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(54) **HUMIDITY CONTROLLER**

(57) A dividing member (25) divides an inside of a storage tank (41) into a humidification region (31) and a supply region (32), and a space above the supply region (32) is covered with a covering member (26). In water, the dividing member (25) defines a communication path (33) through which the supply region (32) and the humidification region (31) communicate with each other. Active

species generated in an electrical discharge unit (51) are supplied to the supply region (32) to purify the water. A release of the supplied active species to outside is reduced by the dividing member (25) and the covering member (26), and the water in the supply region (32), which is purified by the active species flows into the humidification region (31) through the communication path (33).

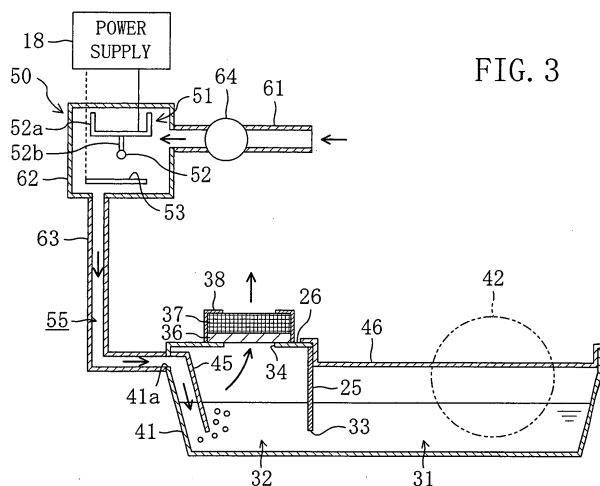


FIG. 3

Description

TECHNICAL FIELD

[0001] The present invention relates to a humidity control apparatus.

BACKGROUND ART

[0002] Conventionally, a humidity control apparatus has been broadly known, which includes a humidification unit configured to impart water in a water tank to air. An example of the humidity control apparatus of this type includes a humidity control apparatus in which ozone gas is supplied to a water tank, and the ozone gas comes into contact with water to remove bacteria and harmful substances in the water, thereby purifying the water (see, e.g., Patent Document 1).

[0003] In a humidity control apparatus disclosed in Patent Document 1, an ozone gas outlet is formed in a bottom section of a water tank, and a porous plate with similarly-sized pores is provided above the outlet. In the humidity control apparatus, air bubbles of ozone gas discharged through the outlet in the bottom section pass through the similarly-sized pores of the porous plate, and therefore the air bubbles of the ozone gas are uniformly diffused in the water tank. Consequently, water is purified across the entire water tank.

[0004] However, in the humidity control apparatus disclosed in Patent Document 1, the air bubbles of the ozone gas passing through the pores of the porous plate rise due to buoyant force, and then reach a water surface shortly. This results in a release of the remaining ozone gas which does not react with the water, to air. Thus, there is a possibility that, when using the humidity control apparatus for a long period of time in a closed room, an ozone concentration in the room exceeds its environmental limit.

[0005] As in a water purification apparatus disclosed in Patent Document 2, a part of ozone gas diffused in water, which is not dissolved in the water is collected by a collection container. The collected ozone gas is decomposed by an ozone decomposition catalyst, and then is released to air.

CITATION LIST

PATENT DOCUMENT

[0006]

PATENT DOCUMENT 1: Japanese Patent Publication No. 2001-153409

PATENT DOCUMENT 2: Japanese Patent Publication No. H06-178989

SUMMARY OF THE INVENTION

TECHNICAL PROBLEM

[0007] However, in the purification apparatus described in Patent Document 2, there is a possibility that, when changing a water level in a water tank, the ozone gas cannot be fully collected. Specifically, in the purification apparatus, the water level in the water tank is substantially constant, and an ozone gas outlet is constantly soaked in water. Ozone gas which is discharged through the outlet, and which is not dissolved in the water is collected by the collection container when rising to a water surface due to buoyant force. However, the water in the water tank of the humidity control apparatus is used for air humidification, and then the water level is gradually lowered. As a result, the outlet is positioned above the water surface. When discharging the ozone gas through the outlet in such a state, the ozone gas is diffused in air, and therefore a part of the ozone gas discharged through the outlet is released to air without being collected by the collection container.

[0008] In order to reduce or prevent the release of the ozone gas to air, it is required to arrange the ozone decomposition catalyst for decomposing the ozone gas on an upstream or downstream side of an air blowing fan; and the ozone decomposition catalyst is required, which has a broad surface area so that an air path on the upstream or downstream side of the air blowing fan is covered. Thus, a disadvantage in cost is caused.

[0009] Since humidified air containing moisture passes through the ozone decomposition catalyst, it is required to select and use a water-resistant catalyst, resulting in an increase in cost. Further, the configuration is employed, in which air sent by the air blowing fan passes through the catalyst. Consequently, there is a possibility that a pressure loss is caused to degrade air distribution performance.

[0010] The present invention has been made in view of the foregoing, and it is an object of the present invention to reduce a release of active species to air, and to efficiently purify water in a storage tank.

SOLUTION TO THE PROBLEM

[0011] In order to accomplish the foregoing object, in the present invention, a dividing member divides an inside of a storage tank into a supply region and a humidification region, and the supply region is covered with a covering member. Active species are supplied only to the supply region.

[0012] Specifically, the present invention is intended for a humidity control apparatus including a storage tank (41) for storing water, and a humidification mechanism (43) for humidifying air by imparting the water in the storage tank (41) to air. The followings are provided as solutions to the problem.

[0013] That is, a first aspect of the invention is intended

for the humidity control apparatus including an electrical discharge unit (51) configured to generate electrical discharge to generate active species; a dividing member (25) which divides an inside of the storage tank (41) into a humidification region (31) where the humidification mechanism (43) is arranged to impart the water to air, and a supply region (32) to which the active species generated in the electrical discharge unit (51) are supplied to purify the water, so that the humidification region (31) and the supply region (32) are arranged along a horizontal direction; and which defines a communication path (33) in the water, through which the water purified in the supply region (32) flows into the humidification region (31); and a covering member (26) configured to cover a space above the supply region (32) of the storage tank (41).

[0014] In the first aspect of the invention, the electrical discharge unit (51) generates the electrical discharge to generate the active species. The active species are supplied to the supply region (32) in the storage tank divided by the dividing member (25). A release of the active species supplied to the supply region (32) to an outside of the storage tank (41) is reduced by the dividing member (25) and the covering member (26), and therefore the water stored in the supply region (32) is purified. The water purified by the active species flows from the supply region (32) to the humidification region (31) through the communication path (33).

[0015] As described above, the inside of the storage tank (41) is divided into the supply region (32) and the humidification region (31), and the active species are supplied only to the supply region (32). Thus, the release of the active species to outside is reduced by the dividing member (25) and the covering member (26). Consequently, such a state is preferable because an ozone component etc. contained in the active species do not cause an ozone concentration in a room, which exceeds its environmental limit even if the humidity control apparatus is used for a long period of time in the closed room.

[0016] Since the active species are not released to the outside of the storage tank (41), a catalyst is not necessarily arranged on an upstream or downstream side of an air blowing fan in order to decompose and remove the active species. Thus, degradation of air distribution performance due to a pressure loss can be reduced or prevented, and it is advantageous in cost reduction of the catalyst.

[0017] The water in the supply region (32), which is purified by the supplied active species flows into the humidification region (31) through the communication path (33). Thus, bacteria and harmful substances in the water are removed, thereby efficiently purifying the water across the entire storage tank (41).

[0018] A second aspect of the invention is intended for the humidity control apparatus of the first aspect of the invention, in which the active species generated in the electrical discharge unit (51) are supplied to a space above a water surface of water stored in the supply region

(32) of the storage tank (41), which is covered with the covering member (26).

[0019] In the second aspect of the invention, the active species are supplied from the electrical discharge unit (51) to the space above the water surface of the water stored in the supply region (32) covered with the covering member (26). Thus, as compared to a case where the active species are directly supplied into the water in the supply region (32), e.g., a pump having a lower discharge pressure can be used to send the active species to the supply region (32). Consequently, it is advantageous in the cost reduction and life extension for the entire apparatus.

[0020] A third aspect of the invention is intended for the humidity control apparatus of the second aspect of the invention, which further includes a gas-liquid mixing mechanism (66) for mixing air containing the active species supplied to the supply region (32) with the water stored in the supply region (32).

[0021] In the third aspect of the invention, the gas-liquid mixing mechanism (66) mixes the air containing the active species with the stored water in the supply region (32). In such a manner, the air containing the active species supplied to the supply region (32) is mixed with the water to efficiently remove bacteria and harmful substances in the water. Consequently, water purification can be facilitated.

[0022] A fourth aspect of the invention is intended for the humidity control apparatus of any one of the first to third aspects of the invention, which further includes an air blowing mechanism (64) for sending air to the electrical discharge unit (51) to supply air containing the active species to the supply region (32) of the storage tank (41).

[0023] In the fourth aspect of the invention, the air blowing mechanism (64) sends air to the electrical discharge unit (51). Then, the air containing the active species is supplied to the supply region (32) of the storage tank (41). This ensures that the active species generated in the electrical discharge unit (51) are sent to the supply region (32).

[0024] A fifth aspect of the invention is intended for the humidity control apparatus of the fourth aspect of the invention, in which the covering member (26) includes an exhaust port (34) through which air is exhausted, which contains the active species supplied to the supply region (32), and accumulated in the space above the water surface of the water stored in the supply region (32). In addition, the covering member (26) further includes an air circulation path (65) in which air containing the accumulated active species circulates back to the air blowing mechanism (64) through the exhaust port (34).

[0025] In the fifth aspect of the invention, the covering member (26) includes the exhaust port (34) through which the air is exhausted, which contains the active species supplied to the supply region (32). The air containing the active species accumulated in the space above the water surface of the water stored in the supply region

(32) circulates back to the air blowing mechanism (64) through the exhaust port (34) and the air circulation path (65). The active species circulate between the supply region (32) and the air blowing mechanism (64), thereby using the active species without wastage. Thus, an amount of the active species to be generated in the electrical discharge unit (51) can be reduced, and water purification efficiency can be improved. Further, an operation time of the electrical discharge unit (51) and the air blowing mechanism (64), which is required to ensure water purification capability can be shortened, and therefore it is advantageous in power consumption.

[0026] A sixth aspect of the invention is intended for the humidity control apparatus of any one of the first to fourth aspects of the invention, the covering member (26) includes an exhaust port (34) through which air is exhausted, which contains the active species supplied to the supply region (32), and accumulated in the space above the water surface of the water stored in the supply region (32). In addition, the covering member (26) further includes an ozone decomposition catalyst (37) for decomposing an ozone component contained in the active species, which is arranged on the exhaust port (34).

[0027] In the sixth aspect of the invention, the ozone decomposition catalyst (37) for decomposing the ozone component contained in the active species is arranged on the exhaust port (34). Thus, the ozone component of the active species accumulated in the space above the water surface of the water stored in the supply region (32) is decomposed by the ozone decomposition catalyst (37), and then is released to the outside of the storage tank (41). Such a state is preferable because ozone etc. contained in the active species do not cause the ozone concentration in the room, which exceeds its environmental limit even if the humidity control apparatus is used for a long period of time in the closed room.

[0028] A seventh aspect of the invention is intended for any one of the first to sixth aspects of the invention, which further includes a mixing mechanism (35) for mixing the water in the storage tank (41) to forcibly send the water of the supply region (32) to the humidification region (31) through the communication path (33).

[0029] In the seventh aspect of the invention, the mixing mechanism (35) mixes the water in the storage tank (41). The mixed water is forcibly sent from the supply region (32) to the humidification region (31) through the communication path (33). Thus, the water in the supply region (32), which is purified by the active species flows into the humidification region (31) without being accumulated in the supply region (32). Bacteria and harmful substances in the water are removed, thereby efficiently purifying the water across the entire storage tank (41).

[0030] An eighth aspect of the invention is intended for the humidity control apparatus of any one of the first to seventh aspects of the invention, in which an electrical discharge process is intermittently performed by the electrical discharge unit (51).

[0031] In the eighth aspect of the invention, the elec-

trical discharge process is intermittently performed by the electrical discharge unit (51). According to such a configuration, the water purification capability can be ensured with the minimum power, and therefore it is advantageous in the power consumption.

[0032] Specifically, in, e.g., an apparatus configuration in which the air circulation path (65) is provided to collect and recirculate the remaining active species which are not used for a water purification process, even if the electrical discharge process by the electrical discharge unit (51) is stopped, the collected active species are continuously supplied to the water to perform the water purification process. The electrical discharge process is intermittently performed at a timing at which a concentration of the active species in the supply region (32) becomes equal to or less than a predetermined concentration due to consumption of the active species upon the water purification process, or due to gradual reduction of the active species by, e.g., natural destruction of the active species, and therefore it is advantageous in the power consumption. In addition, by shortening an electrical discharge time, contaminants are less likely to adhere to discharge electrodes, and the discharge electrodes are less likely to be damaged. Consequently, a life extension of the discharge electrode can be realized.

[0033] In order to intermittently perform the electrical discharge process by the electrical discharge unit (51), a feedback control may be performed by measuring the active species concentration by, e.g., a sensor in real time. However, other than the foregoing control, a lowering speed of the active species concentration etc. may be experimentally calculated in advance, and then a control may be performed so that the electrical discharge process is intermittently performed at the timing at which the active species concentration becomes equal to or less than the predetermined concentration. Thus, such a control is advantageous in reducing costs because there is no need to separately provide the sensor for measuring the concentration.

[0034] A ninth aspect of the invention is intended for the humidity control apparatus of the fourth or fifth aspect of the invention, in which an air blowing process is intermittently performed by the air blowing mechanism (64).

[0035] In the ninth aspect of the invention, the air blowing process is intermittently performed by the air blowing mechanism (64). According to such a configuration, the water purification capability can be ensured with the minimum power, and it is advantageous in the power consumption.

[0036] Specifically, in, e.g., an apparatus configuration in which the active species applied to the space above the water surface of the water stored in the supply region (32) are gradually mixed with the water by, e.g., the gas-liquid mixing mechanism (66), even if the air blowing process by the air blowing mechanism (64) is stopped, the active species are mixed with the water by the gas-liquid mixing mechanism (66) to perform the water purification process. That is, even if the active species are

not continuously supplied to the supply region (32), the water purification process can be continued for a while by mixing the active species accumulated in the supply region (32) with the water by the gas-liquid mixing mechanism (66).

[0037] The air blowing process (and the electrical discharge process) is intermittently performed at the timing at which the concentration of the active species in the supply region (32) becomes equal to or less than the predetermined concentration due to the consumption of the active species upon the water purification process, or due to the gradual reduction of the active species by, e.g., the natural destruction of the active species. Thus, the water purification capability can be ensured with the minimum power, and it is advantageous in the power consumption and the life extension of the air blowing mechanism (64). In addition, the intermittent operation allows reduction in noise due to an operation of an air blowing pump and an air blowing pump configuring the air blowing mechanism (64).

ADVANTAGES OF THE INVENTION

[0038] According to the present invention, the inside of the storage tank (41) is divided into the supply region (32) and the humidification region (31) so that the supply region (32) and the humidification region (31) are arranged along the horizontal direction, and the space above the supply region (32) is covered with the covering member (26). In addition, the active species are supplied only to the supply region (32). Thus, the release of the active species to the outside of the storage tank (41) is reduced. Consequently, such a state is preferable because ozone etc. contained in the active species do not cause the ozone concentration in the room, which exceeds its environmental limit even if the humidity control apparatus is used for a long period of time in the closed room.

[0039] Since the active species are not released to the outside of the storage tank (41), the catalyst is not necessarily arranged on the upstream or downstream side of the air blowing fan in order to decompose and remove the active species. Thus, the degradation of the air distribution performance due to the pressure loss can be reduced or prevented, and it is advantageous in the cost reduction of the catalyst.

[0040] The water in the supply region (32), which is purified by the supplied active species flows into the humidification region (31) through the communication path (33). Thus, bacteria and harmful substances in the water are removed, thereby efficiently purifying the water across the entire storage tank (41).

BRIEF DESCRIPTION OF THE DRAWINGS

[0041]

[FIG. 1] FIG. 1 illustrates an entire configuration of

a humidity control apparatus of an embodiment, and is a perspective view illustrating a state in which a storage tank is drawn out from a casing.

[FIG. 2] FIG. 2 is a side cross-sectional view illustrating an internal configuration in the humidity control apparatus.

[FIG. 3] FIG. 3 is a side cross-sectional view illustrating an internal configuration in an active species supply unit and the storage tank.

[FIG. 4] FIG. 4 is a side cross-sectional view illustrating an internal configuration in an active species supply unit and a storage tank of a first variation.

[FIG. 5] FIG. 5 is a side cross-sectional view illustrating an internal configuration in an active species supply unit and a storage tank of a second variation.

[FIG. 6] FIG. 6 is a side cross-sectional view illustrating an internal configuration in an active species supply unit and a storage tank of a second embodiment.

[FIG. 7] FIG. 7 is a side cross-sectional view illustrating an internal configuration in an active species supply unit and a storage tank of a third embodiment.

DESCRIPTION OF EMBODIMENTS

[0042] Embodiments of the present invention will be described below with reference to the drawings. The embodiments below will be set forth merely for purposes of preferred examples in nature, and are not intended to limit the scope, applications, and use of the invention.

<First Embodiment>

[0043] FIG. 1 is a perspective view illustrating a configuration of a humidity control apparatus of a first embodiment of the present invention, and FIG. 2 is a side cross-sectional view illustrating an internal configuration in the humidity control apparatus. As illustrated in FIGS. 1 and 2, a humidity control apparatus (10) allows an operation in which room air is purified while humidifying the room air.

[0044] The humidity control apparatus (10) includes a casing (11) made of resin. The casing (11) is formed in substantially rectangular parallelepiped shape, and a front surface (a left side end surface as viewed in FIG. 2) is defined by a front panel (11a).

[0045] Inlets (12) through which air is injected into the casing (11) are formed on both right and left sides of a front section of the casing (11) (see FIG. 1). In addition, an outlet (13) through which air inside the casing (11) is discharged to an outside of the casing (11) is formed in a rear-side upper section of the casing (11). An air path (14) in which air flows from the inlets (12) to the outlet (13) is formed inside the casing (11).

[0046] As illustrated in FIG. 2, in the humidity control apparatus (10), an air purification unit (20), a humidification unit (40), and a centrifugal fan (15) are provided in the air path (14) in this order from an air-flow upstream

side to an air-flow downstream side; and an active species supply unit (50) is also arranged in the air path (14).

Configuration of Air Purification Unit

[0047] As illustrated in FIG. 2, the air purification unit (20) is for purifying air, and includes a prefilter (21), an ionization section (22), and a pleated filter (23).

[0048] The prefilter (21) serves as a duct collection filter for trapping relatively-large dust contained in air.

[0049] The ionization section (22) serves as a dust charging unit configured to charge dust in air. For example, a linear electrode and a plate-like electrode facing the liner electrode are provided in the ionization section (22). In the ionization section (22), voltage is applied from a power source (not shown in the figure) to the electrodes, thereby generating corona discharge. Such corona discharge charges dust in air to a predetermined voltage (positive or negative charge).

[0050] The pleated filter (23) is a corrugated plate-like electrostatic filter. That is, the pleated filter (23) electrically attracts and traps the dust charged in the ionization section (22). Deodorizing material such as a photocatalyst may be deposited on the pleated filter (23).

Configuration of Humidification Unit

[0051] As illustrated in FIG. 2, the humidification unit (40) includes a storage tank (41) for storing water; a water turbine (42) for drawing up the water in the storage tank (41); a humidification rotor (43) serving as a humidification mechanism for imparting the water drawn up by the water turbine (42) to air; and a drive motor (44) for rotatably driving the humidification rotor (43). In addition, the humidification unit (40) includes a heater (48) for heating the humidification rotor (43).

[0052] The storage tank (41) is installed in a lower space of the casing (11), and can be drawn out through a draw-out opening (11b) of the casing (11) (see FIG. 1). This allows a user to refill the storage tank (41) with humidification water (e.g., tap water) as necessary.

[0053] As illustrated in FIG. 3, the storage tank (41) is a horizontally-elongated container with an upper opening. A dividing member (25) divides an inside of the storage tank (41) into a humidification region (31) where the humidification unit (40) is arranged to impart the water to air; and a supply region (32) to which active species are supplied from the active species supply unit (50) to purify the water. That is, the dividing member (25) extends in a direction perpendicular to a water surface, and divides the inside of the storage tank (41) into the humidification region (31) and the supply region (32) which are arranged along a horizontal direction (water surface direction). A covering member (26) for covering a space above the supply region (32) is provided above the supply region (32). The covering member (26) is provided so as to cross between an upper end of a side wall of the storage tank (41) and an upper end of the dividing member

(25). The supply region (32) is surrounded by the dividing member (25) and the covering member (26).

[0054] An outlet (41a) communicating with the supply region (32) surrounded by the dividing member (25) and the covering member (26) is formed in an upper section of the side wall of the storage tank (41). A delivery pipe (63) of the active species supply unit (50) which will be described later is connected to an upstream side of the outlet (41a). A discharge nozzle (45) downwardly extending along the side wall of the storage tank (41) is connected to a downstream side of the outlet (41a). That is, the delivery pipe (63) and the discharge nozzle (45) are connected to the outlet (41a) with the side wall of the storage tank (41) being interposed therebetween. The active species are discharged from the outlet (41a) into the water in the supply region (32) of the storage tank (41) through the discharge nozzle (45).

[0055] A lower end of the dividing member (25) is positioned higher than a bottom surface of the storage tank (41), and a clearance is formed between the dividing member (25) and the bottom surface of the storage tank (41). Such a clearance serves as a communication path (33) through which the water purified in the supply region (32) flows into the humidification region (31). That is, the dividing member (25) defines the communication path (33) in the water.

[0056] An exhaust port (34) is formed in the covering member (26). The exhaust port (34) is for exhausting air containing the active species which are supplied to the supply region (32), and which are accumulated in a space above the water surface of the water stored in the supply region (32). The covering member (26) includes a dehumidifying agent (36) and an ozone decomposition catalyst (37) which are stacked above the exhaust port (34) in this order. The dehumidifying agent (36) is for removing moisture in air containing the active species, and the ozone decomposition catalyst (37) is for decomposing and removing an ozone component contained in the active species. The dehumidifying agent (36) and the ozone decomposition catalyst (37) are held by a holding member (38) which is engaged at a circumferential edge of an upper surface of the ozone decomposition catalyst (37), and which surrounds side walls of the dehumidifying agent (36) and the ozone decomposition catalyst (37). Material having excellent dehumidification performance, such as silica gel, can be used as the dehumidifying agent (36).

[0057] An opening above the humidification region (31) of the storage tank (41) is closed with a lid (46) having an outer shape defined along upper edges of the storage tank (41) and the dividing member (25), and therefore a release of the evaporated water in the humidification region (31) to air are reduced.

[0058] As illustrated in FIG. 2, the water turbine (42) is formed in substantially discoid shape, and a rotating shaft (42a) is provided so as to protrude from a shaft center section of the water turbine (42). The rotating shaft (42a) is rotatably supported by a bearing member (not shown

in the figure) vertically arranged on the bottom surface of the storage tank (41). The water turbine (42) is provided so that a part (a predetermined section including a lower end section) of the water turbine (42) is soaked in the water in the humidification region (31) of the storage tank (41).

[0059] A plurality of recessed sections (42b) are formed around the shaft in a rear-side surface (side surface facing the humidification rotor (43)) of the water turbine (42). In an outer end section in a radial direction of the water turbine (42), the plurality of recessed sections (42b) are arranged at equal distance in a circumferential direction. During rotating the water turbine (42), each of the recessed sections (42b) is alternately displaced between a position in which the recessed section (42b) is soaked in the water in the storage tank (41), and a position in which the recessed section (42b) is taken out from the water.

[0060] In the rear-side surface of the water turbine (42), a toothed wheel (42c) is integrally formed in a section closer to the shaft center of the water turbine (42). The toothed wheel (42c) engages with a driven toothed wheel (43a) of the humidification rotor (43).

[0061] The humidification rotor (43) includes a discoid adsorbing member (43b), and the circular driven toothed wheel (43a) formed along an outer circumferential surface of the adsorbing member (43b). The adsorbing member (43b) is made of non-woven fabric having high hygroscopic properties in order to adsorb moisture.

[0062] The humidification rotor (43) is rotatably held with the rotating shaft in a position higher than a water level of a full capacity of the storage tank (41). In addition, the humidification rotor (43) is arranged so that the predetermined section including the lower end of the humidification rotor (43) substantially contacts the water turbine (42). That is, the humidification rotor (43) has a section overlapping with the recessed sections (42b) of the water turbine (42) as viewed in an axial direction of the humidification rotor (43). This allows the adsorbing member (43b) to contact and adsorb the water drawn up by the recessed sections (42b) of the water turbine (42) when such water flows out from the recessed sections (42b).

[0063] The drive motor (44) is connected to the driven toothed wheel (43a) of the humidification rotor (43) through a power transmission unit (not shown in the figure) such as a toothed wheel. This transmits rotational force of the drive motor (44) to the driven toothed wheel (43a) of the humidification rotor (43) through the power transmission unit, thereby rotating the driven toothed wheel (43a). When further rotating the driven toothed wheel (43a), the toothed wheel (42c) engaged with the driven toothed wheel (43a) rotates, resulting in rotation of the water turbine (42).

[0064] The heater (48) is arranged adjacent to an upper end section of an upstream-side surface of the humidification rotor (43). The heater (48) can heat air flowing into the humidification rotor (43).

Configuration of Active Species Supply Unit

[0065] The active species supply unit (50) is for supplying the active species such as radicals, excited molecules, and ozone to the water in the supply region (32) of the storage tank (41), which will be supplied to the humidification rotor (43), to purify such water. As illustrated in FIG. 3, the active species supply unit (50) includes an electrical discharge unit (51) serving as an active species generation unit; a delivery path (55) through which the active species generated in the electrical discharge unit (51) are guided into the supply region (32) of the storage tank (41); and an air blowing pump (64) for sending the active species into the supply region (32) of the storage tank (41) through the delivery path (55) by blowing air. The air blowing pump (64) serves as an air blowing mechanism of the present invention.

[0066] The electrical discharge unit (51) is arranged inside an active species generation chamber (62). An injection pipe (61) through which air is injected into the active species generation chamber (62), and the delivery pipe (63) defining the delivery path (55) are connected to the active species generation chamber (62). An inflow end of the injection pipe (61) opens to the air path (14), and the air blowing pump (64) is connected to the middle of the injection pipe (61). A part of air flowing in the air path (14) is branched and injected into the injection pipe (61).

[0067] The electrical discharge unit (51) generates the active species by streamer discharge. Specifically, the electrical discharge unit (51) includes a rod-like electrode (52) and a flat plate-like electrode (53). The rod-like electrode (52) is supported by a base plate (52a) provided inside the active species generation chamber (62), through a support plate (52b). The rod-like electrode (52) is formed in elongated linear shape, and has a substantially circular cross section. The flat plate-like electrode (53) is formed in flat plate-like shape. The rod-like electrode (52) and the flat plate-like electrode (53) are arranged so as to be parallel to each other. Tip ends of the rod-like electrode (52) face the flat plate-like electrode (53).

[0068] The rod-like electrode (52) is connected to a positive electrode side of a power source (18), and the flat plate-like electrode (53) is connected to a negative electrode side (or ground) of the power source (18). When applying a potential difference from the power source (18) to the electrodes (52, 53), streamer discharge is generated from the tip ends of the rod-like electrode (52) toward the flat plate-like electrode (53). Consequently, molecules of, e.g., oxygen, nitrogen, and water in air are ionized or excited, thereby generating a large amount of the active species such as radicals and excited molecules. High DC voltage is preferably applied from the power source (18) to the electrical discharge unit (51), and discharge current is preferably maintained constant, i.e., a constant current control is preferably performed.

[0069] According to such a configuration, in the active

species supply unit (50), the active species are generated in the electrical discharge unit (51), and such active species are sent out through the delivery pipe (63). The active species are discharged from the outlet (41a) of the storage tank (41) into the water in the supply region (32) of the storage tank (41) through the discharge nozzle (45) as air bubbles, and then the water in the supply region (32) is purified.

[0070] Meanwhile, the active species which are not dissolved in the water in the supply region (32) rise to the water surface due to buoyant force, and are accumulated in a space above the water surface. The water in the supply region (32), which is purified by the active species flows into the humidification region (31) through the communication path (33), and then circulates between the supply region (32) and the humidification region (31).

Operation

[0071] An operation of the humidity control apparatus (10) of the first embodiment will be described. In the humidity control apparatus (10), a humidification operation is performed, in which room air is simultaneously purified and humidified. In the humidification operation, the centrifugal fan (15) is driven while rotatably driving the humidification rotor (43), and power is applied to the heater (48). In addition, voltage is applied to the electrodes of the ionization section (22).

[0072] As illustrated in FIG. 2, when driving the centrifugal fan (15), room air is injected into the air path (14) through the inlet (12). The air injected into the air path (14) passes through the prefilter (21), and dust is trapped. Subsequently, the air passes through the ionization section (22). In the ionization section (22), corona discharge is generated between the electrodes, thereby charging dust in the air. The air flowing out from the ionization section (22) passes through the pleated filter (23). In the pleated filter (23), the charged dust is electrically attracted and trapped. The air flowing out from the pleated filter (23) is heated by the heater (48), and then passes through the humidification rotor (43).

[0073] In the humidification unit (40), the water turbine (42) rotates to supply the water in the storage tank (41) to the adsorbing member (43b) of the humidification rotor (43) as necessary. Specifically, the water turbine (42) rotates to soak the recessed sections (42b) in the water in the storage tank (41), and therefore the water enters and is held in the recessed section (42b). When further rotating the water turbine (42), the recessed section (42b) in which the water is held is taken out from the water to be upwardly displaced. As the recessed section (42b) upwardly moves, the recessed section (42b) gradually moves toward the humidification rotor (43). In addition, as the recessed section (42b) upwardly moves, the water held in the recessed section (42b) gradually flows out from the recessed section (42b) by its own weight. When the recessed section (42b) reaches an uppermost end

position, a substantially full amount of the water in the recessed section (42b) flows out.

[0074] The water flowing out from the recessed section (42b) contacts a section of the humidification rotor (43) adjacent to the recessed section (42b), and is adsorbed to the adsorbing member (43b). In such a process, the water is continuously supplied to the humidification rotor (43) of the humidification unit (40).

[0075] When air flowing in the air path (14) flows through the adsorbing member (43b), moisture adsorbed to the adsorbing member (43b) is released to the air. Consequently, the air is humidified. The air purified and humidified as described above is supplied to a room through the outlet (13). Note that, in the humidification operation, a voltage supply from the power source (18) to the ionization section (22) is stopped, thereby allowing an operation in which air is not actively purified.

Water Purification Process

[0076] After water is stored in the storage tank (41) for a long period of time, bacteria grow in the water, resulting in contamination of the water in the storage tank (41). If substances such as ammonia (harmful substances or odorous components) are contained in, e.g., air flowing in the air path (14), such substances may be dissolved in and contaminates the water in the storage tank (41). Thus, if such contaminated water is supplied to the room as humidification water, cleanliness in the room is degraded.

[0077] In the humidity control apparatus (10) of the first embodiment, the active species supply unit (50) is used to supply the active species to the water in the air path (14), thereby allowing a water purification process for purifying the water.

[0078] Specifically, the water purification process is performed simultaneously with, e.g., the humidification operation. In the water purification process, the air blowing pump (64) is operated, and voltage is applied from the power source (18) to the electrical discharge unit (51). When operating the air blowing pump (64), air is injected into the active species generation chamber (62) through the injection pipe (61) (see FIG. 3). In the active species generation chamber (62), the electrical discharge unit (51) to which voltage is applied from the power source (18) generates streamer discharge. Consequently, the active species are generated in the active species generation chamber (62). The active species are sent by air from the air blowing pump (64), and then flows toward the storage tank (41) in the delivery path (55) of the delivery pipe (63). The active species are discharged into the water in the supply region (32) of the storage tank (41) through the discharge nozzle (45).

[0079] Consequently, harmful substances, bacteria, etc. contained in the water in the supply region (32) of the storage tank (41) are decomposed and removed by the active species, thereby purifying the water in the supply region (32) of the storage tank (41). The water purified

by the active species flows from the supply region (32) to the humidification region (31) through the communication path (33), thereby purifying the water in the humidification region (31). This allows a removal of bacteria and harmful substances in the water, and therefore the water can be efficiently purified in the entire storage tank (41). Thus, in the humidification operation, the clean water in the humidification region (31) of the storage tank (41) is imparted to air by the humidification rotor (43), thereby not degrading the cleanliness in the room. In the supply region (32), the active species rising to the water surface without being dissolved in the water flow out through the exhaust port (34) together with air. At this point, moisture in air containing the active species is removed by the dehumidifying agent (36), and an ozone component in the active species is decomposed and removed by the ozone decomposition catalyst (37). Thus, a release of the active species to an outside of the storage tank (41) is reduced.

[0080] As described above, according to the humidity control apparatus (10) of the first embodiment, the dividing member (25) divides the inside of the storage tank (41) into the supply region (32) and the humidification region (31), and the space above the supply region (32) is covered with the covering member (26). In addition, the active species are supplied only to the supply region (32). Thus, the release of the active species to the outside of the storage tank (41) is reduced by the dividing member (25) and the covering member (26). Such a state is preferable because the ozone component contained in the active species does not cause an ozone concentration in the room, which exceeds its environmental limit even if the humidity control apparatus (10) is used for a long period of time in the closed room.

[0081] Since the active species are not released to the outside of the storage tank (41), the ozone decomposition catalyst (37) is not necessarily arranged on an upstream or downstream side of the centrifugal fan (15) in order to decompose and remove the ozone component contained in the active species. Thus, degradation of air distribution performance due to a pressure loss can be reduced, and it is advantageous in cost reduction of the catalyst.

[0082] The water in the supply region (32), to which the active species are supplied for purification flows into the humidification region (31) through the communication path (33). Thus, bacteria and harmful substances in the water are removed to efficiently purify the water across the entire storage tank (41).

<First Variation>

[0083] FIG. 4 is a side cross-sectional view illustrating an internal configuration in an active species supply unit and a storage tank of a first variation of the present invention. As illustrated in FIG. 4, in the present variation, a part of air sucked by a centrifugal fan (15) is sent to an active species generation chamber (62). Specifically, one end of a branched pipe (15a) for branching air flowing

in the centrifugal fan (15) is connected to the middle of a flow path of the centrifugal fan (15), and the other end of the branched pipe (15a) is connected to the active species generation chamber (62) of an active species supply unit (50).

[0084] When the centrifugal fan (15) is operated to start an air blowing process, air in which an ozone component is decomposed by an ozone decomposition catalyst (37), and air leaking from a clearance formed by a lid (46) closing a space above a humidification region (31) of a storage tank (41) are sucked through an inlet in a center section of the centrifugal fan (15). The air sucked into the centrifugal fan (15) is discharged through an outlet. However, a part of the air is branched in the middle of the flow path of the centrifugal fan (15), and is sent to the active species supply unit (50) through the branched pipe (15a).

[0085] Such a configuration ensures that active species generated in an electrical discharge unit (51) are sent to a supply region (32) of the storage tank (41). Air is branched from the centrifugal fan (15) toward the electrical discharge unit (51), and therefore it is not necessary to separately provide a purpose-built air blowing pump (64) etc. as in the first embodiment. Consequently, it is advantageous in cost reduction.

+ <Second Variation>

[0086] FIG. 5 is a side cross-sectional view illustrating an internal configuration in an active species supply unit and a storage tank of a second variation of the present invention. As illustrated in FIG. 5, a mixing turbine (35) for mixing water in a supply region (32) as a mixing mechanism is arranged in a storage tank (41). The mixing turbine (35) is arranged near a communication path (33). The mixing turbine (35) rotates about a center shaft (35a) extending in a depth direction as viewed in FIG. 5, thereby mixing the water in the supply region (32). The water mixed by the mixing turbine (35) is forcibly sent from the supply region (32) to a humidification region (31) through the communication path (33).

[0087] A plurality of blades (35b) are provided apart from each other in a circumferential direction on an outer circumferential surface of the mixing turbine (35). Active species discharged into the water through a discharge nozzle (45) are sprayed on the blades (35b), and then air bubbles are used as power to rotate the mixing turbine (35) about the center shaft (35a) in a clockwise direction. Thus, a flow of the water is generated.

[0088] According to such a configuration, the water in the supply region (32), which is purified by the active species is forcibly sent to the humidification region (31) without being accumulated in the supply region (32). Bacteria and harmful substances in the water are removed, thereby efficiently purify the water across the entire storage tank (41).

<Second Embodiment>

[0089] FIG. 6 is a side cross-sectional view illustrating an internal configuration in an active species supply unit and a storage tank of a second embodiment of the present invention. The second embodiment is different from the first embodiment in that an air circulation path (65) is provided, through which active species supplied to a supply region (32) of a storage tank (41) circulate back to an air blowing pump (64). Thus, the same reference numerals as those described in the first embodiment are used to represent equivalent elements, and only differences will be described.

[0090] As illustrated in FIG. 6, in the present embodiment, a dehumidifying agent (36), and an ozone decomposition catalyst (37), and a holding member (38) are omitted in a covering member (26). In addition, in the present embodiment, the air circulation path (65) is connected between an exhaust port (34) of the covering member (26) and an active species generation chamber (62). An air blowing pump (64) is connected to the middle of a flow path of the air circulation path (65). The air blowing pump (64) is operated to circulate the active species accumulated in a space above a water surface in the supply region (32) back to the active species generation chamber (62) through the exhaust port (34) and the air circulation path (65).

[0091] According to such a configuration, the active species circulate between the supply region (32) and the active species generation chamber (62), thereby using the active species without wastage. In addition, an amount of the active species to be generated in an electrical discharge unit (51) can be reduced, and water purification efficiency can be improved. Further, an operation time of the electrical discharge unit (51) and the air blowing pump (64), which is required to ensure water purification capability can be shortened, and therefore it is advantageous in power consumption.

[0092] In the present invention, an electrical discharge process may be intermittently performed by the electrical discharge unit (51) to realize the power consumption. That is, even if the electrical discharge process by the electrical discharge unit (51) is stopped, the active species in the supply region (32) are collected by the air blowing pump (64) through the air circulation path (65) to be recirculated, and then are continuously supplied to the water for a water purification process.

[0093] At a timing at which a concentration of the active species in the supply region (32) becomes equal to or less than a predetermined concentration due to consumption of the active species upon the water purification process, or due to gradual reduction of the active species by, e.g., natural destruction of the active species, the electrical discharge process is intermittently performed to ensure the water purification capability with the minimum power, and therefore it is advantageous in power consumption. By shortening an electrical discharge time, contaminants are less likely to adhere to discharge elec-

trodes, and the discharge electrodes are less likely to be damaged. Consequently, a life extension of the discharge electrode can be realized.

[0094] In order to intermittently perform the electrical discharge process by the electrical discharge unit (51), a feedback control may be performed by measuring an active species concentration by, e.g., a sensor in real time. However, other than the foregoing control, a lowering speed of the active species concentration etc. may be experimentally calculated in advance, and then a control may be performed so that the electrical discharge process is intermittently performed at the timing at which the active species concentration becomes equal to or less than the predetermined concentration. Thus, it is advantageous in cost reduction without separately providing the sensor for measuring the concentration.

<Third Embodiment>

[0095] FIG. 7 is a side cross-sectional view illustrating an internal configuration in an active species supply unit and a storage tank of a third embodiment of the present invention. The third embodiment is different from the first embodiment in that a gas-liquid mixing roller (66) for mixing active species with water in a supply region (32) is provided. Thus, the same reference numerals as those described in the first embodiment are used to represent equivalent elements, and only differences will be described.

[0096] As illustrated in FIG. 7, in a storage tank (41) of the present embodiment, a discharge nozzle (45) is omitted, and an outlet (41a) opens to a space above a water surface in the supply region (32). As in the first embodiment, a delivery pipe (63) of an active species supply unit (50) is connected to the outlet (41a). That is, in the storage tank (41) of the present embodiment, the active species are discharged into the space above the water surface in the supply region (32) through the outlet (41a).

[0097] According to such a configuration, as compared to a case where the active species are directly supplied into the water in the supply region (32), an air blowing pump (64) having a lower discharge pressure can be used to send the active species to the supply region (32). Consequently, it is advantageous in cost reduction and life extension for the entire apparatus.

[0098] The gas-liquid mixing roller (66) is arranged in the supply region (32) of the storage tank (41). The gas-liquid mixing roller (66) is for mixing the stored water with the active species accumulated in the space above the water surface in the supply region (32). The gas-liquid mixing roller (66) is arranged so that an upper section of the gas-liquid mixing roller (66) is exposed above the water surface, and a lower section of the gas-liquid mixing roller (66) is soaked in the water. The gas-liquid mixing roller (66) serves as a gas-liquid mixing mechanism of the present invention.

[0099] The gas-liquid mixing roller (66) is made of po-

rous material. The gas-liquid mixing roller (66) rotates about a center shaft (66a) extending in a depth direction as viewed in FIG. 7 in a clockwise direction, and then an outer circumferential surface of the lower section soaked in the water is exposed above the water surface. At this point, a water film is formed on the outer circumferential surface exposed above the water surface. The active species accumulated in the space above the water surface react with the water film in the upper section of the gas-liquid mixing roller (66) in order to purify the water. The purified water in the upper section of the gas-liquid mixing roller (66) is mixed with the water in the supply region (32) by the rotation of the gas-liquid mixing roller (66), thereby purifying the water in the supply region (32).

[0100] According to such a configuration, the gas-liquid mixing roller (66) mixes the active species supplied to the supply region (32) with the water, thereby efficiently removing bacteria and harmful substances in the water. Consequently, water purification can be facilitated.

[0101] In the present invention, an electrical discharge process by an electrical discharge unit (51), and an air blowing process by the air blowing pump (64) may be intermittently performed to realize power consumption. That is, even if the electrical discharge process by the electrical discharge unit (51) or the air blowing process by the air blowing pump (64) is stopped, the active species are mixed with the water by the gas-liquid mixing roller (66) to purify the water. In such a manner, even if the active species are not continuously supplied to the supply region (32), the active species accumulated in the space above the supply region (32) (space above the water surface) are mixed with the water by the gas-liquid mixing roller (66), and therefore the water purification process can be continued for a while.

[0102] At a timing at which a concentration of the active species in the supply region (32) becomes equal to or less than a predetermined concentration due to consumption of the active species upon the water purification process, or due to gradual reduction of the active species by, e.g., natural destruction of the active species, the electrical discharge process and the air blowing process are intermittently performed to ensure the water purification capability with the minimum power, and therefore it is advantageous in power consumption and life extension of the electrical discharge unit (51) and the air blowing pump (64). The intermittent operation allows reduction in noise due to an operation of the air blowing pump (64).

<Other Embodiments>

[0103] In the foregoing embodiments and variations, the active species generation unit is the electrical discharge unit (51) for generating the active species by the streamer discharge. However, the active species generation unit of the present invention is not limited to the unit of this type, and an ultraviolet lamp for generating active species by ultraviolet may be used. In addition, the electrical discharge unit (51) is not limited to the unit gener-

ating the streamer discharge.

[0104] The humidity control apparatus (10) includes the air purification unit (20) and the humidification unit (40); and allows the air purification and the humidification operation. However, the humidity control apparatus (10) may further include a dehumidification unit, and allow a dehumidification operation. In such a case, water collected in the storage tank (41) in the dehumidification operation is purified in order to reuse the water as humidification water without a water exchange.

INDUSTRIAL APPLICABILITY

[0105] As described above, the present invention provides highly-practical advantages that the release of the active species to air can be reduced, and the water in the storage tank can be efficiently purified. Thus, the present invention is extremely useful, and has a high industrial applicability.

DESCRIPTION OF REFERENCE CHARACTERS

[0106]

10	Humidity Control Apparatus
25	Dividing Member
26	Covering Member
31	Humidification Region
32	Supply Region
33	Communication Path
34	Exhaust Port
35	Mixing Turbine (Mixing Mechanism)
37	Ozone Decomposition Catalyst
41	Storage Tank
43	Humidification Rotor (Humidification Mechanism)
51	Electrical Discharge Unit
64	Air Blowing Pump (Air Blowing Mechanism)
65	Air Circulation Path
66	Gas-Liquid Mixing Roller (Gas-Liquid Mixing Mechanism)

Claims

1. A humidity control apparatus including a storage tank (41) for storing water, and a humidification mechanism (43) for humidifying air by imparting the water in the storage tank (41) to air, comprising:

an electrical discharge unit (51) configured to generate electrical discharge to generate active species;
a dividing member (25) which divides an inside of the storage tank (41) into a humidification region (31) where the humidification mechanism (43) is arranged to impart the water to air, and a supply region (32) to which the active species generated in the electrical discharge unit (51)

- are supplied to purify the water, so that the humidification region (31) and the supply region (32) are arranged along a horizontal direction; and which defines a communication path (33) in the water, through which the water purified in the supply region (32) flows into the humidification region (31); and
- a covering member (26) configured to cover a space above the supply region (32) of the storage tank (41).
2. The humidity control apparatus of claim 1, wherein the active species generated in the electrical discharge unit (51) are supplied to a space above a water surface of the water stored in the supply region (32) of the storage tank (41), which is covered with the covering member (26).
 3. The humidity control apparatus of claim 2, further comprising:

a gas-liquid mixing mechanism (66) for mixing air containing the active species supplied to the supply region (32) with the water stored in the supply region (32).
 4. The humidity control apparatus of claim 1, further comprising:

an air blowing mechanism (64) for sending air to the electrical discharge unit (51) to supply air containing the active species to the supply region (32) of the storage tank (41).
 5. The humidity control apparatus of claim 4, wherein the covering member (26) includes an exhaust port (34) through which air is exhausted, which contains the active species supplied to the supply region (32), and accumulated in the space above the water surface of the water stored in the supply region (32); and the covering member (26) further includes an air circulation path (65) in which air containing the accumulated active species circulates back to the air blowing mechanism (64) through the exhaust port (34).
 6. The humidity control apparatus of claim 1, wherein the covering member (26) includes an exhaust port (34) through which air is exhausted, which contains the active species supplied to the supply region (32), and accumulated in the space above the water surface of the water stored in the supply region (32); and the covering member (26) further includes an ozone decomposition catalyst (37) for decomposing an ozone component contained in the active species, which is arranged on the exhaust port (34).
 7. The humidity control apparatus of claim 1, further

comprising:

a mixing mechanism (35) for mixing the water in the storage tank (41) to forcibly send the water of the supply region (32) to the humidification region (31) through the communication path (33).

8. The humidity control apparatus of claim 1, wherein an electrical discharge process is intermittently performed by the electrical discharge unit (51).
9. The humidity control apparatus of claim 4, wherein an air blowing process is intermittently performed by the air blowing mechanism (64).

FIG. 1

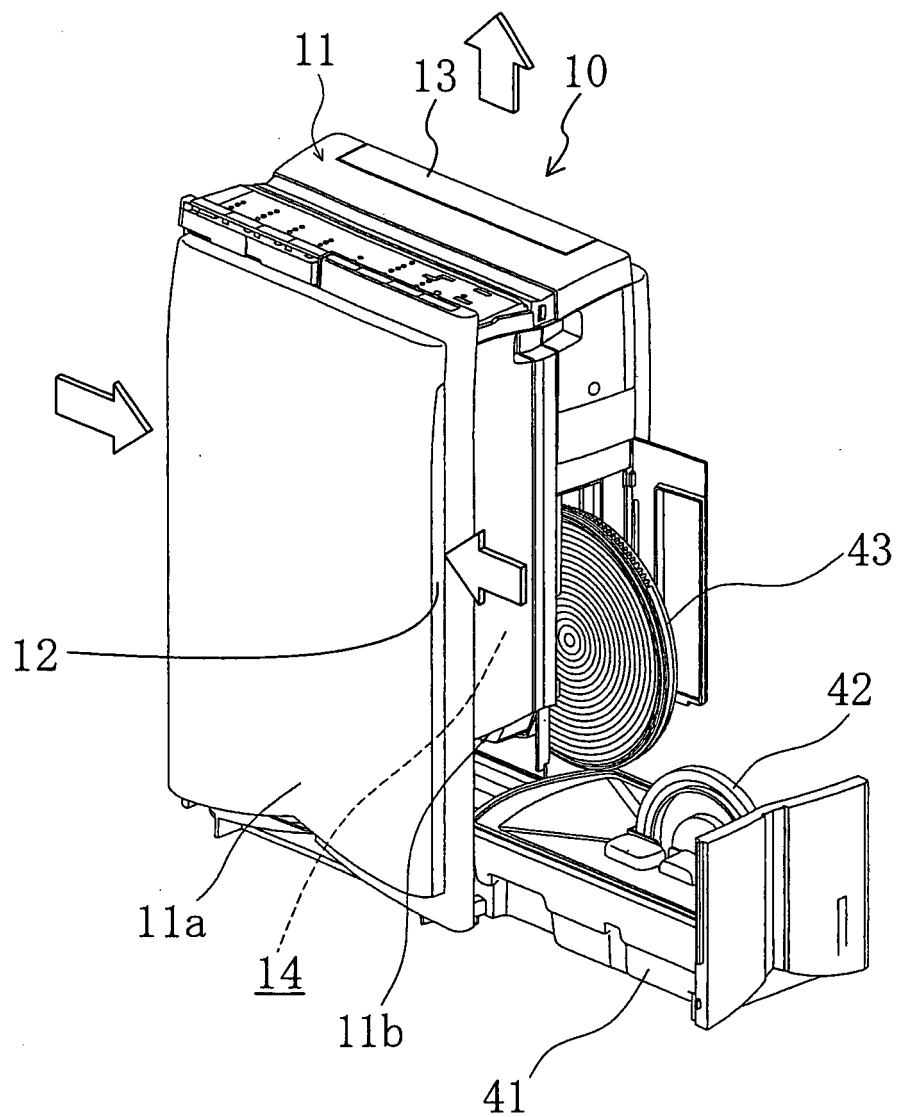
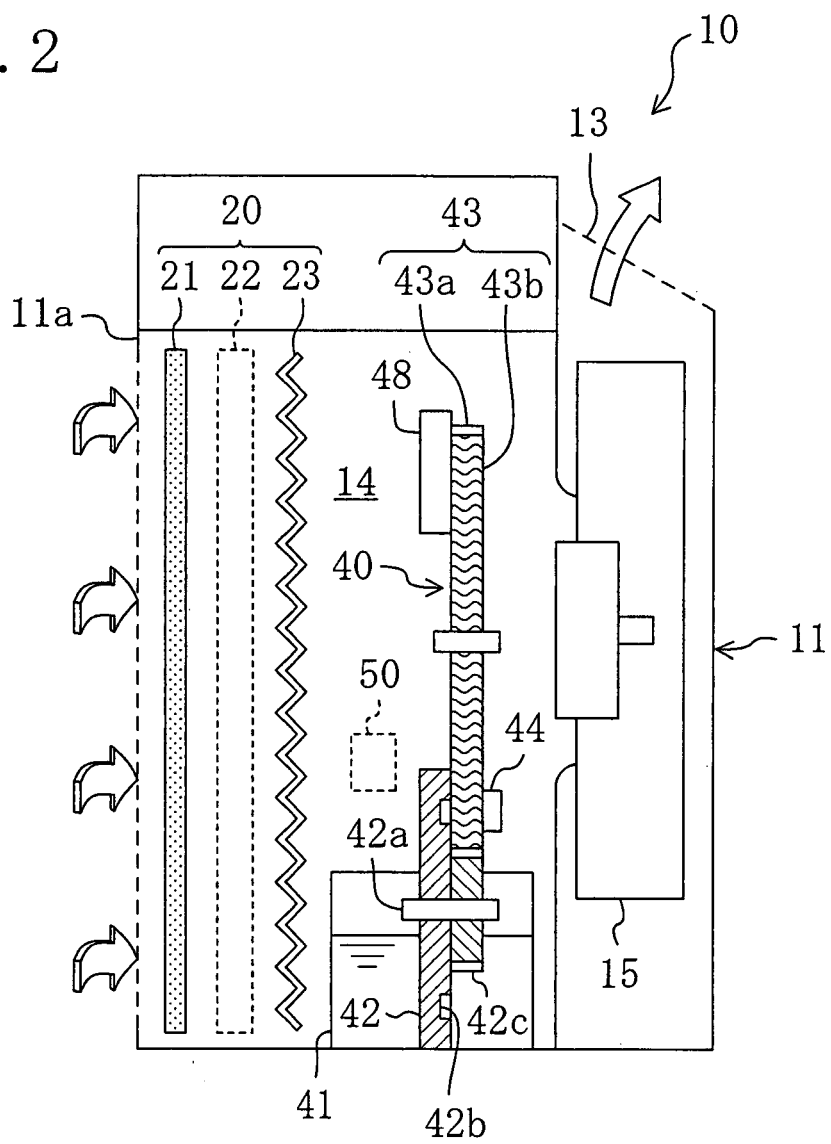
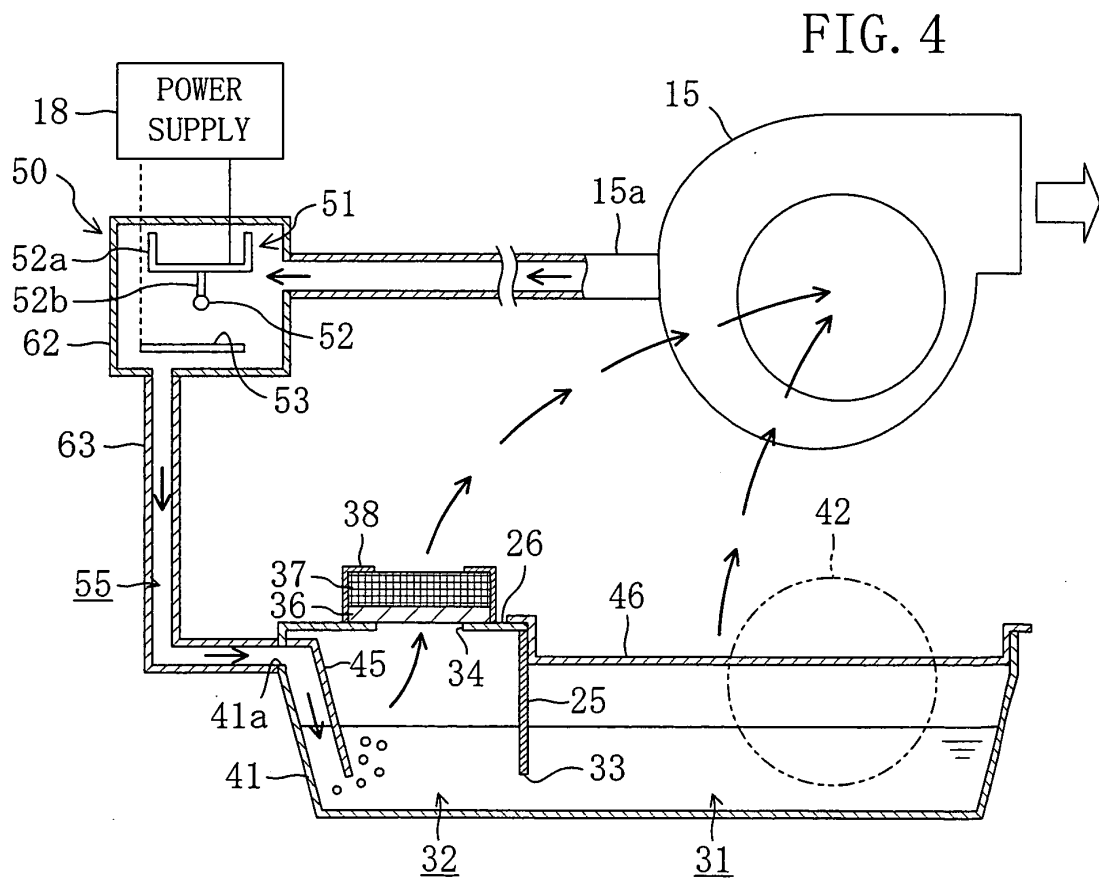
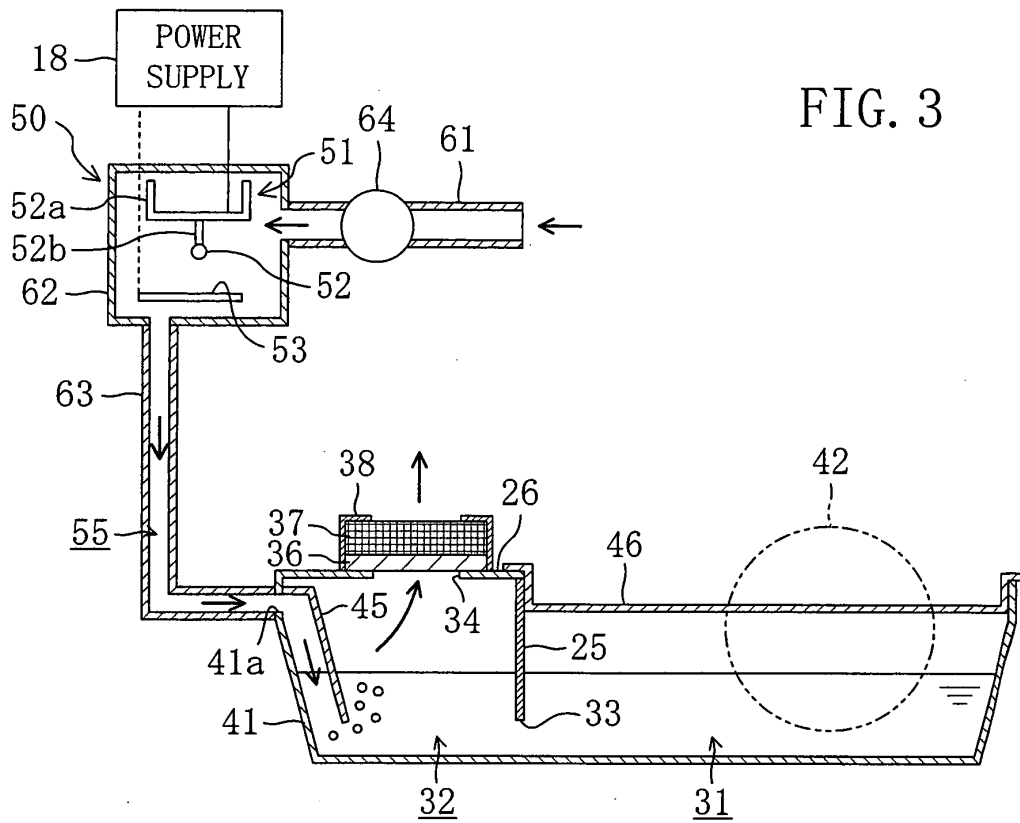


FIG. 2





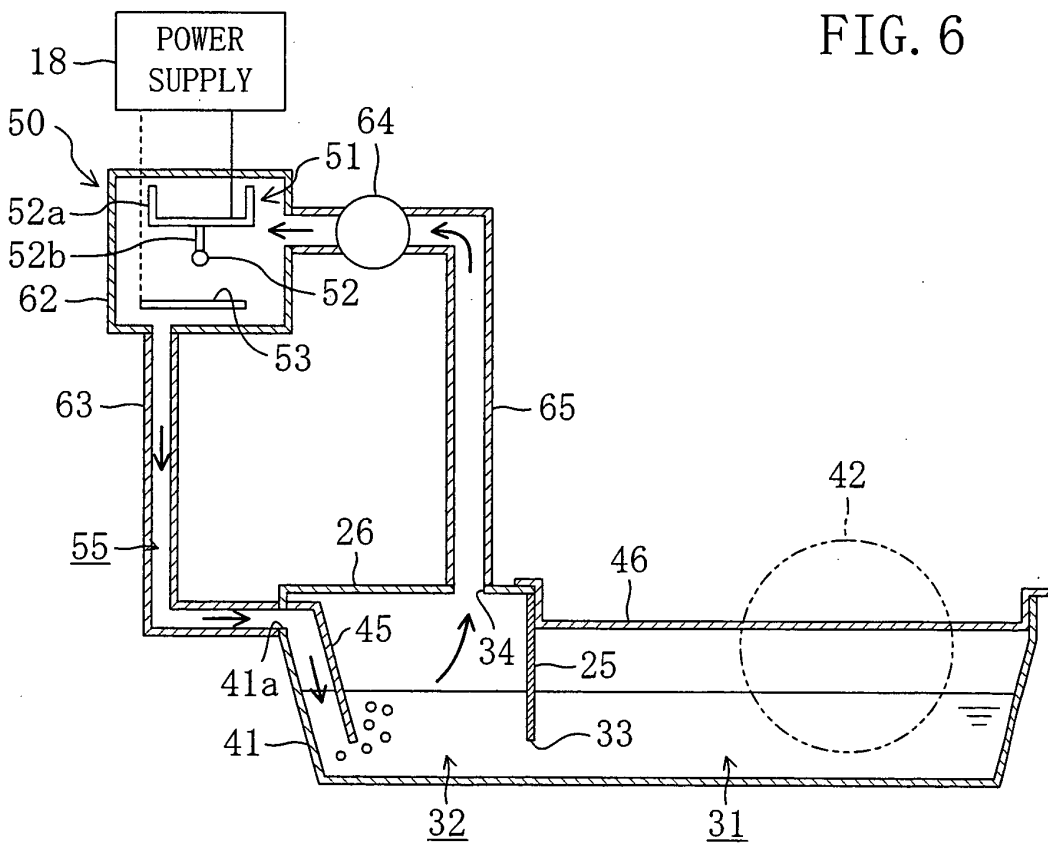
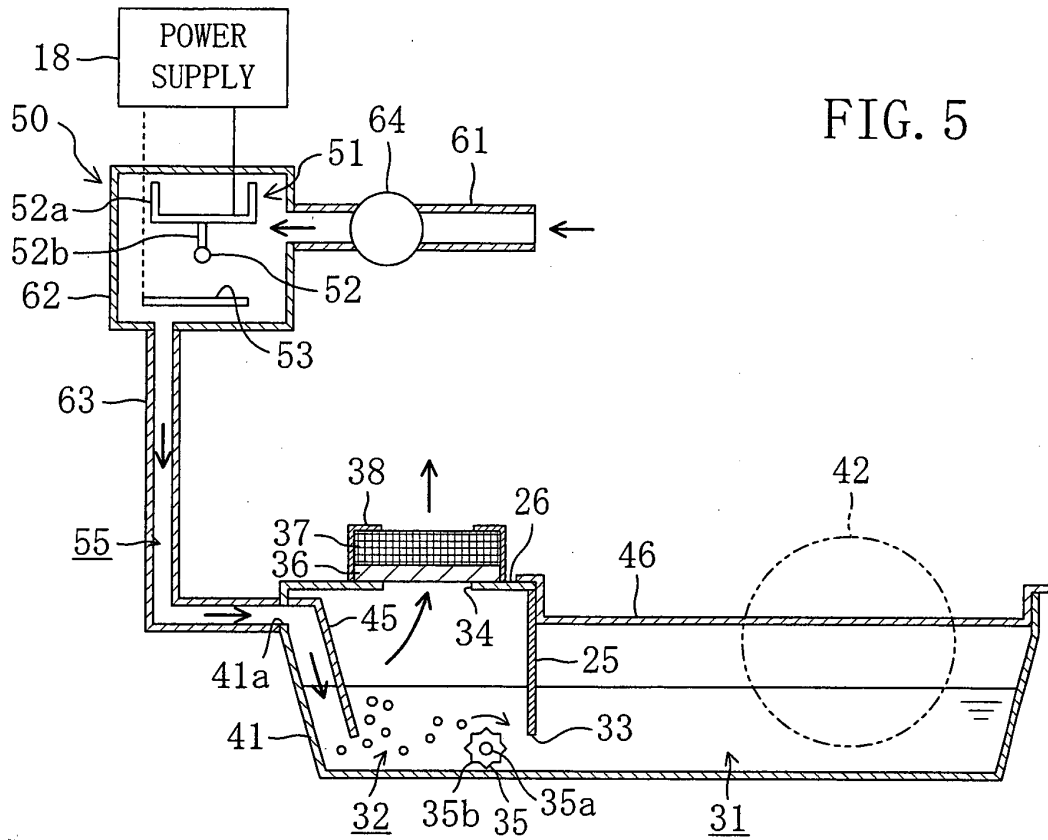
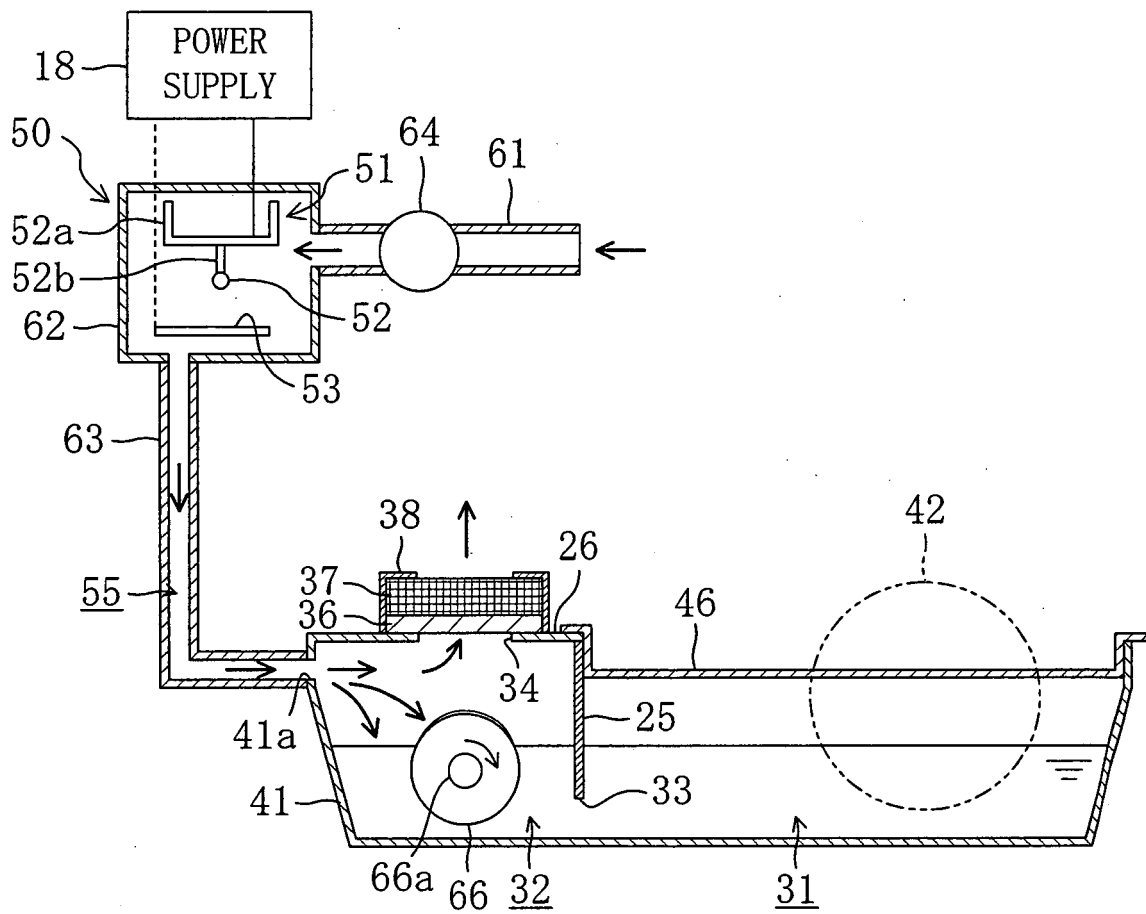


FIG. 7



INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2009/003237

A. CLASSIFICATION OF SUBJECT MATTER

F24F6/00 (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)

F24F6/00

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 A	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 67717/1987 (Laid-open No. 175735/1988) (Nihon Radiator Co., Ltd.), 15 November, 1988 (15.11.88), Full text; Fig. 1 (Family: none)	1, 2 3, 4, 7-9 5, 6
Y A	JP 2007-236576 A (Sanyo Electric Co., Ltd.), 20 September, 2007 (20.09.07), Par. Nos. [0013] to [0015]; Fig. 4 & EP 1832817 A2 & KR 10-2007-0092090 A & CN 101032628 A	1-4, 7-9 5, 6

☒ 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
24 July, 2009 (24.07.09)Date of mailing of the international search report
04 August, 2009 (04.08.09)Name and mailing address of the ISA/
Japanese Patent Office

Authorized officer

Facsimile No.

Telephone No.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2009/003237

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 14964/1984 (Laid-open No. 128241/1985) (Mitsubishi Heavy Industries, Ltd.), 28 August, 1985 (28.08.85), Full text; Fig. 2 (Family: none)	1-4, 7-9
Y	JP 2002-22217 A (Yukyan Kabushiki Kaisha), 23 January, 2002 (23.01.02), Fig. 1 (Family: none)	2
Y	JP 10-291879 A (Hitachi, Ltd.), 04 November, 1998 (04.11.98), Par. No. [0065]; Figs. 3, 4 (Family: none)	3
Y	Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 139953/1986 (Laid-open No. 49427/1988) (Nissan Motor Co., Ltd.), 04 April, 1988 (04.04.88), Description, page 2, lines 15 to 19; Fig. 1 (Family: none)	7
Y	JP 2-238237 A (Matsushita Seiko Co., Ltd.), 20 September, 1990 (20.09.90), Page 4, upper right column, line 15 to lower left column, line 17; Fig. 1 & JP 2116871 C	7
Y	JP 2006-153316 A (Dainichi Co., Ltd.), 15 June, 2006 (15.06.06), Par. Nos. [0024] to [0027] (Family: none)	8, 9

Form PCT/ISA/210 (continuation of second sheet) (April 2007)

INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP2009/003237

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

For the reasons stated below, the inventions of claims 1-9 are not so linked to one another as to form a single general inventive concept.

Namely, the common matter among the inventions of claims 1-9 is a matter described in claim 1 (referred to as "a common matter", hereinbelow).

However, as a result of the search, it is found that the common matter is not novel, as substantially disclosed in a document "a microfilm (Nihon Radiator Co., Ltd.) which films the contents of the description and the drawings annexed to the request of Japanese Utility Model Application No. 62-67717 (Laid-open No. 63-175735) 15 November, 1988 (15.11.88), full text, Fig.1 (having no family member)". (continued to extra sheet)

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☒ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest
the

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

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Continuation of Box No.III of continuation of first sheet (2)

Consequently, the common matter is still included within the scope of the prior art, and cannot be regarded as a special technical feature in the meaning within PCT Rule 13.2, second sentence.

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP 2001153409 A [0006]
- JP H06178989 B [0006]