likely to clog the area L_L with a larger pressure loss than the area L_S with a smaller pressure loss. Accordingly, the first temperature sensor 36 provided near the area L_L may more accurately detect the temperature of the dry air for a long period. Since the temperature detected with the first temperature sensor 36 changes if lint and other foreign matter clog the filter 40, the output signal of the first temperature sensor 36 is used for detecting the clogging of the filter 40. Accordingly, the first temperature sensor 36 disposed near the area L_L may accurately detect the clogging of the filter 40 for a long period.

[0090] The first temperature sensor 36 between the filter 40 and the heat exchanger 80 and the second temperature sensor 37 disposed at a downstream position of the blower 9 are disposed inside a shorter circulatory ventilation flue 8. The interval between the first temperature sensor 36 and the second temperature sensor 37 becomes shorter. The first temperature sensor 36 and the second temperature sensor 37 in a shorter interval is less sensitive to an error factor (for example, leakage of dry air) which causes errors in the temperature detection. Accordingly, the first temperature sensor 36 and the second temperature sensor 37 may accurately detect the temperature of the dry air without being affected by error factors such as the leakage of dry air.

(Support Mechanism)

[0091] Fig. 8 is a schematic perspective view of components disposed in the upper space of the washing and drying machine 500. Fig. 9 is a perspective view schematically showing an upper configuration of the washing and drying machine 500. Fig. 10 is a perspective view schematically showing a supporting member of the washing and drying machine 500. Fig. 11 is a perspective view schematically showing the washing and drying machine 500. The support mechanism is now described with reference to Fig. 6 and Figs. 8 to 11.

[0092] The washing and drying machine 500 further comprises a support mechanism 560 configured to support the heat pump device 30 in the housing 1. The support mechanism 560 includes a supporting member 61 configured to support the heat pump device 30 and a confining member 62 configured to confine upward displacement of the heat pump device 30.

[0093] As shown in Fig. 10, both ends of the supporting member 61 supporting the heat pump device 30 between the compressor 31 and the confining member 62 are engaged with upper edges of the right wall 1a and the left wall 1b, respectively. Similarly, both ends of the confining member 62 are engaged with the upper edges of the right wall 1a and the left wall 1b, respectively.

[0094] The supporting member 61 extending between the right wall 1a and the left wall 1b below the heating portion 32 and/or the dehumidifier 34 disposed at an upstream position of the compressor 31 supports the heat pump device 30. At a farther position from the compressor 31 than the supporting member 61, the confining member 62 extending between the right wall 1a and the left wall 1b confines the upward displacement of the heat pump device 30: In this embodiment, the supporting member 61 is adjacent to the compressor 31. The confining member 62 extends above the filter 40 disposed at the upstream position of the heat pump device 30.

[0095] As shown in Fig. 8(A), the washing and drying machine 500 further comprises a screw 70 configured to fix the heat pump device 30 to the supporting member 61, and a helical coil wire screw thread insert (not shown) configured to engage with the screw 70. In this embodiment, the screw 70 and/or the helical coil wire screw thread insert configured to engaged with the screw 70 is exemplified as the first fixing member.

[0096] As shown in Fig. 8(B), the washing and drying machine 500 further comprises a screw 71 (refer to Fig. 6) configured to fix the filter 40 to the confining member 62 and a helical coil wire screw thread insert 72 configured to engage with the screw 71. As a result of connection between the filter 40 and the confining member 62, the heat pump device 30 is fixed to the confining member 62. In this embodiment, the screw 71 and/or the helical coil wire screw thread insert 72 is exemplified as the second fixing member.

[0097] In the heat pump device 30, the compressor 31 is relatively heavier. The weight of the compressor 31 is applied to the right wall 1a and the left wall 1b via the supporting member 61 supporting the heat pump device 30 in the vicinity of the compressor 31. Consequently, the weight of the compressor 31 reduces vibration of the upper edges of the right wall 1a and the left wall 1b caused by vibration factors such as the rotation of the rotating drum 3. The weight of the heat pump device 30 loaded on the right wall 1a and the left wall 1b means increase in weight of the vibratory element group including the right wall 1a and the left wall 1b. The increase in the weight of the vibratory element group including the right wall 1a and the left wall 1b decreases vibration amplitude arising from the same excitation force. Consequently, since considerable downward force is applied to the right wall 1a and the left wall 1b of the housing 1, even if the right wall 1a and the left wall 1b are subjected to the rotation of the rotating drum 3 or other vibration factors, the vibration of the right wall 1a and the left wall 1b suitably decreases, which means less overall vibration of the housing 1.

[0098] The support mechanism 560 comprising the supporting member 61 uses the gravity working on the heat pump device 30 including the compressor 31 to press the upper edges of the right wall 1a and the left wall 1b to effectively decrease the vibration of the right and left walls 1a and 1b of the housing 1 caused by the rotation of the rotating drum 3 and other vibration factors.

[0099] Fig. 12 is a perspective view showing alternative arrangement of the supporting member in the washing and drying machine 500. Fig. 13 is a schematic perspective view of the washing and drying machine 500. The alternative arrangement of the supporting member is now described with reference to Figs. 12 and 13.

[0100] The weight of the compressor 31 may be loaded on one of the right wall 1a and the left wall 1b. For example, as shown in Fig. 13, the support mechanism 560 may comprise a supporting member 63 extending between the right wall 1a and the rear wall 1d in stead of the aforementioned supporting member 61. As shown in Fig. 13, the compressor 31 is disposed at a corner between the right wall 1a and the rear wall 1d. Since the compressor 31 is surrounded by the right wall 1a, the rear wall 1d and the supporting member 63, even if the washing and drying machine 500 is dropped or toppled, the heavier compressor 31 is appropriately supported by the right wall 1a, the rear wall 1d and the supporting member 63.

[0101] The support mechanism 560 is now described in further detail with reference to Figs. 4, 6 and Figs. 9 to 13.

[0102] As shown in Fig. 9, the blower 9 disposed near the compressor 31 is fixed to the heat pump device 30 with the fixing member 38 (refer to Fig. 4 or 6). Accordingly, the weight of the blower 9 is loaded on the right wall 1a and/or the left wall 1b in addition to the weight of the heat pump device 30. Consequently, the vibration of the right wall 1a and/or the left wall 1b of the housing 1 caused by the rotation of the rotating drum 3 or other vibratory elements effectively decreases.

[0103] The blower 9 includes a blast fan 9b configured to cause the dry air flow in the circulatory ventilation flue 8, and a blast motor 9a configured to rotate the blast fan 9b. When the blast motor 9a rotates the blast fan 9b, the dry air after passing through the heat pump device 30 is sent into the rotating drum 3. The blast motor 9a is considerably heavier, similarly to the compressor 31. As described above, the blower 9 is disposed near the compressor 31. The supporting member 61, 63 below the blower 9 extends along the compressor 31 and the blower 9, so that the supporting member 61, 63 is also used for supporting the blower 9 in addition to the compressor 31, which results in a simpler structure for supporting heavier elements (compressor 31 and blower 9). The simpler support structure significantly contributes to reduction in a number of components, weight and cost of the washing and drying machine 500.

[0104] As described above, the confining member 62 above the heat pump device 30 extends between the right wall 1a and the left wall 1b. The confining member 62 is farther from the compressor 31 than the supporting member 61.

[0105] The confining member 62 is now described with reference to Figs. 1, 3 and 9.

[0106] As shown in Figs. 1 and 3, the heavier compressor 31 and the heavier blower 9 are disposed near the rear wall 1d. Meanwhile, lighter elements (for example, the heat exchanger 80) are closer to the front wall 1 e than the compressor 31 and the blower 9. Accordingly, a moment for uplifting the lightweight elements near the front wall 1e may work on the circulation mechanism of the dry air including the heat pump device 30.

[0107] The confining member 62 closer to the front wall 1e than the supporting member 61 prevents the upward displacement of the lighter elements such as the heat exchanger 80. In this embodiment, the filter 40 apart from the compressor 31 is connected to the heat pump device 30. The confining member 62 is provided across a space above the filter 40 between the heat pump device 30 and the front wall 1e. The confining member 62 appropriately confines the upward displacement of the filter 40 and the heat pump device 30 of the heat exchanger 80. Since the upward displacement of the lighter members disposed between the compressor 31 and the front wall 1e is integrally confined with the confining member 62, the support mechanism 560 is simplified, which results in less components, weight and cost of the washing and drying machine 500.

[0108] As described above, the confining member 62 comes in contact with the filter 40 which is separated from the compressor 31 to confine the upward displacement of the heat pump device 30. The heavier compressor 31 generates momentum around the supporting member 61. The moment generates upward force acting on the heat pump device 30 and the filter 40. The upward force applied to the heat pump device 30 and the filter 40 becomes greater as the heat pump device 30 and the filter 40 are more distanced from the supporting member 61. Since the confining member 62 confines the upward displacement of the filter 40 to which a larger force is applied, the heat pump device 30 and the filter 40 are stably held in the upper space.

[0109] Alternatively, the confining member 62 may be bridged across a space above the heat exchanger 80 of the heat pump device 30. The confining member 62 directly confines the upward displacement of the heat exchanger 80.

[0110] As described above, the heat pump device 30 and the peripheral elements (filter 40 and blower 9) of the heat pump device 30 are appropriately supported by the supporting members 61, 63 extending across a space below the heat pump device 30. Moreover, the confining member 62 is mounted across the space above the heat pump device 30 and/or the filter 40. The confining member 62 and the supporting member 61, 63 disposed above and below the heat pump device 30, respectively, suitably reduce the vertical vibration amplitude, which results in less overall vibration of the housing 1 caused by the rotation of the rotating drum 3.

[0111] The aforementioned support mechanism 560 inhibits failure modes such as the breakage or damage of a fixing member such as a screw 70, 71 for fastening various elements disposed in the upper space in the housing 1, in addition to the vibration of the housing 1. The support mechanism 560 may appropriately hold the heat pump device 30 and the peripheral elements (filter 40 and blower 9) of the heat pump device 30 even when, for example, the washing and drying machine 500 is accidentally dropped or toppled during transport and/or installation thereof. The effect of the support mechanism

560 on the fixing member used for fixing the elements is now described.

[0112] Several components are disposed in the upper space of the housing of an ordinary washing and drying machine as well. The components disposed in the upper space are typically connected to a supporting element such as an upper wall of the housing. If the washing and drying machine is dropped or toppled, the securing member (for example, a screw or a helical coil wire screw thread insert for engagement with the screw) for fixing the components in the upper space to the supporting element is subject to a greater tensile force due to the gravity working on the components in the upper space as well as an impact force caused by the toppling and the dropping. A securing member used for fixing heavier components is subject to much greater tensile force. Accordingly, the securing member used for fixing the components disposed in the upper space of the ordinary general washing machine is likely to break when the ordinary washing and drying machine is toppled or dropped.

[0113] In this embodiment, the compressor 31 and the blower 9 of the heat pump device 30 is heavier. The supporting member 61, 63 appropriately support the compressor 31 and/or the blower 9. Moreover, the confining member 62 farther from the compressor 31 than the supporting member 61, 63 is bridged across the space above the heat pump device 30 and/or the filter 40.

[0114] When the washing and drying machine 500 is dropped or toppled, the supporting member 61, 63 is subject to the weight of the heat pump device 30 and/or the blower 9 and the impact force associated with the dropping or toppling of the washing and drying machine 500. The weight of the heat pump device 30 and/or the blower 9 and the impact force associated with the dropping or toppling of the washing and drying machine 500 works as compression force against the supporting member 61, 63.

[0115] The compression force, which works on the supporting member 61, 63, also works on the fixing member such as a screw 70 or helical coil wire screw thread insert for fixing the supporting member 61, 63 and the heat pump device 30/ blower 9. Unlike the tensile force, the fixing member is, however, less likely to be broken by the compression force.

[0116] In this embodiment, the supporting member 61, 63 is disposed near the heavier compressor 31. Consequently, a moment is generated around the supporting member 61, 63. The moment around the supporting member 61, 63 is likely to uplift the lighter elements (filter 40 and heat exchanger 80) existing between the supporting member 61, 63 and the front wall 1e. The moment around the supporting member 61, 63 causes compression force on the confining member 62 installed across a space above the heat pump device 30 and/or the filter 40. The compression work working on the confining member 62 also works on the fixing member such as the screw 71 or the helical coil wire screw thread insert 72 for fixing the confining member 62 to the heat pump device 30 and/or the filter 40. Unlike the tensile force, the fixing member is, however, less likely to be broken by compression force.

[0117] As described above, the supporting member 61 disposed near the compressor 31 appropriately supports the heat pump device 30. Moreover, the confining member 32 apart from the compressor 31 appropriately confines the upward displacement of the heat pump device 30 or the filter 40 connected to the heat pump device 30. Accordingly, the support mechanism 560 may appropriately support the heat pump device 30 in the upper space of the housing 1.

[0118] A height of the housing of the ordinary washing and drying machine is increased according to a height of the supporting member for supporting the components in the upper space.

[0119] In this embodiment, the rotating drum 3 and the water tank 2 are tilted in the housing 1. Consequently, the upper space becomes wider near the rear wall 1d than near the front wall 1e. The larger volume of elements (compressor 31 and/or blower 9) is disposed in the upper space near the rear wall 1d. Accordingly, sufficiently wide space is provided for disposing the supporting member 61, 63 without the increase in the height of the housing 1.

[0120] The generatrix G defining the outer surface of the peripheral wall 521 of the water tank 2 is tilted downward from the front wall 1e toward the rear wall 1d. Accordingly, the closer to the rear wall 1d, the longer distance between an inner surface of the upper wall 1 c defining the upper boundary of the upper space and the peripheral wall 521 of the water tank 2 is. Since the heat pump device 30 is closer to the rear wall 1d than to the front wall 1e, not only the heat pump device 30 and also the supporting members 61, 63 configured to support the heat pump device 30 are appropriately disposed in the compact housing 1. In this embodiment, the front wall 1e is exemplified as a first wall. The rear wall 1d is exemplified as a second wall. The upper wall 1c is exemplified as a third wall.

(Arrangement of heat pump device)

[0121] The dehumidifier 34 and the heating portion 32 of the heat pump device 30 are preferably formed with highly conductive metal such as copper or aluminum. Since the heat pump device 30 is disposed above the water tank 2 as described above, the dehumidifier 34 and the heating portion 32 are less likely to be exposed to the wash water. Accordingly, the dehumidifier 34 and the heating portion 32 are less likely to cause metallic corrosion arising from chemical components such as detergent, softener or bleach contained in the wash water.

[0122] Since the dehumidifier 34 and the heating portion 32 of the heat exchanger 80 are linearly aligned with respect to the blower 9 along the circulatory path of the dry air, the dry air substantially linearly flows in the heat exchanger 80. In general, inflected flow of fluid results in drift and pressure loss of the fluid, but the linear arrangement of the dehumidifier 34 and the heating portion 32 according to this embodiment is less likely to cause such drift and pressure loss of the fluid, which results in an efficient circulation of dry air. Accordingly, the blower 9 consumes less power to blow the dry air in the circulatory ventilation flue 8.

[0123] The structure for fixing the blower 9 and the heat pump device 30 is now described with reference to Fig. 4.

[0124] The washing and drying machine 500 comprises a fastening member 38 for fixing the blower 9 to the heat pump device 30. The blower 9 fixed to the heat pump device 30 with the fastening member 38 is disposed beside the compressor 31. Consequently, as described above, the weight of the blower 9 is loaded to the right wall 1a and/or the left wall 1b, in addition to the weight of the heat pump device 30. The vibration of the right wall 1a and/or the left wall 1b caused by the rotation of the rotating drum 3 and other vibration factors thereby effectively decreases.

[0125] The blast motor 9a is considerably heavier, similarly to the compressor 31. The supporting member 61, 63 may support both the compressor 31 and the blower 9 because of the closer arrangement of the heavier compressor 31 and the heavier blower 9, which results in a simpler structure for supporting the heavier elements (compressor 31 and blower 9). The support of the heavier elements (compressor 31 and blower 9) using the simpler structure significantly contributes to reduction in a number of components, weight and cost of the washing and drying machine 500.

[0126] As a result of less drift of the dry air, the dry air passing through the dehumidifier 34 is less likely to become locally high speed. As described above, the dehumidifier 34 condenses the moisture in the dry air. The condensed water component will be carried once again to the rotating drum 3 via the blower 9 by the dry air if the high speed flow of the dry air locally occurs locally in the dehumidifier 34. Consequently, the clothing in the rotating drum 3 will absorb the water component once again. In this embodiment, the straight arrangement of the dehumidifier 34 and the heating portion 32 is less likely to cause the local high speed flow of the dry air as described above. Accordingly, there is hardly any deterioration in the drying efficiency arising from circulation of the condensed water component.

[0127] In general, if a flow rate of fluid passing through the heat pump device decreases, a heat absorber absorbs less heat from the fluid, which results in incomplete vaporization of refrigerant passing through the heat absorber. Subsequently, the incompletely vaporized refrigerant reaches a compression device. The compression device may potentially malfunction as a result of compressing a liquid refrigerant.

[0128] In this embodiment, since the linear arrangement of the dehumidifier 34 and the heating portion 32 maintains an appropriate flow rate of the dry air in the heat exchanger 80, the complete vaporization of the refrigerant in the dehumidifier 34 may be more easily achieved. Since a liquid refrigerant is less likely to flow into the compressor 31, the compressor 31 is less likely to malfunction, which results in higher reliability of the washing and drying machine 500 comprising the heat pump device 30. As a result of the higher reliability, continuous dehumidification may be achieved without stopping the compressor 31 to shorten the drying operation time.

[0129] It should be noted that ordinary refrigerant such as HFC (hydrofluorocarbon)-based refrigerant, HFO (hydrofluoroolefin)-based refrigerant and carbon dioxide refrigerant may be suitably used as the refrigerant employed in the heat pump device 30.

(Arrangement of Blower)

[0130] The arrangement of the blower 9 is now described with reference to Fig. 1.

[0131] As described above, the blower 9 comprises the blast motor 9a and the blast fan 9b. The blast motor 9a is mounted above the blast fan 9b. A rotational axis of the blower 9 is thereby tilted downward toward the upstream side. Consequently, even if the water component condensed at the dehumidifier 34 is scattered to the blower 9, the water component adhered to the blast fan 9b seeps in the opposite direction to the blast motor 9a because of the gravity and the blow from the blast fan 9b. Thus the water component adhered to the blast fan 9b hardly heads toward the blast motor 9a positioned above the blast fan 9b.

(Arrangement of Control Board)

[0132] The arrangement of the control board is now described with reference to Fig. 11.

[0133] The washing and drying machine 500 comprises a control board 50 disposed in the housing 1. The control board 50 is mounted with electronic components (various circuits) for controlling the washing and drying machine 500. The control board 50 is positioned above the detergent supply unit 10 accommodated in the housing 1.

[0134] In comparison to a control board disposed in the lower space of the housing, the control board 50 according to this embodiment requires a shorter lead wire for connecting electrical elements such as the drive motor 7 and the blast motor 9a. The control board 50 is disposed in the upper space of the housing 1 (preferably near the front wall 1e). Accordingly, the worker may repair the control board 50 while standing near the front wall 1e of the housing 1, which result in efficient maintenance work for the washing and drying machine 500.

(Alternative configuration)

[0135] In this embodiment, the filter 40 includes a first filter 40A and a second filter 40B and performs two-step filtering process. Alternatively, the drying machine may comprise a filter device configured to perform one-step filtering process by using a single filter element. Furthermore, the drying machine may also comprise a filter device configured to perform multistep filtering process including more than two steps by using more than two filter elements.

[0136] In this embodiment, the filter 40 comprises a substantially cylindrical first filter 40A. Alternatively, the drying machine may also comprise a flat filter element or a filter element of other shapes.

[0137] In this embodiment, the washing and drying machine 500 has a washing function and a drying function. Alternatively, the drying machine does not have to have the washing function. For example, if the washing function is removed from the aforementioned washing and drying machine 500, a drying machine with only the drying function is obtained. A drying machine with only the drying function does not require pipe lines such as the water supply pipe and the drainage pipe connected to the water tank 2 of the aforementioned washing and drying machine 500. The element corresponding to the aforementioned water tank 2 is used as an outer vessel for surrounding the rotating drum 3. The other elements may be the same as various elements of the aforementioned washing and drying machine 500.

[0138] In this embodiment, the washing and drying machine 500 is a drum-type washing and drying machine. Alternatively, the drying machine may also be an upright washing and drying machine for drying hung clothing. Even with the upright washing and drying machine, the principle according to the aforementioned embodiment may improve reliability of the heat pump device, shorten the drying time, and achieve lower power consumption.

[0139] The aforementioned embodiment primarily includes the drying machine configured as described below.

[0140] The drying machine according to one aspect of the aforementioned embodiment comprises a housing; an outer vessel supported in the housing; a rotatable storage mounted in the outer vessel and configured to accommodate clothing; a heat pump device configured to dry the clothing in the storage; a supporting member configured to support the heat pump device; and a first fixing member configured to fix the heat pump device to the supporting member, wherein the heat pump device disposed in an upper space formed above the outer vessel in the housing includes a compressor configured to compress refrigerant, and the supporting member below the heat pump device is disposed near the compressor.

[0141] According to the aforementioned configuration, the upper space is formed above the outer vessel in the housing. The heat pump device with a heavier compressor is disposed in the upper space. The supporting member disposed near the compressor and below the heat pump device supports the heat pump device. The supporting member may stably support the heat pump device even if the drying machine is accidentally dropped or toppled. When the drying machine is accidentally dropped or toppled, the supporting member is loaded by weight of the heat pump device and the impact force resulting from the dropping or toppling. The weight of the heat pump device and the impact force resulting from the dropping or toppling compress the supporting member. The compression force applied to the supporting member also works on the first fixing member configured to fix the heat pump device to the supporting member. Unlike with tensile force, the first fixing member is less likely to be broken with compression force. Accordingly, the supporting member may stably support the heat pump device even if the drying machine is accidentally dropped or toppled. Even if the drying machine is accidentally dropped or toppled, the heat pump device may continue to be supported in the upper space, so that the drying machine is less likely to be damaged. A more reliable drying machine is thereby provided.

[0142] In the aforementioned configuration, preferably, the drying machine further comprises a confining member disposed above the heat pump device; and a second fixing member configured to fix the heat pump device to the confining member, wherein the supporting member is disposed between the confining member and the compressor, and the confining member confines upward displacement of the heat pump device.

[0143] According to the aforementioned configuration, since the supporting member is disposed between the confining member above the heat pump device and the heavier compressor, a moment is generated around the supporting member. The moment around the supporting member generates force to displace the heat pump device upwardly. Since the confining member confines the upward displacement of the heat pump device, the heat pump device compresses the confining member. The compression of the confining member caused by the upward displacement of the heat pump device generates compression force to the second fixing member. Unlike with tensile force, the second fixing member is less likely to be broken with compression force. As a result of the heat pump device fixed to the upper confining member, the heat pump device is stably supported in the upper space.

[0144] In the aforementioned configuration, preferably, the drying machine further comprises a blower including a blast fan configured to blow dry air after passage through the heat pump device into the storage, and a blast motor configured to rotate the blast fan, wherein the blower fixed to the heat pump device is disposed near the compressor, and the supporting member disposed below the blower extends along the compressor and the blower to support the blower.

[0145] According to the aforementioned configuration, the blower includes a blast fan configured to blow dry air after passage through the heat pump device into the storage, and a blast motor configured to rotate the blast fan. The blower comprising the heavier blast motor is disposed near the compressor. The supporting member disposed below the blower extends along the compressor and the blower to support the blower. Since the supporting member with a simplified structure may support the heavier blower and the heavier compressor, a number of components, weight and cost of the drying machine may decrease.

[0146] In the aforementioned configuration, preferably, the drying machine further comprises a circulatory ventilation flue configured to define a circulation path of the circulated dry air between the outer vessel and the heat pump device; and a filter configured to prevent infiltration of dust components into the heat pump device, wherein the filter mounted on the circulatory ventilation flue in the upper space is fixed to the heat pump device, and the confining member comes in contact with the filter apart from the compressor to confine the upward displacement of the heat pump device.

[0147] According to the aforementioned configuration, the filter removes dust components from the dry air before it flows into the heat pump device. The filter is connected to the heat pump device. The confining member comes in contact with the filter which is disposed separated from the compressor to confine the upward displacement of the heat pump device. Since the confining member confines the upward displacement of the filter in addition to the heat pump device, the number of components, weight and cost of the drying machine may decrease.

[0148] The confining member apart from the compressor receives larger upward force from the filter. Since the confining member is disposed so as to receive a larger force, the heat pump device is stably held in the upper space.

[0149] In the aforementioned configuration, preferably, the housing includes an upright first wall, a second wall opposite to the first wall, and a third wall extending between the first wall and the second wall, the third wall defines an upper boundary of the upper space, the outer vessel includes a peripheral wall with an outer surface defined by a generatrix extending between the first wall and the second wall, the generatrix is tilted downward from the first wall to the second wall, and the heat pump device is closer to the second wall than to the first wall.

[0150] According to the aforementioned configuration, the housing includes the upright first wall, the second wall placed opposite to the first wall, and the third wall extending between the first wall and the second wall. The third wall defines the upper boundary of the upper space. The outer vessel includes the peripheral wall with the outer surface defined by the generatrix extending between the first wall and the second wall. Since the generatrix is tilted downward from the first wall toward the second wall, the upper space becomes vertically wider beside the second wall side. Since the heat pump device is closer to the second wall than to the first wall, the supporting member is appropriately disposed in the upper space. Accordingly, the supporting member configured to support the heat pump device in the upper space is appropriately disposed without increase in height of the housing.

[0151] The washing and drying machine according to another aspect of the aforementioned embodiment comprises a housing; an outer vessel supported in the housing and configured to store wash water; a rotatable storage mounted in the outer vessel and configured to wash and dry clothing; a heat pump device configured to dry the clothing in the storage; a supporting member configured to support the heat pump device; and a first fixing member configured to fix the heat pump device to the supporting member, wherein the heat pump device disposed in an upper space formed above the outer vessel in the housing includes a compressor configured to compress refrigerant, and the supporting member below the heat pump device are disposed near the compressor.

[0152] According to the aforementioned configuration, the heat pump device continues to be supported in the upper space even if the drying machine is accidentally dropped or toppled, so that the drying machine is less likely to be damaged. A more reliable drying machine is thereby provided.

Industrial Applicability

[0153] The principle of the aforementioned embodiment may be suitably applied to devices configured to dehumidify and heat dry air to dry clothing with a heat pump mechanism.

Claims

1. A drying machine (500) comprising:

   a housing (1);
   a storage (3) configured to accommodate clothing; a heat pump device (30) configured to dry the clothing in the storage (3);
   a supporting member (61, 63) configured to support the heat pump device (30); and
   wherein at least part of the heat pump device (30) is disposed in an upper space formed above the storage (3) in the housing (1).

2. The drying machine (500) according to claim 1 further comprising
   an outer vessel (2) supported in the housing (1); wherein the storage (3) is mounted in the outer vessel (2) and wherein the upper space is formed above the outer vessel (2).

3. The drying machine (500) of claim 1 or 2, wherein the storage is rotatable.

4. The drying machine (500) of claim 1 or 2, wherein a first fixing member (70) is configured to fix the heat pump device (30) to the supporting member (61, 63).

5. The drying machine (500) of one of preceding claims, wherein the supporting member (61, 63) is below at least part of the heat pump device (30) and/or is disposed near the compressor (31).

6. The drying machine (500) of one of preceding claims, wherein the heat pump device includes a compressor (31) configured to compress refrigerant.

7. The drying machine (500) according to claim 6 further comprising:

a confining member (62) disposed above the heat pump device (30); and
a second fixing member (71, 72) configured to fix the heat pump device (30) to the confining member (62),
wherein the supporting member (61, 63) is disposed between the confining member (62) and the compressor (31), and
the confining member (62) confines upward displacement of the heat pump device (30).

8. The drying machine (500) according to one of preceding claims, further comprising a blower (9) including a blast fan (9b) configured to blow dry air after passage through the heat pump device (30) into the storage (3), and a blast motor (9a) configured to rotate the blast fan (9b),
wherein the blower (9) fixed to the heat pump device (30) is disposed near the compressor (31), and
the supporting member (61) disposed below the blower (9) extends along the compressor (31) and the blower (9) to support the blower (9).

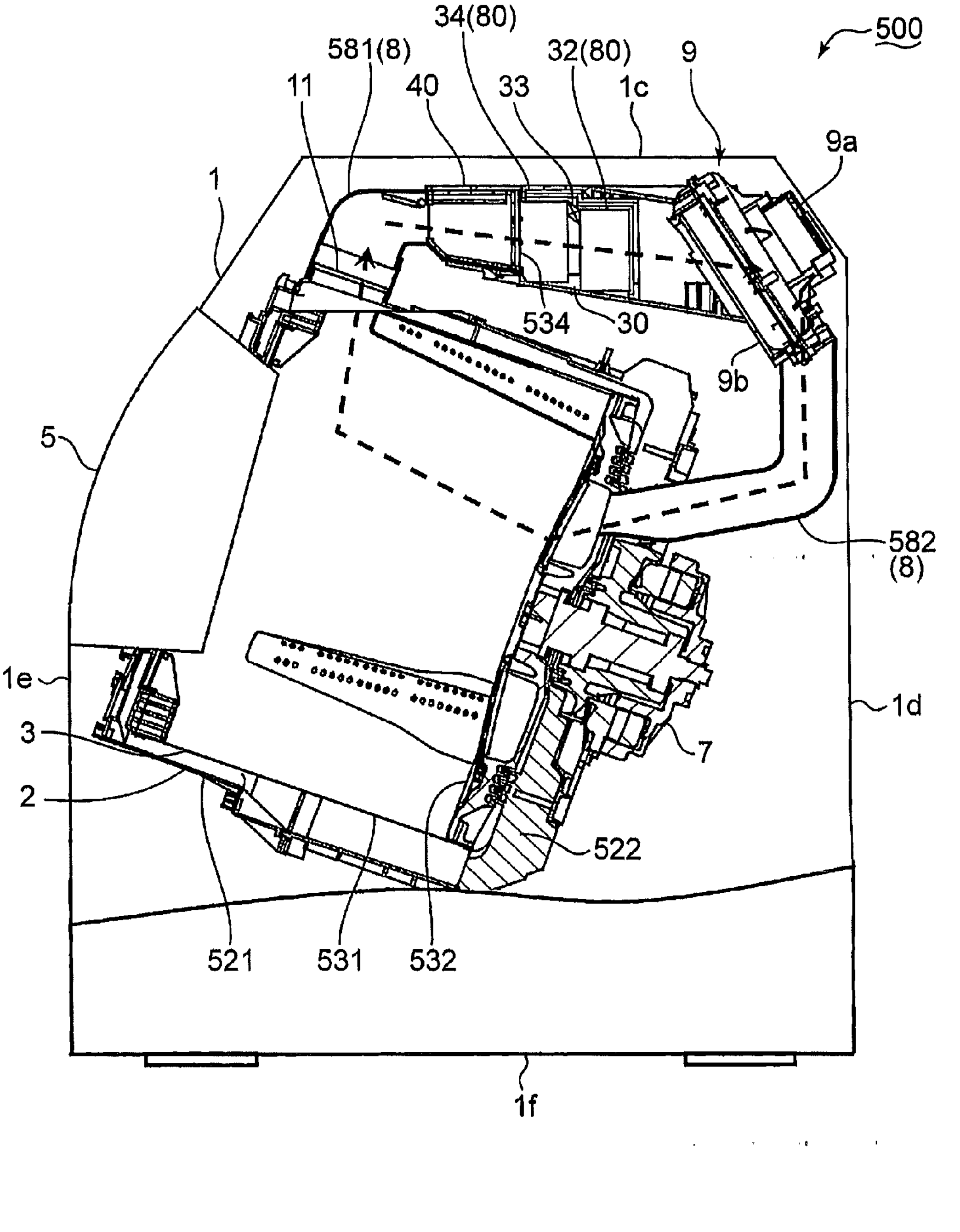
9. The drying machine (500) according to claim 7 or claim 8 as far as depending from claim 7 further comprising:

a circulatory ventilation flue (8) configured to define a circulation path of the circulated dry air between the outer vessel (2) and the heat pump device (30); and
a filter (40) configured to prevent infiltration of dust components into the heat pump device (30),
wherein the filter (40) mounted on the circulatory ventilation flue (8) in the upper space is fixed to the heat pump device (30), and
the confining member (62) comes in contact with the filter (40) apart from the compressor (31) to confine the upward displacement of the heat pump device (30).

10. The drying machine (500) according to any one of preceding claims,
wherein the housing (1) includes an upright first wall (1e), a second wall (1d) opposite to the first wall (1e), and a third wall (1c) extending between the first wall (1e) and the second wall (1d),
the third wall (1c) defines an upper boundary of the upper space,
the outer vessel (2) includes a peripheral wall (521) with an outer surface defined by a generatrix (G) extending between the first wall (1e) and the second wall (1d),
the generatrix (G) is tilted downward from the first wall (1e) to the second wall (1d), and the heat pump device (30) is closer to the second wall (1d) than to the first wall (1e).

11. A washing machine comprising the drying machine of one of preceding claims as far as including the claims 2 and 3, wherein
the outer vessel (2) is supported in the housing (1) and configured to store wash water;
and
the rotatable storage (3) is mounted in the outer vessel (2) and configured to wash and dry clothing.

FIG.1


500
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581(8)
32(80)
9
11
40
33
1c
9a
1
534
30
9b
5
582
(8)
1e
1d
3
7
2
522
521
531
532
1f

FIG.2

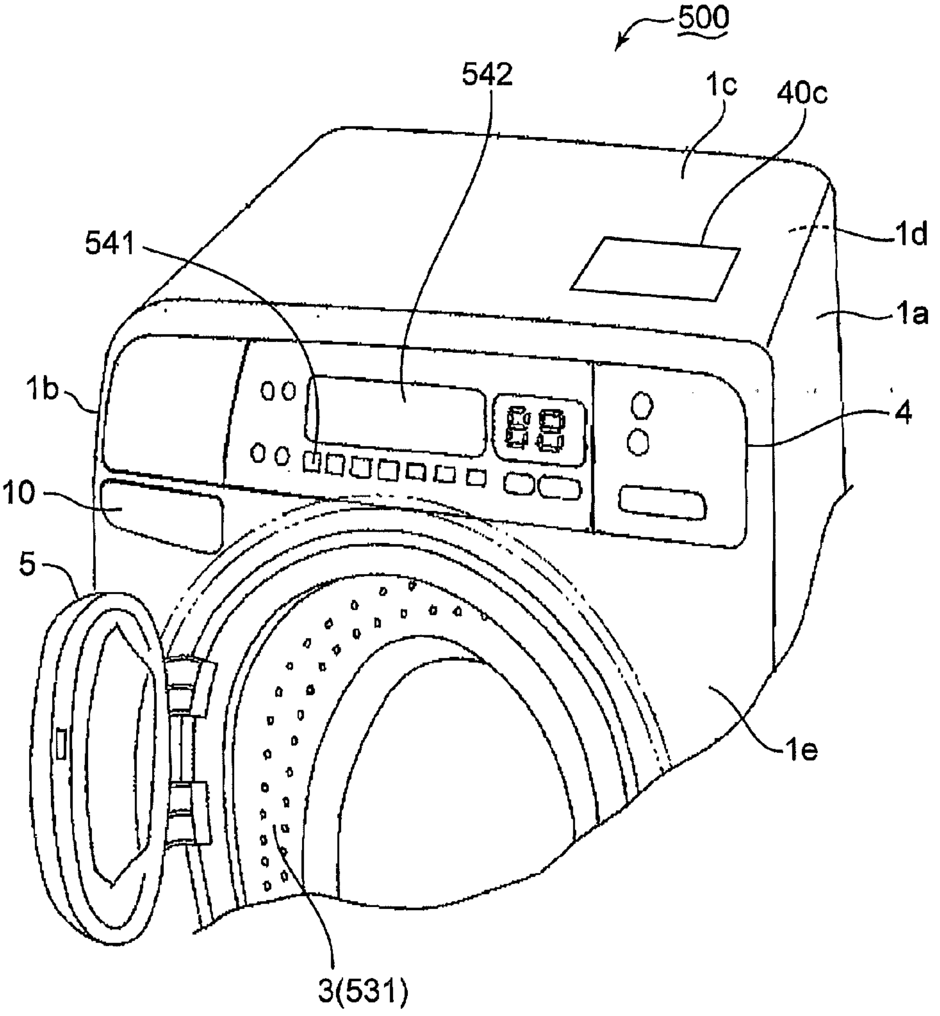
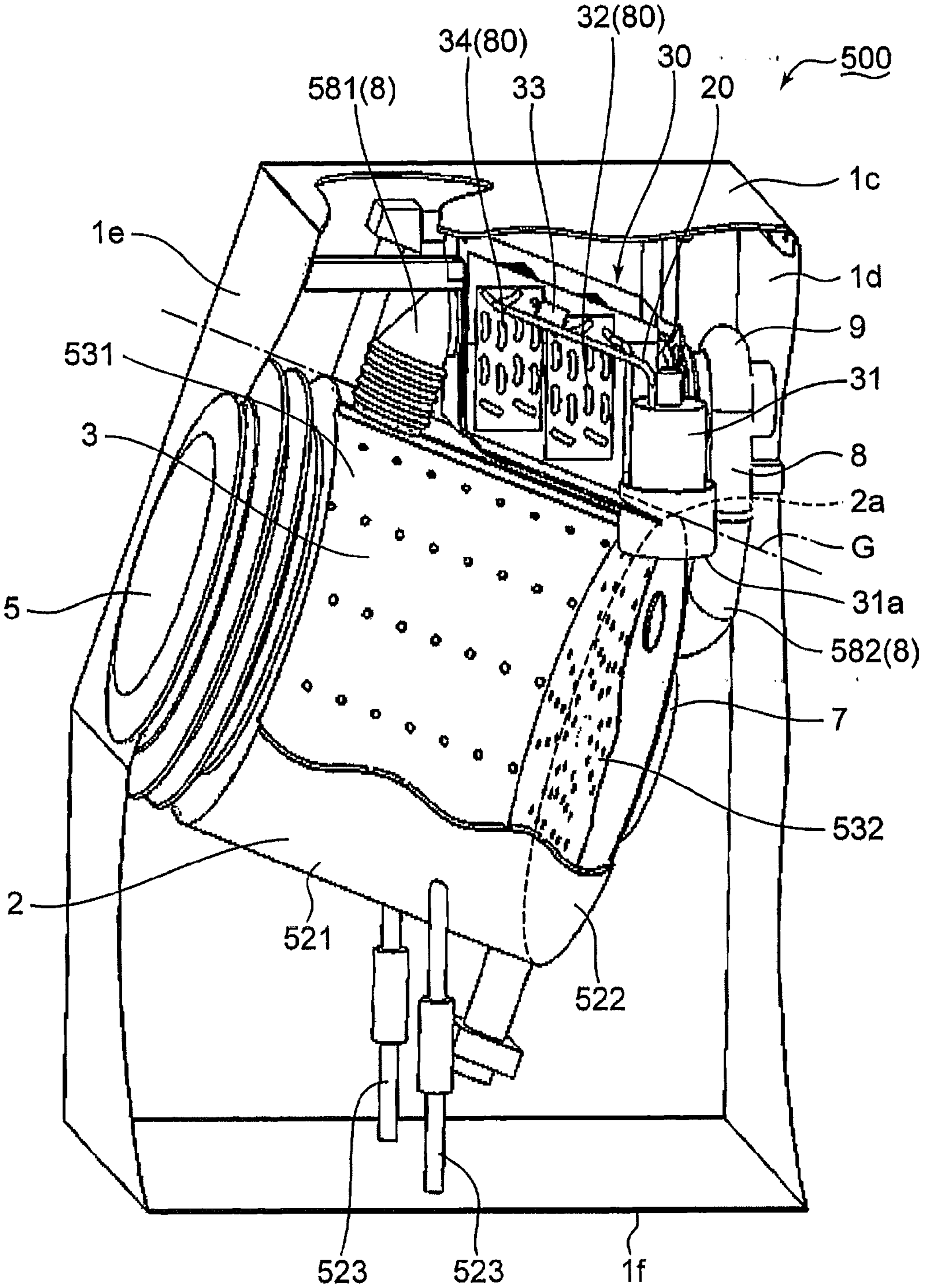


FIG.3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1f

FIG.4

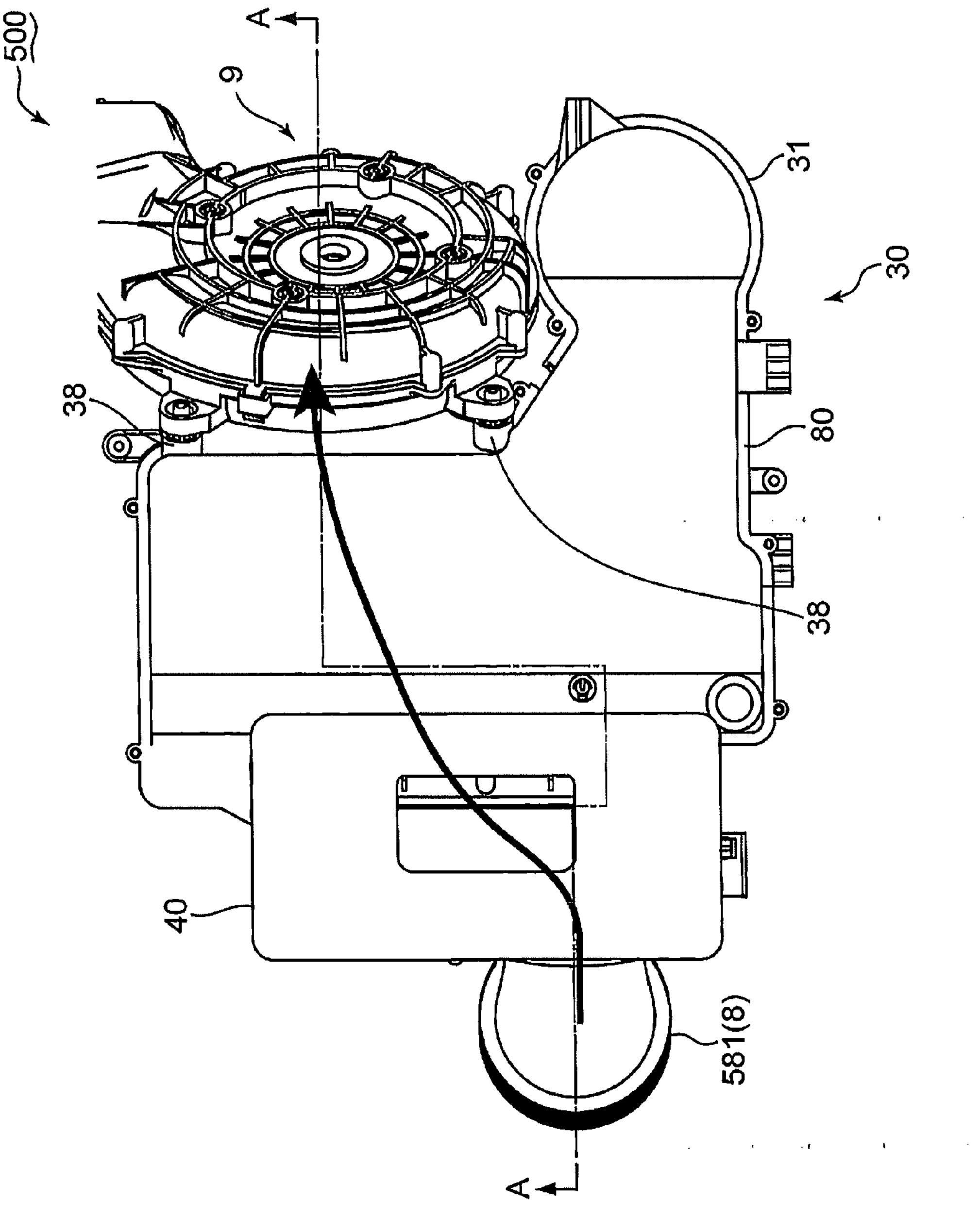


FIG.5

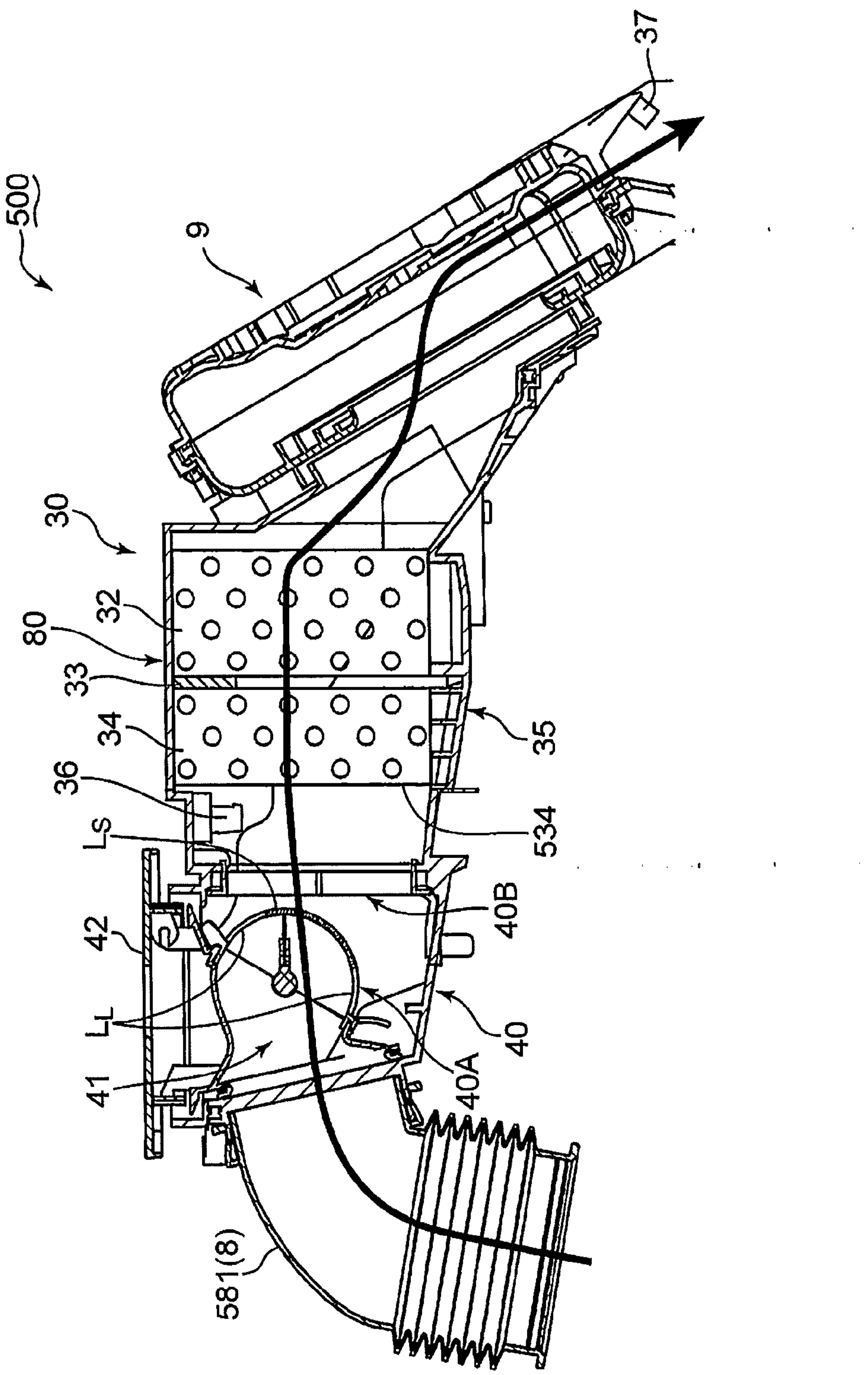


FIG.6

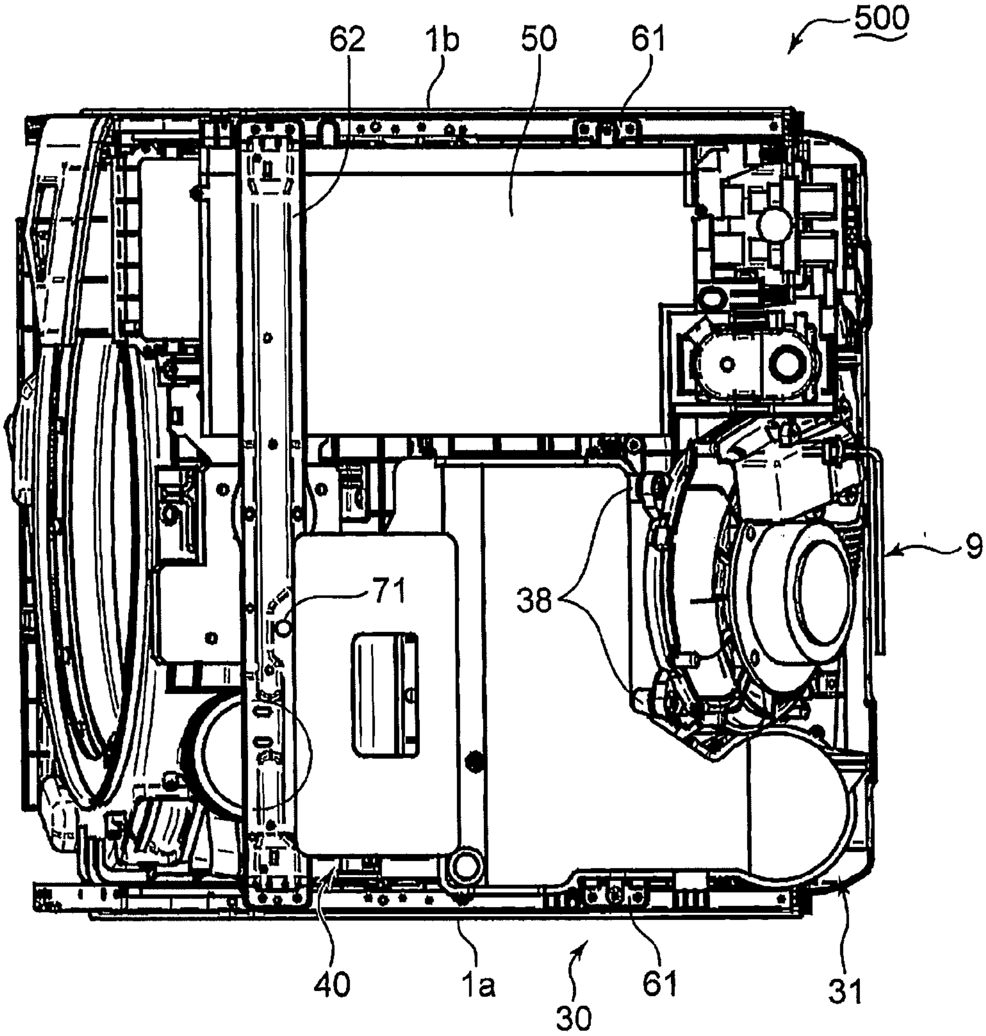


FIG.7

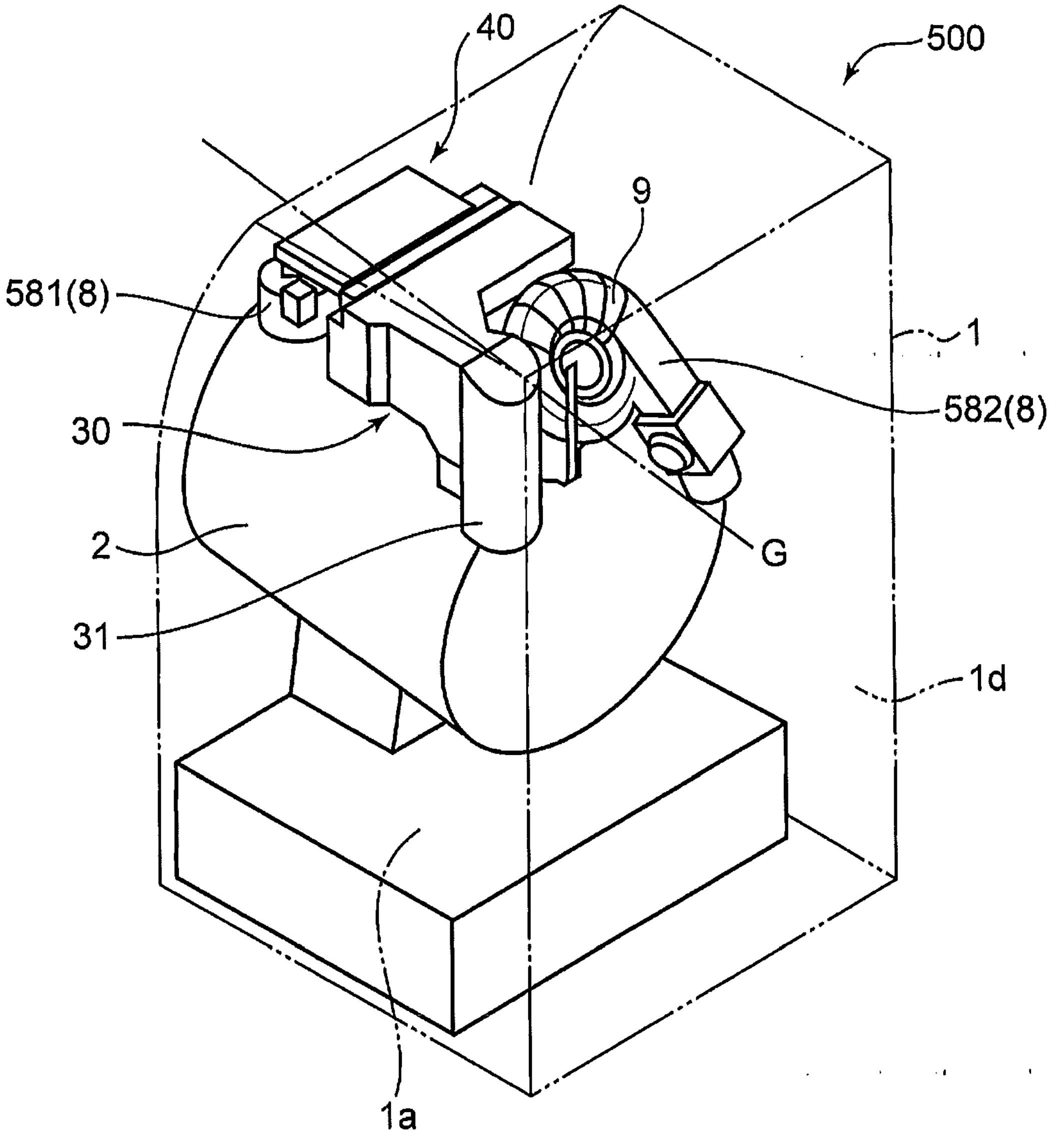


FIG.8A

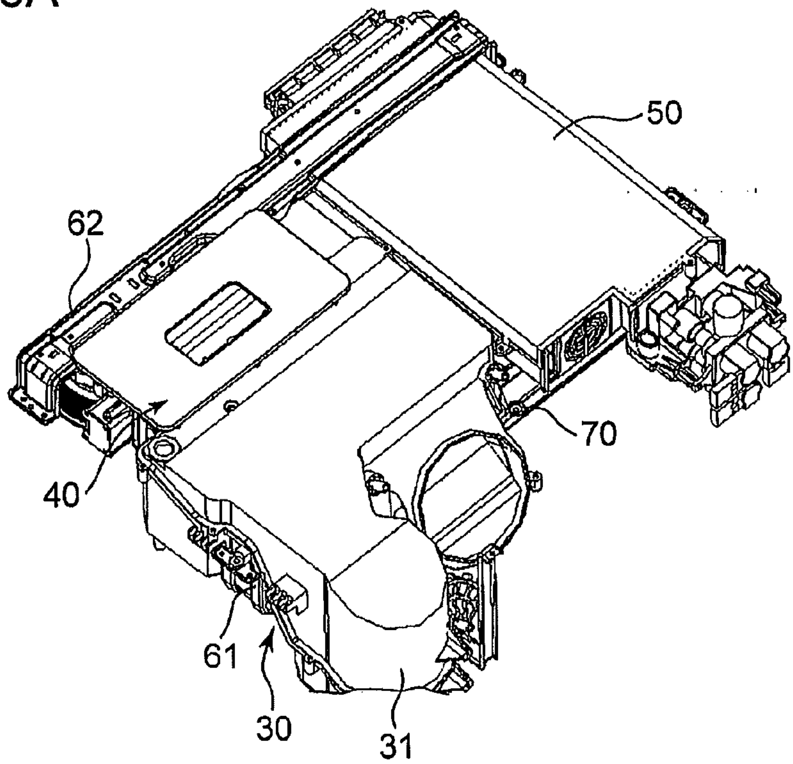


FIG.8B

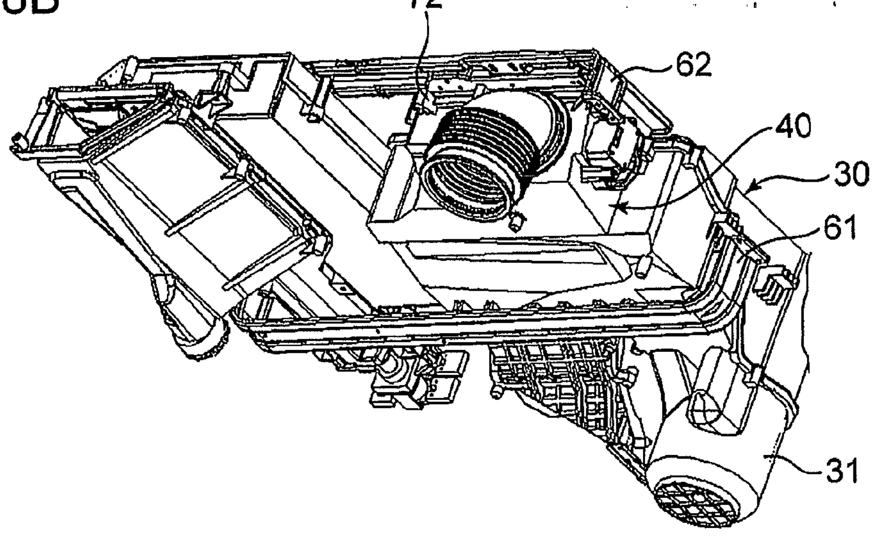


FIG.9

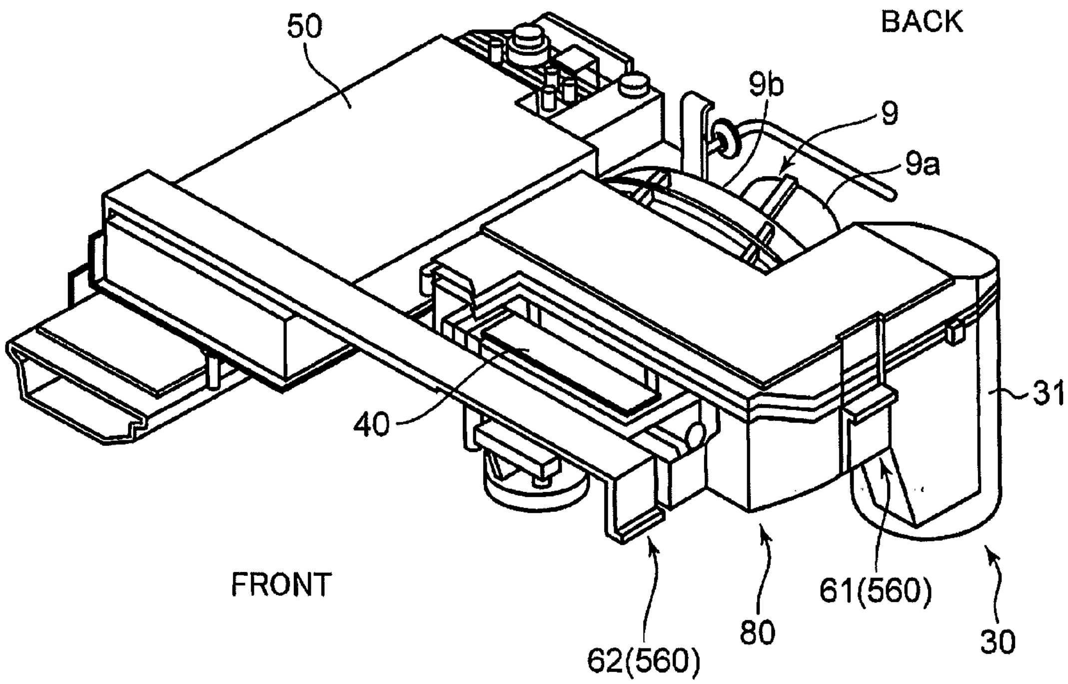


FIG.10

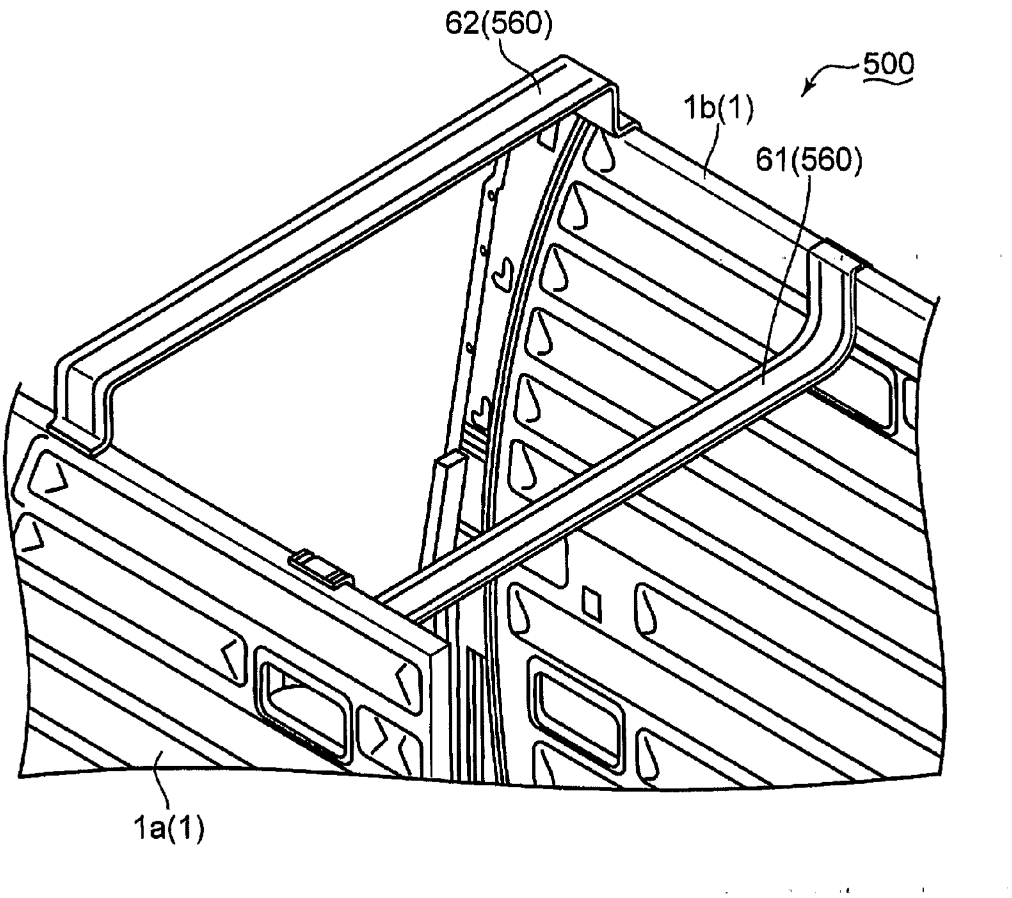


FIG.11

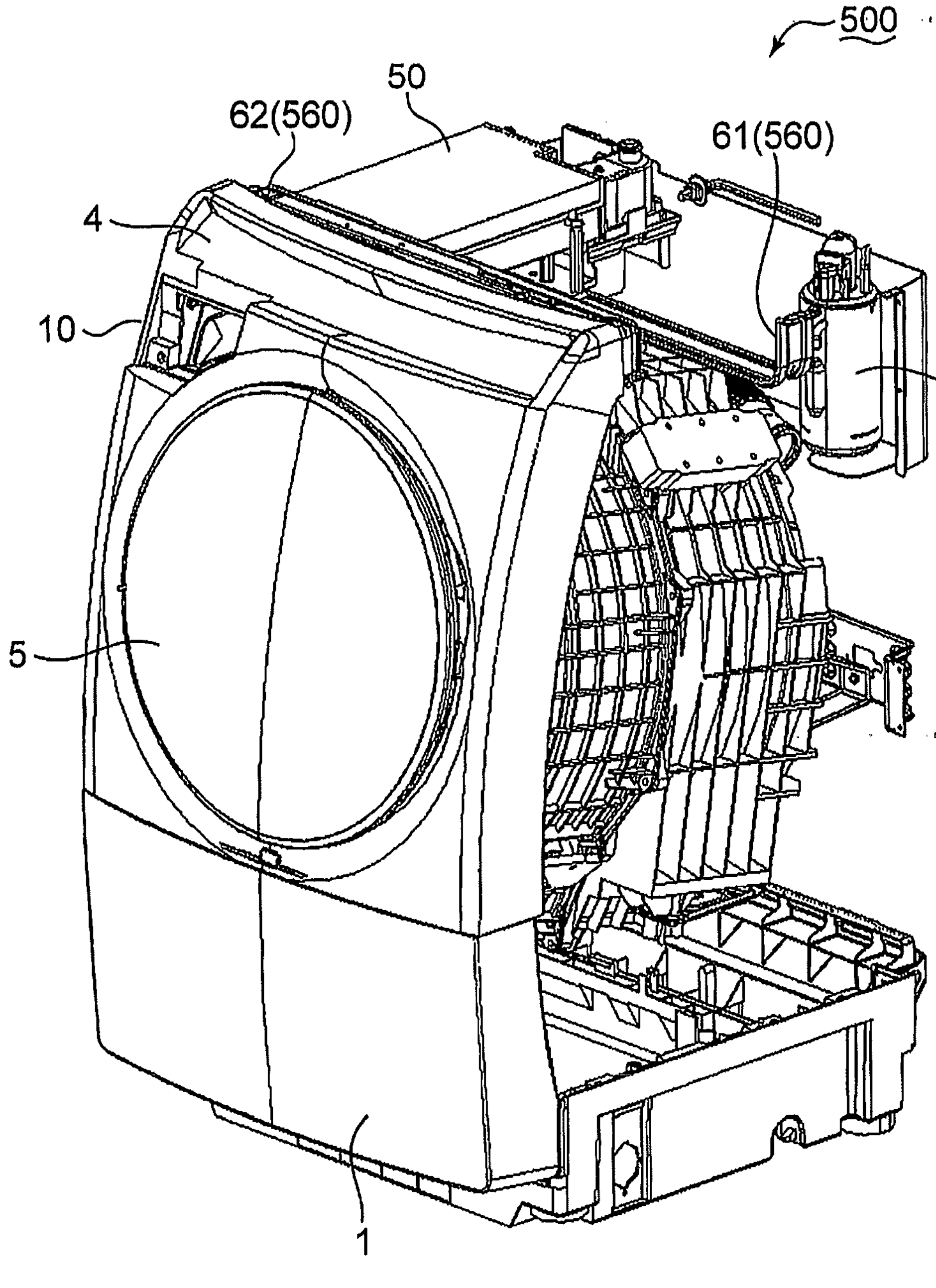


FIG.12

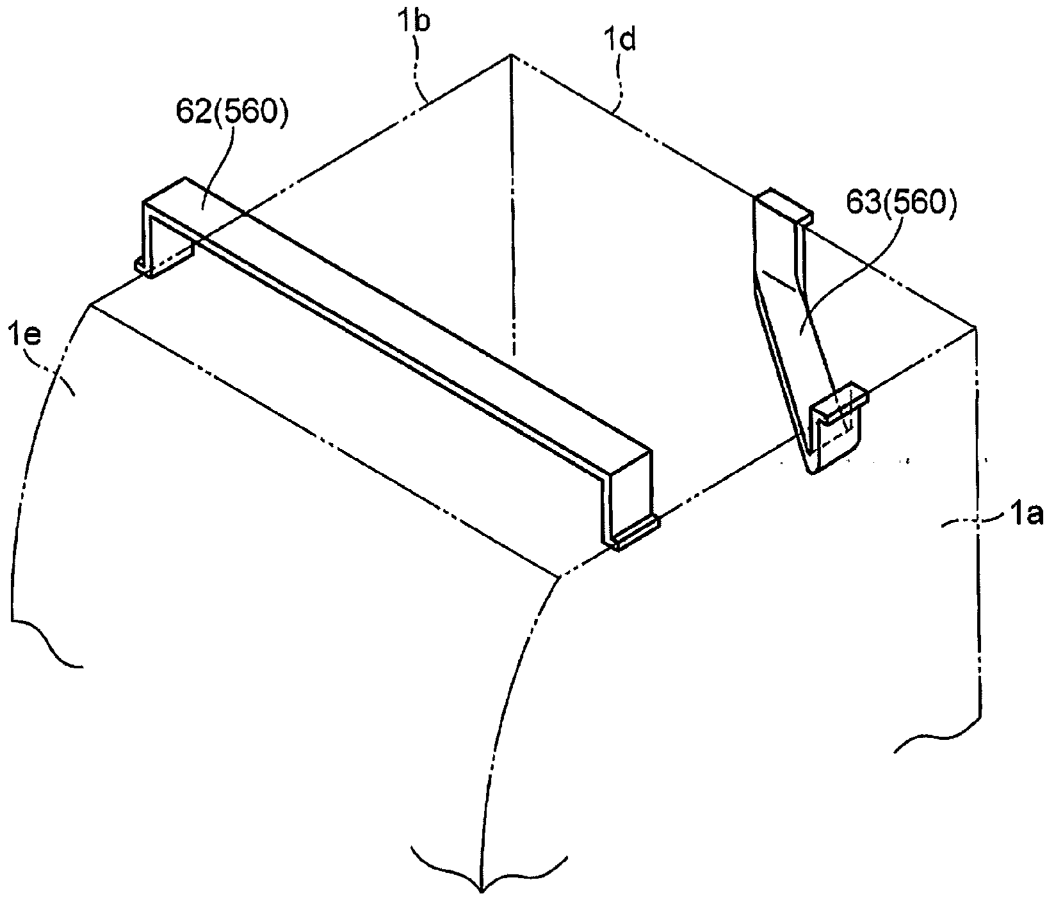


FIG.13

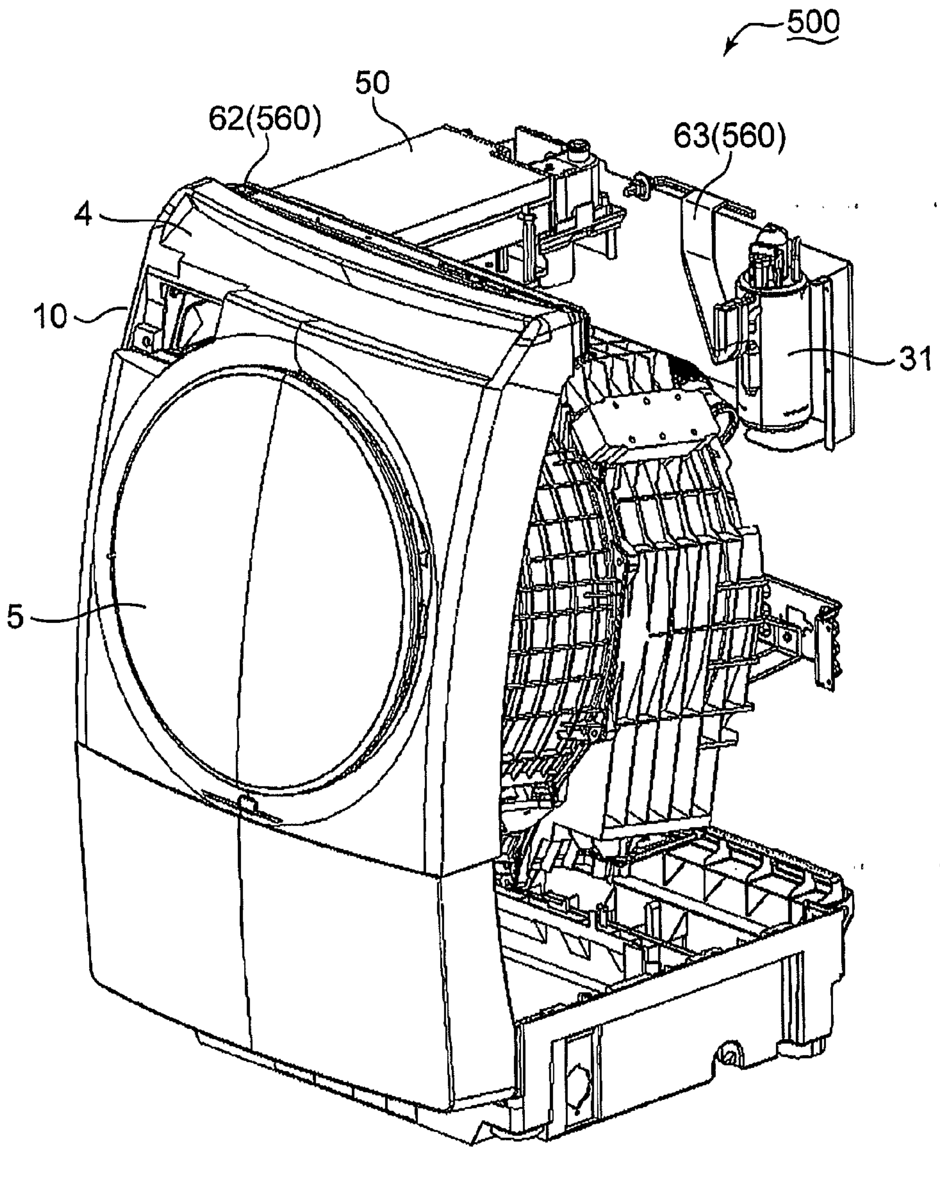


FIG.14

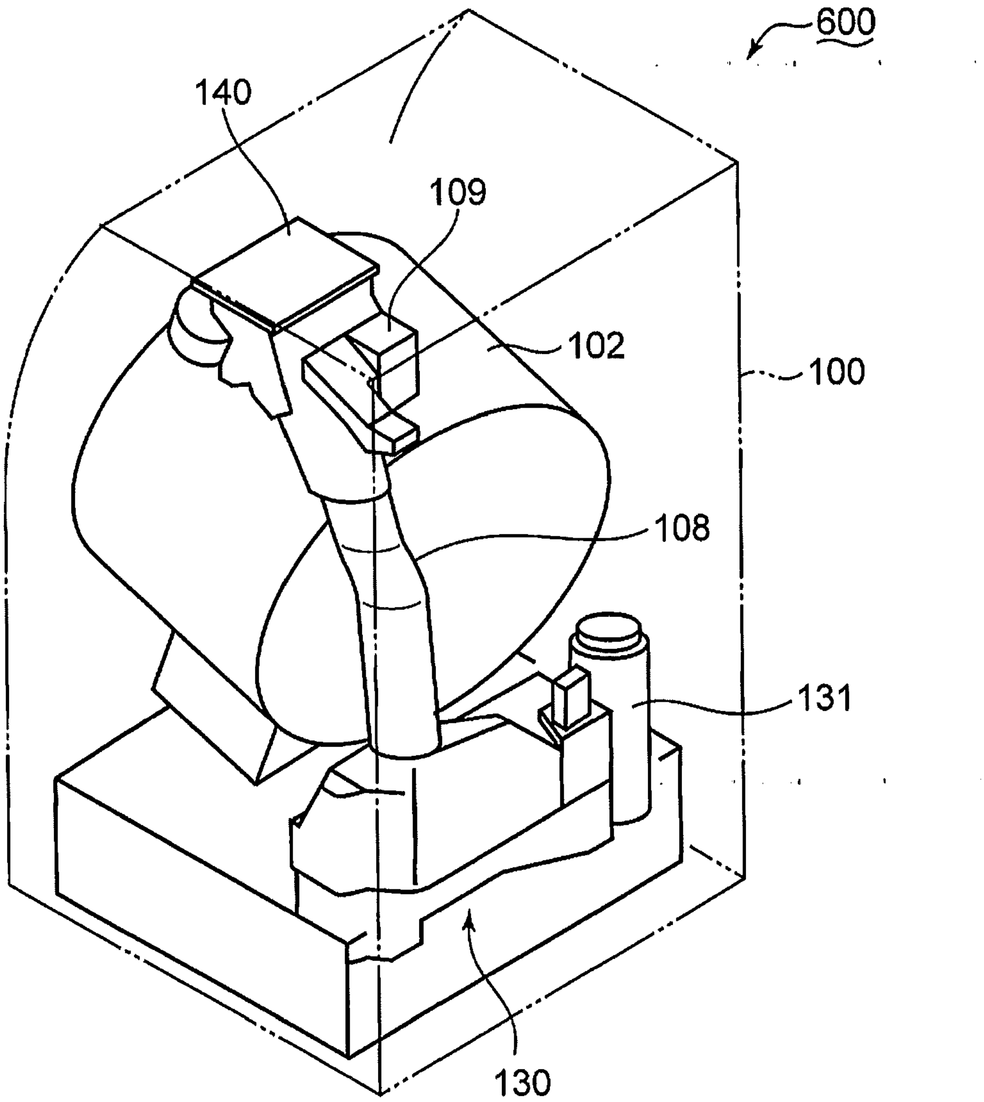
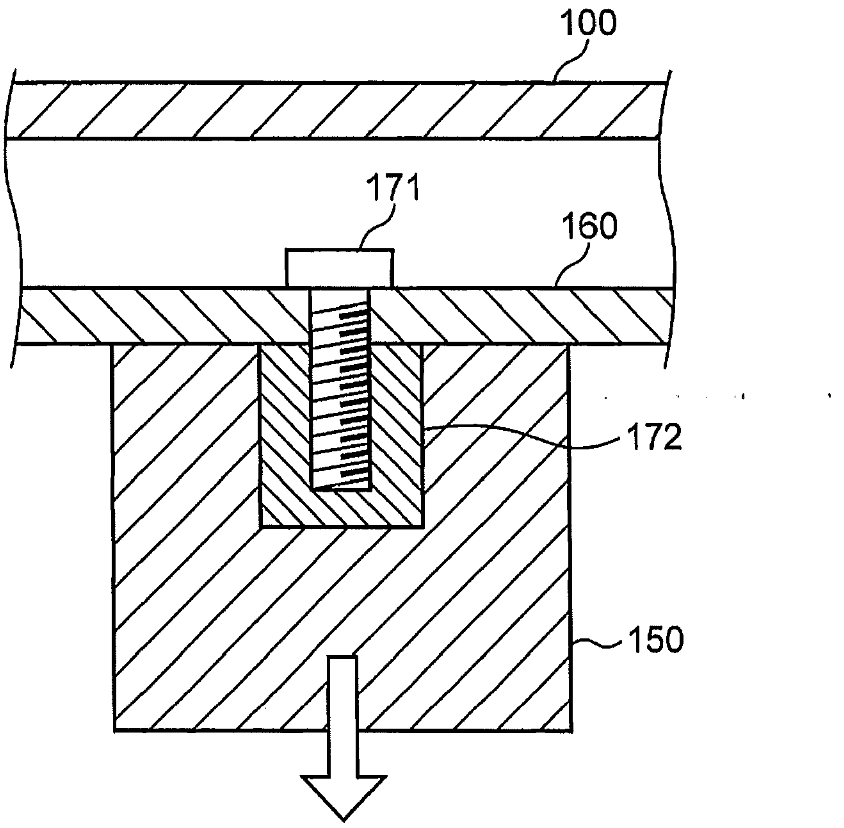


FIG.15



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