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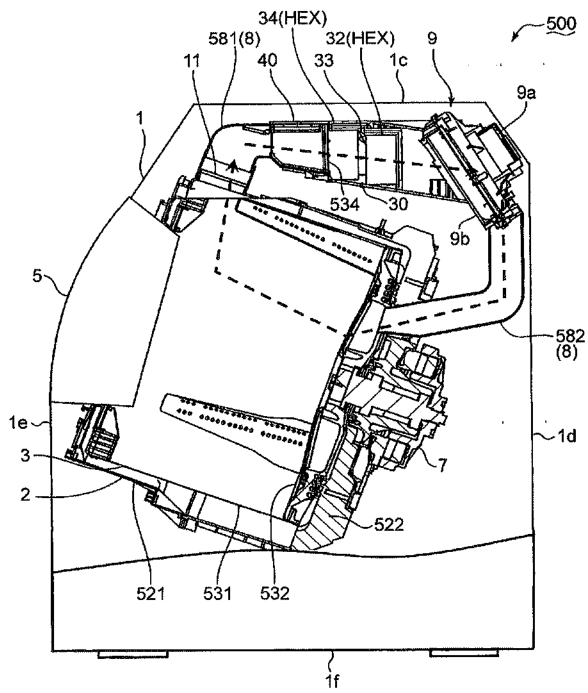
(54) **Drying machine**

(57) A drying machine (500) comprising a rotating drum (3) configured to accommodate clothing; a heat pump device (30) configured to dry the clothing; a housing (1) including a wall configured to define an internal space to accommodate the rotating drum (3) and the heat pump device (30); and a support mechanism (560) configured to support, in the housing (1), the heat pump device (30) including a compressor (31) configured to compress refrigerant,wherein the heat pump device (30) is disposed above the rotating drum (3),the wall includes vertically standing side walls (1a, 1b), and the side walls (1a, 1 b) are connected to the support mechanism (560).

FIG.1



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Description

Technical Field

[0001] The present invention relates to a drying machine including a heat pump device. The drying machine can be a machine for only drying or can be a drying machine which also includes a washing machine and which can also work as a washing 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] Fig. 12 schematically shows a conventional drying machine.

[0004] The drying machine 150 comprises a drying drum 102 configured to dry clothing, a housing 100 configured to define an internal space for accommodating the drying drum 102, and a heat pump mechanism 130 configured to dehumidify and heat the dry air to be sent to the drying drum 102. The heat pump mechanism 130 is disposed at a lower part of the internal space in the housing 100.

[0005] The heat pump mechanism 130 comprises a compressor 131 configured to compress refrigerant, a heat exchanger 132 including a heater (not shown in Fig. 12) and a dehumidifier (not shown in Fig. 12), and a circulatory tube (not shown in Fig. 12) configured to guide the refrigerant to be circulated between the compressor 131 and the heat exchanger 132.

[0006] The drying drum 102 of the drying machine 150 includes a rotating drum (not shown in Fig. 12). The drying machine 150 comprises a suspension (not shown in Fig. 12) configured to absorb the vibration resulting from rotation of the rotating drum. A part of the vibration resulting from the rotation of the rotating drum is transmitted to the housing 100 via the suspension which supports the drying drum 102. The vibration transmitted to the housing 100 causes the heat pump mechanism 130 to vibrate. Accordingly, the heat pump mechanism 130 is subjected to the vibration resulting from the rotation of the rotating drum in addition to the vibration of the compressor itself. The vibration caused by the rotation of the rotating drum is considerably greater than the vibration of the compressor itself. The vibration caused by the rotation of the rotating drum generates extra strain on the circulatory tube for guiding the refrigerant, and potentially induce malfunctions of the heat pump mechanism 130 (for example, breakage of the circulatory tube).

Disclosure of the Invention

[0007] An object of the present invention is to improve a drying machine using a heat pump device. The object is solved by the subject-matter of the independent claim 1. The dependent claims are directed to embodiments of advantage.

[0008] 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. The drum can be a rotating drum or a static drum. Advantageously, the vibration of the housing resulting from rotation of the rotating drum is reduced.

Brief Description of the Drawings

[0009]

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

Fig. 7 is a perspective view schematically showing the washing and drying machine shown in Fig. 1.

Fig. 8 is a perspective view schematically showing a supporting member in the washing and drying machine shown in Fig. 1.

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

Fig. 10 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. 11 is a perspective view schematically showing the drum-type washing and drying machine shown in Fig. 10.

Fig. 12 is a perspective view schematically showing a conventional washing and drying machine configured to dry clothing with a heat pump.

Description of the Preferred Embodiments

[0010] 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)

[0011] 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.

[0012] 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.

[0013] The wall of the housing 1 includes an upper wall 1c 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 1f surrounded by lower edges of the front wall 1e, the rear wall 1d, the right wall 1a and the left wall 1b.

[0014] 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.

[0015] The washing and drying machine 500 further comprises an approximately 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 for forming 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 placed through the access opening is accommodated in the rotating drum 3.

[0016] 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.

[0017] 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.

[0018] 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.

[0019] As described above, the door 5 configured to open and close 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 place and remove the clothing to and from the rotating drum 3. The washing and drying machine 500 further comprises a water supply pipe (not shown) for supplying 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) for draining 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.

[0020] 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.

[0021] 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.

[0022] 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.

[0023] 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.

(Heat pump device)

[0024] 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 perspective view schematically showing an upper configuration 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, Figs. 3 to 7 and Fig. 12.

[0025] 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.

[0026] 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 narrower space above the water tank 2 in the internal space of the housing 1 is referred to as an upper space. Moreover, the 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 the dry air between the heat pump device 30 and the rotating drum 3, are disposed in the upper space.

[0027] 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.

[0028] 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.

[0029] 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.

[0030] The heat pump device 30 is disposed near the rear wall 1d of the housing 1 in the upper space. As shown in Fig. 12, a conventional heat pump mechanism 130 is disposed in the lower space of the housing 100. Since the heat pump device 30 of this embodiment is disposed in the upper space of the housing 1, a flow path of the dry air passing through the upstream ventilation flue 581, the filter 40, the heat pump device 30, the blower 9 and the downstream ventilation flue 582 becomes shorter, which results in reduction or downsizing of components for connecting the filter 40, the heat pump device 30 and the blower 9.

[0031] 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.

[0032] As shown in Figs. 3 to 5, the heat pump device 30 comprises a compressor 31 configured to compress refrigerant, a heat exchanger HEX configured to dry the clothing in the rotating drum 3 and a decompressor 33 including an expansion valve (or capillary tube) for decompressing pressure of the highly pressurized refrigerant. The heat exchanger HEX comprises a heating portion 32 configured to radiate heat of the highly heated and pressurized refrigerant after compression by the compressor 31, and a dehumidifier 34 configured to remove 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.

[0033] 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 HEX, 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.

[0034] Figs. 3 and 7 show 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 among generatrices representing an outer surface of the peripheral wall 521 of the water tank 2.

[0035] The compressor 31 above the peripheral wall 521 of the water tank 2 is shifted toward the right wall 1a with respect to the generatrix G. The compressor 31 includes 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.

[0036] 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.

[0037] 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.

[0038] 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.

[0039] 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.

[0040] 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.

[0041] 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.

[0042] As shown in Figs. 4, 6 and 7, the blower 9 fixed to the heat pump device 30 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 mounting the blower 9, the blower 9 may be appropriately accommodated in the smaller housing 1. The 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 increase height of the housing 1, which results in the smaller washing and drying machine 500.

[0043] 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.

(Support Mechanism)

[0044] Fig. 8 is a perspective view schematically showing a supporting member of the washing and drying machine 500. Fig. 9 is a perspective view schematically showing the washing and drying machine 500. The support mechanism is now described with reference to Figs. 6, 8 and 9.

[0045] 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.

[0046] As shown in Fig. 8, 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 the 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.

[0047] 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.

[0048] 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.

[0049] 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.

[0050] Fig. 10 is a perspective view showing another arrangement of the supporting member in the washing and drying machine 500. Fig. 11 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. 10 and 11.

[0051] 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. 11, 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. 11, 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.

[0052] The support mechanism 560 is now described in further detail with reference to Fig. 6 and Figs. 8 to 11.

[0053] As shown in Fig. 6, the blower 9 near the compressor 31 is fixed to the heat pump device 30. 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.

[0054] 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.

[0055] 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.

[0056] The confining member 62 is now described with reference to Figs. 1, 3 and 6.

[0057] 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 HEX) are closer to the front wall 1e 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.

[0058] The confining member 62 closer to the front wall 1e than the supporting member 61 decrease the upward displacement of the lighter elements such as the heat exchanger HEX. In this embodiment, the filter 40 is connected to the heat pump device 30. The confining member 62 extends across a space above the filter 40 between the heat pump device 30 and the front wall 1e. Consequently, the confining member 62 appropriately confines the upward displacement of the filter 40 and the heat pump device 30 of the heat exchanger HEX. Alternatively, the confining member 62 may extend across a space above the heat exchange HEX of the heat pump device 30, so that the confining member 62 directly confines the upward displacement of the heat exchanger HEX.

[0059] 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.

(Fastening of elements)

[0060] The aforementioned support mechanism 560 inhibits failure modes such as breakage or damage of a securing member such as a screw 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 support 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. Effect of the support mechanism 560 on the securing member used for fastening the elements is now described.

[0061] 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.

[0062] 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.

[0063] 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.

[0064] The compression force working on the supporting member 61, 63 is also applied to the securing member such as a screw or a helical coil wire screw thread insert for fastening the supporting member 61, 63 and the heat pump device 30/ blower 9. Nevertheless, unlike the tensile force, the securing member is less likely to be broken by the compression force.

[0065] 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 HEX) existing between the supporting member 61, 63 and the front wall 1e. The moment around the supporting member 61, 63 results in a compression force on the confining member 62 mounted across the space above the heat pump device 30 and/or the filter 40. The compression force working on the confining member 62 is also applied to the securing member such as a screw or a helical coil wire screw thread insert for fixing the confining member 62 to the heat pump device 30 and/or the filter 40. Nevertheless, unlike the tensile force, the securing member is less likely to be broken by the compression force.

[0066] 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.

[0067] 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.

[0068] The structure for fixing the blower 9 and the heat pump device 30 is now described with reference to Fig. 4.

[0069] 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.

[0070] 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.

(Arrangement of heat pump device)

[0071] 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.

[0072] Since the dehumidifier 34 and the heating portion 32 of the heat exchanger HEX are linearly aligned with respect to the blower 9 along the circulatory path of the dry air, the dry air approximately linearly flow in the heat exchanger HEX. In general, inflected flow of fluid induces drift and pressure loss of the fluid, but the straight arrangement of the dehumidifier 34 and the heating portion 32 according to this embodiment hardly causes such drift and pressure loss of the fluid, which results in efficient circulation of the dry air. Accordingly, the blower 9 consumes less power to flow the dry air in the circulatory ventilation flue 8.

[0073] 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.

[0074] 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.

[0075] In this embodiment, since the straight arrangement of the dehumidifier 34 and the heating portion 32 maintains an appropriate flow rate of the dry air in the heat exchanger HEX, the complete vaporization of the refrigerant in the dehumidifier 34 may be easily achieved. Since a liquid refrigerant is less likely to flow into the compressor 31, the compressor 31 hardly malfunctions, which results in enhanced reliability of the washing and drying machine 500 comprising the heat pump device 30. As a result of the increase in reliability, continuous dehumidification without stop of the compressor 31 is allowed to shorten drying operation period.

(Arrangement of Blower)

[0076] The arrangement of the blower 9 is now described with reference to Fig. 1.

[0077] 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)

[0078] The arrangement of a control board is now explained with reference to Fig. 9.

[0079] 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.

[0080] 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.

(Filter)

[0081] The filter 40 is now described with reference to Figs. 1, 2 and Figs. 4 to 6.

[0082] Lint (dust components) is generated from the clothing dried in the rotating drum 3. Adhesion and accumulation of lint to the heat exchanger HEX worsens effective circulation of dry air and effective heat exchange by the heat exchanger HEX.

[0083] The washing and drying machine 500 comprises a filter 40 disposed an upstream side of the heat exchanger HEX. The filter 40 traps and collects foreign matters such as lint, dust and pollen from the dry air before the dry air passes through the heat exchanger HEX to prevent the lint from infiltrating into the heat exchanger HEX. 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 attempting 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 highly efficient maintenance work for the washing and drying machine 500.

[0084] 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.

[0085] 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.

[0086] 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.

[0087] The heat exchanger HEX is disposed immediately after the second filter 40B. As described above, the heat exchanger HEX causes flow of the refrigerant heated by the compressor 31. The second filter 40B fixed to the circulatory ventilation flue 8 is likely to prevents a user unfamiliar with the maintenance work from easily contacting the heat exchanger HEX. In addition, unlike the first filter 40A, since the second filter 40B. is fixed to the circulatory ventilation flue 8, the position of the second filter 40B hardly changes, which results in less infiltration of lint into the heat exchanger HEX because the second filter 40B is less likely to be inappropriately installed.

[0088] The filter 40 causes pressure loss of the dry air. As a result of such pressure loss, the velocity distribution of the dry air becomes uniform (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 HEX. Accordingly, the regulated dry air flows into the heat exchanger HEX.

[0089] In general, if a circulatory ventilation flue is shortened in order to downsize the washing and drying machine, it may be 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, a shorter flow path length is required to regulate the dry air. The inflow of the regulated dry air to the heat exchanger HEX is less likely to cause a considerable and local change in the heat exchange efficiency, which results in enhanced heat exchange efficiency of the heat exchanger HEX.

[0090] As described above, the filter 40 provided at the upstream side of the heat exchanger HEX regulates the dry air without installation of any rectification mechanism (for example, a straight pipe) in the circulatory ventilation flue 8. Therefore the shorter circulatory ventilation flue 8 may be designed.

[0091] As shown in Figs. 1 and 5, the dehumidifier 34 of the heat exchanger HEX 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.

[0092] 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.

(Recovery structure)

[0093] The recovery structure configured to recover the water component condensed at the dehumidifier 34 is now described with reference to Fig. 5.

[0094] 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.

[0095] 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.

[0096] 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.

[0097] 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.

[0098] The recovery structure 35 is disposed in the upper space of the housing 1 together with the heat exchanger HEX. 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.

(Maintenance of heat exchanger)

[0099] Maintenance of the heat exchanger HEX is now described with reference to Figs. 2 and 5.

[0100] As described above, the filter 40 disposed immediately before the heat exchanger HEX effectively decreases the inflow of lint and other foreign matter into the heat exchanger HEX. Nevertheless, as a result of long time usage of the washing and drying machine 500, line and other foreign matter may become adhered to and/or accumulated in the heat exchanger HEX.

[0101] As described above, the heat exchanger HEX is provided at the upper part in the housing 1. The worker may remove the first filter 40A through the opening 40c formed on the upper wall 1c 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 HEX to remove the lint and other foreign matter from the heat exchanger HEX. The worker may perform the series of operations such as removing the first filter 40A, the second filter 40B and cleaning out the lint and other foreign matter from the heat exchanger HEX 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.

(Structure of Filter)

[0102] The structure of the filter 40 is now described with reference to Fig. 5.

[0103] 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.

[0104] The second filter 40B fixed at a downstream position of the first filter 40A includes a flat filter mesh.

[0105] 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 hosing. 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.

[0106] 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.

[0107] The dry air after passing through the cylindrical first filter 40A, which causes the aforementioned profile of the pressure loss, flows into the heat exchanger HEX. 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.

[0108] 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.

[0109] As described above, the velocity of the dry air at the lower part of the dehumidified 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)

[0110] 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

HEX 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 HEX.

[0111] The filter 40, the heat exchanger HEX and the blower 9 are disposed in order along the flow direction of the dry air. The filter 40 regulates the dry air. The regulated dry air flows into the heat exchanger HEX. The heat exchanger HEX dehumidifies and heats the dry air. The blower 9 thereafter sends the dry air to the rotating drum 3.

[0112] 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.

[0113] As described above, in this embodiment, since the filter 40 is disposed near the heat exchanger HEX, the dry air is circulated using a circulatory ventilation flue 8 shorter than the circulatory ventilation flue adopted in the aforementioned conventional washing and drying machine. Accordingly, less pressure loss of the dry air flowing in the circulatory ventilation flue 8 is achieved. The Reduction in the pressure loss of the dry air decreases the power consumption of the blower 9 which blows the dry air. The reduction in the pressure loss of the dry air additionally increases a flow rate of the dry air flowing in the circulatory ventilation flue 8.

[0114] The filter 40 disposed in the shorter circulatory ventilation flue 8 regulates the dry air. Regulation for the dry air improves the heat exchange efficiency of the heat exchanger HEX. Consequently, in comparison to the conventional washing and drying machine, an amount of the heat exchange considerably increases per unit time, which results in less power consumption and shorter drying time.

(Temperature Detection of Dry Air)

[0115] Temperature detection of the dry air is now described with reference to Fig. 5.

[0116] 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.

[0117] The first temperature sensor 36 detects the temperature of the dry air flowing between the rotating drum 3 and the heat exchanger HEX. The first temperature sensor 36 is disposed between the filter 40 and the dehumidifier 34.

[0118] The second temperature sensor 37 detects the temperature of the dry air between the heat exchanger HEX and the rotating drum 3. The second temperature sensor 37 is disposed immediately after the blower 9.

[0119] The first temperature sensor 36 detects the temperature of the dry air before the dry air is dehumidified and heated by the heat exchanger HEX. The second temperature sensor 37 detects the temperature of the dry air after the dry air is dehumidified and heated by the heat exchanger HEX. The output signals of the first temperature sensor 36 and the second temperature sensor 37 are used for controlling the heat pump device 30.

[0120] The first temperature sensor 36 between the filter 40 and the heat exchanger HEX is provided near the area L_L where the pressure loss of the substantially cylindrical first filter 40A is larger (the upper portion or the lower portion of the first filter 40A). In the first filter 40A, the clogging in the area L_L with a large pressure loss is less likely to be caused by lint and other foreign matter than the area L_S with a smaller pressure loss. Accordingly, the first temperature sensor 36 near the area L_L may accurately detect the temperature of the dry air for a long period. Since the temperature detected with the first temperature sensor 36 changes if the clogging caused by lint and other foreign matter occurs in the filter 40, the output signal of the first temperature sensor 36 may be used for detecting the clogging of the filter 40. Accordingly, the first temperature sensor 36 near the area L_L may accurately detect the clogging of the filter 40 for a long period.

[0121] The first temperature sensor 36 between the filter 40 and the heat exchanger HEX and the second temperature sensor 37 disposed at the downstream position of the blower 9 are deployed inside the shorter circulatory ventilation flue 8. An 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 the shorter interval may be less sensitive to error factors (for example, leakage of dry air) which cause 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.

(Alternative configuration)

[0122] 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.

[0123] 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.

[0124] 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.

[0125] 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.

[0126] The foregoing embodiment primarily includes the drying machine configured as described below.

[0127] The drying machine according to one aspect of the foregoing embodiment includes: a rotating drum configured to accommodate clothing; a heat pump device configured to dry the clothing; a housing including a wall configured to define an internal space to accommodate the rotating drum and the heat pump device; and a support mechanism configured to support, in the housing, the heat pump device including a compressor configured to compress refrigerant, wherein the heat pump device is disposed above the rotating drum, the wall includes an upright side wall, and the side wall is connected to the support mechanism.

[0128] According to the foregoing configuration, the heat pump device includes a compressor configured to compress the refrigerant. The compressor is pretty heavier. The support mechanism supports the heat pump device in the housing. The side wall of the housing is connected to the support mechanism. Accordingly, the heavier compressor is loaded on the side walls, of which vibration amplitude thereby decreases. As a result of connection of the side walls to the heat pump device via the support mechanism, a group of heavier vibratory elements including the side walls and the heat pump device is formed. Accordingly, the vibration amplitude resulting from the same excitation force decreases. Since the weight of the heat pump including the compressor is applied to the side wall, the vibration of the side wall of the housing, which is caused by the rotation of the rotating drum, is likely to effectively decrease.

[0129] Since the heat pump device is disposed above the rotating drum, the worker may more easily access the heat pump device, which results in easy maintenance of the heat pump device.

[0130] In the foregoing configuration, preferably, the drying machine further includes: an outer vessel including a cylindrical peripheral wall configured to surround the rotating drum, wherein the side wall includes a first side wall and a second side wall opposite to the first side wall, and the compressor disposed above the peripheral wall and shifted toward one of the first side wall and the second side wall with respect to an uppermost generatrix of the peripheral wall includes a bottom surface positioned below the generatrix.

[0131] According to the foregoing configuration, the drying machine further includes the outer vessel including the cylindrical peripheral wall configured to surround the rotating drum. Since the compressor is disposed above the peripheral wall and is shifted toward one of the first side wall and the second side wall, the compressor may be installed so that the bottom surface of the compressor is positioned below the uppermost generatrix of the peripheral wall. Since the space in the housing above the rotating drum may be effectively used as a place for installing the compressor, it is not necessary to increase the height of the housing. Accordingly, a compact drying machine is provided.

[0132] In the foregoing configuration, preferably, the drying machine further includes: a blower including a blast fan configured to blast dry air, and a blast motor; and a circulatory ventilation flue configured to connect the outer vessel with the heat pump device and to form a circulatory path for the dry air from the blower, wherein the blower fixed to the heat pump device is disposed between the compressor and another of the first side wall and the second side wall.

[0133] According to the foregoing configuration, since the blower is loaded on the side walls in addition to the heat pump device, the vibration of the side walls of the housing caused by the rotation of the rotating drum may effectively decrease. The pretty heavier blower, similarly to the compressor, is disposed between the compressor and another side wall of the first side wall and the second side wall. Since the blower and the compressor are aligned between the first side wall and the second side wall, the support mechanism may easily support the blower and the compressor, which results in a simpler structure of the support mechanism and reduction in the number of components, weight and cost of the support mechanism.

[0134] In the foregoing configuration, preferably, the heat pump device includes a heat absorber configured to absorb heat from the dry air using the refrigerant, and a radiator configured to heat the dry air using the refrigerant, and the heat absorber and the radiator are linearly aligned with respect to the blower along the circulatory ventilation flue.

[0135] According to the foregoing configuration, since the heat absorber and the radiator are linearly aligned with respect to the blower along the circulatory ventilation flue, the dry air may flow without inflection. Since the pressure loss of the dry air is reduced, the power consumption of the blower for blowing the dry air in the circulatory ventilation flue decreases. Since drift resulting from the inflection of the dry air is less likely to occur, the local high speed flow of the dry air is less likely to be caused. Accordingly, the water component in the dry air, which is condensed at the heat absorber, is less likely to be returned to the rotating drum once again by the blower. Consequently, the closing is efficiently dried.

[0136] In the foregoing configuration, preferably, the blast motor is disposed above the blast fan, and the blower is configured to blow the dry air downward.

[0137] According to the foregoing configuration, since the blast motor is disposed above the blast fan and the blower sends the dry air downward, even if the water component condensed at the dehumidifier is scattered to the blower, the water component is likely to flow downward, so that the water component is less likely to infiltrate into the blast motor, which results in less failure rate and higher reliability of the blast motor.

[0138] In the foregoing configuration, preferably, the support mechanism includes a supporting member extending below the heat pump device and configured to support the heat pump device; and a confining member extending above the heat pump device and configured to confine upward displacement of the heat pump device.

[0139] According to the foregoing configuration, the supporting member extending below the heat pump device stably supports the heat pump device. Moreover, the confining member extending above the heat pump device confines the upward displacement of the heat pump device. Accordingly, the supporting member inhibits the vertical vibration of the heat pump device.

[0140] In the foregoing configuration, preferably, the confining member is farther from the compressor than the supporting member.

[0141] According to the foregoing configuration, since the confining member is farther from the compressor than the supporting member, the upward displacement of the heat pump device, which arises from a moment caused by the weight of the compressor, is appropriately confined.

Industrial Applicability

[0142] The principle of the foregoing embodiment may be suitably applied to various types of drying equipment such as a drum-type or a hang dry-type of drying equipments.

Claims

1. A drying machine (500) comprising:

a drum (3) configured to accommodate clothing;
a heat pump device (30) configured to dry the clothing;
a housing (1) including a wall configured to define an internal space to accommodate the rotating drum (3) and the heat pump device (30); and
a support mechanism (560) configured to support, in the housing (1), the heat pump device (30) including a compressor (31) configured to compress refrigerant,
wherein the heat pump device (30) is disposed above the rotating drum (3),
the wall includes an upright side wall (1a, 1b), and
the side wall (1a, 1b) is connected to the support mechanism (560).

2. The drying machine (500) according to claim 1, further comprising:

an outer vessel (2) including a cylindrical peripheral wall (521) configured to surround the rotating drum (3),
wherein the side wall (1a, 1b) includes a first side wall (1a) and a second side wall (1b) opposite to the first side wall (1a), and
the compressor (31) disposed above the peripheral wall (521) and shifted toward one of the first side wall (1a) and the second side wall (1b) with respect to an uppermost generatrix of the peripheral wall (521) includes a bottom surface positioned below the generatrix.

3. The drying machine (500) according to claim 2, further comprising:

a blower (9) including a blast fan (9b) configured to blast dry air, and a blast motor (9a); and
a circulatory ventilation flue (8) configured to connect the outer vessel (2) with the heat pump device (30) and to form a circulatory path for the dry air from the blower (9),
wherein the blower (9) fixed to the heat pump device (30) is disposed between the compressor (31) and another of the first side wall (1a) and the second side wall (1b).

4. The drying machine (500) according to claim 3, wherein the heat pump device (30) includes a heat absorber (34) configured to absorb heat from the dry air using the refrigerant, and a radiator (32) configured to heat the dry air using the refrigerant, and the heat absorber (34) and the radiator (32) are linearly aligned with respect to the blower (9) along the circulatory ventilation flue (8).

5. The drying machine (500) according to claim 3 or claim 4,
wherein the blast motor (9a) is disposed above the blast fan (9b), and
the blower (9) is configured to blow the dry air downward.

6. The drying machine (500) according to any one of claims 1 to 5,
wherein the support mechanism (560) includes:

a supporting member (61, 63) extending below the heat pump device (30) and configured to support the heat pump device (30); and
a confining member (62) extending above the heat pump device (30) and configured to confine upward displacement of the heat pump device (30).

7. The drying machine (500) according to claim 6, wherein the confining member (62) is farther from the compressor (31) than the supporting member (61).

8. The drying machine (500) according to one of the previous claims, wherein the drum is a rotatable drum.

FIG.1

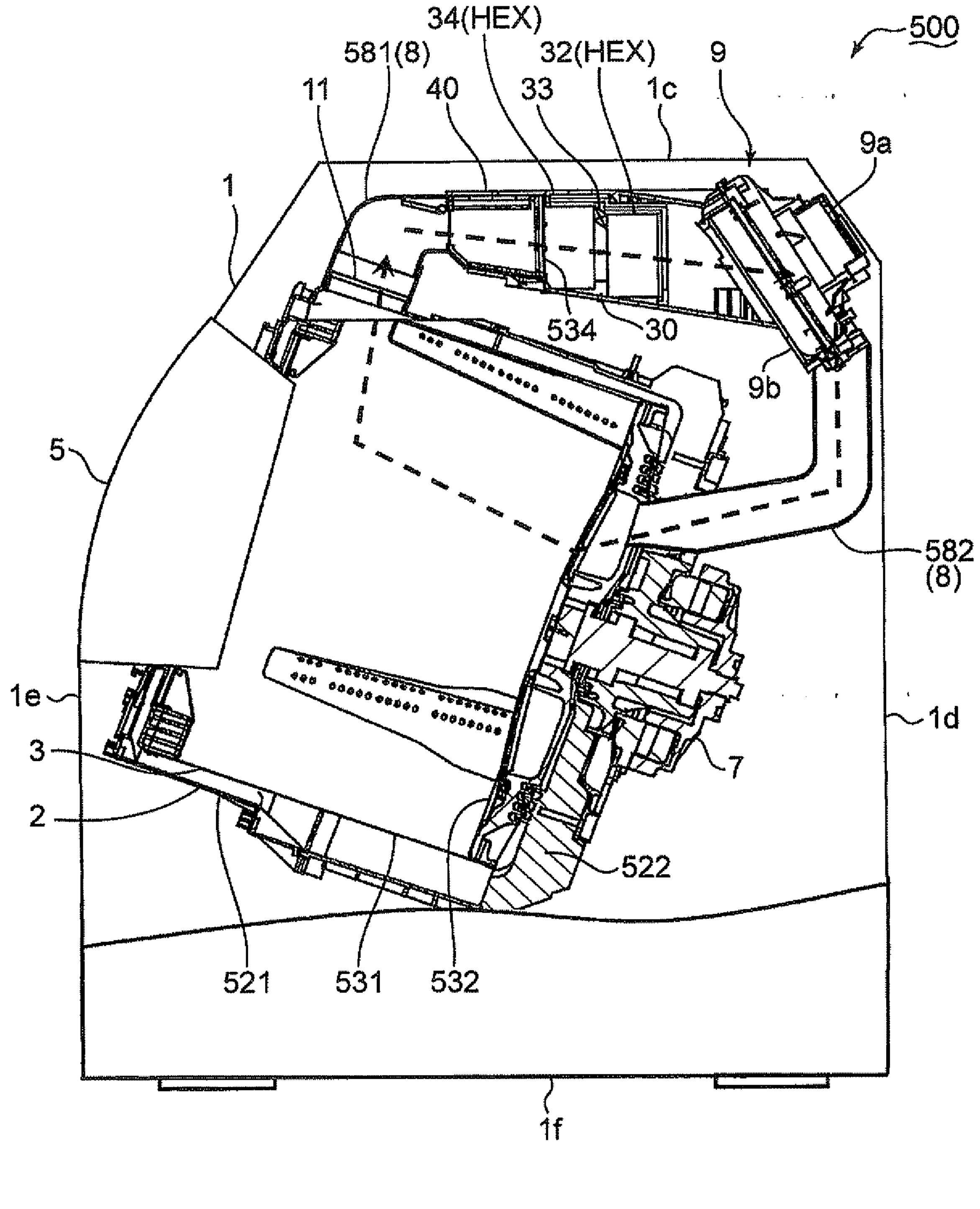

500
34(HEX)
581(8)
32(HEX)
9
11
40
33
1c
9a
1
534
30
9b
5
582
(8)
1e
1d
3
7
2
522
521
531
532
1f

FIG.2

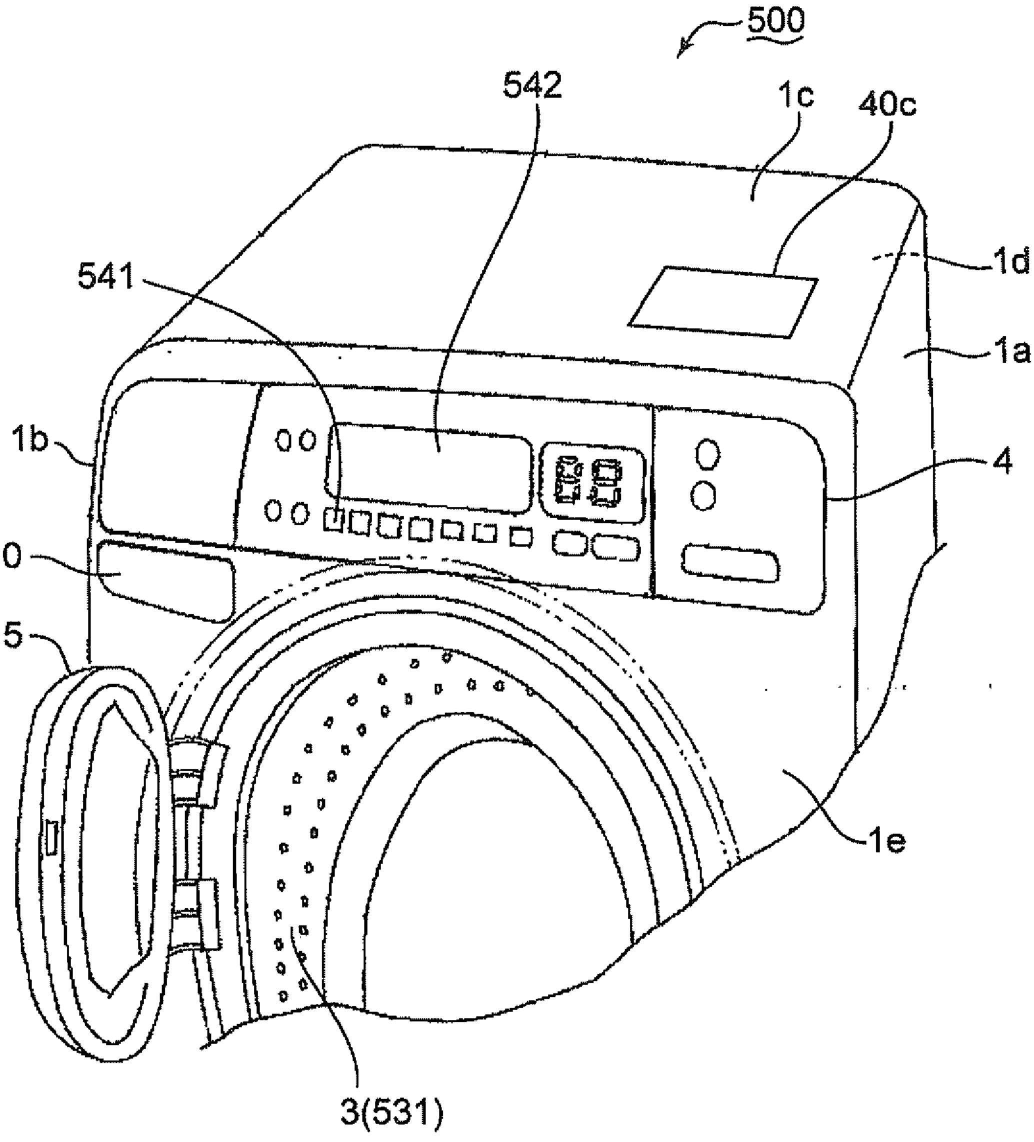
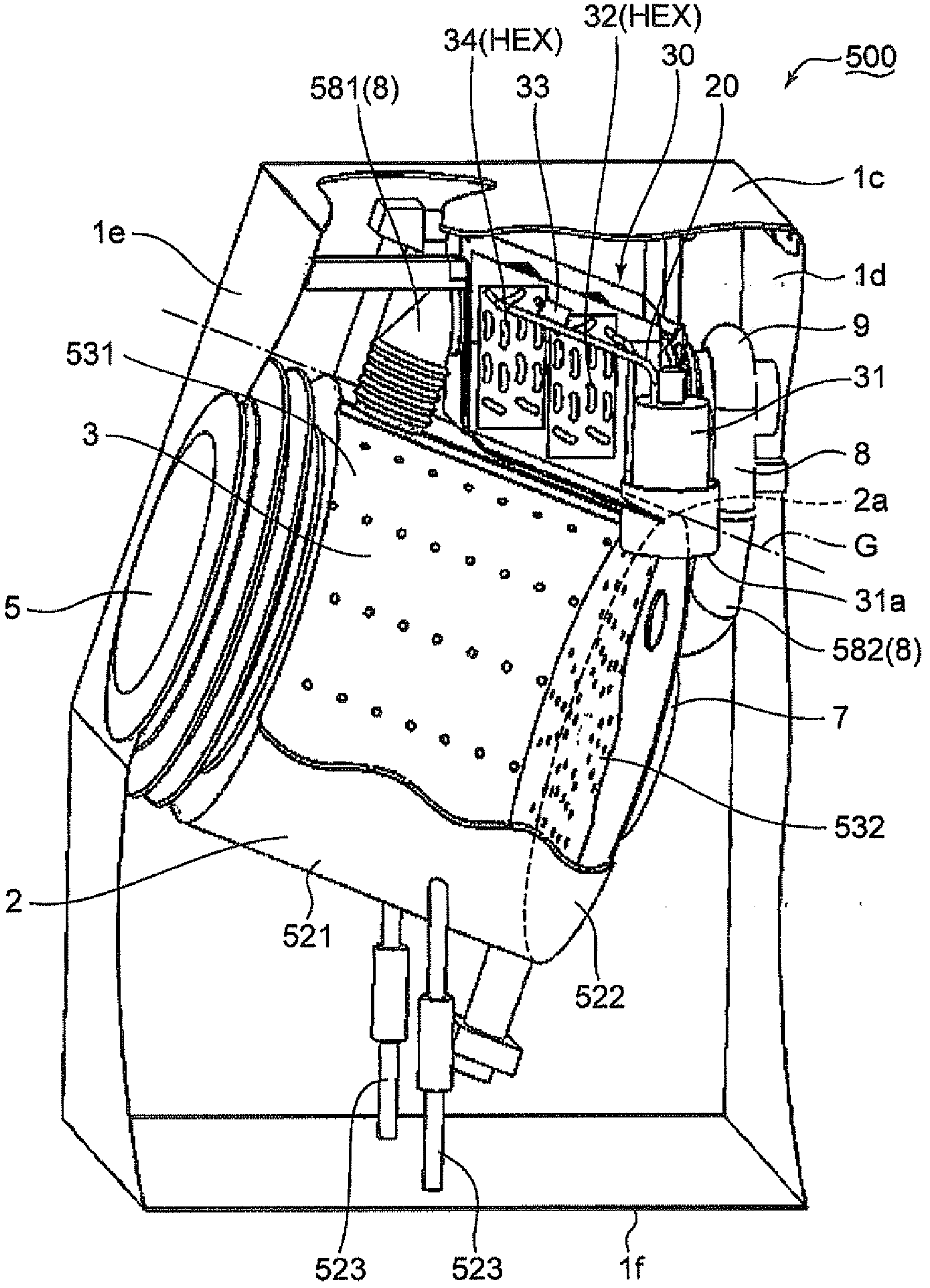


FIG.3



34(HEX)
32(HEX)
30
500
581(8)
33
20
1c
1e
1d
9
531
31
3
8
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523
523
1f

FIG.4

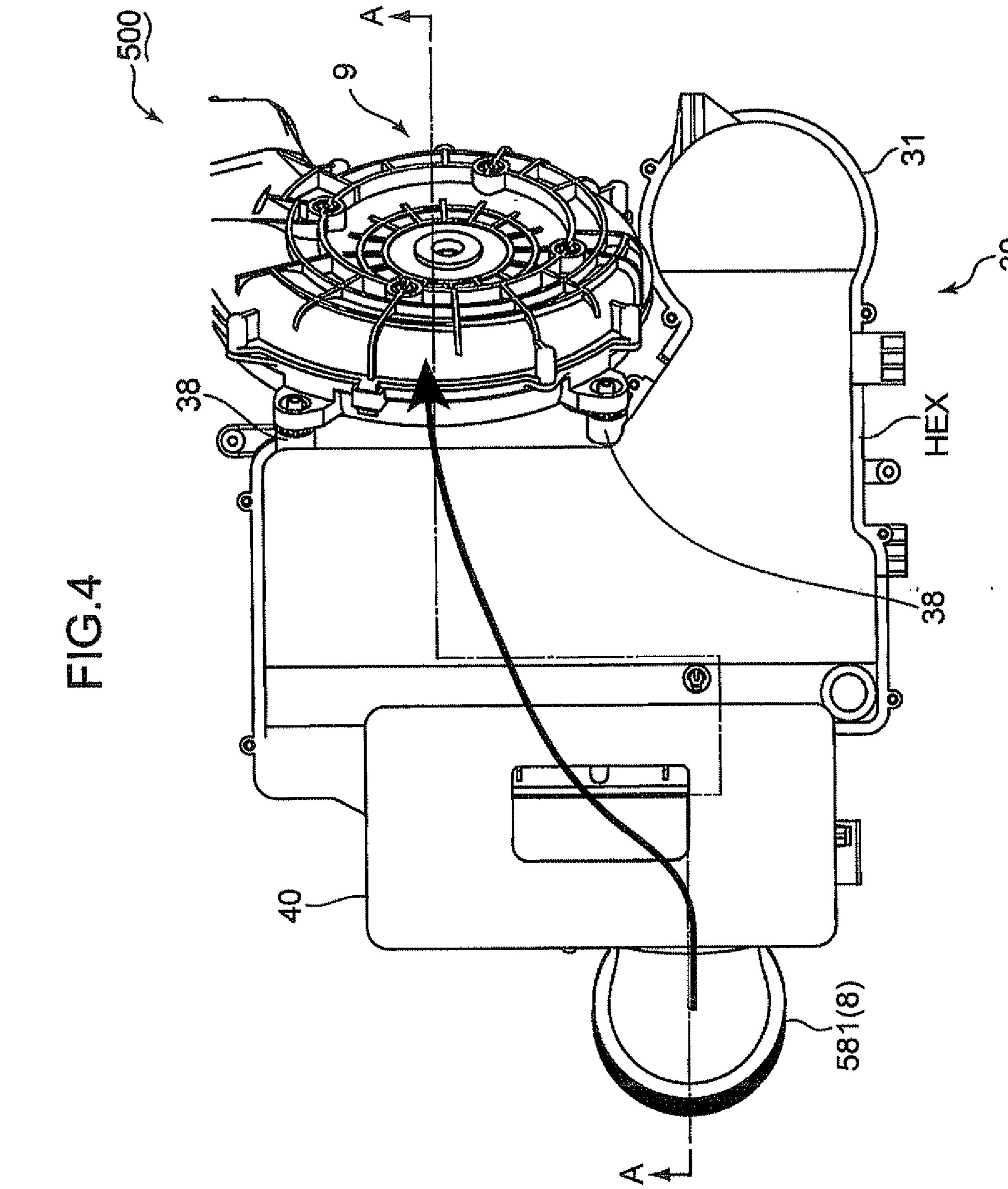


FIG.5

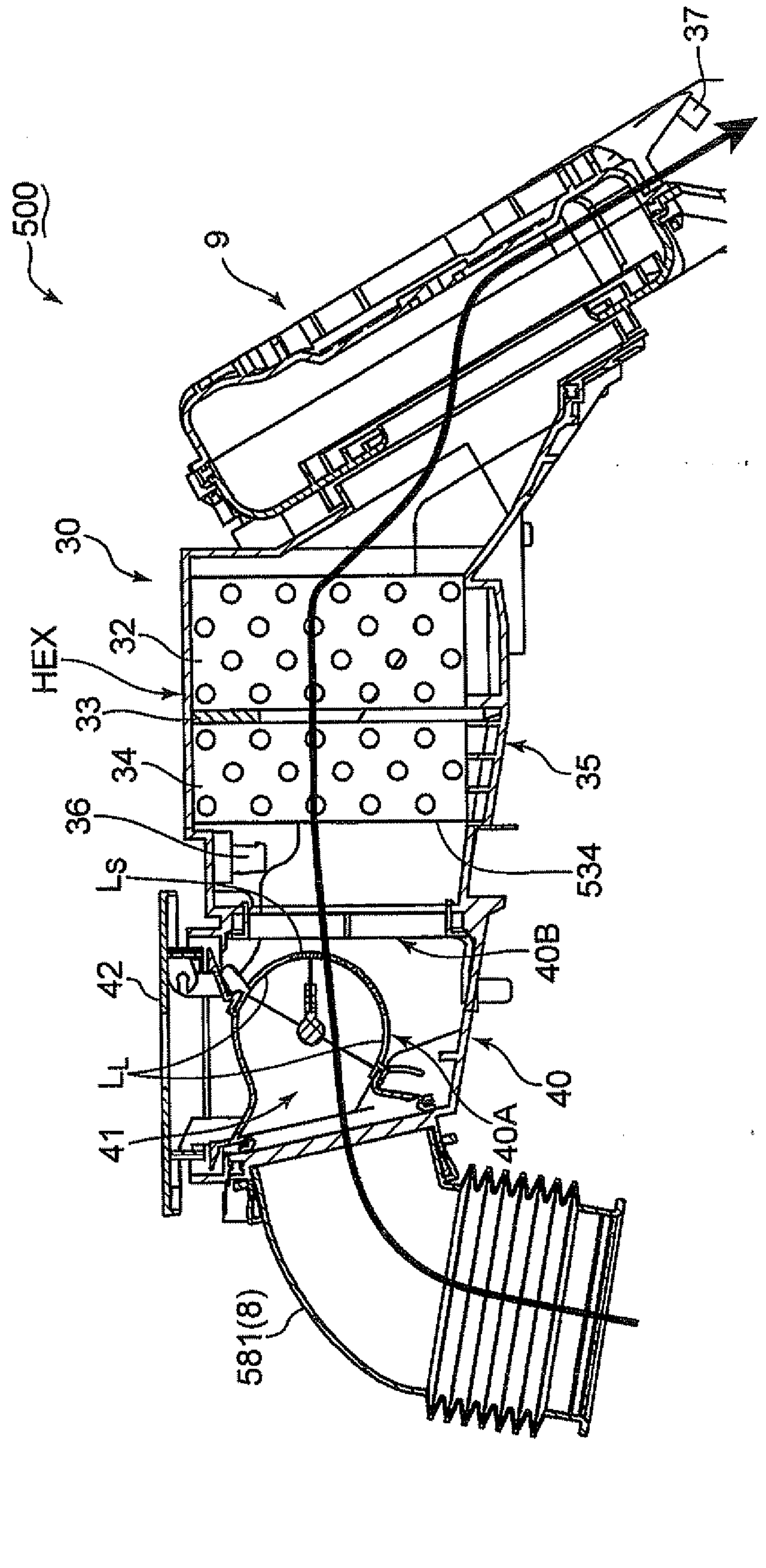


FIG.6

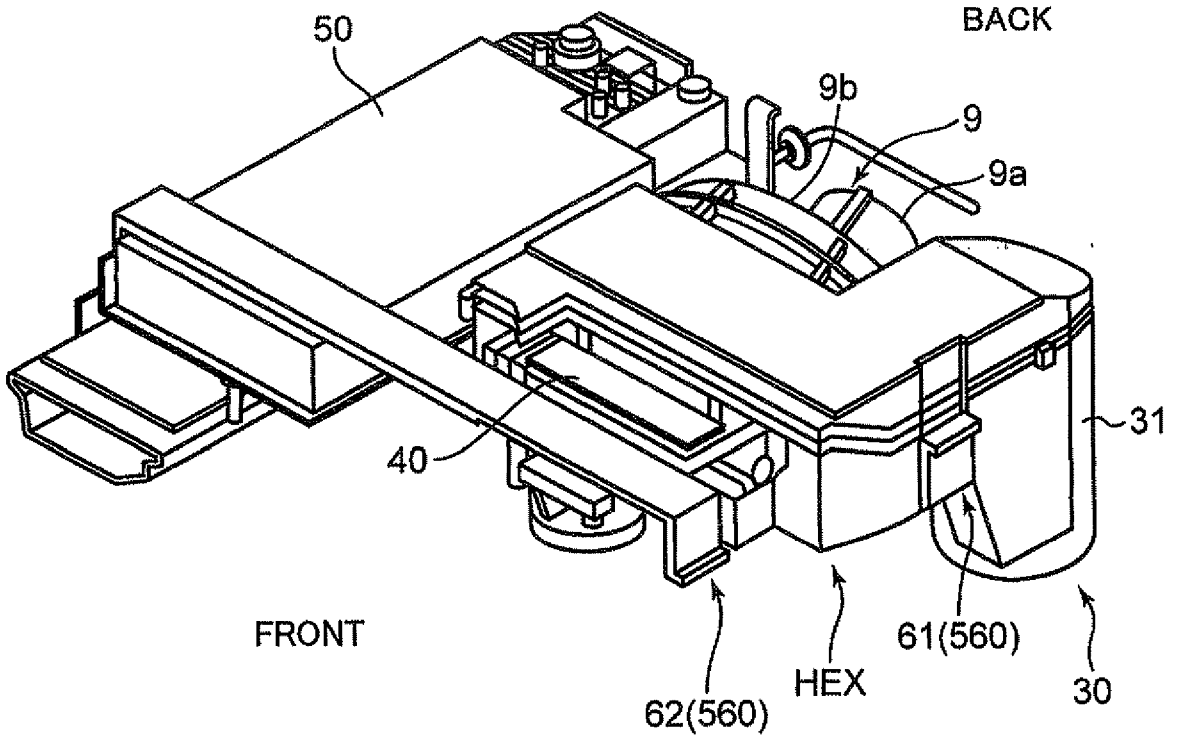


FIG.7

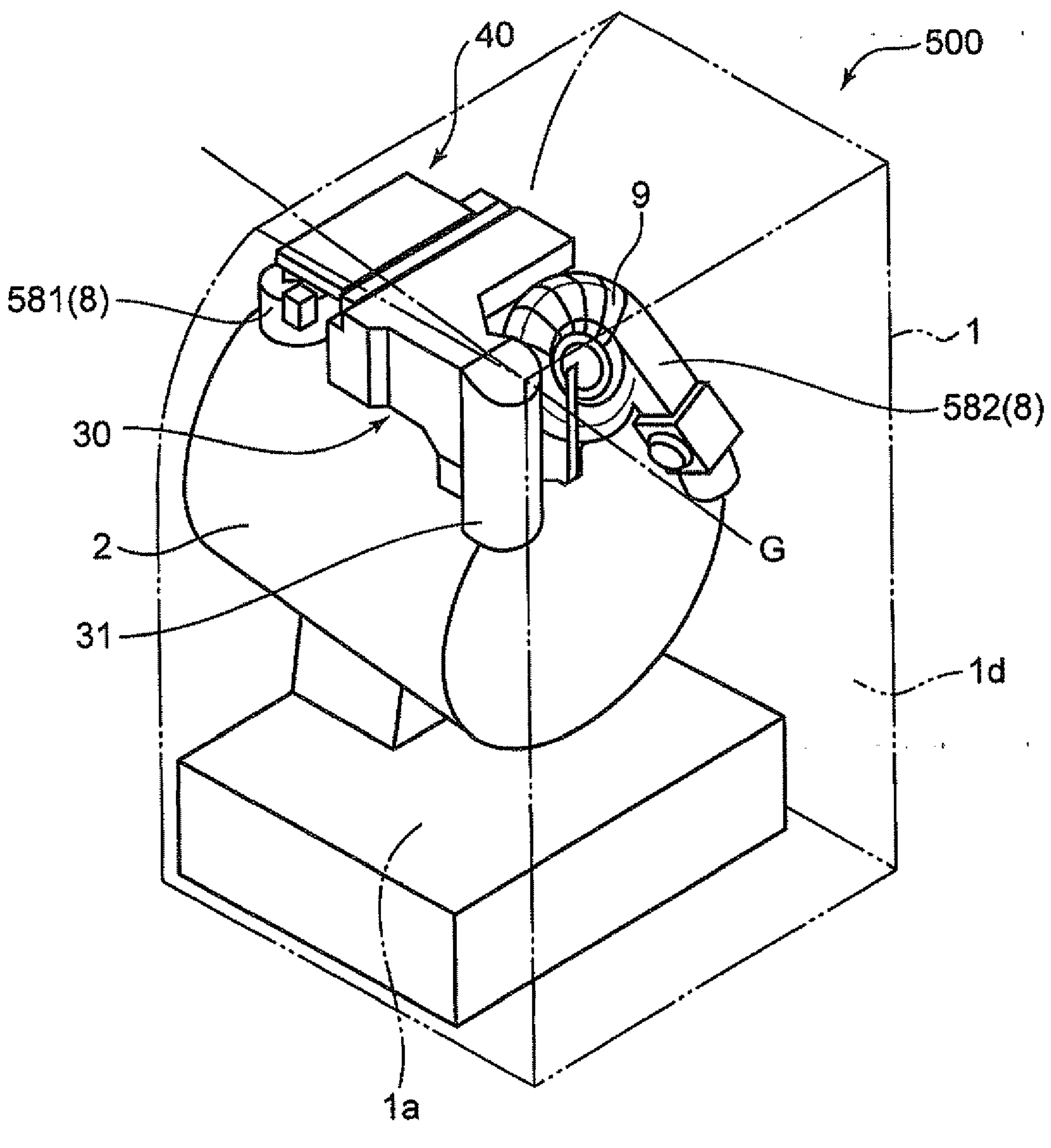


FIG.8

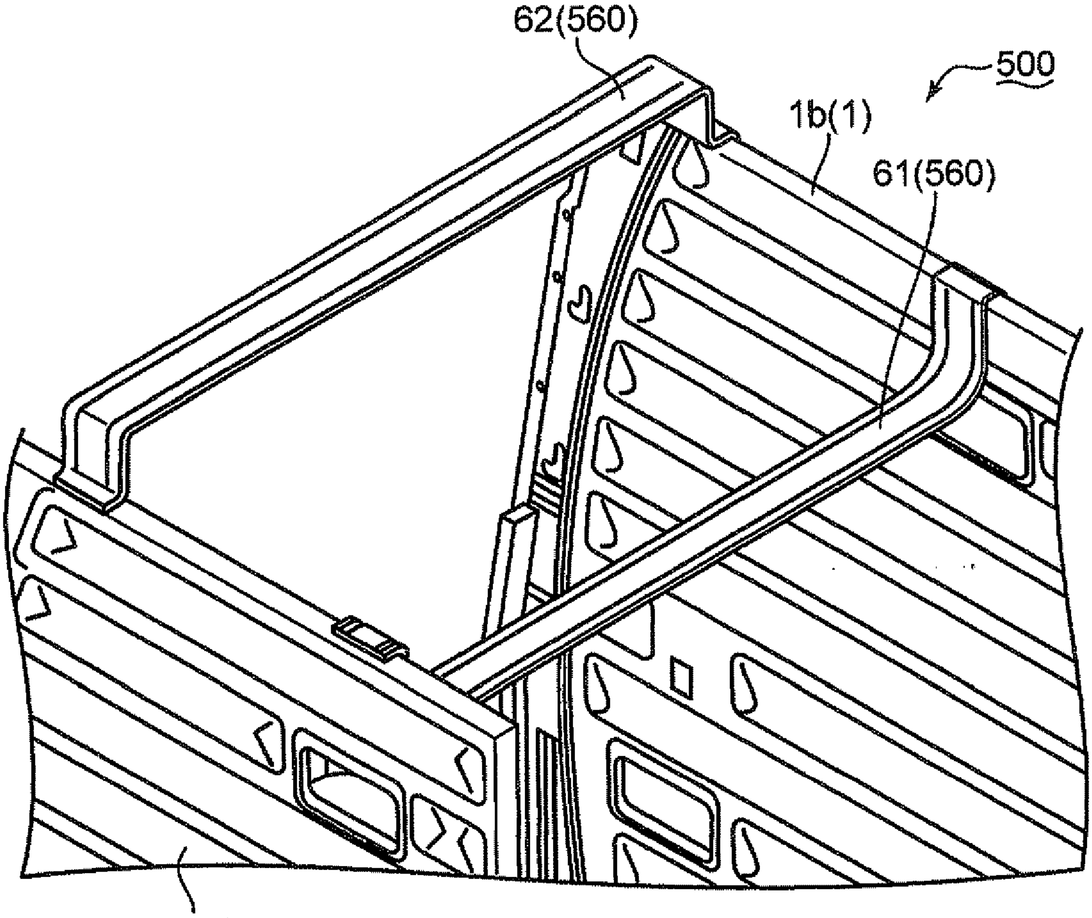


FIG.9

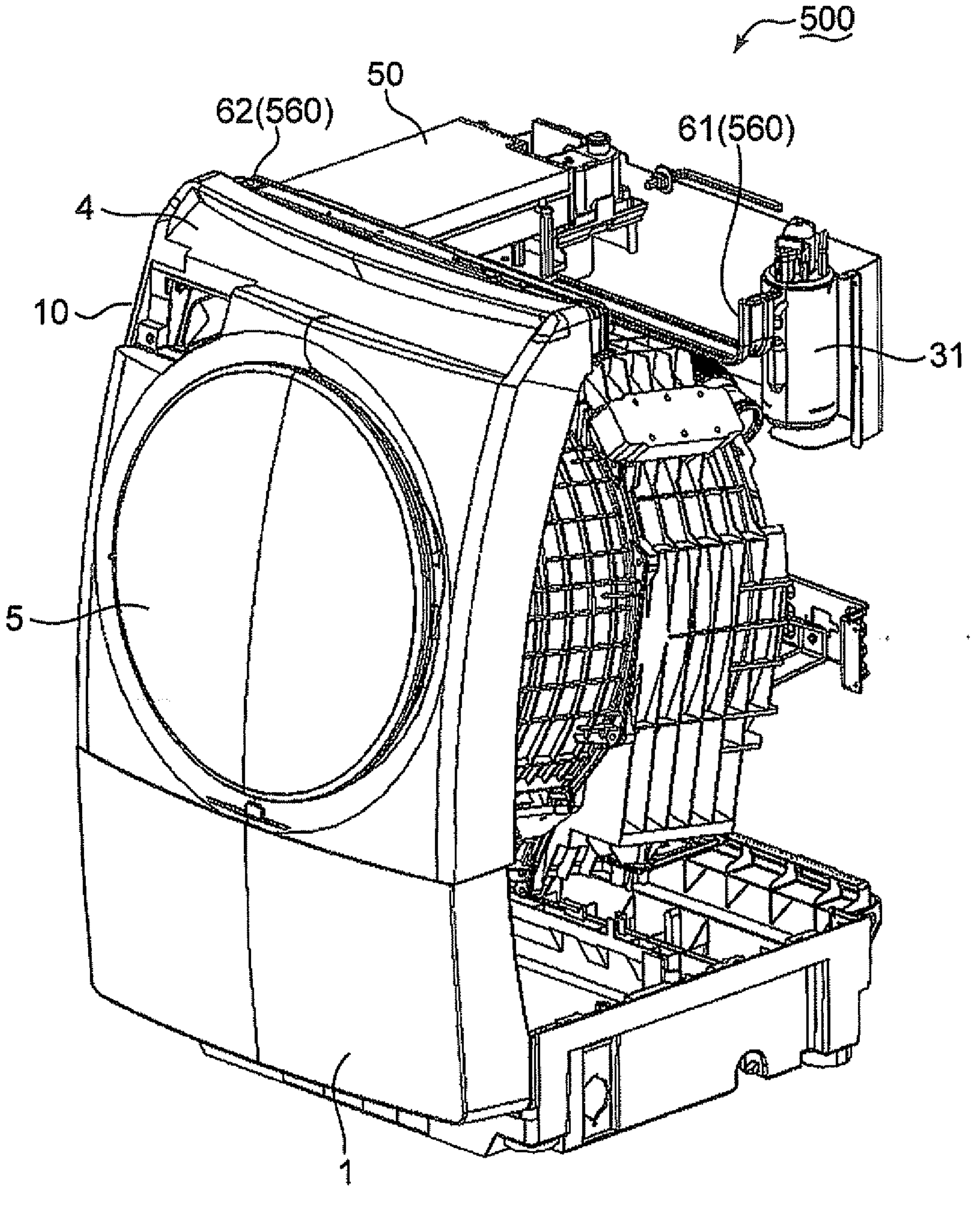


FIG.10

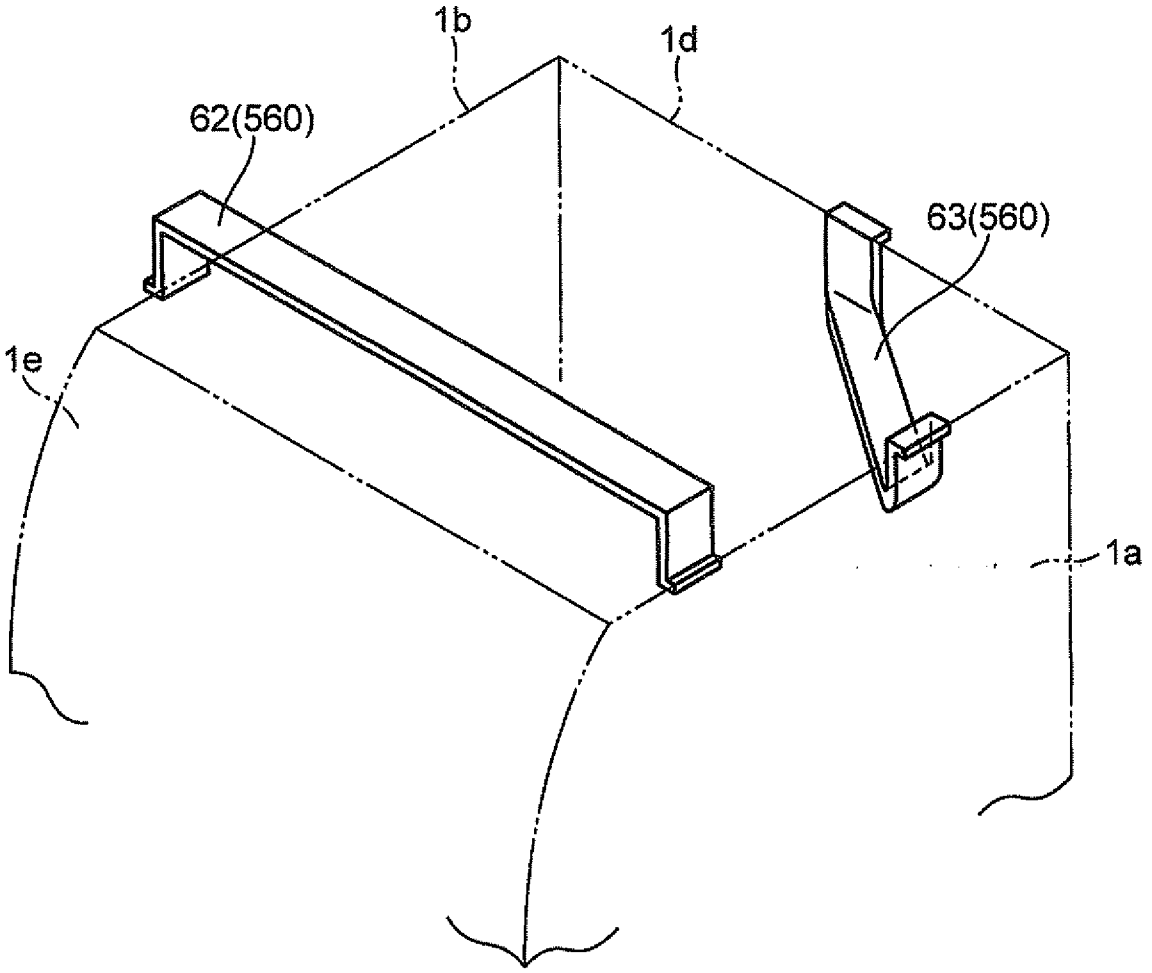


FIG.11

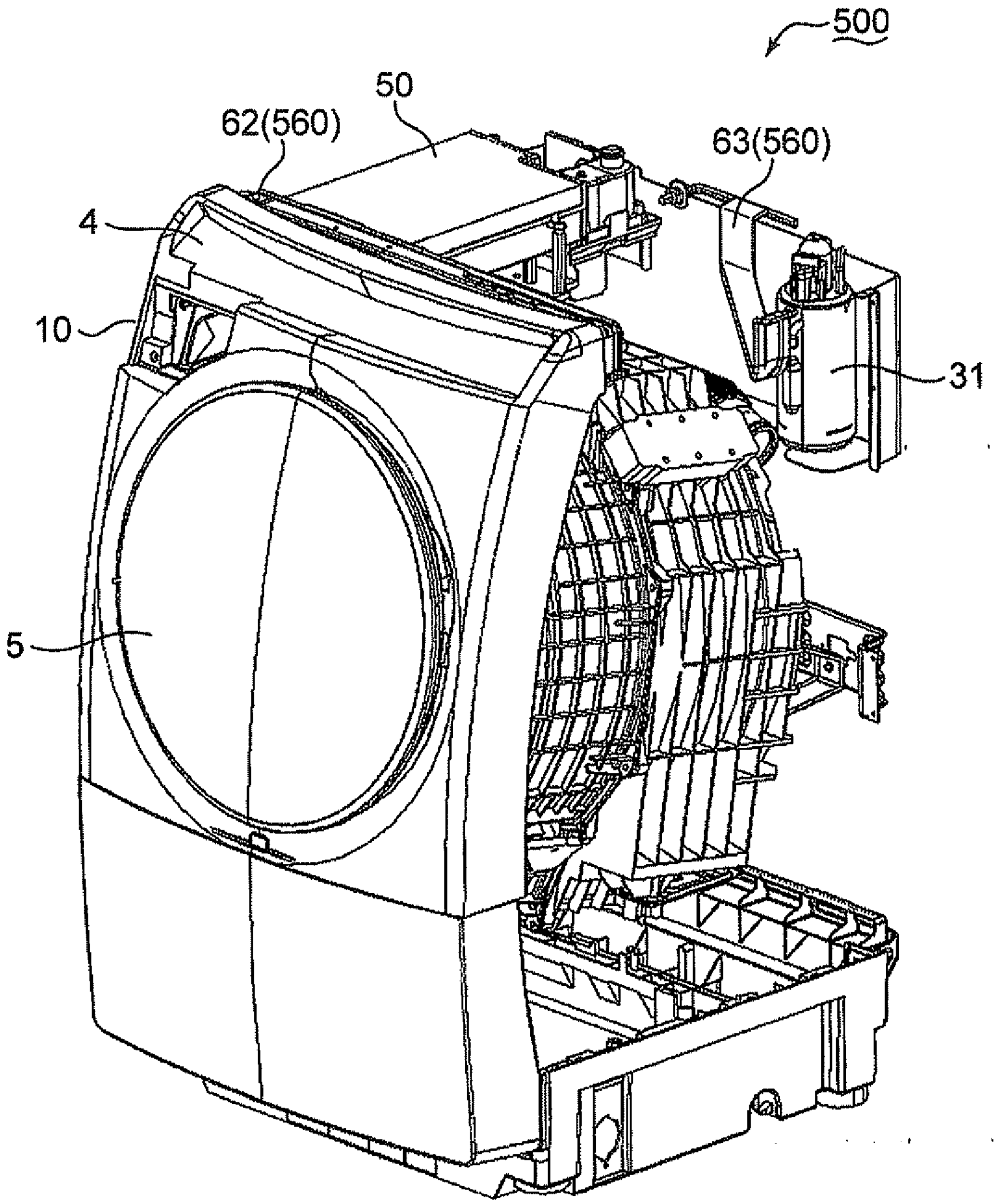
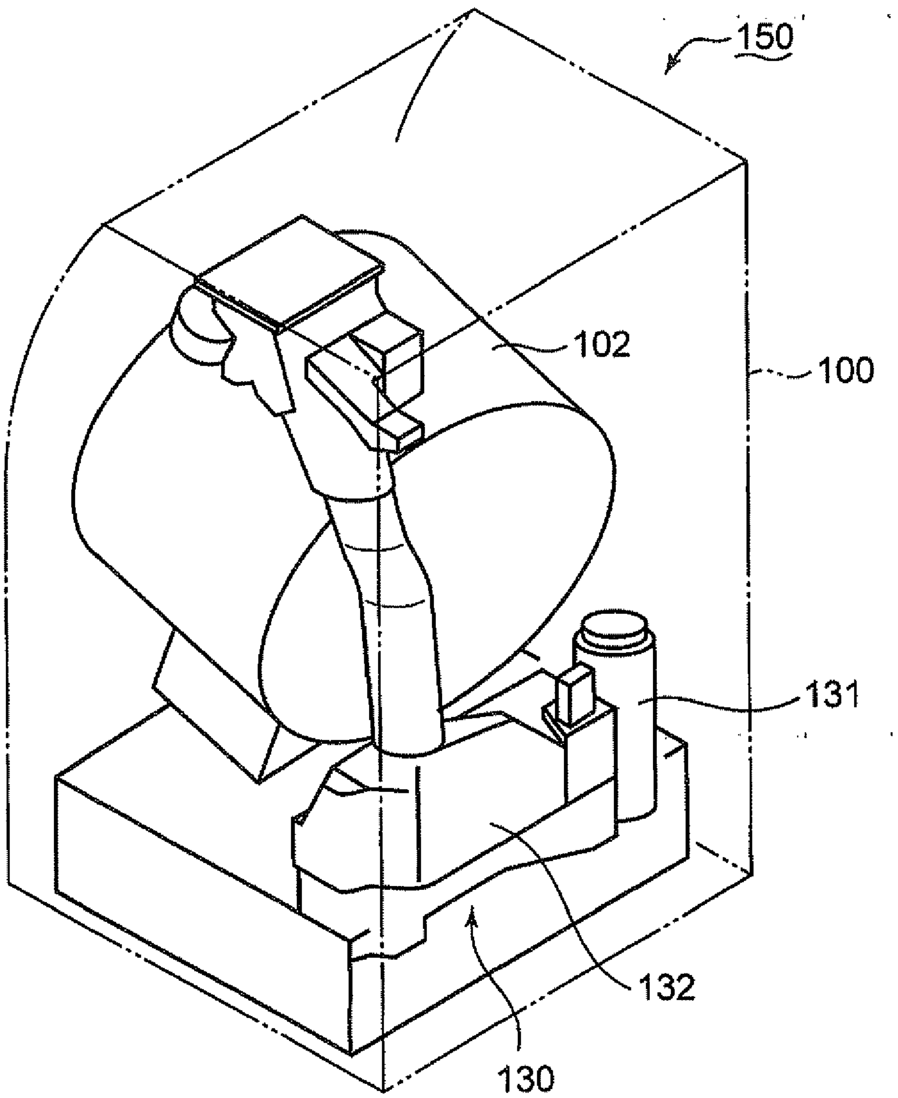


FIG.12



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Patent documents cited in the description

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