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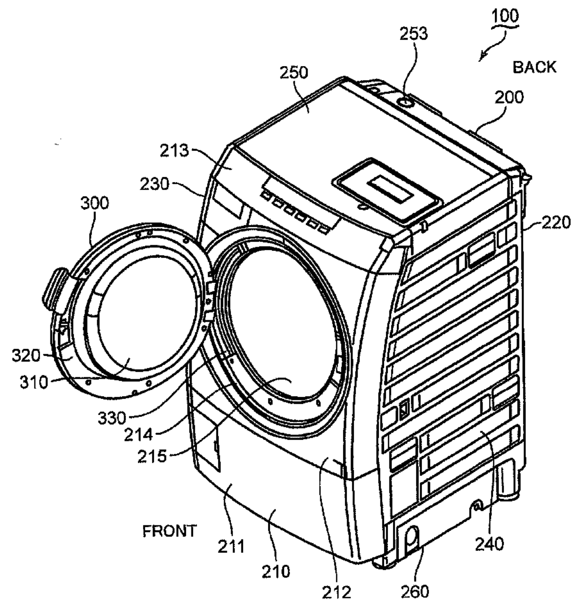
(54) **Drying apparatus**

(57) Drying apparatus (100) has drying tub (410) for storing laundry (C) and circulation system (600) of dry air. Circulation system (600) includes dehumidifier (635), blower (621) for sending dry air into drying tub (410), and support element (500) for supporting dehumidifier, (635). Support element (500) has drainage port (531) from which water is discharged, main tilted surface (511) for guiding water toward drainage port (531), first tilted surface (542) below dehumidifier (635), and first partition wall (546) protruding from first tilted surface (542) to partition first tilted surface (542) into first upstream tilted surface (544) and first downstream tilted surface (545) that is closer to blower (621) than first upstream tilted surface (544). First tilted surface (542) is tilted such that water flows toward main tilted surface (511), and first partition wall (546) extends in transverse direction with respect to dry air flow toward blower (621).

FIG.1



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Description

Field of the Invention

[0001] The present invention is related to a drying apparatus for drying laundry.

Description of the Background Art

[0002] A drying apparatus such as a drying machine configured to dry laundry or a washing and drying machine with washing functions in addition to drying functions typically supplies dry air into a drum in which laundry is stored and dried. Japanese Patent Application Laid-open No. 2005-52533 discloses such a washing and drying machine configured to dry and wash laundry.

[0003] Fig. 11 schematically shows an internal structure of the washing and drying machine according to the disclosure of Japanese Patent Application Laid-open No. 2005-52533. The washing and drying machine of Japanese Patent Application Laid-open No. 2005-52533 is described with reference to Fig. 11.

[0004] The washing and drying machine 900 has a washing and drying tub 910 configured to store laundry and a circulation system 920 configured to circulate dry air, which is used for drying the laundry. The circulation system 920 comprises a circulation duct 930 which includes a first end 931 connected to the bottom surface of the washing and drying tub 910 and a second end 932 connected to the circumferential surface of the washing and drying tub 910, a fan 940 which is attached to the second end 932 of the circulation duct 930, a filter 950 which removes lint (dust such as a yarn waste) from the dry air flowing in the circulation duct 930, and a heat pump 960 which is situated between the filter 950 and the fan 940. The fan 940 causes a negative pressure in the first end 931 of the circulation duct 930, as well as a positive pressure in the second end 932 thereof. As a result, the dry air in the washing and drying tub 910 is sucked from the first end 931 of the circulation duct 930. Thereafter, the dry air passes through the filter 950. The dry air passed through the filter 950 further moves through the heat pump 960, and is sent into the washing and drying tub 910 from the second end 932 of the circulation duct 930.

[0005] The heat pump 960 comprises a heat absorber 961 immediately after the filter 950, and a radiator 962 between the heat absorber 961 and the fan 940. The heat absorber 961 cools the dry air to condense moisture contained in the dry air, which is thereby dehumidified. The dry air passed through the heat absorber 961 moves through the radiator 962, which heats the dry air. Thus, the dry air subjected to the dehumidification and heating processes is sent into the washing and drying tub 910 again by the fan 940.

[0006] The circulation duct 930 includes a pool 933 configured to store the water (condensation water) removed from the dry air by the heat absorber 961. The pool 933 forms a space which expands downwardly between the heat absorber 961 and the radiator 962. The water stored in the pool 933 is discharged by a pump (not shown).

[0007] Like Japanese Patent Application Laid-open No. 2005-52533, each of Japanese Patent Application Laid-open No. 2010-63694 and Japanese Patent Application Laid-open No. 2010-64020 discloses a circulation system. The aforementioned circulation system of each patent document comprises a structure which makes the dry air flow less sensitive to the suction of the pump, which is used to discharge the water removed from the dry air.

[0008] According to the aforementioned circulation system, the stored water after the removal from the dry air is subjected to the negatively pressurized environment caused by the fan. Consequently, the stored water is blown up due to the dry air flow, and is potentially brought downstream.

[0009] As shown in Fig. 11, in the circulation system 900 according to the disclosure of Japanese Patent Application Laid-open No. 2005-52533, the blown up water is heated and evaporated by the radiator 962, which results in an inefficient drying process.

SUMMARY OF THE INVENTION

[0010] An object of the present invention is to provide a drying apparatus, which may maintain a relatively high drying efficiency.

[0011] A drying apparatus according to one aspect of the present invention has: a drying tub configured to store laundry; and a circulation system configured to circulate dry air for drying the laundry, wherein the circulation system includes a dehumidifier configured to remove water contained in the dry air, an blower which sucks the dry air after removal of the water by the dehumidifier to send the dry air into the drying tub, and a support element configured to support the dehumidifier, the support element includes a drainage port from which the water is discharged, a main tilted surface tilted to guide the water toward the drainage port, a first tilted surface below the dehumidifier, and a first partition wall which protrudes from the first tilted surface to partition the first tilted surface into a first upstream tilted surface and a first downstream tilted surface that is closer to the blower than the first upstream tilted surface, the first tilted surface is tilted such that the water flows toward the main tilted surface, and the first partition wall extends in a transverse direction with respect to a flow of the dry air toward the blower.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012]

Fig. 1 is a schematic perspective view of a washing and drying machine according to one embodiment;

Fig. 2 is a schematic cross-sectional view of the washing and drying machine depicted in Fig. 1;

Fig. 3 is a schematic cross-sectional view of the washing and drying machine depicted in Fig. 1;

Fig. 4 is a schematic view of a heat pump of the washing and drying machine depicted in Fig. 1;

Fig. 5 is a schematic plan view of the heat pump depicted in Fig. 4 and a support plate configured to support the heat pump;

Fig. 6 is a schematic plan view of the support plate depicted in Fig. 5;

Fig. 7 is a schematic side view of the support plate depicted in Fig. 6;

Fig. 8 is a schematic view of a right support wall of the support plate depicted in Fig. 6;

Fig. 9 is a schematic view of a first partition wall of the support plate depicted in Fig. 6;

and

Fig. 10 is a schematic view of a second partition wall of the support plate depicted in Fig. 6.

Fig. 11 is a schematic view of a structure of a washing and drying machine according to a prior art.

DESCRIPTION OF THE PREFERRED EMBODIMENT

[0013] A drying apparatus according to one embodiment is described with reference to the accompanying drawings. It should be noted that directional terms used hereinafter such as "above", "below", "left", "right" and alike are used only for the purpose of clarification of the description, and are not intended to limit methodologies of the drying apparatus.

(Entire Structure of Washing and Drying Machine)

[0014] Fig. 1 is a schematic perspective view of a washing and drying machine exemplified as the drying apparatus according to one embodiment. In the present embodiment, the washing and drying machine with washing functions and drying functions is exemplified as the drying apparatus. Alternatively, a drying machine without the washing function may be used as the drying apparatus.

[0015] The washing and drying machine 100 comprises a housing 200 and a door 300. The housing 200 is formed into a generally rectangular boxed shape. The housing 200 includes an upright front wall 210, a back wall 220 opposite to the front wall 210, left and right walls 230, 240 which vertically stands between the front and back walls 210, 220, a top wall 250 which forms the upper surface of the housing 200, and a bottom wall 260 which forms the lower surface of the housing 200.

[0016] The front wall 210 includes a lower wall 211 situated in a lower portion thereof, a central wall 212 above the lower wall 211, and an upper wall 213 above the central wall 212. The central wall 212 and the upper wall 213 are tilted upward to curve toward the back wall 220.

[0017] The central wall 212 includes an annular concave surface 214 which forms a concave region substantially complementary to the substantially disk-shaped door 300. The concave surface 214 surrounds a feeding opening 215 configured to extend through a substantially central portion of the central wall 212. The feeding opening 215 communicates with a washing and drying tub (described later), which is stored inside the housing 200. A user may put and take clothing (laundry and alike) in and out of the housing 200 through the feeding opening 215.

[0018] The washing and drying machine 100 comprises a hinge structure 330 which pivotally connects the door 300 to the housing 200. The hinge structure 330 allows the door 300 to pivot between a closing position where the door 300 closes the feeding opening 215 and an opening position where the door 300 opens the feeding opening 215. The door 300 pivoted to the closing position is accommodated in the concave region surrounded by the concave surface 214. It should be noted that the door 300 depicted in Fig. 1 is positioned at the opening position.

[0019] Fig. 2 is a schematic cross-sectional view of the washing and drying machine 100 with the door 300 positioned at the closing position. Arrangements, shapes, and structures of elements in the housing 200 depicted in Fig. 2 should not be restrictively interpreted. The arrangements, shapes, and structures of the elements in the housing 200 may be appropriately determined in accordance with designs and functions of the washing and drying apparatus. The entire structure of the washing and drying machine 100 is further described with reference to Figs. 1 and 2.

[0020] As shown in Fig. 2, a processing apparatus 400 configured to perform a drying process is constructed in the housing 200. In the present embodiment, the processing apparatus 400 executes processes required for washing and drying laundry C such as a washing process, a rinsing process, and a dewatering process in addition to the drying process. Alternatively, if the drying machine without the washing function is used as the drying processing apparatus, the processing apparatus may execute only the drying process.

[0021] The processing apparatus 400 comprises a washing and drying tub 410 configured to dry and wash the laundry C. The washing and drying tub 410 configured to store the laundry C includes a water tub 420 shaped in a bottomed cylinder which is supported but allowed to rock in the housing 200, and a rotary drum 440 shaped in a bottomed cylinder which is supported in the water tub 420. The processing apparatus 400 comprises a suspension 490 configured to elastically support the washing and drying tub 410. The suspension 490 connected to the bottom wall 260 of the housing 200 appropriately absorbs vibration during various processes such as the aforementioned drying process, washing process, rinsing process, and spin-drying process. In the present embodiment, the washing and drying tub 410 is exemplified as the drying tub.

[0022] The processing apparatus 400 further includes a motor 430 configured to rotate the rotary drum 440. The main body of the motor 430 is mounted to the outer surface of the bottom wall 431 of the water tub 420. The rotary shaft of the motor 430 extends through the bottom wall 431 of the water tub 420, and is connected to the bottom wall 432 of the rotary drum 440. The motor 430 rotates the rotary drum 440 during various processes such as the drying process, washing process, rinsing process, and spin-drying process.

[0023] A front wall 433 opposite to the bottom wall 431 of the water tub 420 is provided with an opening 434 substantially concentric with the substantially circular door 300 at the closing position. Similarly, a front wall 435 opposite to the bottom wall 432 of the rotary drum 440 is provided with an opening 436 substantially concentric with the opening 434 formed on the front wall 433 of the water tub 420. A user may turn the door 300 to the opening position to feed laundry C into the rotary drum 440 through the feeding opening 215. The processing apparatus 400 further comprises a bellows 437 situated between the central wall 212 of the housing 200 and the front wall 433 of the water tub 420. The water tub 420 is elastically connected to the housing 200 via the bellows 437.

[0024] As shown in Fig. 1, the door 300 includes a transparent window 310, which looks like a bottomed generally trapezoidal conical shape, and a substantially disk-like support frame 320 configured to support the window 310. As shown in Fig. 2, if the door 300 is positioned at the closing position, the window 310 is inserted into the feeding opening 215 formed on the housing 200. If the door 300 is positioned at the closing position, a user may visually access the laundry C in the washing and drying tub 410 through the transparent window 310.

[0025] The washing and drying machine 100 comprises a watering system 340 configured to supply water, which is used for washing laundry, to the washing and drying tub 410, and a circulatory drainage system 350 configured to circulate and drain the water, which is supplied to the washing and drying tub 410 (washing water). In the present embodiment, the watering system 340 is formed in an upper portion of the internal space of the housing 200. The circulatory drainage system 350 is formed in a lower portion of the internal space of the housing 200.

[0026] The top wall 250 of the housing 200 is provided with a water inlet 253, which is connected to, for example, a hose (not shown). The watering system 340 comprises a storage chamber 341 configured to store detergent, and a first watering duct 342 which connects the water inlet 253 with the storage chamber 341. The storage chamber 341 is adjacent to the inner surface of the top wall 250 of the housing 200. The watering system 340 further comprises a second watering duct 343 which extends from the storage chamber 341 to the water tub 420.

[0027] Water supplied through the water inlet 253 flows into the storage chamber 341 through the first watering duct 342. The water and the detergent are mixed up in the storage chamber 341 to become washing water. The washing water is supplied into the water tub 420 through the second watering duct 343.

[0028] The water tub 420 is formed with an outlet port 423 from which the washing water is discharged, and an inlet port 424 through which the washing water flows into the water tub 420. The bottom wall 260 of the housing 200 is provided with a drainage port 261 from which the washing water is drained to the outside of the housing 200. The circulatory drainage system 350 comprises a drainage duct 351 which extends between the outlet port 423 of the water tub 420 and the drainage port 261 of the housing 200, and a drainage valve 352 which is mounted to the drainage duct 351. The drainage valve 352 is used to control drainage of the washing water to the outside of the housing 200. The drainage valve 352 is opened and closed as appropriate. In the present embodiment, the circulatory drainage system 350 is exemplified as the drainage system.

[0029] The circulatory drainage system 350 comprises a circulation duct 353, which is branched from the drainage duct 351 before the drainage valve 352, and a circulation pump 354 which is mounted to the circulation duct 353. The circulation duct 353 is connected to the inlet port 424 of the water tub 420. If the drainage valve 352 is closed and the circulation pump 354 is operated, the washing water in the water tub 420 is sucked to the circulation pump 354.

[0030] Thereafter, the washing water is pumped to the inlet port 424 by the circulation pump 354, and then is used for washing the laundry C in the washing and drying tub 410.

[0031] The water tub 420 is further formed with a limitation hole 422 configured to limit a liquid level in the water tub 420. The circulatory drainage system 350 further comprises an overflow pipe 355 which is connected to the limitation hole 422. The overflow pipe 355 is also connected to the drainage duct 351 before the drainage valve 352. If the liquid level of the washing water in the water tub 420 exceeds a given level, the drainage valve 352 is opened. The redundant washing water in the water tub 420 flows into the overflow pipe 355 through the limitation hole 422, and is eventually drained from the drainage port 261 of the housing 200.

[0032] The circulatory drainage system 350 further comprises a hollow block 356 which is mounted to the drainage duct 351, and a liquid level sensor 357 which is connected to the hollow block 356. A layer of the washing water and an air layer are formed in the hollow block 356 mounted between the drainage valve 352 and the washing and drying tub 410. Since the hollow block 356 is connected to the water tub 420 via the drainage duct 351, a thickness of the washing water layer in the hollow block 356 fluctuates correspondingly to the liquid level of the washing water in the water tub 420. The fluctuation in thickness of the washing water layer inside the hollow block 356 varies pressure of the air layer in the hollow block 356. The liquid level sensor 357 detects the fluctuation in the air layer pressure in the hollow block 356. The output from the liquid level sensor 357 is used to adjust the liquid level of the washing water in the water tub 420.

[0033] Fig. 3 is a schematic cross-sectional view of the washing and drying machine 100. The entire structure of the washing and drying machine 100 is further described with reference to Figs. 1 and 3.

[0034] The washing and drying machine 100 has a circulation system 600 configured to circulate dry air for drying the laundry C stored in the rotary drum 440. The circulation system 600 is also constructed in the housing 200, like the washing and drying tub 410 and the circulatory drainage system 350.

[0035] The water tub 420 includes a cylindrical circumferential wall 438 which extends between the bottom and front walls 431,433. The circumferential wall 438 of the water tub 420 is provided with an exhaust port 601 through which the dry air is exhausted from the washing and drying tub 410. The bottom wall 431 of the water tub 420 is provided with an inflow port 643 through which the dry air is sucked into the washing and drying tub 410. The circulation system 600 circulates the dry air to dry the laundry C between the exhaust and inflow ports 601, 643.

[0036] The bottom wall 432 of the rotary drum 440 is provided with a bottom hole 645 to introduce the dry air, which has been sucked through the inflow port 643, into the rotary drum 440. The rotary drum 440 includes a cylindrical circumferential wall 439 which extends between the bottom and front walls 432, 435. The circumferential wall 439 of the rotary drum 440 is provided with a lot of circumferential holes 646 to flow the dry air into the exhaust port 601 formed on the circumferential wall 438 of the water tub 420. The dry air from the bottom hole 645 to the circumferential holes 646 facilitates to dry the laundry C in the rotary drum 440.

[0037] The circulation system 600 comprises a first duct 610, which protrudes from the exhaust port 601 of the water tub 420 and extends along the top wall 250 of the housing 200, a filter apparatus 700 which removes lint (dust such as a yarn waste) from the dry air discharged from the washing and drying tub 410, a heat pump 630 adjacent to the filter apparatus 700, and a fan 621 which circulates the dry air. The first duct 610 includes a support plate described later, and a connection duct 602 which connects the support plate to the exhaust port 601. In the present embodiment, the support plate supports the filter apparatus 700, the heat pump 630, and the fan 621. The fan 621 is exemplified as the blower. The connection duct 602 is exemplified as the connection pipe.

[0038] The first duct 610 guides the dry air from the washing and drying tub 410 to the fan 621. The filter apparatus 700 in the first duct 610 removes the lint from the dry air. The heat pump 630 performs heat exchange with the dry air to dehumidify and heat the dry air. The fan 621 sucks the dehumidified and heated dry air, and then sends the dry air to the washing and drying tub 410.

[0039] The circulation system 600 further comprises a second duct 620 which guides the dry air from the fan 621 to the washing and drying tub 410. The dry air sent from the fan 621 is guided by the second duct 620, and flows into the washing and drying tub 410 via the inflow port 643.

[0040] The circulation system 600 comprises a branch duct 650 which is branched from the second duct 620, and a switching valve 651 situated at a junction between the second and branch ducts 620, 650. The branch duct 650 includes a tip end which communicates with the opening 436 formed on the front wall 435 of the rotary drum 440. The switching valve 651 pivots between a first position where the switching valve 651 blocks the dry air flow from the fan 621 to the inflow port 643 and a second position where the switching valve 651 aligns the dry air flow from the fan 621 to the inflow port 643. If the switching valve 651 is at the first position, most of the dry air is blown on the laundry C from the opening 436 of the rotary drum 440 through the branch duct 650 whereas if the switching valve 651 is at the second position, most of the dry air flows to the inflow port 643. After the drying process is started, the switching valve 651 is set to the second position for a given time period. Thereafter, the switching valve 651 is set to the first position until the drying process is completed. Thus, the drying operation is changed in response to a dryness level of the laundry C.

(Heat Pump)

[0041] Fig. 4 is a schematic view diagrammatically showing the heat pump 630. The heat pump 630 is described with reference to Figs. 3 and 4.

[0042] The heat pump 630 comprises a circulation pipe 631. Coolant flows in the circulation pipe 631. The heat pump 630 comprises a compressor 632 configured to compresses the coolant. The compressor 632 is situated along the path of the circulation pipe 631, which contours a closed loop.

[0043] The circulation pipe 631, in which the coolant sent from the compressor 632 flows, protrudes into the first duct 610 to form a radiator 633. The radiator 633 configured to radiate heat of the coolant heated by means of compression in the compressor 632 includes the circulation pipe 631 which meanders in the first duct 610, and fins 638 which are attached to the circulation pipe 631. The dry air passing through the first duct 610 is heated by the radiator 633. In the present embodiment, the radiator 633 is exemplified as the heater.

[0044] The heat pump 630 has a decompressor 634 configured to decompress the coolant, which has been highly compressed by the compressor 632. The coolant passing through the radiator 633 is simultaneously decompressed and cooled by the decompressor 634.

[0045] The coolant passing through the decompressor 634 flows in the circulation pipe 631, which protrudes again into the first duct 610 to form a heat absorber 635.

The heat absorber 635 configured to absorb heat by means of the coolant cooled by decompression in the decompressor 634 includes the circulation pipe 631 which meanders in the first duct 610, and fins 636 which are attached to the circulation pipe 631. The heat of the dry air in the first duct 610 is absorbed by the heat absorber 635. As a result, the moisture in the dry air is condensed on the fins 636 and/or the circulation pipe 631, and is removed from the dry air. In the following description, the moisture in the dry air condensed on the fins 636 and/or the circulation pipe 631 is referred to as condensation water. In the present embodiment, the heat absorber 635 is exemplified as the dehumidifier.

[0046] As shown in Fig. 3, the circulation system 600 comprises a drain tube 639 connected between the first duct 610 and the drainage duct 351 below the heat absorber 635. In the present embodiment, the drain tube 639 is connected to the hollow block 356 provided in the drainage duct 351. The drain tube 639 is used to guide the condensation water to the drainage duct 351.

[0047] The heat pump 630 is adjacent to the top wall 250 of the housing 200 to cause a relatively large water head of the condensation water in the drain tube 639. Thus, the condensation water appropriately flows into the drainage duct 351 by the gravity action.

[0048] The circulation system 600 further comprises a check valve 637 which is attached to the drain tube 639. Most of the internal space in the first duct 610 is negatively pressurized under operation of the fan 621. The check valve 637 checks the negative pressure environment in the first duct 610 along the path of the drain tube 639, so that it becomes less likely that fluid elevates from the drainage duct 351 to the first duct 610. The attachment position of the check valve 637 in the drain tube 639 is appropriately determined such that the water head between the check valve 637 and the first duct 610 becomes high enough to send the condensation water into the drainage duct 351.

(Support Plate)

[0049] Fig. 5 is a schematic plan view of the filter apparatus 700, the heat pump 630, and the fan 621 which are situated on the support plate. Fig. 6 is a schematic plan view of the support plate. Fig. 7 is a schematic right side view of the support plate. The support plate is described with reference to Figs. 3 and 5 to 7.

[0050] The support plate 500 includes a bottom wall 510 which supports the filter apparatus 700, the heat pump 630, and the fan 621, and a circumferential wall 520 which vertically stands from the circumferential edge of the bottom wall 510. The circumferential wall 520 includes a connection wall 521 which is connected to the connection duct 602. The connection wall 521 is formed with an opening 522 which is connected to the connection duct 602.

[0051] The filter apparatus 700 adjacent to the connection wall 521 removes lint from the dry air introduced from the opening 522. The fan 621 is mounted on the bottom wall 510 so that the fan 621 is offset leftward with respect to the opening 522. It should be noted that, in the present embodiment, the connection wall 521 stands from the front edge of the bottom wall 510 whereas the fan 621 is mounted near the back edge of the bottom wall 510.

[0052] The heat absorber 635 of the heat pump 630 adjacent to the filter apparatus 700 removes the moisture from the dry air immediately after the dry air passes through the filter apparatus 700. A right portion 635R of the heat absorber 635 faces the opening 522. A left portion 635L adjacent to the right portion 635R faces the fan 621. In the present embodiment, the support plate 500 configured to support the heat absorber 635 is exemplified as the support element. The right portion 635R of the heat absorber 635 is exemplified as the first dehumidification section. The left portion 635L of the heat absorber 635 is exemplified as the second humidification section.

[0053] The radiator 633 of the heat pump 630 is adjacent to the heat absorber 635. The radiator 633 situated between the heat absorber 635 and the fan 621 has the substantially same shape and size as the heat absorber 635. A right portion 633R of the radiator 633 is adjacent to the right portion 635R of the heat absorber 635. A left portion 633L of the radiator 633 is adjacent to the left portion 635L of the heat absorber 635. In the present embodiment, the right portion 633R of the radiator 633 is exemplified as the first heating section. The left portion 633L adjacent to the right portion 633R is exemplified as the second heating section.

[0054] The bottom wall 510 includes a main tilted surface 511 which is formed at the right sides of the heat absorber 635 and the radiator 633. The condensation water from the heat absorber 635 flows to the main tilted surface 511. The main tilted surface 511 is tilted such that the condensation water on the main tilted surface 511 flows backward.

[0055] The support plate 500 includes a pool 530 adjacent to a backside end of the main tilted surface 511. The pool 530 is depressed downward with respect to the main tilted surface 511. Consequently, the condensation water reached the backside end of the main tilted surface 511 flows into the pool 530. The pool 530 may temporarily stores a given amount of the condensation water.

[0056] The support plate 500 includes a connection port 531 which is formed at the bottom of the pool 530. The connection port 531 formed to drain the condensation water in the pool 530 from the support plate 500 is connected to the upper end of the drain tube 639. As described above, the main tilted surface 511 is tilted to guide the condensation water to the pool 530. In the present embodiment, the connection port 531 is exemplified as the drainage port.

[0057] The support plate 500 includes a cylindrical wall 540 which surrounds the compressor 632 of the heat pump 630. The cylindrical wall 540 is adjacent to the pool

530.

[0058] Fig. 8 is a schematic right side view of the heat absorber 635 and the radiator 633 supported by the support plate 500. The support plate 500 is described with reference to Figs. 5, 6, and 8.

[0059] The support plate 500 includes a right support wall 512 which supports the right ends of the heat absorber 635 and the radiator 633. The right support wall 512 defines the left boundary of the main tilted surface 511. The left ends of the heat absorber 635 and the radiator 633 are appropriately supported by a left support wall 513 which protrudes from the circumferential wall 520 of the support plate 500.

[0060] The right support wall 512 which protrudes from the upper surface of the bottom wall 510 includes a first right support wall 514 along the front and bottom edges of the right side surface of the heat absorber 635, a second right support wall 515 along the back edge and a part of the bottom edge of the right side surface of the radiator 633, and a third right support wall 516 which supports the bottom edge of the right side surface of the radiator 633 between the first and second right support walls 514, 515. The right support wall 512 is formed with notches 517 and 518. The notch 517 is formed between the first and third right support walls 514, 516. The notch 518 is formed between the second and third right support walls 515, 516.

[0061] As shown in Fig. 6, the support plate 500 includes a boundary wall 541 which protrudes upward between the heat absorber 635 and the radiator 633. The bottom wall 510 of the support plate 500 includes a first tilted surface 542 which is formed below the heat absorber 635, and a second tilted surface 543 which is formed below the radiator 633. The right support wall 512 separates the main tilted surface 511 from the first tilted surface 542. The right support wall 512 also separates the main tilted surface 511 from the second tilted surface 543. In the present embodiment, the right support wall 512 which protrudes between the main tilted surface 511 and the first and/or second tilted surfaces 542, 543 is exemplified as the support wall.

[0062] The support plate 500 comprises a first partition wall 546 which partitions the first tilted surface 542 into a first upstream tilted surface 544 and a first downstream tilted surface 545 which is farther from the connection wall 521 (situated nearby the fan 621) than the first upstream tilted surface 544. The first partition wall 546 which protrudes from the first tilted surface 542 extends in a left-to-right direction (a transverse direction with respect to the dry air flow toward the fan 621).

[0063] The support plate 500 comprises a second partition wall 549 which partitions the second tilted surface 543 into a second upstream tilted surface 547 and a second downstream tilted surface 548 which is farther from the connection wall 521 (situated nearby the fan 621) than the second upstream tilted surface 547. The second partition wall 549 which protrudes from the second tilted surface 543 extends in the left-to-right direction (a transverse direction with respect to the dry air flow toward the fan 621).

[0064] Fig. 9 is a schematic cross-sectional view around a connection between the right support wall 512 and the first partition wall 546. The support plate 500 is further described with reference to Figs. 5, 6, and 9.

[0065] A series of the fins 636 of the heat absorber 635 are disposed along the first partition wall 546. The circulation pipe 631 extends through the fins 636. Thus, the fins 636 are sufficiently cooled by the coolant flowing in the circulation pipe 631. The dry air which is brought into contact with the fins 636 and/or the circulation pipe 631 is cooled. As a result, the condensation water occurs on the surfaces of the fins 636 and/or the circulation pipe 631. The condensation water drips onto the first tilted surface 542 (the first upstream tilted surface 544, the first downstream tilted surface 545) formed below the heat absorber 635. The first tilted surface 542 is tilted such that the condensation water dripped on the first tilted surface 542 flows toward the right support wall 512/the main tilted surface 511 (i.e. from below the left portion 635L of the heat absorber 635 toward below the right portion 635R thereof).

[0066] The first partition wall 546 is formed with a notch 551 nearby the right support wall 512. The notch 551 of the first partition wall 546 allows the condensation water to flow from the fist upstream tilted surface 544 to the first downstream tilted surface 545. The notch 517 formed between the first and third right support walls 514, 516 allows the condensation water to flow from the first downstream tilted surface 545 to the main tilted surface 511. In the present embodiment, the notch 517 formed between the first and third right support walls 514, 516 is exemplified as the first notch. The notch 551 of the first partition wall 546 is exemplified as the second notch.

[0067] Fig. 10 is a schematic cross-sectional view around a connection between the right support wall 512 and the second partition wall 549. The support plate 500 is further described with reference to Figs. 4 to 6 and 10.

[0068] A series of the fins 638 of the radiator 633 are disposed along the second partition wall 549. The circulation pipe 631 extends through the fins 638. As described in the context of Fig. 4, the coolant in the radiator 633 is sufficiently heated by the compressor 632. Consequently, unlike the heat absorber 635, it is less likely that there is condensation directly on the fins 638 or the circulation pipe 631 in the radiator 633. However, the condensation water occurred in the heat absorber 635 is potentially carried by the dry air flow and adheres to the fins 638 and the circulation pipe 631 in the radiator 633. It should be noted that the boundary wall 541 protruding between the first downstream tilted surface 545 and the second upstream tilted surface 547 extends in the left-to-right direction (a transverse direction with respect to the dry air flow toward the fan 621) to partially interfere with transit of the condensation water from the heat absorber 635 to the radiator 633.

[0069] The condensation water adhered to the fins 638 and the circulation pipe 631 in the radiator 633 drips onto the second tilted surface 543 (the second upstream tilted surface 547, the second downstream tilted surface 548) formed below the radiator 633. The second tilted surface 543 is tilted such that the condensation water dripped on the second tilted surface 543 flows toward the right support wall 512/the main tilted surface 511 (i.e. from below the left portion 633L of the radiator 633 toward below the right portion 633R thereof).

[0070] The second partition wall 549 is formed with a notch 552 nearby the right support wall 512. The notch 552 of the second partition wall 549 allows the condensation water to flow from the second upstream tilted surface 547 to the second downstream tilted surface 548. The notch 518 formed between the second and third right support walls 515, 516 allows the condensation water to flow from the second downstream tilted surface 548 to the main tilted surface 511. In the present embodiment, the notch 518 formed between the second and third right support walls 515, 516 is exemplified as the third notch. The notch 552 of the second partition wall 549 is exemplified as the fourth notch.

(Drainage of Condensation Water)

[0071] A drainage process of the condensation water is described with reference to Figs. 2, 3, and 6.

[0072] The condensation water dripped on the first and/or second tilted surfaces 542, 543 is flows onto the main tilted surface 511. Thereafter, the condensation water is collected into the pool 530. The condensation water stored in the pool 530 occasionally flows into the drain tube 639, which results in a high water head between the check valve 637, which is attached to the drain tube 639, and the connection port 531. The high head causes the condensation water flow toward the portion below the check valve 637 against the negative pressure environment resulting from the operation of the fan 621. Thus, the condensation water is occasionally sent to the hollow block 356 below the check valve 637.

[0073] In the present embodiment, the condensation water flow from the support plate 500 to the hollow block 356 is caused by the gravity action. Consequently, the condensation water flow becomes less influential to the circulation of the dry air by the fan 621.

[0074] In conventional technologies, the condensation water flow is caused by a pump. The suction of the pump frequently affects the dry air circulation. However, in the present embodiment, the condensation water flow is independent from the dry air circulation.

[0075] The condensation water flow into the hollow block 356 potentially increases the thickness of the washing water layer in the hollow block 356. The liquid level sensor 357 may detect a fluctuation in the air pressure in the hollow block 356 resulting from the condensation water flow into the hollow block 356, The drainage valve 352 may be opened in response to the increase in air pressure in the hollow block 356, so that the condensation water is drained to the outside of the housing 200. Alternatively, if the drainage valve 352 is opened in accordance with a program for conducting various processes such as the washing process, the rinsing process, and the spin-drying process, the condensation water may be drained together with the washing water.

[0076] The washing and drying machine 100 according to the present embodiment may execute the appropriate drainage of the condensation water without an additional component or program. It is also unnecessary to use conventional dedicated pump equipment for drainage of the condensation water.

[0077] The aforementioned embodiment mainly includes a drying apparatus with the following configurations. The drying apparatus with the following configurations may maintain a relatively high drying efficiency.

[0078] A drying apparatus according to one aspect of the aforementioned embodiment has: a drying tub configured to store laundry; and a circulation system configured to circulate dry air for drying the laundry, wherein the circulation system includes a dehumidifier configured to remove water contained in the dry air, an blower which sucks the dry air after removal of the water by the dehumidifier to send the dry air into the drying tub, and a support element configured to support the dehumidifier, the support element includes a drainage port from which the water is discharged, a main tilted surface tilted to guide the water toward the drainage port, a first tilted surface below the dehumidifier, and a first partition wall which protrudes from the first tilted surface to partition the first tilted surface into a first upstream tilted surface and a first downstream tilted surface that is closer to the blower than the first upstream tilted surface, the first tilted surface is tilted such that the water flows toward the main tilted surface, and the first partition wall extends in a transverse direction with respect to a flow of the dry air toward the blower.

[0079] According to the aforementioned configuration, the circulation system circulates the dry air for drying the laundry stored in the drying tub. The dehumidifier removes the water contained in the dry air. The blower sucks the dry air after the removal of the water to send the dry air into the drying tub. The support element configured to support the dehumidifier has the drainage port from which the water is discharged. The main tilted surface guides the water toward the drainage port. The first tilted surface is situated below the dehumidifier. The first partition wall protruding from the first tilted surface partitions the first tilted surface into the first upstream tilted surface and the first downstream tilted surface which is closer to the blower than the first upstream tilted surface. The first tilted surface causes the water flow toward the main tilted surface. Since the first partition wall extends in the transverse direction with respect to the dry air flow toward the blower, it becomes likely that the water flowing on the first upstream tilted surface is prevented from being blown up and sent downstream. Consequently, the water amount in the dry air which is sent into the drying tub by the blower is maintained at a low level. Thus, the drying apparatus may maintain a relatively high drying efficiency.

[0080] In the aforementioned configuration, the support element preferably includes a support wall which protrudes between the main tilted surface and the first tilted surface to support the dehumidifier and the support wall is formed with a first notch which allows the water to flow from the first tilted surface to the main tilted surface.

[0081] According to the aforementioned configuration, the support wall protruding between the main tilted surface and the first tilted surface supports the dehumidifier. The first notch formed on the support wall allows the water to flow from the first tilted surface to the main tilted surface. Thus, the water flowing on the first tilted surface is likely to transit onto the main tilted surface through the first notch, and is eventually discharged from the drainage port.

[0082] In the aforementioned configuration, the first partition wall is preferably formed with a second notch which allows the water to flow from the first upstream tilted surface to the first downstream tilted surface.

[0083] According to the aforementioned configuration, the second notch formed on the first partition wall allows the water to flow from the first upstream tilted surface to the first downstream tilted surface. Thus, the water flowing on the first upstream tilted surface flows onto the first downstream tilted surface through the second notch.

[0084] In the aforementioned configuration, the first notch preferably allows the water to flow from the first downstream tilted surface to the main tilted surface.

[0085] According to the aforementioned configuration, the first notch allows the water to flow from the first downstream tilted surface to the main tilted surface. Consequently, the water flown onto the first downstream tilted surface through the second notch and the water directly received by the second downstream tilted surface from the dehumidifier are likely to transit onto the main tilted surface through the first notch. Thereafter, the water is discharged from the drainage port.

[0086] In the aforementioned configuration, the support element configured to support the blower preferably includes a connection wall formed with an opening into which the dry air sucked from the drying tub toward the dehumidifier by the blower is introduced, the dehumidifier includes a first dehumidification section facing the opening and a second dehumidification section adjacent to the first dehumidification section, and the second dehumidification section faces the blower.

[0087] According to the aforementioned configuration, the support element configured to support the blower includes the connection wall formed with the opening into which the dry air sucked from the drying tub toward the dehumidifier by the blower is introduced. The dehumidifier includes the first dehumidification section facing the opening and the second dehumidification section adjacent to the first dehumidification section. The second dehumidification section faces the blower. Consequently, the dry air moving toward the blower flows obliquely across the dehumidifier. Thus, it takes a relatively long time period for the dry air to pass through the dehumidifier, which results in more efficient dehumidification.

[0088] In the aforementioned configuration, the first upstream tilted surface is preferably tilted such that the water removed by the second dehumidification section flows underneath the first dehumidification section.

[0089] According to the aforementioned configuration, the water removed by the second dehumidifier flows underneath the first dehumidification section in response to the tilt of the first upstream tilted surface.

[0090] In the aforementioned configuration, the first downstream tilted surface is preferably tilted such that the water removed by the second dehumidification section flows underneath the first dehumidification section.

[0091] According to the aforementioned configuration, the water removed by the second dehumidification section flows underneath the first dehumidification section in response to the tilt of the first downstream tilted surface.

[0092] In the aforementioned configuration, the second notch is preferably formed nearby the support wall.

[0093] According to the aforementioned configuration, the water on the first upstream tilted surface flows underneath the first dehumidification section. Consequently, since it is likely that a level of the water become relatively high underneath the first dehumidification section, the water is facilitated to flow onto the first downstream tilted surface through the second notch. The inflow of the water through the second notch and the flow of the water which has been received by the first downstream tilted surface from the dehumidifier facilitate the water to flow onto the main tilted surface via the first notch. The dry air flow obliquely across the dehumidifier is less influential near the support wall. Therefore, even if the water level of the water becomes high underneath the first dehumidification section, it becomes less likely that the water is blown up by the dry air. As a results, the water amount in the dry air, which is sent into the drying tub by the blower, is maintained at a low level. Thus, the drying apparatus may maintain a relatively high drying efficiency.

[0094] In the aforementioned configuration, the drying apparatus preferably further has a heater configured to heat the dry air, wherein the support wall supports the heater situated between the dehumidifier and the blower, and the heater includes a first heating section adjacent to the first dehumidification section and a second heating section adjacent to the second dehumidification section.

[0095] According to the aforementioned configuration, the heater supported by the support wall between the dehumidifier and the blower heats the dry air. The heater includes the first heating section adjacent to the first dehumidification section and the second heating section adjacent to the second dehumidification section, so that the dry air moving toward the blower flows obliquely move across the heater. Thus, it takes a relatively long time period for the dry air to pass through the heater, which results in more efficient heating.

[0096] In the aforementioned configuration, the support element preferably includes a second tilted surface below the heater and a second partition wall which protrudes from the second tilted surface to partition the second tilted surface into a second upstream tilted surface and a second downstream tilted surface that is closer to the blower than the second upstream tilted surface, and the second partition wall extends in the transverse direction with respect to the flow of the dry air toward the blower.

[0097] According to the aforementioned configuration, the second tilted surface is situated below the heater. The water after transition to the heater by the dry air flow is received by the second tilted surface. The second partition wall protruding from the second tilted surface partitions the second tilted surface into the second upstream tilted surface and the second downstream tilted surface which is closer to the blower than the second upstream tilted surface. Since the second partition wall extends in the transverse direction with respect to the dry air flow toward the blower, it becomes likely that the water flowing on the second upstream tilted surface is prevented from being blown up and sent downstream. Consequently, the water amount in the dry air which is sent into the drying tub by the blower is maintained at a low level. Thus, the drying apparatus may maintain a relatively high drying efficiency.

[0098] In the aforementioned configuration, the second tilted surface is preferably tilted such that the water below the second heating section flows underneath the first heating section.

[0099] According to the aforementioned configuration, the water below the second heating section flows underneath the first heating section in response to the tilt of the second tilted surface.

[0100] In the aforementioned configuration, the support wall separating the main tilted surface from the second tilted surface is preferably formed with a third notch which allows the water to flow from the second tilted surface to the main tilted surface.

[0101] According to the aforementioned configuration, the third notch formed in the support wall, which separates the main tilted surface from the second tilted surface, allows the water to flow from the second tilted surface to the main tilted surface. Consequently, the water flowing underneath the first heating section in response to the tilt of the second tilted surface is transit onto the main tilted surface through the third notch.

[0102] In the aforementioned configuration, the second partition wall is preferably formed with a fourth notch which allows the water to flow from the second upstream tilted surface to the second downstream tilted surface.

[0103] According to the aforementioned configuration, the fourth notch formed on the second partition wall allows the water to flow from the second upstream tilted surface to the second downstream tilted surface.

[0104] In the aforementioned configuration, the third notch preferably allows the water to flow from the second downstream tilted surface to the main tilted surface.

[0105] According to the aforementioned configuration, the third notch allows the water to flow from the second downstream tilted surface to the main tilted surface.

[0106] In the aforementioned configuration, the fourth notch is preferably formed near the support wall.

[0107] According to the aforementioned configuration, the water on the second upstream tilted surface flows underneath the first heating section. Consequently, since it becomes likely that a water level becomes relatively high underneath the first heating section, the water is facilitated to flow onto the second downstream tilted surface through the fourth notch. The inflow of the water through the fourth notch and the flow of the water which has been received by the second downstream tilted surface from the heater facilitate the water to flow onto the main tilted surface via the third notch. The dry air flow obliquely across the heater is less influential near the support wall. Therefore, even if a water level becomes high underneath the first heating section, the water is less likely to be blown up by the dry air. As a result, the water amount in the dry air, which is sent into the drying tub by the blower, is maintained at a low level. Thus, the drying apparatus may maintain a relatively high drying efficiency.

[0108] In the aforementioned configuration, the support element preferably includes a boundary wall protruding between the first downstream tilted surface and the second upstream tilted surface, and the boundary wall extends in the transverse direction with respect to the flow of the dry air toward the blower.

[0109] According to the aforementioned configuration, since the boundary wall protruding between the first downstream tilted surface and the second upstream tilted surface extends in the transverse direction with respect to the dry air flow toward the blower, it becomes likely that the water flowing on the first downstream tilted surface is prevented from being blown up and sent downstream. Consequently, the water amount in the dry air, which is sent into the drying tub by the blower, is maintained at a low level. Thus, the drying apparatus may maintain relatively high drying efficiency.

Industrial Applicability

[0110] The methodologies of the present embodiment are suitably applicable to an apparatus with a drying function such as a washing and drying machine or a drying machine.

Claims

1. A drying apparatus (100) comprising:

a drying tub (410) configured to store laundry (C); and

a circulation system (600) configured to circulate dry air for drying the laundry (C),

wherein

the circulation system (600) includes a dehumidifier (635) configured to remove water contained in the dry air, an blower (621) which sucks the dry air after removal of the water by the dehumidifier (635) to send the dry air into the drying tub (410), and a support element (500) configured to support the dehumidifier (635),

the support element (500) includes a drainage port (531) from which the water is discharged, a main tilted surface (511) tilted to guide the water toward the drainage port (531), a first tilted surface (542) below the dehumidifier (635), and a first partition wall (546) which protrudes from the first tilted surface (542) to partition the first tilted surface (542) into a first upstream tilted surface (544) and a first downstream tilted surface (545) that is closer to the blower (621) than the first upstream tilted surface (544),

the first tilted surface (542) is tilted such that the water flows toward the main tilted surface (511), and

the first partition wall (546) extends in a transverse direction with respect to a flow of the dry air toward the blower (621).

2. The drying apparatus (100) according to claim 1, wherein
the support element (500) includes a support wall (512) which protrudes between the main tilted surface (511) and the first tilted surface (542) to support the dehumidifier (635), and
the support wall (512) is formed with a first notch (517) which allows the water to flow from the first tilted surface (542) to the main tilted surface (511).

3. The drying apparatus (100) according to claim 2, wherein
the first partition wall (546) is formed with a second notch (551) which allows the water to flow from the first upstream tilted surface (544) to the first downstream tilted surface (545).

4. The drying apparatus (100) according to claim 3, wherein
the first notch (517) allows the water to flow from the first downstream tilted surface (545) to the main tilted surface (511).

5. The drying apparatus (100) according to claim 4, wherein
the support element (500) configured to support the blower (621) includes a connection wall (521) formed with an opening (522) into which the dry air sucked from the drying tub (410) toward the dehumidifier (635) by the blower (621) is introduced,
the dehumidifier (635) includes a first dehumidification section (635R) facing the opening (522) and a second dehumidification section (635L) adjacent to the first dehumidification section (635R), and
the second dehumidification section (635L) faces the blower (621).

6. The drying apparatus (100) according to claim 5, wherein
the first upstream tilted surface (544) is tilted such that the water removed by the second dehumidifcation section (635L) flows underneath the first dehumidification section (635R).

7. The drying apparatus (100) according to claim 6, wherein
the first downstream tilted surface (545) is tilted such that the water removed by the second dehumidification section (635L) flows underneath the first dehumidification section (635R).

8. The drying apparatus (100) according to claim 6, wherein
the second notch (551) is formed nearby the support wall (512).

9. The drying apparatus (100) according to any one of claims 5 to 8, further comprising a heater (633) configured to heat the dry air, wherein
the support wall (512) supports the heater (633) situated between the dehumidifier (635)
and the blower (621), and
the heater (633) includes a first heating section (633R) adjacent to the first dehumidification section (635R) and a second heating section (633L) adjacent to the second dehumidification section (635L).

10. The drying apparatus (100) according to claim 9, wherein
the support element (500) includes a second tilted surface (543) below the heater (633) and a second partition wall (549) which protrudes from the second tilted surface (543) to partition the second tilted surface (543) into a second upstream tilted surface (547) and a second downstream tilted surface (548) that is closer to the blower (621) than the second upstream tilted surface (547), and
the second partition wall (549) extends in the transverse direction with respect to the flow of the dry air toward the blower (621).

11. The drying apparatus (100) according to claim 10, wherein
the second tilted surface (543) is tilted such that the water below the second heating section (633L) flows underneath the first heating section (633R).

12. The drying apparatus (100) according to claim 11, wherein
the support wall (512) separating the main tilted surface (511) from the second tilted surface (543) is formed with a third notch (518) which allows the water to flow from the second tilted surface (543) to the main tilted surface (511).

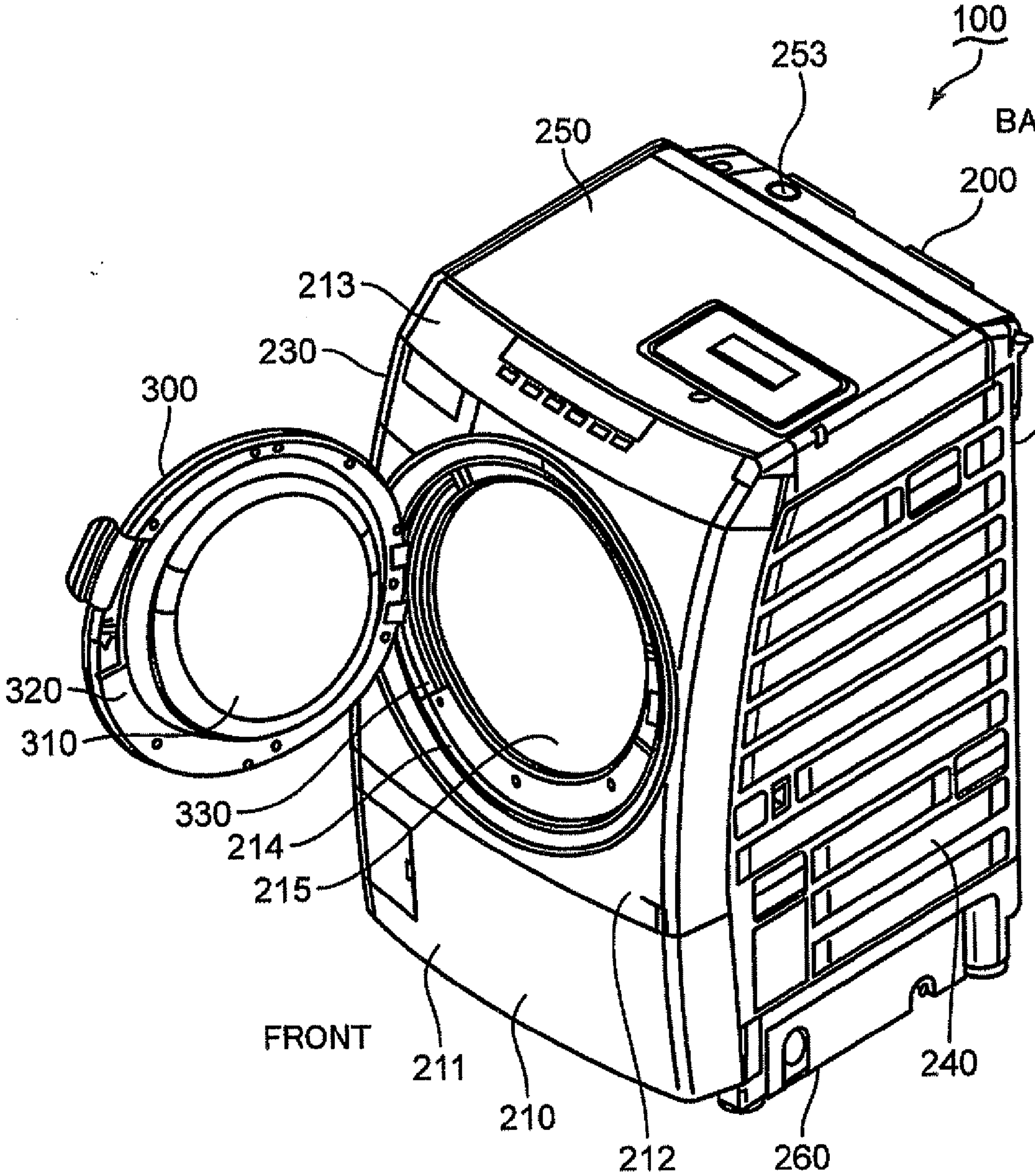
13. The drying apparatus (100) according to claim 12, wherein the second partition wall (549) is formed with a fourth notch (552) which allows the water to flow from the second upstream tilted surface (547) to the second downstream tilted surface (548).

14. The drying apparatus (100) according to claim 13, wherein
the third notch (518) allows the water to flow from the second downstream tilted surface (548) to the main tilted surface (511).

15. The drying apparatus (100) according to claim 13 or 14, wherein
the fourth notch (552) is formed nearby the support wall (512).

16. The drying apparatus (100) according to any one of claims 13 to 15, wherein
the support element (500) includes a boundary wall (541) protruding between the first downstream tilted surface (545) and the second upstream tilted surface (547), and
the boundary wall (541) extends in the transverse direction with respect to the flow of the dry air toward the blower (621).

FIG.1


100
253
BACK
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330
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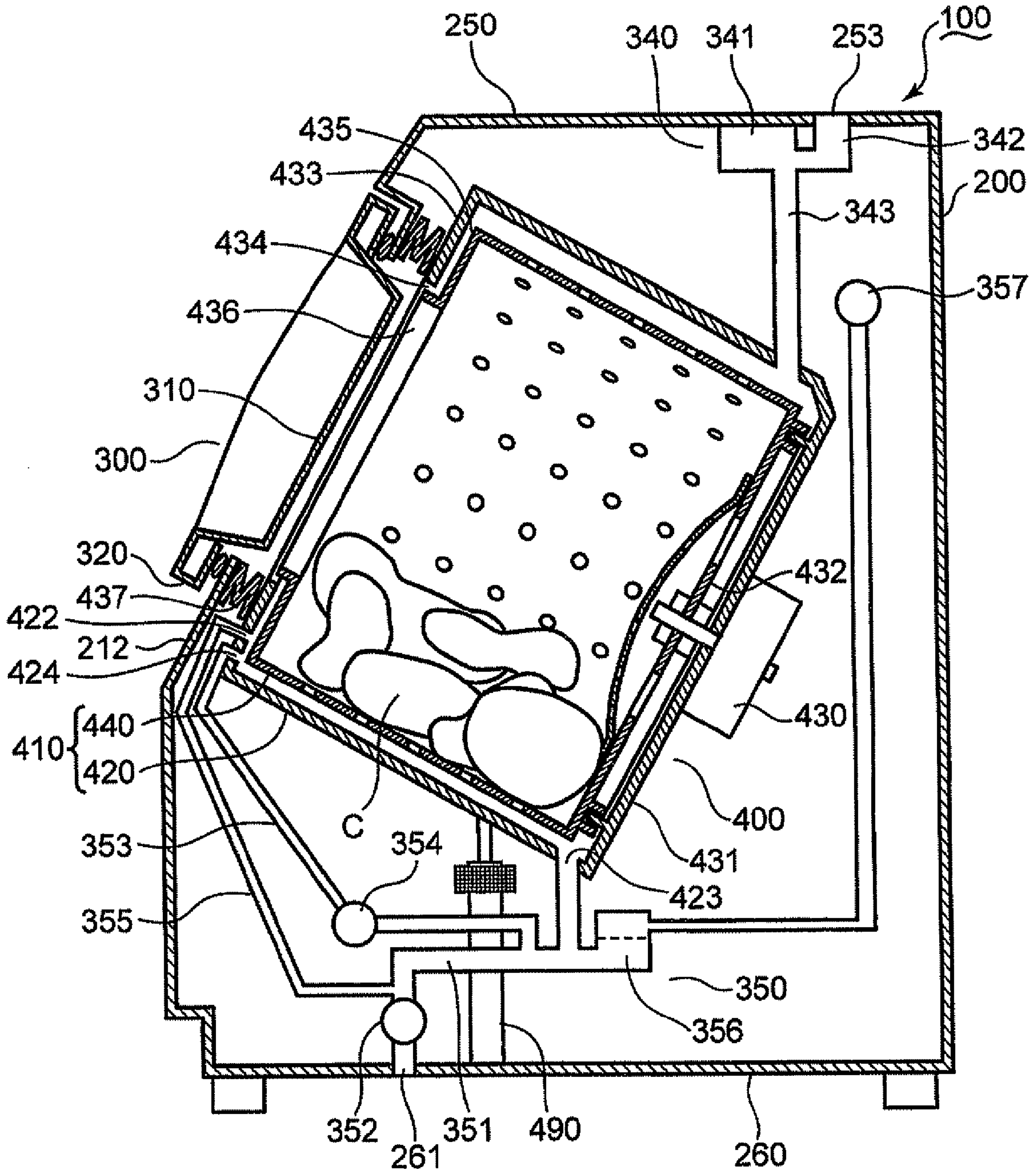
240
FRONT
211
210
212
260

FIG.2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341
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100
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200
435
433
343
434
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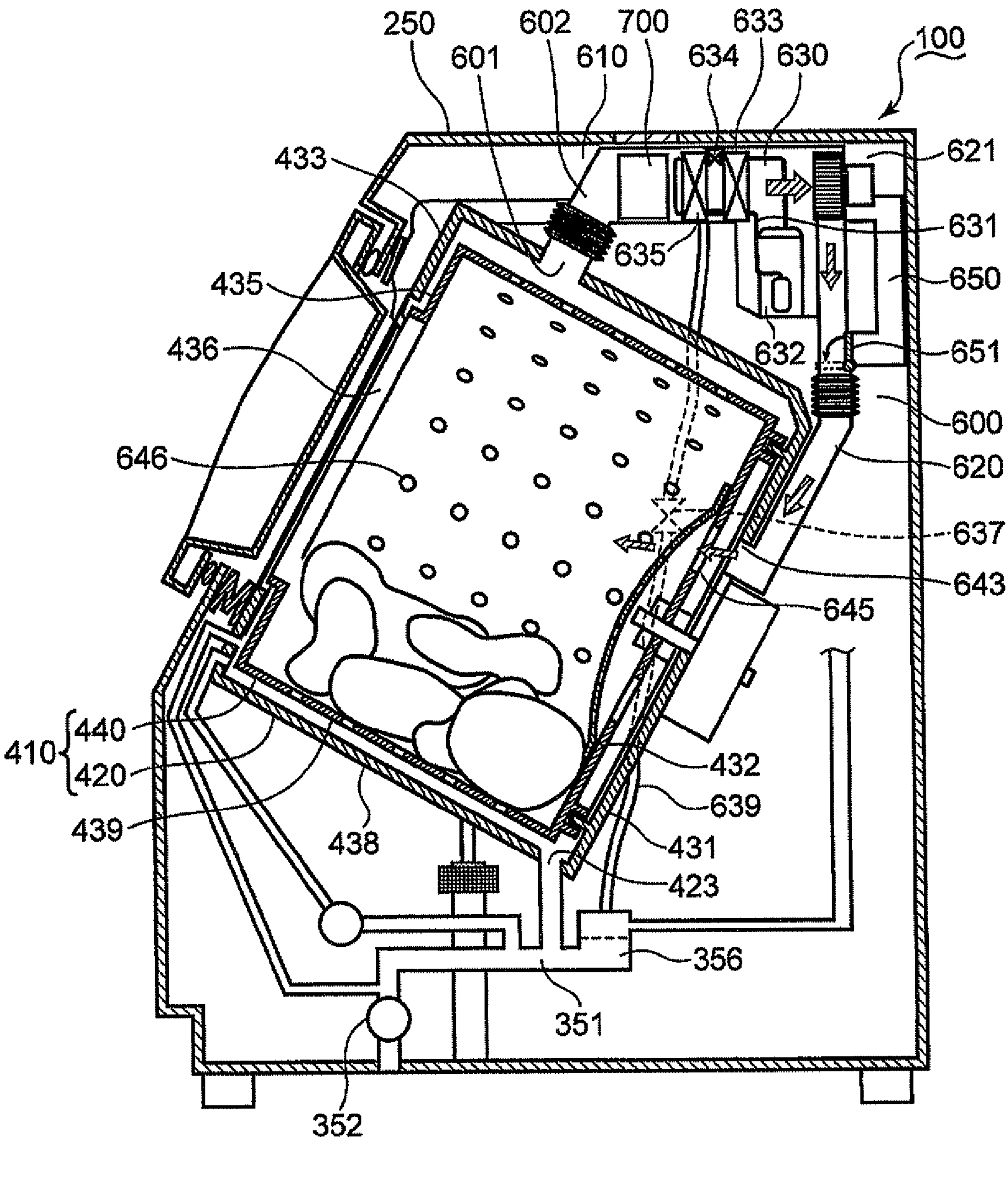
436
310
300
432
320
437
422
212
424
430
410
440
420
400
353
C
354
431
423
355
350
356
352
261
351
490
260

FIG.3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602
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633
100
601
610
634
630
433
621
635
631
435
650
436
632
651
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645
410
440
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432
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439
438
431
423
356
351
352

FIG.4

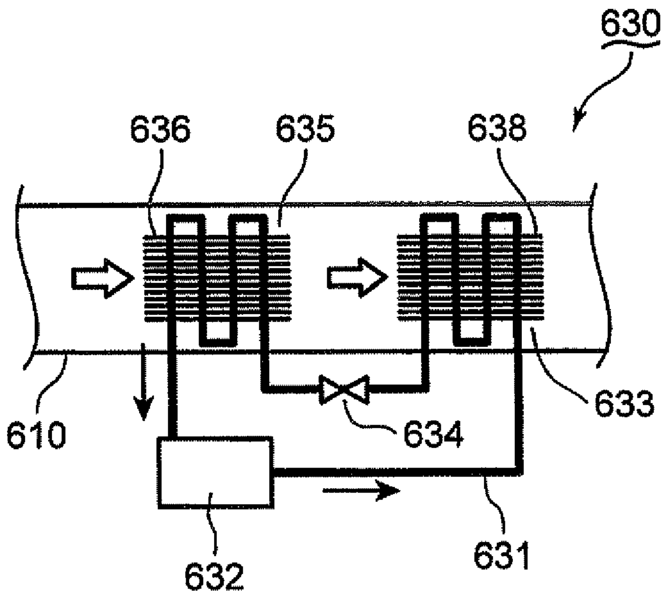


FIG.5

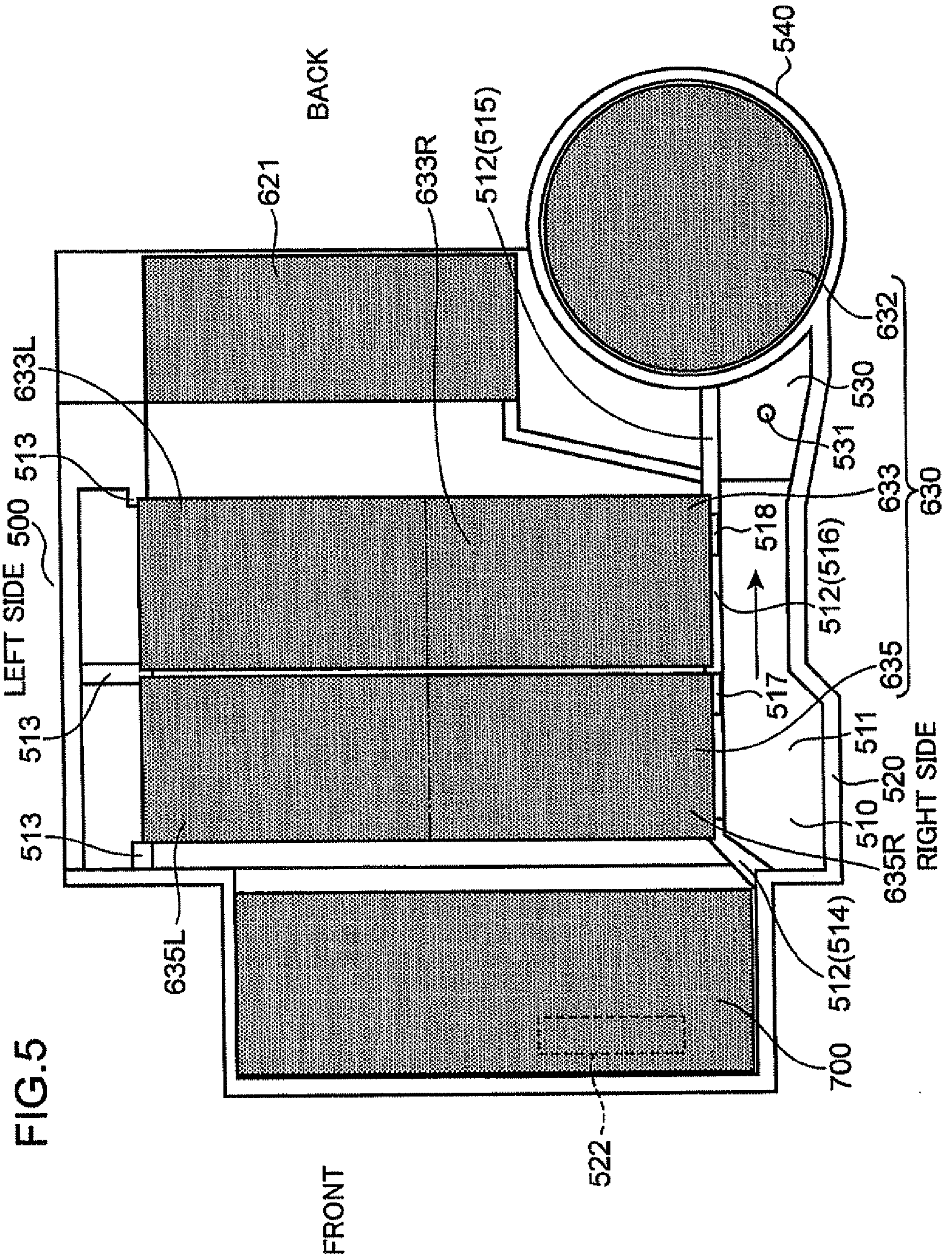

BACK
FRONT
LEFT SIDE
RIGHT SIDE
500
513
513
513
621
633L
633R
512(515)
540
632
530
531
633
630
518
512(516)
517
635
511
520
510
635R
512(514)
635L
700
522

FIG.6

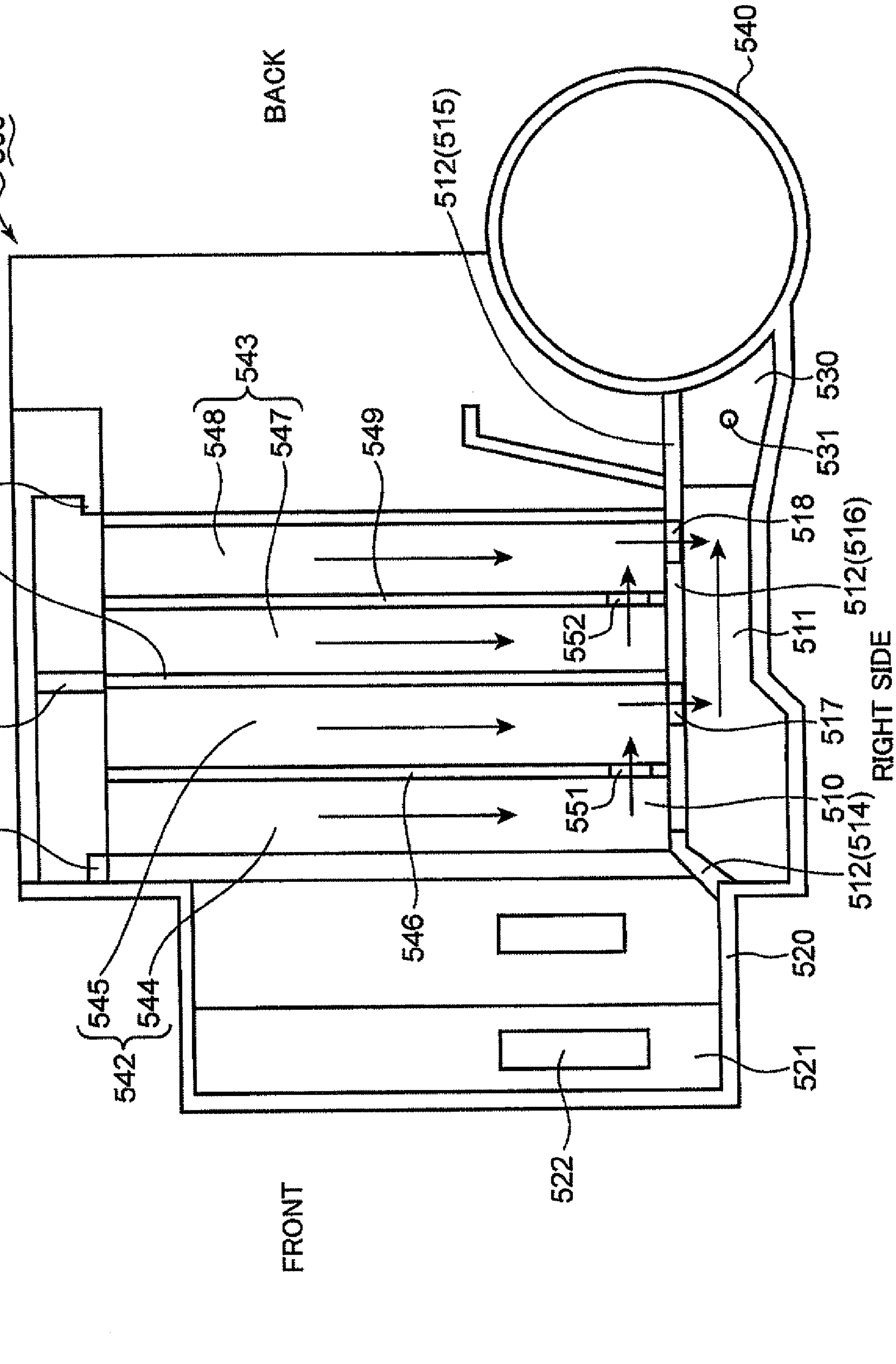

500
BACK
LEFT SIDE
RIGHT SIDE
FRONT
540
512(515)
543
548
547
549
530
531
513
518
512(516)
541
552
511
513
517
510
551
513
512(514)
546
520
545
544
542
521
522

FIG.7

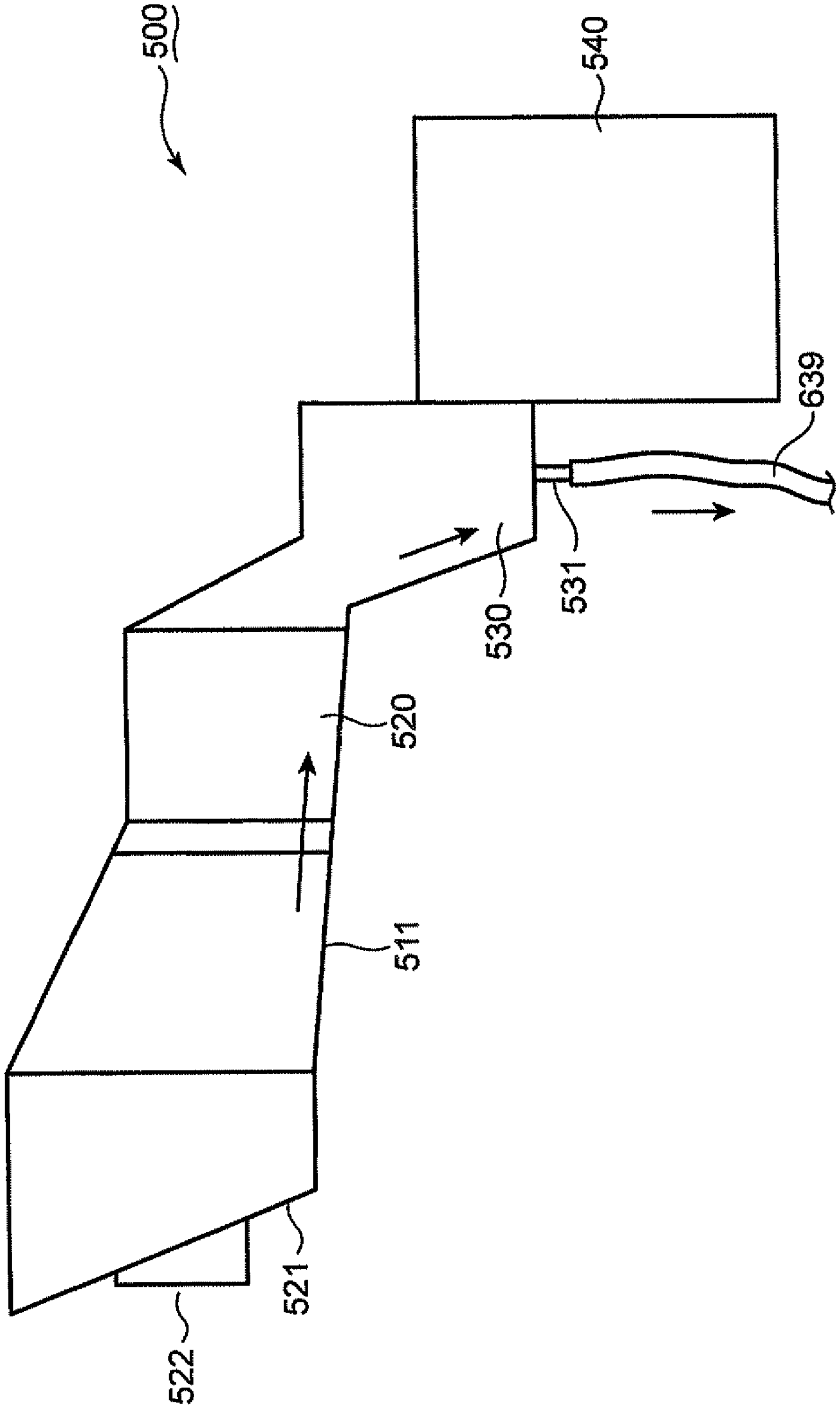


FIG.8

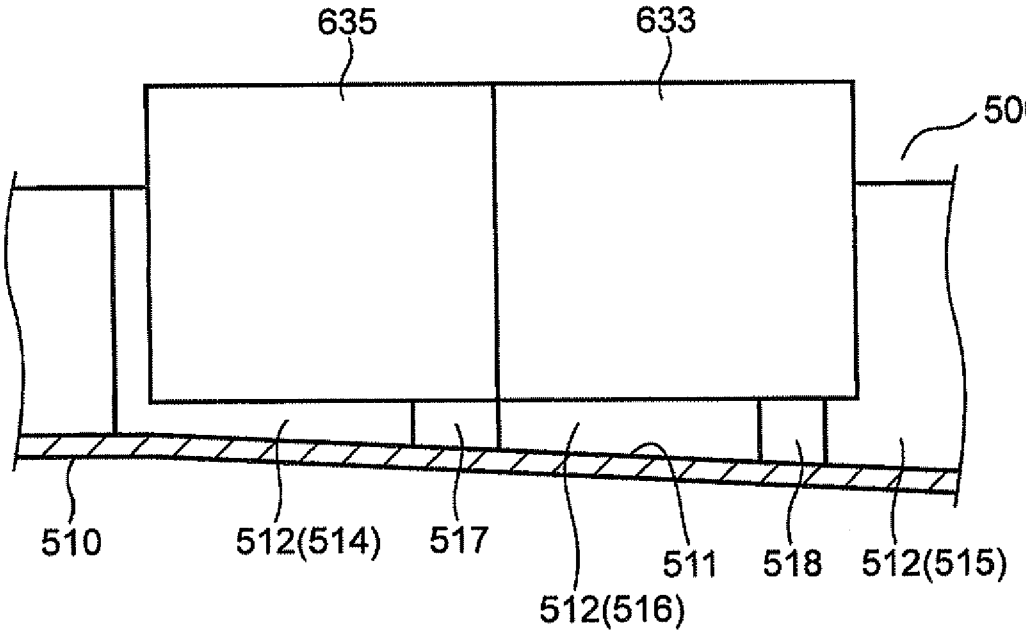


FIG.9

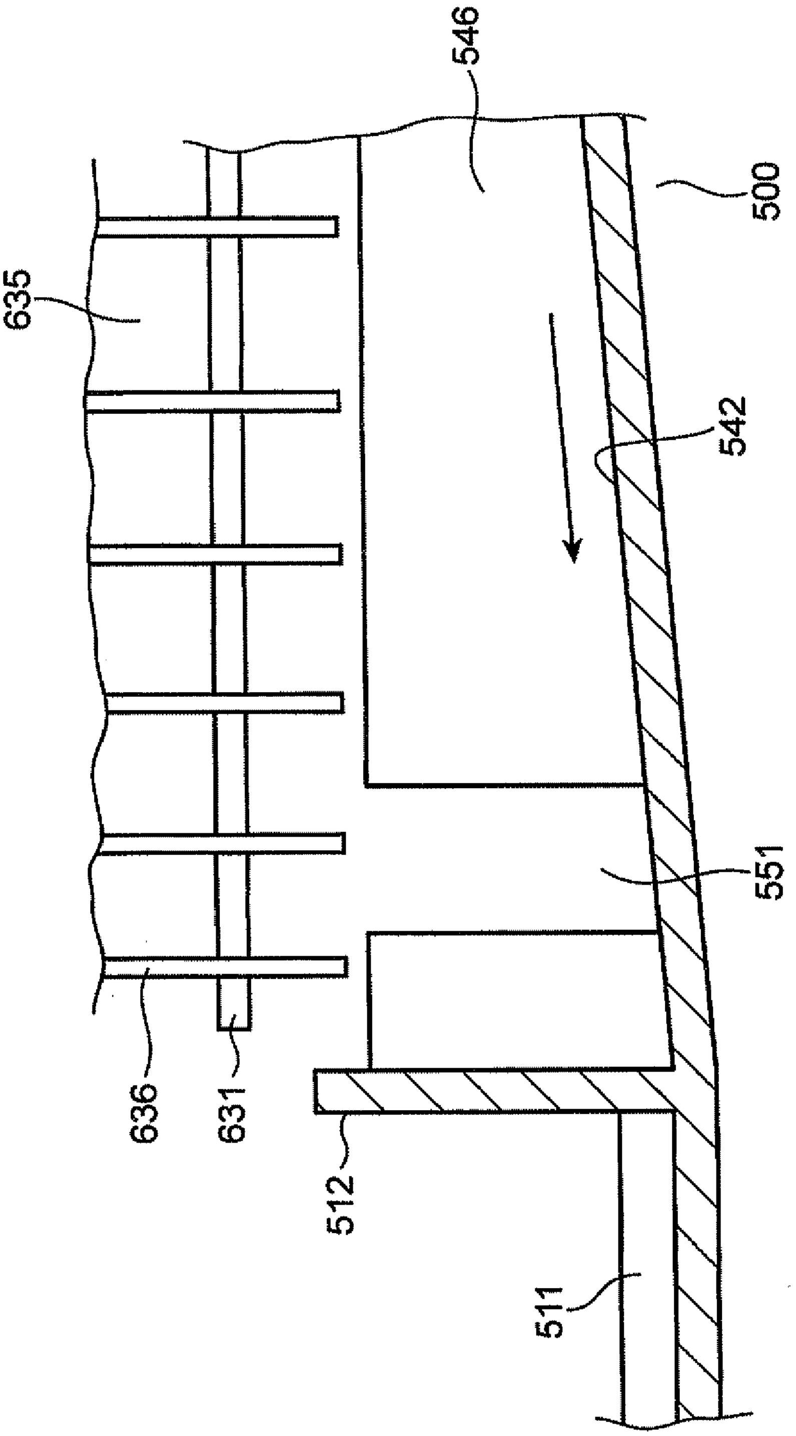


FIG.10

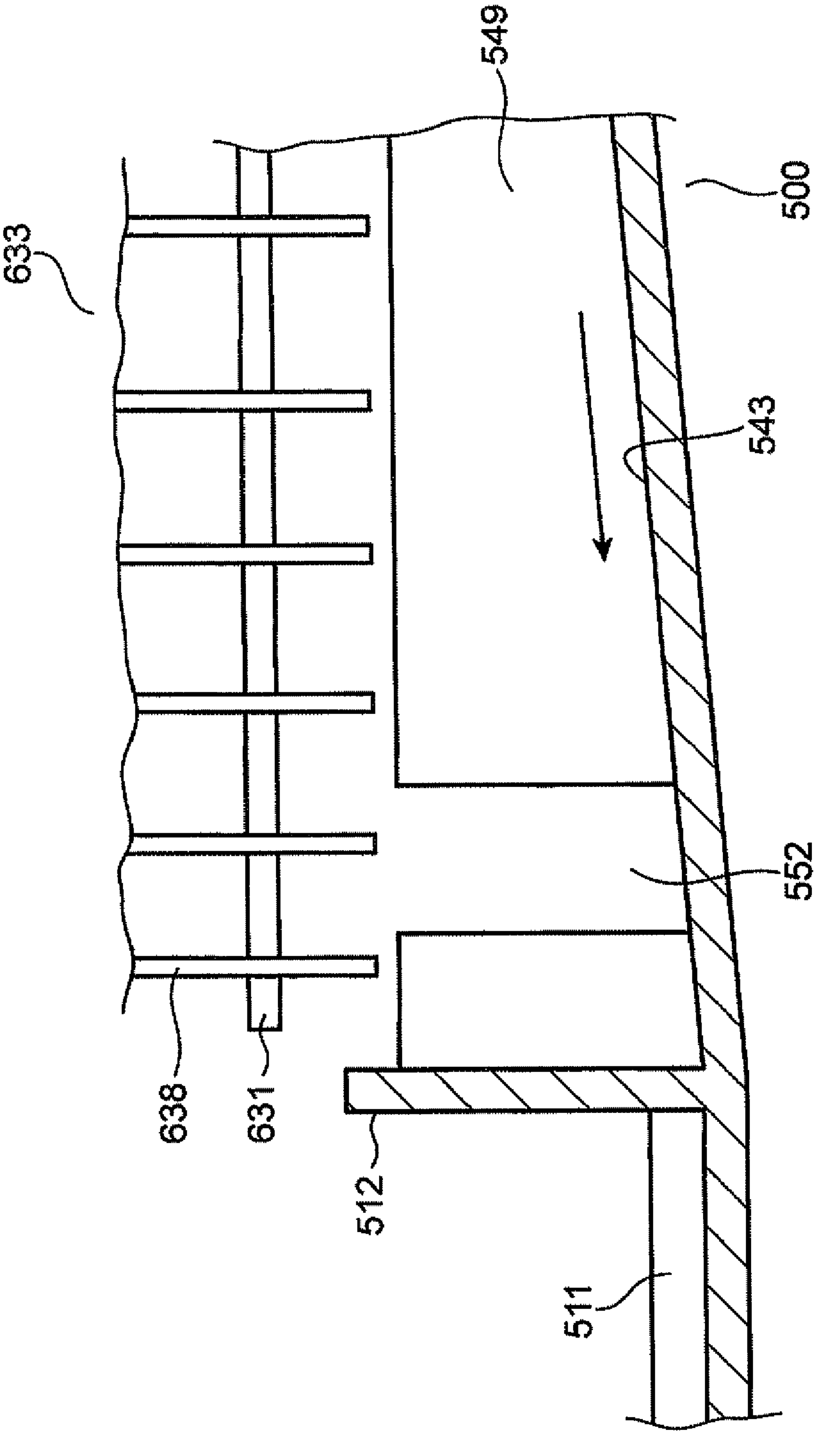
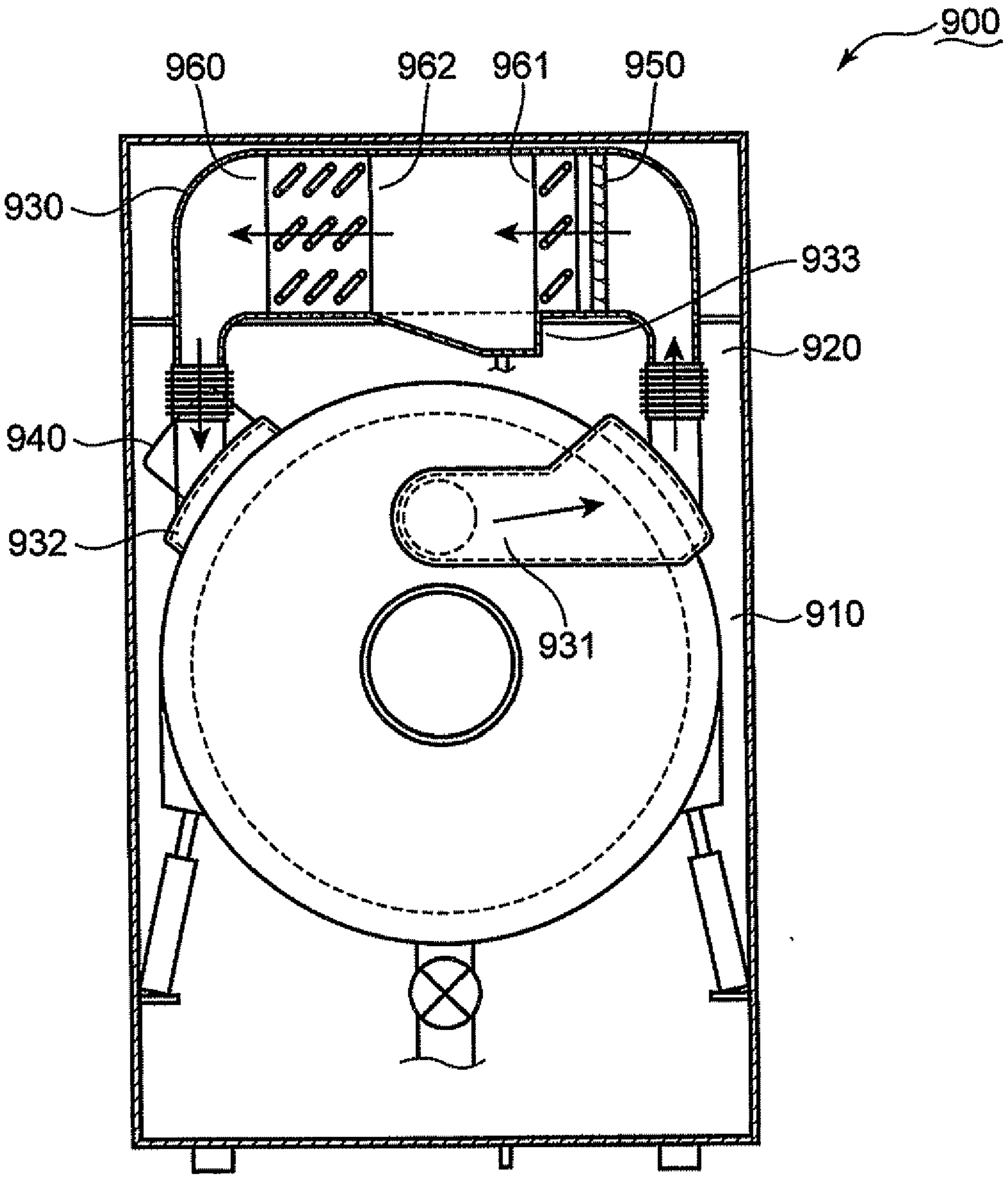


FIG.11



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- JP 2010063694 A **[0007]**
- JP 2010064020 A **[0007]**