



(12) **EUROPEAN PATENT APPLICATION**
published in accordance with Art. 153(4) EPC

(43) Date of publication:
11.05.2011 Bulletin 2011/19

(51) Int Cl.:
D06F 58/02 (2006.01) D06F 25/00 (2006.01)

(21) Application number: **09812852.3**

(86) International application number:
PCT/JP2009/004280

(22) Date of filing: **01.09.2009**

(87) International publication number:
WO 2010/029703 (18.03.2010 Gazette 2010/11)

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO SE SI SK SM TR
Designated Extension States:
AL BA RS

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(30) Priority: **12.09.2008 JP 2008234682**
12.09.2008 JP 2008234684
11.12.2008 JP 2008315359
11.12.2008 JP 2008315361

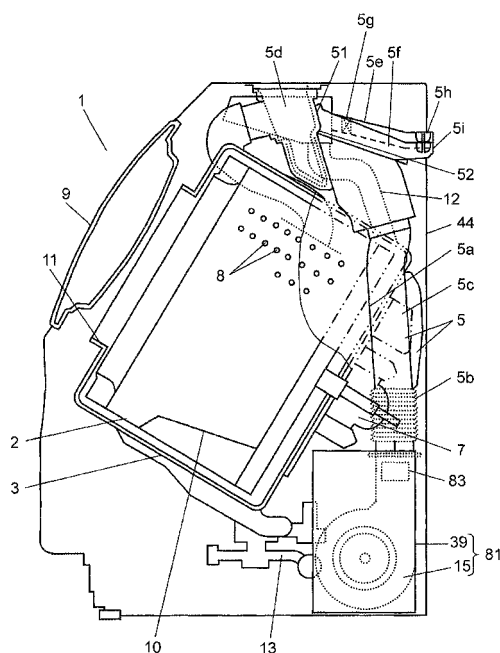
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(54) **WASHING AND DRYING MACHINE**

(57) A washing and drying machine includes a washing tub for accommodating laundry, an outer tub holding the washing tub rotatably, a housing for elastically supporting the outer tub, a water feeder for supplying wash water to the outer tub, a heater for heating air in the outer tub, an air circulation duct for circulating the air in the outer tub via the heater, a blower for pressurizing and circulating the air in the air circulation duct, and an electrostatic atomizer placed in the air circulation duct for supplying electrostatically atomized particles into the washing tub and the outer tub.

FIG. 1



Description

Technical Field

[0001] The present invention relates to washing and drying machines.

Background Art

[0002] In recent years, sanitary environment in life space has drawn attention, so that various sanitary-care goods for debacterialization or deodorization have prevailed in the market. This trend can be found in laundry goods, for instance, washing and drying machines with the function of debacterializing and deodorizing clothes, fabric goods, leather goods, toys, and small articles are available in the market.

[0003] The foregoing washing and drying machine has a specialized course in debacterialization and deodorization in addition to regular courses. This specialized course takes several tens minutes after targets articles are loaded into the washing tub. Although there are various specific means for debacterialization and deodorization, e.g. heating the inside of the tub, using ozone or a chemical, the basic means is heat application.

[0004] The inside of the washing tub has been worried about tending to produce bacteria and mold because the water left in the tub generates high humidity or clothes have been kept in the washing tub until the machine is driven, whereby various bacteria attached to the clothes invade the tub. On top of that, the washing tub has been designed more airtight for the debut of the washing and drying machine in the market makes, so that the washing tub obtains higher retentions of heat and moisture.

[0005] Some countermeasures against bacteria and mold in the washing tub have been proposed, for instance, the inside of the washing tub is fully dried with heating means such as a heater. However, a user cannot determine when or how often the washing tub should be dried for efficient debacterialization and deodorization, so that some users might dry the tub frequently. The frequent drying operations involve a large amount of time and electricity, so that it goes against the trend of energy saving. Drying the washing tub is indeed an excellent measures for debacterialization and deodorization; however many users cannot make full use of this measures.

[0006] Here is another countermeasure against bacteria and mold in the laundry and the washing tub: antibacterial component is added to the parts made of resin or metal before they are assembled into the washing tub, thereby avoiding bacteria or mold. For instance, Patent Literature 1 discloses that the surface of the washing tub is coated with resin film in which depressor of organic germ reproduction is mixed.

[0007] Here is still another countermeasure: antibacterial component is supplied into the washing tub during the washing. For instance, Patent Literature 2 discloses that Ag ions are supplied during the rinsing for debacte-

rialization or antibacterialization of the clothes, and the washing tub thus is provided with debacterialization and anti-mold properties.

[0008] However, the conventional method makes users not to determine when or how often the washing tub should be dried for efficient debacterialization and deodorization, so that some users might dry the tub frequently.

[0009] Since the conventional method for debacterialization and deodorization uses heat application, target articles are restricted to the materials strong enough to thermal stress. In such a case, articles as many as inadequate to a standard drying machine are inadequate to this subject drying machine. On top of that, it is difficult and cumbersome work for the users to determine which articles are adequate to the machine, and a long-time heat application consumes a large amount of electricity. A deodorant means using atomized water to clothes may produce stress because the clothes are moistened with water.

[0010] The washing machine disclosed in Patent Literature 1 invites this problem: wash scum attaches to the surface of the washing tub, and bacteria or mold propagates itself from the scum. In this case, bacteria or mold propagates itself on the surface of the wash scum, so that the antibacterial component contained in the parts of the washing machine cannot touch the bacteria or mold. The antibacterial component thus cannot work properly, and little advantage of the addition of this component is acknowledged.

[0011] When the washing machine disclosed in Patent Literature 2 supplies Ag ions, which are needed for preventing mold, in an amount enough to producing debacterialization effect, the clothes get blackish. This method thus adversary affects the washing performance. On top of that, the cost of generating the Ag ions is not negligible. A more economical countermeasure against debacterialization and deodorization of the laundry and the washing tub per se is thus needed.

Related Art Literatures

[0012]

Patent Literature 1: Unexamined Japanese Patent Application Publication No. H08 - 252392

Patent Literature 2: Unexamined Japanese Patent Application Publication No. 2001 - 276484

Disclosure of Invention

[0013] A washing and drying machine of the present invention comprises the following structural elements:

a washing tub for accommodating laundry;
an outer tub holding the washing tub rotatably;
a housing for elastically supporting the outer tub;
a water feeder for supplying water to the outer tub;

a heater for heating air in the outer tub;
 an air circulation duct for circulating the air in the outer tub via the heater;
 a blower for pressurizing and circulating the air in the air circulation duct; and
 an electrostatic atomizer placed in the air circulation duct for supplying electrostatically atomized particles into the washing tub and the outer tub.

[0014] The foregoing washing and drying machine allows supplying electrostatically atomized particles into the outer tub with the aid of the air circulation duct which is used during a drying operation, whereby the washing tub and laundry can be efficiently prevented from getting moldy and having bacteria. Each one of the electrostatically atomized particles is a cluster of fine water molecules electrically charged and includes a radical that gives oxidative destruction with ease to others. The supply of electrostatically atomized particles by using the atomizer allows carrying out debacterialization and deodorization as well as preventing mold from increasing without using the heat. This method is different from the conventional way of debacterialization, deodorization, and mold prevention in using the atomizer instead of the heater, so that a running cost of the machine can be lowered.

Brief Description of Drawings

[0015]

Fig. 1 is a sectional view showing a structure of an essential part of a washing and drying machine in accordance with a first embodiment of the present invention.

Fig. 2 is an inside rear view showing an air circulation duct and a rear part of an outer tub of the washing and drying machine shown in Fig. 1.

Fig. 3 is a perspective view showing the inside of a heat-pump blowing unit of the washing and drying machine shown in Fig. 1.

Fig. 4 is a perspective view of the heat-pump blowing unit of the washing and drying machine shown in Fig. 1.

Fig. 5 is a sectional view showing the inside of an electrostatic atomizer of the washing and drying machine shown in Fig. 1.

Fig. 6 is a perspective view showing a vicinity of a clamping plate of an atomizing and discharging block of the washing and drying machine shown in Fig. 1.

Fig. 7 is a sectional view showing the inside of the atomizing and discharging block of the washing and drying machine shown in Fig. 1.

Fig. 8 is a vertical sectional view of a washing and drying machine in accordance with a second embodiment of the present invention.

Fig. 9 is a vertical sectional view showing another aspect of the washing and drying machine shown in

Fig. 8.

Fig. 10 is a vertical sectional view showing still another aspect of the washing and drying machine shown in Fig. 8.

Best Mode for Carrying Out the Invention

[0016] The washing and drying machine of the present invention is demonstrated hereinafter with reference to the accompanying drawings. The following embodiments specifically demonstrate the present invention, of which claims are thus not restricted to these embodiments.

Exemplary Embodiment 1

[0017] Fig. 1 is a sectional view showing a structure of an essential part of a washing and drying machine in accordance with the first embodiment of the present invention. Fig. 2 is an inside rear view showing an air circulation duct and a rear part of an outer tub of the washing and drying machine. Fig. 3 is a perspective view showing the inside of a heat-pump blowing unit of the washing and drying machine.

[0018] As shown in Fig. 1 - Fig. 3, washing tub 2 for accommodating laundry is mounted rotatably in outer tub 3 such that the rotary shaft of tub 2 lies horizontally or slants downward toward the rear of washing and drying machine 1, which carries out a drying step in addition to the steps of washing, rinsing, and dewatering.

[0019] The drying step sucks air from outer tub 3 through air-circulation duct 5 with the aid of blower 15 to evaporator 31 and condenser 32 where the air is dehumidified and heated, and then blows the resultant air into outer tub 3. The drying step repeats the foregoing action to dry the laundry. Washing and drying machine 1 is equipped with heat-pump blowing unit 81 somewhere in air circulation duct 5 in order to carry out this drying step.

[0020] Heat-pump blowing unit 81 is formed of heat pump 39 and blower 15 coupled together. Heat pump 39 includes evaporator 31 incorporated with condenser 32 and compressor 37 that circulates a refrigerant through evaporator 31 and condenser 32. Heat pump 39 thus works as a heater for heating the air in outer tub 3. Blower 15 pressurizes the air in air circulation duct 5 to circulate this air through duct 5. Use of heat pump 39 as a heater allows heating the air at a higher thermal efficiency.

[0021] At the front side of outer tub 3, opening 11 is formed such that it communicates with an end of opening of washing tub 2 for loading or unloading the laundry. Opening 11 is formed according to the attitude of washing tub 2 installed horizontally or slantingly. Opening 11 is formed at the front side on an upward slanting face of main body 44 for opening or closing opening 11. Main body 44 works as a housing that elastically supports outer tub 3 with the aid of suspension mechanism.

[0022] The laundry can be loaded or unloaded into washing tub 2 by opening door 9. Since door 9 is formed on the upward slanting face, a user can load or unload

the laundry free from stooping himself or herself.

[0023] Washing tub 2 has numerous vents 8 communicating with outer tub 3 on its circular wall, and includes multiple agitating projections 10 on an inner face of the circular wall in a circumferential direction. Washing tub 2 is driven forward or backward by motor 7 mounted to a rear side of outer tub 3. Outer tub 3 is connected with water supplying tube 12 and water draining tube 13 for supplying water into or draining water from outer tub 3 by controlling a supplying valve or a draining valve (not shown). In other words, a water feeder device formed of water supplying tube 12, the supplying valve and others supplies the wash water into outer tub 3.

[0024] The washing step operates this way: Open door 9, and load the laundry and detergent in washing tub 2. Operate an operation panel placed on, e.g. an upper section of the front of washing and drying machine 1 for starting the operation of machine 1 through the control done by a controlling circuit board placed inside the operation panel. A given amount of water is supplied to outer tub 3 through water supplying tube 12, and washing tub 2 is driven by motor 7, thereby starting the washing step. Rotation of washing tub 2 allows the laundry to be lifted along a rotating direction by agitating projections 10 formed on the inner wall of tub 2, and then the lifted laundry drops from a certain height. This agitating action is repeated for beat-washing the laundry. After a given time of washing, the dirty wash-water is drained through draining tube 13. Washing tub 2 is then spun at a higher rpm, i.e. machine 1 carries out dewatering action, for squeezing wash-liquid from the laundry. Then water is supplied from water supplying tube 12 into outer tub 3 for carrying out a rinsing step, in which the laundry is lifted by projections 10 and drops, i.e. the agitating action is repeated, for carrying out a rinsing step. After the rinsing step, the water is drained, and then washing tub 2 is spun at the higher rpm, i.e. machine 1 carries out the dewatering action, for splashing the water contained in the laundry before the washing ends.

[0025] Next, a drying step is demonstrated hereinafter. Open door 9 for loading the laundry into washing tub 2. Operate the operation panel placed on, e.g. the upper section of the front of washing and drying machine 1 for starting the operation of machine 1 through the control done by the controlling circuit board placed inside the operation panel. The air in outer tub 3 is sucked through air circulation duct 5 by blower 15 and the air goes to evaporator 31 and condenser 32 via filtering box 5d. This air is dehumidified and heated by evaporator 31 and condenser 32, and then the resultant air is circulated into outer tub 3. This circulation is repeated for removing the water from the laundry, thereby drying the laundry. The drying step has a rotary mode and a stationary mode of washing tub 2, and these modes can be selected in response to the target laundry to be dried.

Fig. 4 is a perspective view of the heat-pump blowing unit of the washing and drying machine in accord-

ance with the first embodiment of the present invention. Fig. 5 is a sectional view showing the inside of an electrostatic atomizer of the washing and drying machine. Fig. 6 is a perspective view showing a vicinity of a clamping plate of an atomizing and discharging block of the washing and drying machine. Fig. 7 is a sectional view showing the inside of the atomizing and discharging block of the washing and drying machine.

[0026] Washing and drying machine 1 in accordance with this first embodiment of the present invention includes four operating courses: a washing course carrying out only the washing step, a drying course carrying out only the drying step, a washing and drying course carrying out sequentially the steps from the washing to the drying, and a "nanoe" course carrying out debacterIALIZATION and deodorization, where "nanoe" is a trademark registered by Panasonic Co., Ltd. As shown in Fig. 4 and Fig. 7, the nanoe course uses air circulation duct 5 which is used for circulating the air in outer tub 3 during the drying step. Electrostatic atomizer 83 is placed somewhere in air circulation duct 5 for supplying electrostatically atomized particles 82 which is expected to achieve debacterIALIZATION and deodorization. The air is blown through air circulation duct 5, whereby the target articles in washing tub 2 and outer tub 3 are exposed to electrostatically atomized particles 82. The nanoe course can also select one of a rotary mode or a stationary mode of washing tub 2 in response to target articles, and this course takes about 35 minutes.

[0027] Washing and drying machine 1 further includes a nanoe tub-cleaning mode for automatically exposing the target articles to electrostatically atomized particles 82 every time after the washing course ends. The setting of this mode can be turned on or off. After the washing course ends and door 9 is opened and closed, this mode is operated for approx. 60 minutes with washing tub 2 held stationary.

[0028] The sanitary-cared courses discussed above are set as equivalent courses to the washing course and the drying course in washing and drying machine 1 in accordance with the first embodiment of the present invention, and operation buttons dedicated to these courses are provided. Electrostatically atomized particles 82 are capable of giving strong oxidative destruction to others, so that only the supply of particles 82 allows with ease achieving the debacterIALIZATION, deodorization, and preventing mold from increasing. This method saves the conventional heating as well as worrying about risk of degradation in the target articles. Washing and drying machine 1 includes the courses specialized in exposing electrostatically atomized particles 82 to the articles accommodated in washing tub 2, or tub 2 per se, and the surface of outer tub 3.

[0029] Providing machine 1 with the foregoing specialized courses allows the users to select an optimum operation to user's objective in an easier and more carefree

manner. Machine 1 thus obtains the better usability.

[0030] Air circulation duct 5 is detailed hereinafter. As shown in Fig. 3 and Fig. 4, blower 15 is formed of a centrifugal fan including fan 15a of centrifugal type in snail-like housing 15b. Heat pump 39 and blower 15 are coupled together in a sealing manner by fitting suction connecting port 15c of snail-like housing 15b to suction discharging port 38a, which is formed on an end wall of a first end of left-right longitudinal side of housing 38 shown in Fig. 3.

[0031] The foregoing structure allows the suction force of blower 15 acts on the inside of heat pump housing 38, and this suction force acts on the inside of outer tub 3 through suction introducing port 38b, suction path 5a of air circulation duct 5, and filtering box 5d. The air in outer tub 3 is thus sucked into heat pump housing 38 and undergoes evaporator 31 and condenser 32, where the air is dehumidified and heated. The resultant air, i.e. dried air at an elevated temperature, runs through suction discharging port 38a, sucked-air connecting port 15c, and then the air is sucked into snail-like housing 15b. This air then runs through blow-off port 15d of housing 15b, bellows-shaped coupler 5b and blowing path 5c of duct 5, and is finally blown into outer tub 3. The foregoing operation is repeated for drying the laundry in washing tub 2. Electrostatic atomizer 83 is placed near blow-off port 15d. Suction introducing port 38b is placed on a second end of heat-pump housing 38.

[0032] As shown in Fig. 5, electrostatic atomizer 83 is formed of atomizing and discharging block 84, transformer printed board 85, controlling printed circuit board 86, elements housing 87, clamping plate 88, housing 89 of board 85. These structural elements are wired with lead-wires and unitized. Transformer printed circuit board 85 generates a high voltage, and controlling printed circuit board 86 controls atomizing-discharge. Elements housing 87 seals block 84 therein and forms bypath 15f. Clamping plate 88 clamps block 84, thereby forming the shapes of an entrance and an exit of bypath 15f. Housing 89 of board 85 seals transformer printed circuit board 85 therein.

[0033] The placement of electrostatic atomizer 83 within air circulation duct 5 allows supplying electrostatically atomized particles 82 into washing tub 2 and outer tub 3 with the aid of the actions during the drying operation, and this can be achieved with little change in the structure. Electrostatically atomized particles 82 are not diffusible as gases are, it is thus necessary for particles 82 to be carried by the air flowing through air circulation duct 5 so that particles 82 can be exposed to the target articles. At this time, when particles 82 pass through a heat-exchanger fin made of aluminum and used both in evaporator 31 and condenser 32 of heat pump device 39 as well as pass through fan 15a made of aluminum and used in blower 15, particles 82 hit against those structural elements made of aluminum, whereby large amount of particles 82 disappear, which incurs great loss. Actually, approx. 70% and 25% of particles 82 decrease at the heat-exchanger fin made of aluminum and at fan 15a

made of aluminum respectively. It is thus desirable to place electrostatic atomizer 83 near outer tub 3 for getting around the fin and fan 15a made of aluminum. Electrostatic atomizer 83 of washing and drying machine 1 in accordance with this first embodiment of the present invention is placed near blow-off port 15d of blower 15, thereby minimizing the loss in transmission of particles 82 to washing tub 2 and outer tub 3. The debacterialization, deodorization, and mold prevention can be thus achieved more efficiently.

[0034] During the course where electrostatically atomized particles 82 are exposed to washing tub 2 and outer tub 3, when pressurized circulation-air is transmitted, electrostatic atomizer 83 should be operated at the same time. As discussed above, atomizing and blowing should be done simultaneously for producing the expected effect, so that it is vital to expose particles 82 to the target articles with the aid of the optimum pressurized circulation-air transmitted by the blowing means.

[0035] Electrostatic atomizer 83 is placed on main body 44 of washing and drying machine 1, where main body 44 is separated from the movable section of outer tub 3 by bellows-shaped coupler 5b. This structure allows atomizer 83, which is a precision key device, to be kept away from outer tub 3 that vibrates during the dewatering step, so that the durability and reliability of atomizer 83 can be enhanced.

[0036] On top of that, as shown in Fig. 4, electrostatic atomizer 83 is incorporated with blow-off port 15d which is located at the pressurized air discharging side of blower 15. To be more specific, as shown in Fig. 5, snail-like housing 15b has an opening on its wall, and atomizer 83 including bypath 15f is rigidly mounted for covering the opening in a sealing manner. This structure saves installing atomizer 83 newly in air circulation duct 5, and allows constructing a simple and an inexpensive system, which improves an efficiency in assembly and reduces the number of assembling steps. Since the atomizing and the blowing should be done simultaneously to achieve the expected effect, it is desirable to integrate atomizer 83 with blower 15 into one unit.

[0037] Electrostatic atomizer 83 includes mainstream path 15e and bypath 15f which branch off in the unit and then merge together, and atomizing-charging block 84 is placed in bypath 15f. This structure allows avoiding such problems as wind noise and reduction in circulation air volume. It has been worried that these problems might happened because the discharging section of atomizing-discharging block 84 directly has protruded into bypath 15f.

[0038] Use of an optimum branch-off ratio to bypath 15f allows optimizing the volume and velocity of the circulation air, which carries electrostatically atomized particles 82, by changing an opening area of sucking port 88a of the clamping plate protruding into bypath 15f. The optimum volume and velocity of the circulation air thus can be achieved mechanically. In the structure discussed above, the optimum air velocity is desirably set at approx.

1 meter/second, so that the opening area of sucking port 88a of the clamping plate has been thus designed accordingly.

[0039] As shown in Fig. 6, air-guiding plate 88c is placed in discharging port 88b of clamping plate 88 at mainstream path 15e side of the merging section of by-path 15f and mainstream path 15e such that plate 88c lies in parallel with the flow of the circulation air running through duct 5. In a case where no air-guiding plate 88c is placed, the airflow in mainstream path 15e encounters disturbance at the merging section, where the air-streams having temporarily branched off into mainstream path 15e and bypath 15f merge together again. This disturbance will reduce an amount of air circulation, and increases noises. On top of that, the air at bypath 15f side swirly rotates, whereby a large amount of electrostatically atomized particles 82 disappear. Air-guiding plate 88c placed in parallel with the flow of the circulation air in mainstream path 15e of the merging section overcomes this problem.

[0040] As shown in Fig. 7, atomizing and discharging block 84 includes counter-electrode 84b, water feeder 84c, and voltage applier 84d, which applies a high voltage between discharge electrode 84a and counter-electrode 84b for electrostatically atomizing the water supplied to discharge electrode 84a. Counter-electrode 84b is placed opposite to discharge electrode 84a, to which water feeder supplies water.

[0041] In this first embodiment of the present invention, a negative voltage of 4.85 kV is applied between discharge electrode 84a and counter-electrode 84b for electrostatically atomizing the water, and implements feedback control such that a discharging current at this time can take a value of approx. 6 μ A.

[0042] The process of electrostatic atomization is this: A high voltage application makes discharge electrode 84a a negative electrode where electric charges intensively gather, and the water attaches to the surface of discharge electrode 84a rises in a corn shape to form Taylor Cone, and the electric charges intensively gather at the end of this Taylor Cone, so that a density of the electric charges becomes high. The water repeats Rayleigh Division such that the water is divided and scattered by repulsion of high-density electric charges. At this time, the formation of Taylor Cone is affected by surface wettability of discharge electrode 84a, i.e. small wettability prevents Taylor Cone in a given size from being formed, and the water thus cannot be electrostatically atomized. A given amount of water thus should be available on the surface of discharge electrode 84a.

[0043] Water feeder 84c includes a cooling device formed of Peltier element 84e, and this cooling device cools discharge electrode 84a for forming dew from the water (moisture) in the air on the tip surface of discharge electrode 84a, thereby supplying the water to discharge electrode 84a. The necessary amount of water for the electrostatic atomization is approx. 0.5 ml/hour. A first end, at discharge electrode 84a side, of Peltier element

84e forms cooling section 84f, and a second end, at the opposite side, forms heat radiator 84g. Cooling section 84f is connected to discharge electrode 84a and heat radiator 84g is connected to heat radiating fin 84h.

[0044] The air running through bypath 15f of atomizer 83 flows such that it touches heat radiating fin 84h, and this air flow is used for heat radiation during the atomizing discharge. In the case of using a Peltier-type atomizing-discharging unit, an amount of heat radiation necessary for the atomizing discharge has been determined, so that a minimum velocity of air is determined depending on the heat radiating fin. This first embodiment needs the minimum air velocity of 0.5 m/sec, and the foregoing structure can achieve the velocity greater than this minimum value. The use of the air circulating through air circulation duct 5 can eliminate a heat radiating device that has been needed in a conventional machine.

[0045] As shown in Fig. 1 and Fig. 2, washing and drying machine 1 in accordance with the first embodiment of the present invention circulates the air in outer tub 3 through air circulation duct 5, at this time, filtering-box 5d falls into a negative pressure relative to atmospheric pressure. First opening 51 is provided around this filtering-box 5d. Fresh-air intake port 5h is formed by connecting valve 5g and fresh-air introduction duct 5e to first opening 51. Second opening 52 is formed at a part of air circulation duct 5 placed near to filtering box 5d on which a positive pressure relative to the atmospheric pressure acts or a dynamic pressure of the circulation air acts. Circulation air discharging duct 5f is connected to second opening 52 to form circulation air discharging port 5i.

[0046] Opening or closing valve 5g allows exchanging parts of the circulation air in duct 5 with fresh air. During the course specialized in exposure of electrostatically atomized particles 82, valve 5g should be opened at least in an early stage of the course for exchanging the air in outer tub 3 with fresh-air outside machine 1. The reason is this: Washing and drying machine 1 is air-tightly designed in order to carry out the drying operation, so that when door 9 is closed, the air in the tub is scarcely exchanged with the fresh-air. A certain amount of water remains in the washing machine in general, and a relative humidity in the tub exceeds 90% easily when door 9 is closed; however, this high humidity is an inadequate environment for an electric discharge. In a case where electrostatic atomizer 83 operates, the relative humidity in the tub should be not greater than 85%. Gradual exchange of the air in the tub with the fresh-air allows prohibiting an abnormal discharge.

[0047] As discussed above, this specialized course includes a step of exchanging the air in the tub with fresh-air positively by opening valve 5g and by increasing air volume with the aid of blower 15. To be more specific, valve 5g is kept open from the time when this course starts for exchanging the air in outer tub 3 with fresh-air, and on top of that, heat pump 39 is operated in approx. 2 minutes after 3 minutes has passed from the start of this course for dehumidifying. This operation assures

more stable operation during this course.

[0048] During this specialized course, blower 15 pressurizes and transmits the circulation air in air circulation duct 5, and electrostatic atomizer 83 operates at the same time. The simultaneous blowing and atomizing achieves efficient exposure of electrostatically atomized particles 82 to the target articles.

Exemplary Embodiment 2

[0049] Fig. 8 is a vertical sectional view of a washing and drying machine in accordance with the second embodiment of the present invention. In this second embodiment, the descriptions of similar structural elements, operation, and actions to those of the first embodiment are omitted, and only different points are described.

[0050] As shown in Fig. 8, the washing tub, i.e. rotary drum 121, of the washing and drying machine forms a cylindrical shape with a bottom, and numerous vents 122 are formed on the outer circumferential wall. Rotary drum 121 is mounted rotatably in the outer tub, i.e. water tub 123. Rotary drum 121 includes, at its rotation center, rotary shaft 124 slanting from the horizontal, and drum 121 is placed such that the axial direction slants downward from the front face toward the rear face. Rotary shaft 124 is connected with motor 125 mounted on the rear face of water tub 123 for rotating rotary drum 121 forward or backward. Rotary drum 121 includes several projecting plates 126 on its inner wall.

[0051] An opening is formed on an upward slope of the front side of water tub 123, and is covered with lid 127, which is opened for loading or unloading clothes into or from rotary drum 121 through entrance 128. Since lid 127 is provided on the upward slope, a user does not necessarily stoop for loading or unloading the laundry.

[0052] Water tub 123 is suspended in a rockable manner with spring 130 and damper 131 from main body 129 of the washing and drying machine. Water tub 123 is coupled with a first end of drain path 132 at the bottom, and a second end thereof is connected to drain valve 133 for draining the wash water from tub 123. Water supply valve 134 supplies water into tub 123 via water-supply path 135. Water level sensor 136 senses the water level in tub 123.

[0053] In this second embodiment, rotary drum 121 includes, at its rotation center, rotary shaft 124 slanting from the horizontal, and drum 121 is placed such that the axial direction slants downward from the front face toward the rear face. However, rotary shaft 124 can be mounted horizontally at the rotary center, and the axial direction of drum 121 can be laid horizontally.

[0054] Fig. 9 is a vertical sectional view cut along another aspect of the washing and drying machine shown in Fig. 8 for describing the structure of the drying function.

[0055] The drying function is formed of heater 137, blower fan 138, and fan housing 139 which accommodates heater 137 and blower fan 138. Fan housing 139 forms a part of an air circulation duct, and is mounted to

main body 129 of washing and drying machine. Water tub 123 is provided with warm-air inlet 140, forming a part of the air circulation duct, at its trunk for taking the air in from water tub 123, and is provided with warm-air outlet 141 at its rear face.

[0056] Water tub 123 is integrated with heat-exchange path 142 (a part of the air circulation duct), and a first end of path 142 communicates with warm-air inlet 140 and a second end thereof is coupled to sucking end 139a of fan housing 139 via first bellows-shaped hose 143 (a part of the air circulation duct). Discharging end 139b of fan housing 139 communicates with warm-air outlet 141 via second bellows-shaped hose 145 and rear blower duct 144, which is integrated with water tub 123.

[0057] Rear vent 146 is formed on the rear face of rotary drum 121 at a place corresponding to warm-air outlet 141 so that the air blown from outlet 141 can be transmitted into drum 121.

[0058] Plate-like heat-exchange member 147 is mounted in heat-exchange path 142 above warm-air intake port 140 such that it slants downward from the front face to the rear face. Heat-exchange path 142 is divided into lower section 142a and upper section 142b by member 147. Lower section 142a communicates with upper section 142b at lower end 147b side of heat-exchange member 147 via communicating port 142c. Path 142 shapes like a letter "U". Cool-water supply valve 148 regulates an amount of water supplied from water-supply mouthpiece 150 to upper end 147a of heat-exchange member 147 via cool-water hose 149. A cool water feeder is formed of cool-water supply valve 148, cool-water hose 149, and water-supply mouthpiece 150. A cross sectional area of upper section 142b of heat-exchange path 142 is set greater than that of communicating port 142c.

[0059] The drum-type washing and drying machine structured above carries out the steps of washing, rinsing, dewatering, and drying. Those steps are controlled by controller 151.

[0060] The operation of this drum-type washing and drying machine is demonstrated hereinafter. The steps of washing, rinsing, and dewatering are the same as those of a conventional washing and drying machine, so that the descriptions thereof are omitted here.

[0061] During the drying step, as outline allows in Fig. 9 indicate, the air blown by blower fan 138 is heated by heater 137 to a given temperature, and then blown into water tub 123 through second bellows-shaped hose 145, rear blower duct 144, and warm-air outlet 141. The air is further blown into rotary drum 121 through rear vent 146. The heated warm air absorbs water from damped laundry being agitated in rotary drum 121, so that the warm air becomes wet. Then the wet warm air travels through vents 122 to be discharged into water tub 123, and then blown to heat-exchange path 142 through warm-air inlet 140.

[0062] During the operation discussed above, cool-water supply valve 148 is kept open, so that the cool water drops from mouthpiece 150 to upper end 147a side

of heat exchange member 147, and then flows on top face 147c as indicated with arrows in broken line. The water then drops from an edge of lower end 147b to lower section 142a of heat exchange path 142, and is discharged into water tub 123 through drain-hole 152 formed on the bottom of lower section 142a and communicating with water tub 123. The water is finally discharged outside the drum-type washing and drying machine through drain path 132.

[0063] The wet warm air transmitted from warm-air intake 140 into lower section 142a of heat exchange path 142 touches firstly underside 147b of heat exchange member 147. At this time, the cool water flowing on top face 147c of heat exchange member 147 cools underside 147d, which thus exchanges heat with the wet warm air. As a result, the wet warm air is dehumidified (first dehumidifying step).

[0064] The wet warm air at lower end 147b is transmitted to upper section 142b of heat exchange path 142. At this time, the wet warm air raises and scatters the cool water dropping from lower end 147b, and the scattered cool water exchanges heat with the wet warm water. As a result, the wet warm water is dehumidified (second dehumidifying step).

[0065] Then the wet warm air is transmitted to upper section 142b of heat exchange path 142 and touches both of top face 147c of heat exchange member 147 and the cool water flowing on top face 147c. At this time, the wet warm air flows opposite to the flow of the cool water, so that the wet warm air exchanges heat with top face 147c and the cool water flowing on top face 147c. As a result, the wet warm air is dehumidified (third dehumidifying step).

[0066] As discussed above, the wet warm air having undergone the first, second, and third dehumidifying steps is cooled and dehumidified efficiently, and then this cooled and dehumidified air is transmitted into fan housing 139 via first bellows-shaped hose 143 and sucking end 139a of housing 139, and finally arrives at blower fan 138.

[0067] During the steps discussed above, the sectional cross area of upper section 142b of heat exchange path 142 is set greater than that of communicating port 142c, so that the flow speed of the wet warm air in upper section 142b is lower than that at communicating port 142c. The cool water scattered thus rides on the warm air and drops on heat exchange member 147 somewhere in upper section 142b. This structure thus prevents the cool water from traveling into fan housing 139 via sucking end 139a of fan housing 139. As a result, the drops of water cannot travel to heater 137.

[0068] Fig. 9 shows that electrostatic atomizer 83 is placed somewhere in the air circulation duct such that it is located at the upstream of blower fan 138 and at the downstream of sucking end 139a, and valve 90 is placed for taking fresh-air into atomizer 83. The operation of this machine includes four courses similar to what is discussed in the first embodiment: The four courses are a

washing course carrying out only the washing step, a drying course carrying out only the drying step, a washing and drying course carrying out sequentially the steps from the washing to the drying, and a nanoe course carrying out debacterialization and deodorization. The nanoe course uses electrostatic atomizer 83 placed somewhere in the air circulation duct, which is used for circulating the air in water tub 123 during the drying step, and this atomizer 83 supplies electrostatically atomized particles 82 to achieve debacterialization and deodorization. Valve 90 is opened so that the upstream of blower fan 138 can be in a negative pressure, and atomizer 83 blows the air without being adversely affected from heater 137. This blowing allows exposing particles 82 to target articles in rotary drum 121. This specialized course, i.e. "nanoe" course, can also select one of the rotary mode or the stationary mode of rotary drum 121 in response to target articles, and this course takes about 35 minutes.

[0069] The foregoing washing and drying machine further includes a "nanoe" tub-cleaning mode for automatically exposing electrostatically atomized particles 82 in water tub 123 every time after the washing course ends and the laundry is unloaded. The setting of this mode can be turned on or off. After the washing course ends, lid 127 is opened and closed, this mode is operated for approx. 60 minutes with rotary drum 121 held stationary.

[0070] The sanitary-cared courses discussed above are set together with the washing course and the drying course as equals in the washing and drying machine in accordance with the second embodiment of the present invention, and operation buttons dedicated to these courses are provided. Electrostatically atomized particles 82 are capable of giving strong oxidative destruction to the target articles, so that the debacterialization, deodorization, and preventing mold from increasing can be done with ease. This method saves the conventional heating as well as worrying about risk of degradation in the target articles. Providing the foregoing specialized courses allows the users to select an optimum operation to user's objective in an easier and more carefree manner, thereby achieving the better usability.

[0071] The air circulation discussed above allows drying the laundry gradually, and after a lapse of given time or when the laundry reaches a given degree of dryness, the step of drying ends.

[0072] As discussed above, during the drying step in accordance with the second embodiment, the flow velocity of the wet warm air at upper section 142b of the heat exchange path is lower than that at communicating port 142c, so that the warm air carries the scattered cool water, which is thus prevented from traveling into fan housing 139 via sucking end 139a or entering electrostatic atomizer 83. The cool water scattered thus does not absorb electrostatically atomized particles 82. The cool water drops on heat exchange member 147 somewhere in upper section 142b of the heat exchange path. As a result, the drops of water cannot travel to heater 137. Heater 137 can be thus kept stable because the

water never attaches thereto, so that the wet air can be dehumidified efficiently with the safety maintained. Electrostatically atomized particles 82 are prevented from being absorbed by the water, and they can be exposed into rotary drum 121 and water tub 123.

[0073] Fig. 10 is a vertical sectional view showing still another aspect of the washing and drying machine in accordance with the second embodiment. As shown in Fig. 10, electrostatic atomizer 83 is placed near warm-air inlet 141, so that atomizer 83 is less affected by the heat from heater 137. Atomizer 83 is located above the level of water stored in water tub 123, so that the water in tub 123 hardly touches atomizer 83. This structure thus allows electrostatically atomized particles 82 to achieve debacterialization, deodorization, and to prevent mold from growing.

[0074] A bypath can be provided somewhere in the air circulation duct and atomizer 83 is placed in this bypath. An air guiding plate can be also provided in the merging section of the bypath and the mainstream at the mainstream side such that the plate is placed in parallel with the flow of the circulation air. This structure is employed in the first embodiment.

Industrial Applicability

[0075] A washing and drying machine of the present invention supplies electrostatically atomized particles in the washing tub and the outer tub, thereby protecting the washing tub, outer tub, and laundry in the washing tub from bacteria and growing of mold. The washing and drying machine can be thus always kept clean, so that this machine can be employed in the equipment, which requires debacterialization, mold prevention, and deodorization, installed at a wet area. This machine can operate safely and harmlessly at a low running cost, so that it can be used as a household appliance.

[0076] Description of Reference Signs

1	washing and drying machine
2	washing tub
3	outer tub
5	air circulation duct
5a	suction path
5b	bellows-shaped coupler
5c	blowing path
5d	filtering box
5e	fresh-air introduction duct
5f	circulation air discharging duct
5g	valve
7, 125	motor
8, 122	vent
9	door
10	agitating projection
11	opening
12	water supplying tube
13	water draining tube
15	blower

15a	fan
15b	snaillike housing
15c	suction connecting port
15d	blow-off port
5 31	evaporator
32	condenser
37	compressor
38	heat-pump housing
38a	suction discharging port
10 38b	suction introducing port
39	heat-pump
44,	129 main body
51	first opening
52	second opening
15 81	heat-pump blowing unit
82	electrostatically atomized particles
83	electrostatic atomizer
84	atomizing and discharging block
84a	discharge electrode
20 84b	counter electrode
84c	water feeder
84d	voltage applier
84e	Peltier element
84f	cooling section
25 84g	heat radiator
84h	radiating fin
85	transformer printed circuit board
86	controller printed circuit board
87	element housing
30 88a	sucking port of the clamping plate
88b	discharging port
88c	air guiding plate
89	housing of transformer printed circuit board
90	valve
35 121	rotary drum
123	water tub
124	rotary shaft
126	projecting plate
127	lid
40 128	entrance
130	spring
131	damper
132	drain path
133	drain valve
45 134	water-supply valve
135	water-supply path
136	water-level sensor
137	heater
138	blower fan
50 139	fan housing
139a	sucking end
139b	discharging end
140	warm-air intake
141	warm-air outlet
55 142	heat-exchange path
142a	lower section
142b	upper section
142c	communicating port

143 first bellows shaped hose
 144 rear blower duct
 145 second bellows shaped hose
 146 rear vent
 147 heat-exchange member
 147a upper end
 147b lower end
 147c top face
 147d underside
 148 cool-water supply valve
 149 cool water hose
 150 water supply mouthpiece
 151 controller
 152 drain hole

Claims

1. A washing and drying machine comprising:

a washing tub for accommodating laundry;
 an outer tub holding the washing tub rotatably;
 a housing for elastically supporting the outer tub;
 a water feeder for supplying wash water to the outer tub;
 a heater for heating air in the outer tub;
 an air circulation duct for circulating the air in the outer tub via the heater;
 a blower circulating the air in the air circulation duct; and
 an electrostatic atomizer for supplying electrostatically atomized particles into the washing tub and the outer tub,
 wherein the electrostatic atomizer is disposed in the air circulation duct.

2. The washing and drying machine of claim 1, wherein the heater comprises a heat pump having a compressor, an evaporator and a condenser.

3. The washing and drying machine of claim 1 or claim 2, wherein the electrostatic atomizer is disposed near a blow-off port for discharging the air circulated in the air circulation duct into the outer tub after having passed through the heater and the blower.

4. The washing and drying machine of claim 3, wherein the electrostatic atomizer is integrated with the blow-off port.

5. The washing and drying machine of claim 1 or claim 2, wherein the electrostatic atomizer is disposed at the housing side.

6. The washing and drying machine of claim 1 or claim 2, wherein the air circulation duct includes a mainstream path and a bypath branching off from and merging again into the mainstream path, and an at-

omizing and discharging block forming the electrostatic atomizer is disposed in the bypath.

7. The washing and drying machine of claim 6 further comprising an air guiding plate disposed in the mainstream near where the bypath merges into the mainstream path, the air guiding plate oriented in parallel with a flowing direction of circulation air in the air circulation duct.

8. The washing and drying machine of claim 6, wherein the electrostatic atomizer includes a discharge electrode, a voltage applier for applying a high voltage to the discharge electrode, and a water feeder for supplying water to the discharge electrode, the water feeder includes a Peltier element for cooling the discharge electrode and forming dew by condensing moisture in the air and a radiating fin for radiating heat absorbed, and air flowing in the bypath is brought into contact with the radiating fin for dissipating the heat into the air.

9. The washing and drying machine of claim 1 or claim 2 including a specialized course for exposing any of articles accommodated in the wash tub and surfaces of the wash tub and the outer tub to the electrostatically atomized particles.

10. The washing and drying machine of claim 9, wherein the specialized course makes the blower pressurize and circulate the air in the air circulation duct and operates the electrostatic atomizer.

FIG. 1

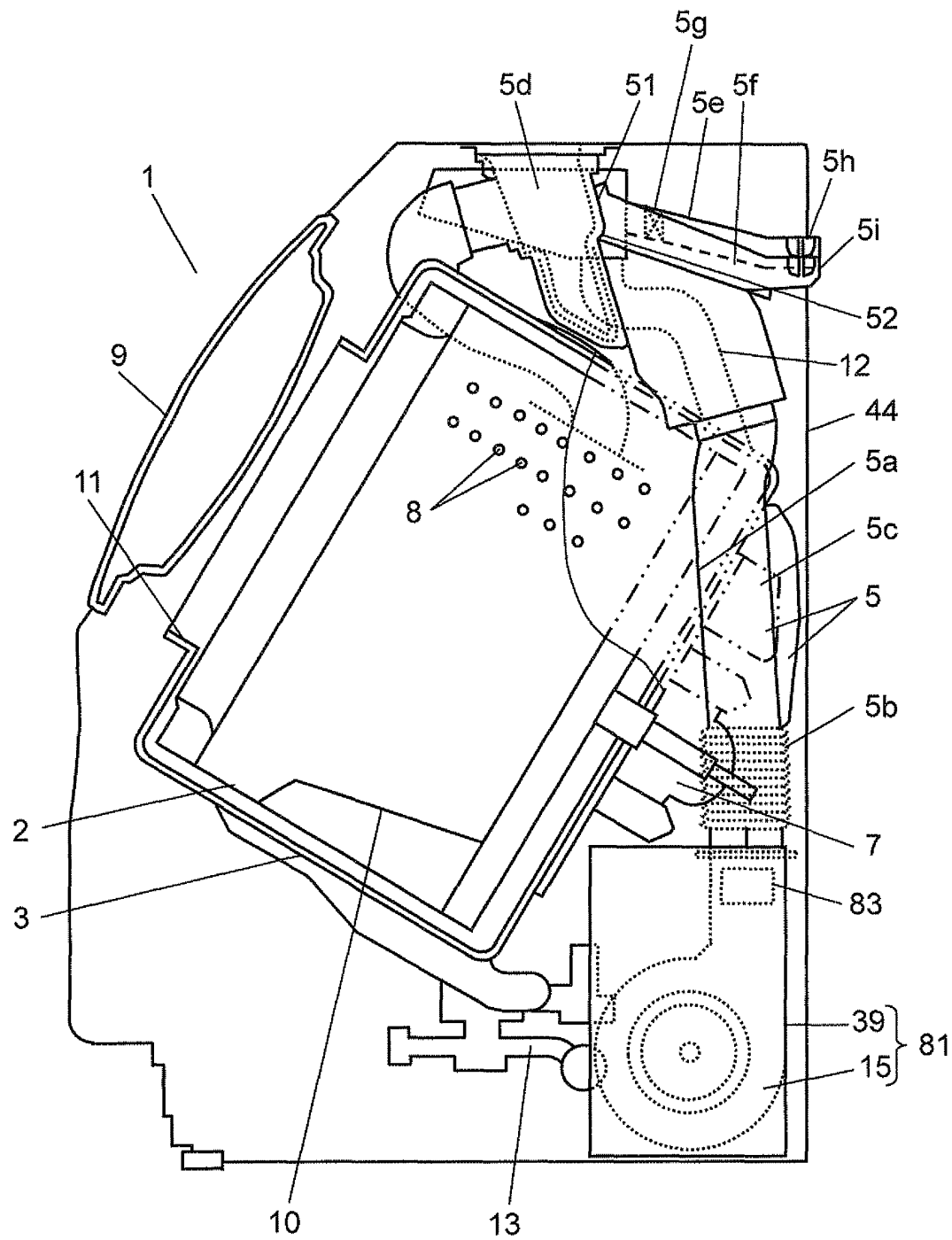


FIG. 2

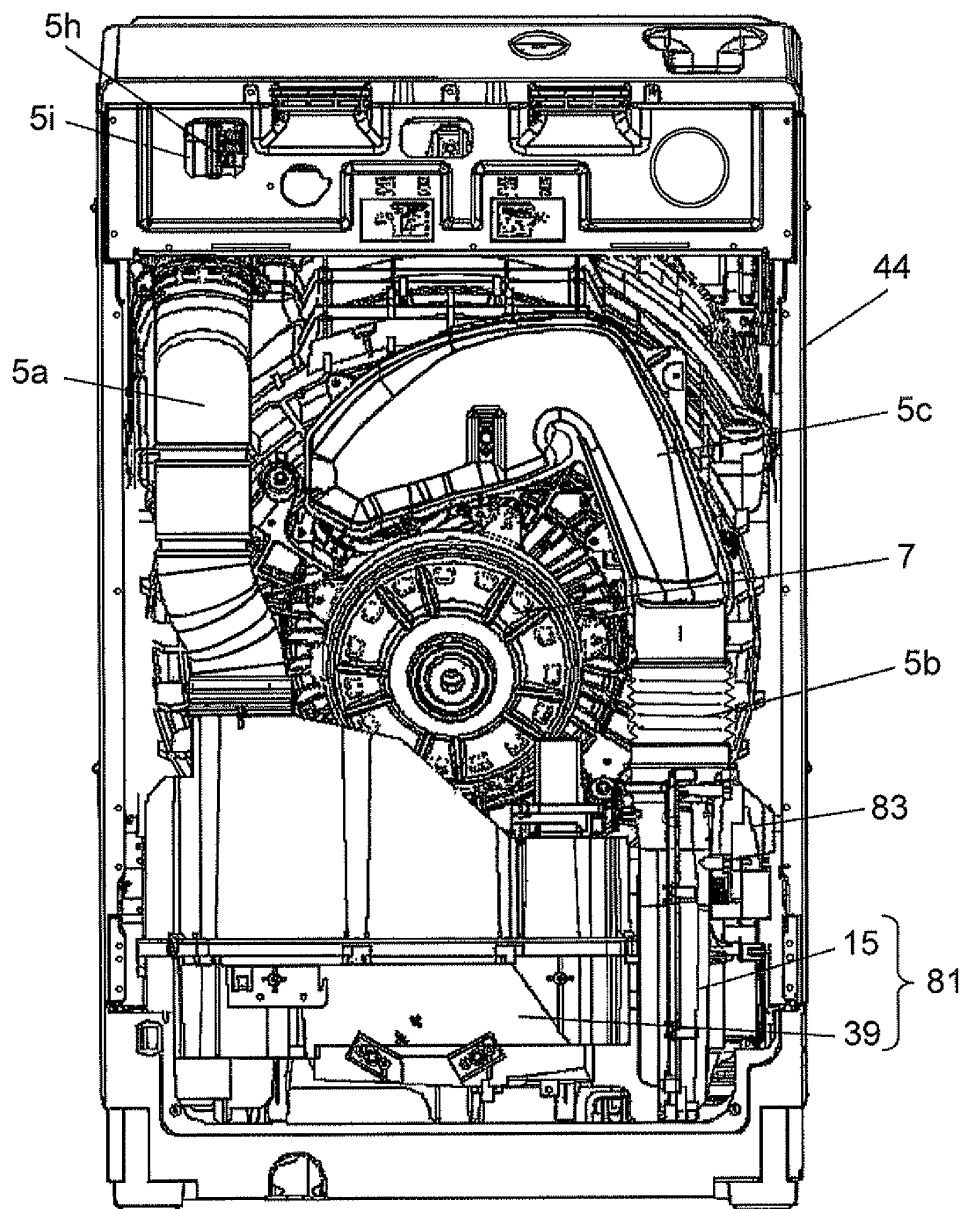


FIG. 3

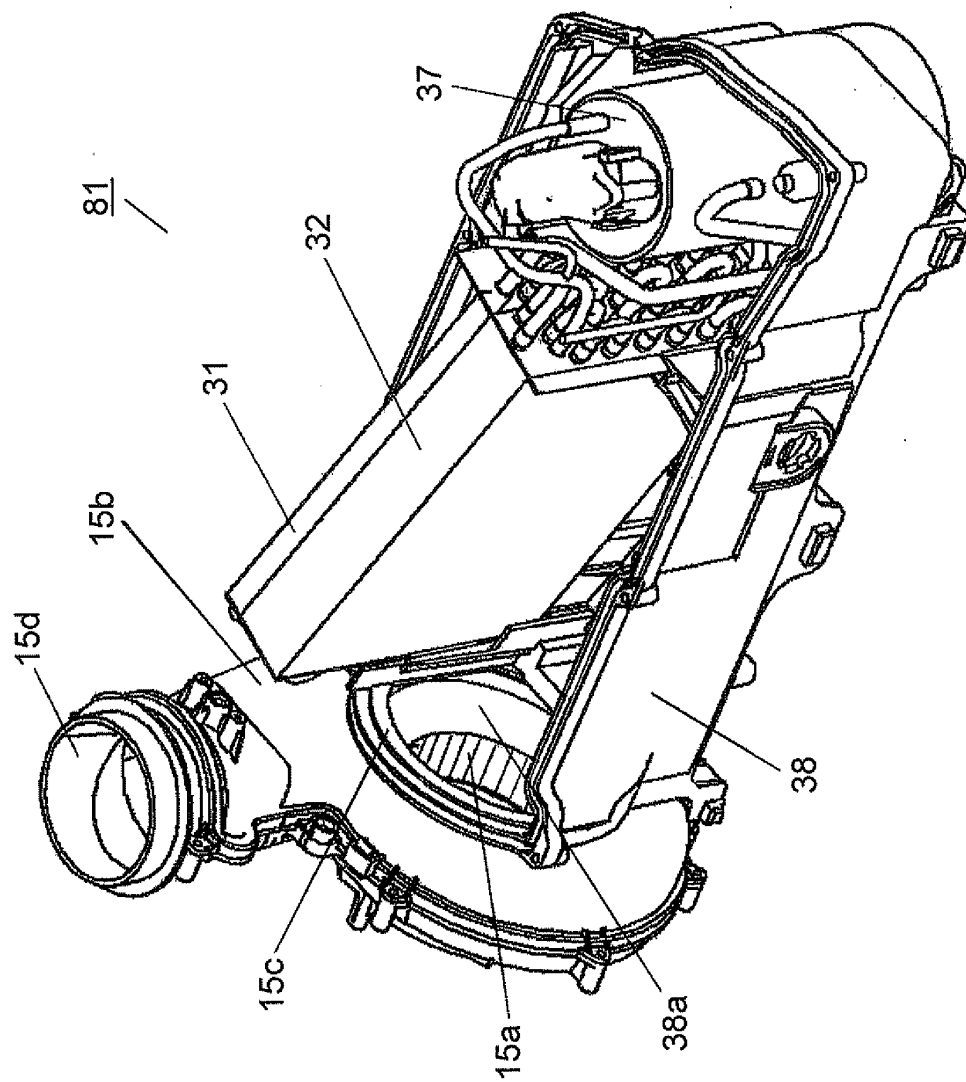


FIG. 4

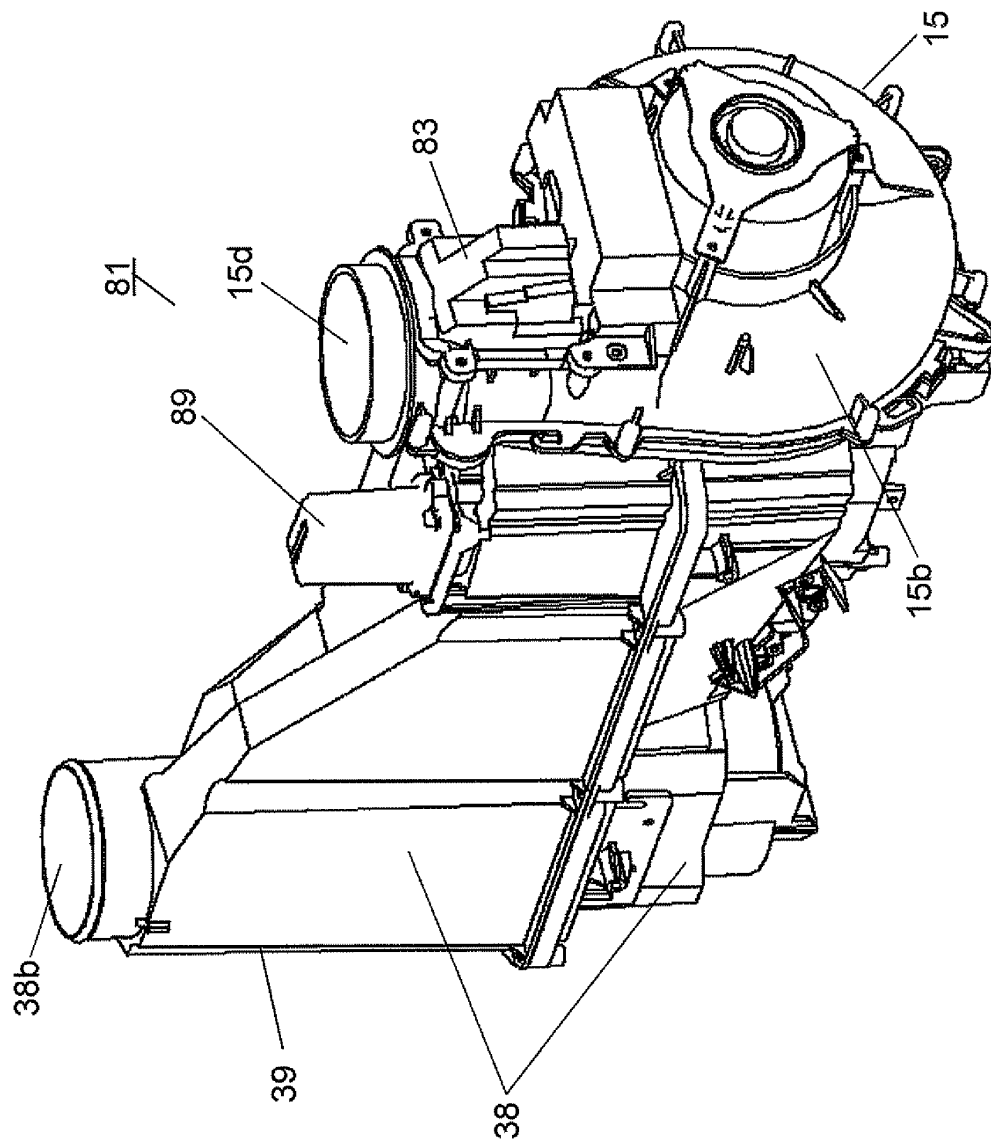


FIG. 5

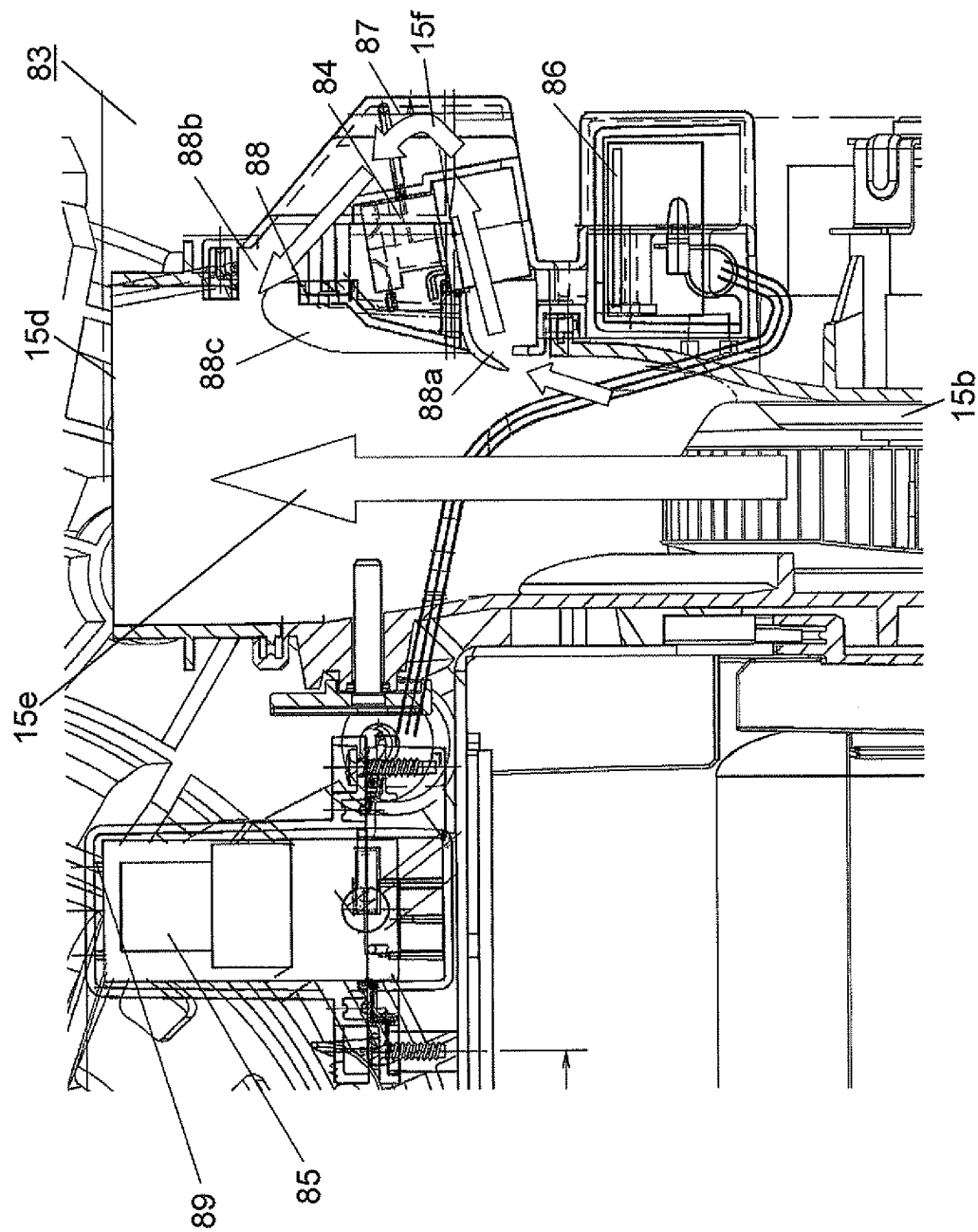


FIG. 6

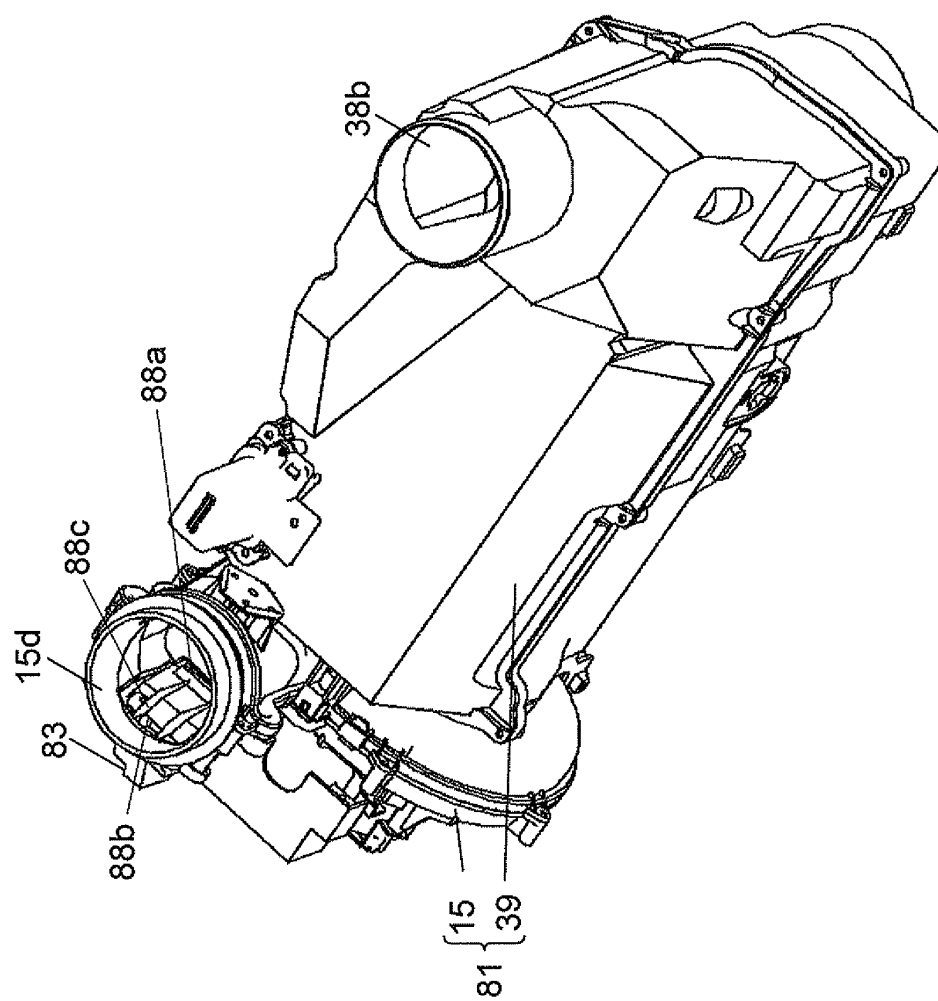


FIG. 7

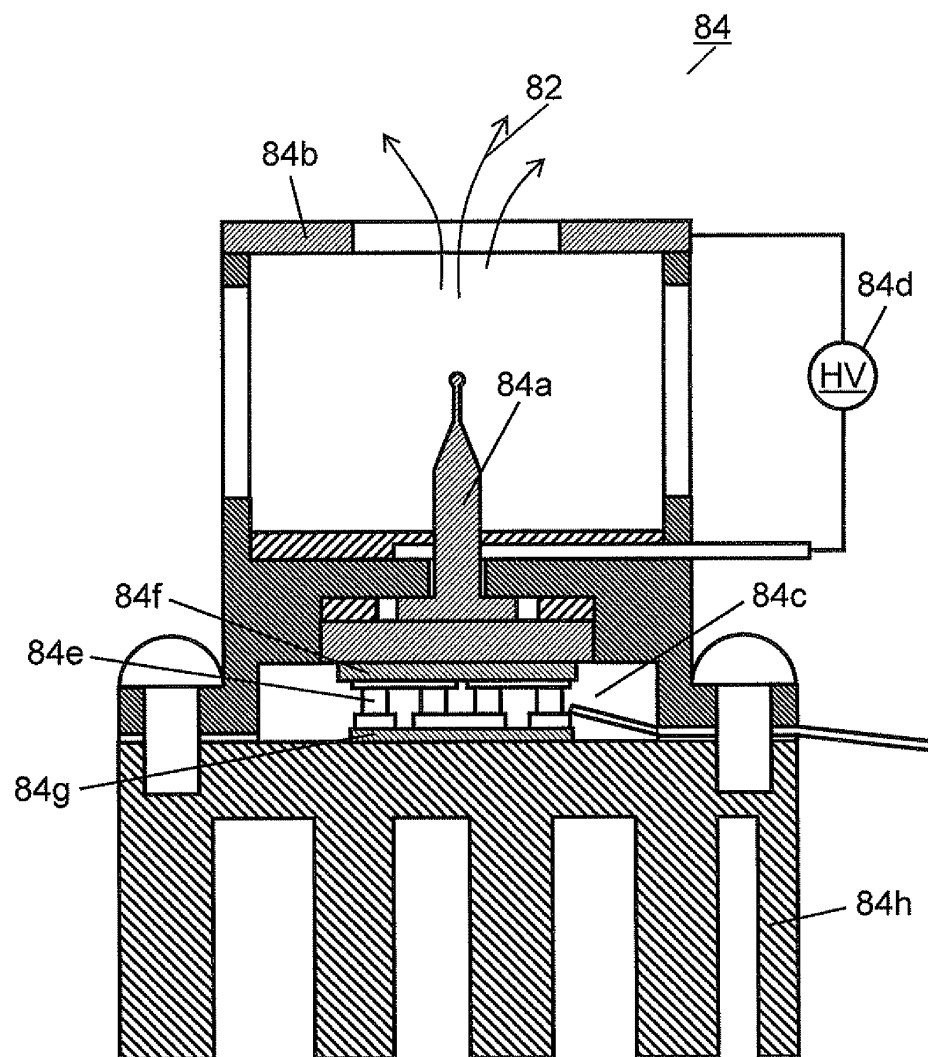


FIG. 8

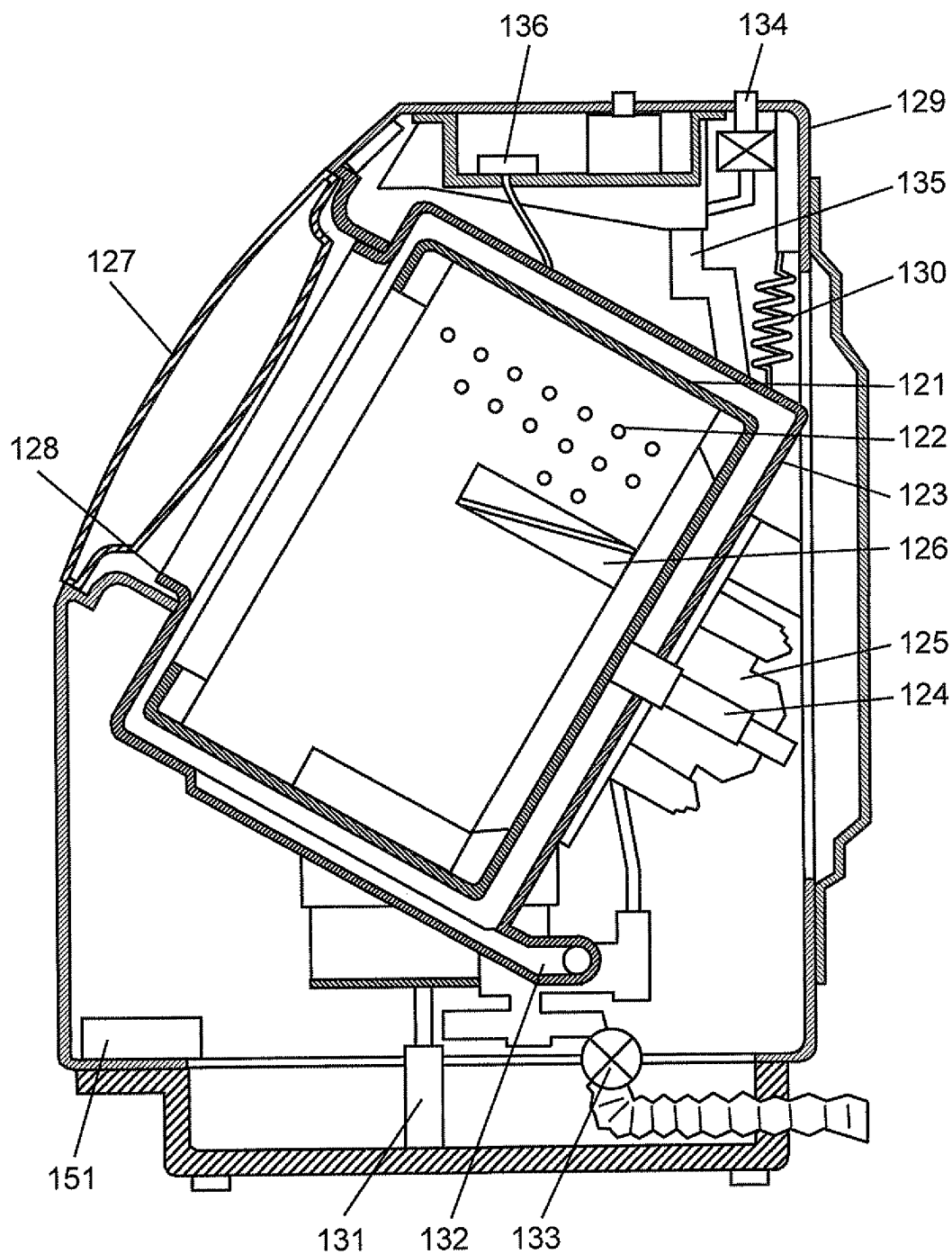


FIG. 9

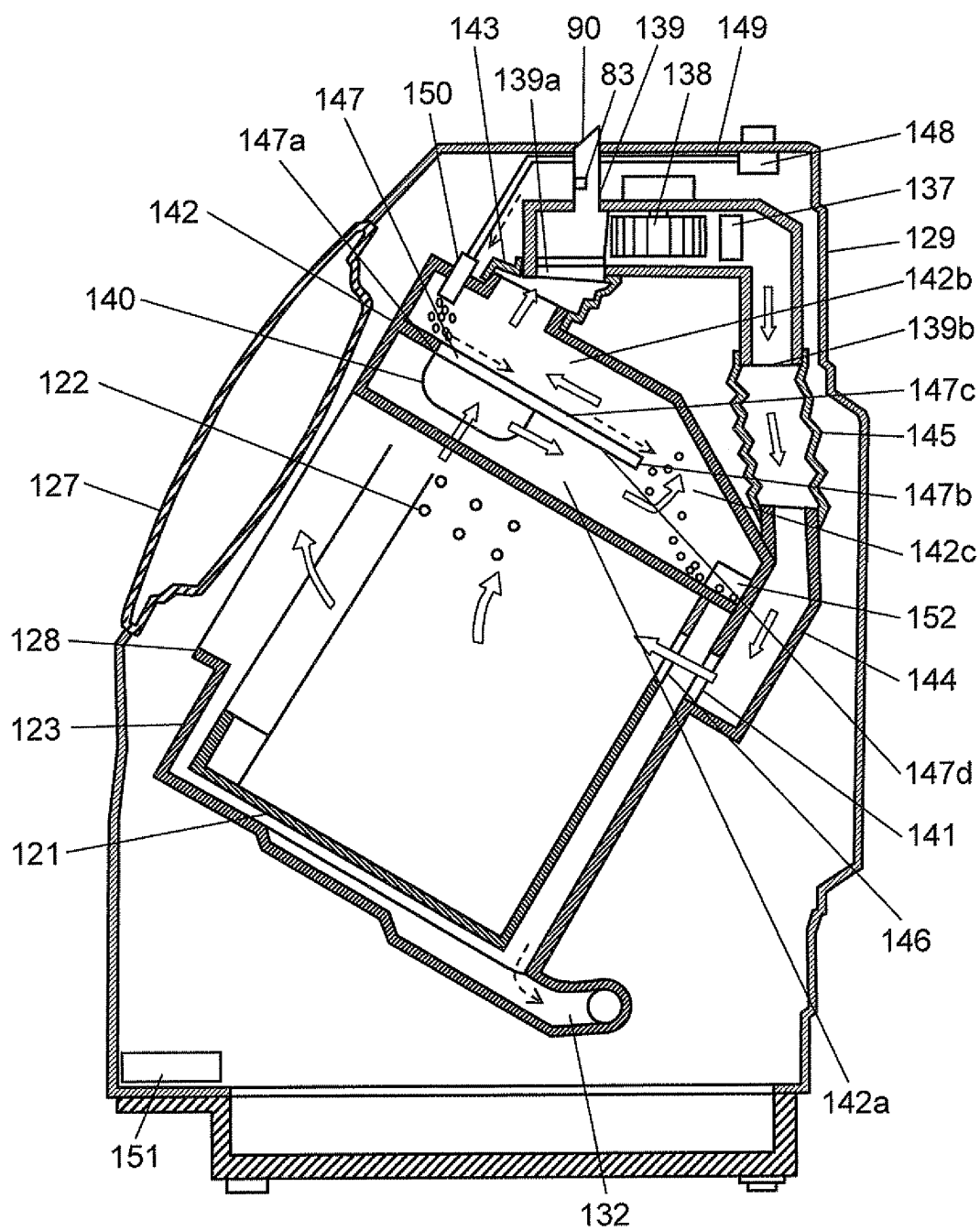
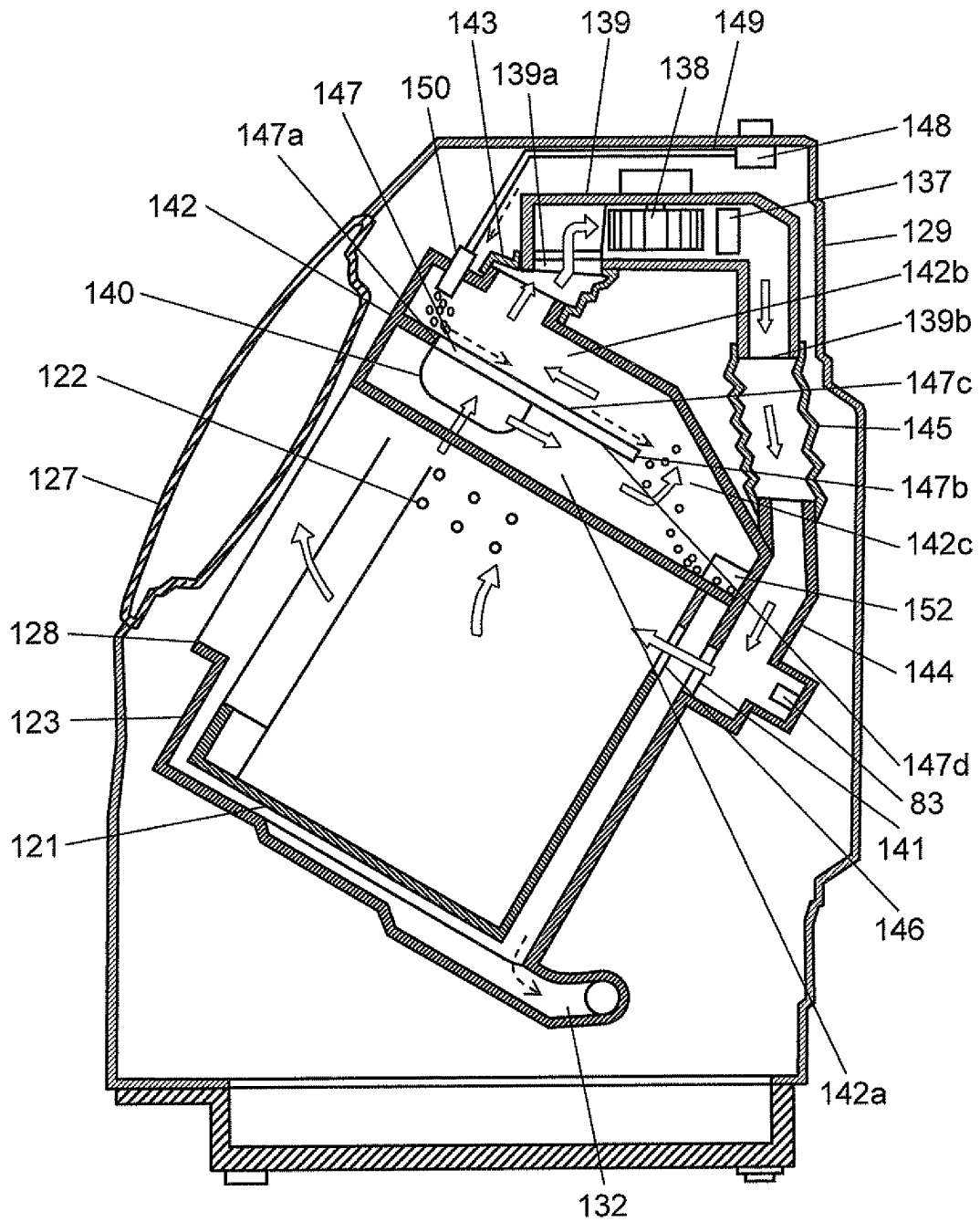


FIG. 10



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2009/004280

A. CLASSIFICATION OF SUBJECT MATTER D06F58/02(2006.01)i, D06F25/00(2006.01)i		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols) D06F58/02, D06F25/00		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Jitsuyo Shinan Koho 1922-1996 Jitsuyo Shinan Toroku Koho 1996-2009 Kokai Jitsuyo Shinan Koho 1971-2009 Toroku Jitsuyo Shinan Koho 1994-2009		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y	JP 2003-135889 A (Sharp Corp.), 13 May, 2003 (13.05.03), Par. Nos. [0020] to [0021]; Fig. 1 & US 2004/0216326 A1 & EP 1445367 A1 & WO 2003/040458 A1	1 2-10
Y	JP 2008-194265 A (Matsushita Electric Industrial Co., Ltd.), 28 August, 2008 (28.08.08), Par. Nos. [0028] to [0035], [0038] to [0040]; Figs. 1 to 4 (Family: none)	2-10
Y	JP 2005-192901 A (Sanyo Electric Co., Ltd.), 21 July, 2005 (21.07.05), Par. Nos. [0027] to [0030]; Fig. 1 (Family: none)	8
☒ Further documents are listed in the continuation of Box C. ☐ See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 02 October, 2009 (02.10.09)		Date of mailing of the international search report 13 October, 2009 (13.10.09)
Name and mailing address of the ISA/ Japanese Patent Office		Authorized officer
Facsimile No.		Telephone No.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2009/004280

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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REFERENCES CITED IN THE DESCRIPTION

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