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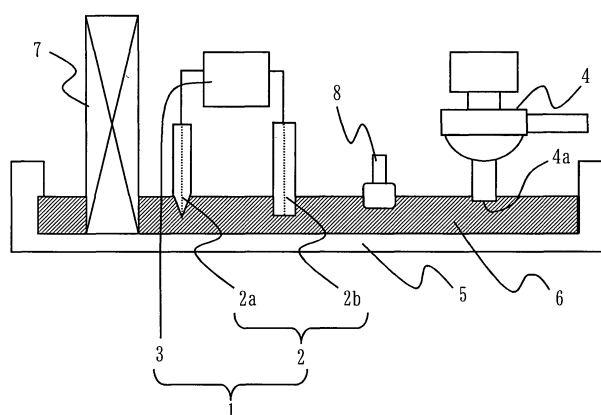
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(54) **Air conditioning apparatus**

(57) An air conditioning apparatus capable of continuously sterilizing drain water in a drain pan almost permanently and thereby solving a drain pump clogging problem in any installation environment of the drain pan and in any environment where bacteria, fungi, etc. can multiply. The air conditioning apparatus may be formed to include a heat exchanger 7, a drain pan 5 receiving condensed water from the heat exchanger 7, and a drain

pump 4 discharging drain water 6 from the drain pan 5. The drain pan 5 may include a sterilizing device 1. The sterilizing device 1 may include:
(1) a discharge electrode 2 that is formed to include at least one pair of a high-voltage electrode 2a and a ground electrode 2b that faces the high-voltage electrode 2a at a predetermined distance; and
(2) a high-voltage power supply 3 that applies high-voltage pulses to the discharge electrode 2.

Fig. 5



Description

[0001] The present invention relates to an air conditioning apparatus (an indoor unit) equipped with a heat exchanger, a drain pan receiving condensed water from the heat exchanger, and a drain pump discharging drain water from the drain pan. More particularly, the present invention relates to a technology to keep the drain pump free from clogging by using electric discharge to destroy bacteria, fungi, etc. in drain water causing drain pump clogging.

[0002] An air conditioning indoor unit capable of implementing antibacterial and antifungal measures to sterilize water in a water channel at low cost has been proposed (see e.g. Patent Document 1). The air conditioning indoor unit is formed to receive drops of water from an indoor heat exchanger at a front side drain pan and a rear side drain pan, and discharge the water outside the machine through a water channel via drain pipes. The front side drain pan is formed to have an antibacterial and antifungal material installed at the bottom. The antibacterial and antifungal material includes antibacterial and antifungal components that solve out when the antibacterial and antifungal material touches water.

[0003] The conventional technology of sterilizing bacteria, fungi, etc. in water in a drain pan disclosed in the Patent Document 1, however, poses the following problems: The amount of antibacterial and antifungal agent is fixed in the first place, and therefore sterilization effects are gone once all the initial amount of the antibacterial and antifungal agent has been solved out. Consequently, bacteria, fungi, etc. can multiply in water in the drain pan, which causes clogging of the drain pump.

[0004] Another problem is that the antibacterial and antifungal agent is not effective for any type of bacteria, fungi, etc. in the water of the drain pan. In bacteria, fungi, etc., some individuals may be resistant to the antibacterial and antifungal agent. Others may develop, over time, to become resistant to the antibacterial and antifungal agent.

[0005] [Patent Document 1] JP 2000-74409

[0006] The present invention is directed to solving such problems as described above. An object is to provide an air conditioning apparatus that is capable of sterilizing water in a drain pan almost permanently and thereby solving a drain pump clogging problem in any installation environment of the drain pan and in any environment where bacteria, fungi, etc. can multiply.

[0007] These and other objects of the embodiments of the present invention are accomplished by the present invention as hereinafter described in further detail.

[0008] According to one aspect of the present invention, an air conditioning apparatus may include, a heat exchanger, a drain pan that receives condensed water from the heat exchanger, and a drain pump that discharges drain water from the drain pan. The air conditioning apparatus may further include a sterilizing device that is installed in the drain pan. The sterilizing device may in-

clude at least one pair of a discharge electrode that is formed to include a high-voltage electrode and a ground electrode that faces the high-voltage electrode at a predetermined distance. The sterilizing device may also include a high-voltage power supply that applies high-voltage pulses to the discharge electrode.

[0009] The discharge electrode may be arranged in the vicinity of the drain pump, and installed so that at least a tip portion of the discharge electrode goes below the surface of the drain water.

[0010] The discharge electrode may be fixed to the drain pump.

[0011] The air conditioning apparatus may further include a housing that is formed to include an outer plate and an installation hole that may be made on the outer plate. The discharge electrode may be supported by an electrode installing member. The discharge electrode may be installed in the housing through the installation hole after the air conditioning apparatus has been installed.

[0012] The electrode installing member may be fixed on the housing by a fixing means.

[0013] The discharge electrode may be installed so that at least the tip portion of the discharge electrode is lower than an intake opening of the drain pump to allow the tip portion to go below the surface of the drain water.

[0014] The air conditioning apparatus may further include a controller that controls the air conditioning apparatus. The controller may control the sterilizing device to operate intermittently during a cooling or dehumidifying operation.

[0015] The sterilizing device may be controlled so that the ratio of the operating time of the sterilizing device to the operating time of the air conditioning apparatus during a cooling or dehumidifying operation may be 50% or higher.

[0016] The air conditioning apparatus may further include a controller that controls the air conditioning apparatus. The controller may control the sterilizing device to operate continuously for a predetermined period of time after the end of a cooling or dehumidifying operation.

[0017] The air conditioning apparatus may further include a controller that may control the air conditioning apparatus, and a drain water level sensor that may detect the water level of the drain water. The controller may control the sterilizing device to start operating when the drain water level sensor detects a predetermined water level.

[0018] The high-voltage electrode and the ground electrode may be molded with a molding resin.

[0019] The high-voltage electrode and the ground electrode may be fixed to the drain pump via an engaging member that is formed on the molding resin.

[0020] The high-voltage electrode and the ground electrode may be formed separately.

[0021] The high-voltage electrode and the ground electrode may be combined while tip portions of the high-voltage electrode and the ground electrode are spaced

at a predetermined creepage distance from each other.

[0022] Further scope of applicability of the present invention will become apparent from the detailed description given hereinafter. However, it should be understood that the detailed description and specific examples, while indicating preferred embodiments of the invention, are given by way of illustration only, since various changes and modifications within the spirit and scope of the invention will become apparent to those skilled in the art from this detailed description.

[0023] The present invention will become more fully understood from the detailed description given hereinafter and the accompanying drawings which are given by way of illustration only, and thus are not limitative of the present invention, and wherein:

Fig. 1 illustrates a perspective view of a ceiling embedded air conditioning apparatus 100 (an indoor unit) mounted on the ceiling of a room 45, when viewed from inside the room 45, according to a first embodiment;

Fig. 2 illustrates a horizontal cross section of the ceiling embedded air conditioning apparatus 100, according to the first embodiment;

Fig. 3 illustrates a conceptual view of the ceiling embedded air conditioning apparatus 100 showing an arrangement of a drain pump 4, etc., according to the first embodiment;

Fig. 4 illustrates a vertical cross section of the ceiling embedded air conditioning apparatus 100, according to the first embodiment;

Fig. 5 illustrates an internal structure of a drain pan 5 having a sterilizing device 1 installed therein, according to the first embodiment;

Fig. 6 illustrates how the drain pump 4, a discharge electrode 2, etc. are fixed to a housing 20, according to the first embodiment;

Fig. 7 illustrates a perspective view showing how the discharge electrode 2, etc. are fixed to the drain pump 4, according to the first embodiment;

Fig. 8 illustrates a schematic structure of the sterilizing device 1, according to the first embodiment;

Fig. 9 illustrates an external view of a high-voltage electrode 2a showing the shape, according to the first embodiment;

Fig. 10 illustrates how the discharge electrode 2, etc. are installed on the ceiling embedded air conditioning apparatus 100 after the ceiling embedded air conditioning apparatus 100 has been installed, according to a second embodiment; and

Fig. 11 illustrates the discharge electrode 2 formed to combine the high-voltage electrode 2a and a ground electrode 2b, according to a third embodiment.

[0024] Reference will now be made in detail to embodiments of the invention, examples of which are illustrated in the accompanying drawings, wherein like reference

numerals indicate like devices through out the several views.

Embodiment 1.

[0025] First, an air conditioning apparatus according to a first embodiment is defined. The air conditioning apparatus of this embodiment is equipped with a heat exchanger, a drain pan receiving condensed water from the heat exchanger, a drain pump discharging drain water from the drain pan. The air conditioning apparatus of this embodiment may include a ceiling embedded type, a ceiling suspended type, a wall mounted type, etc. The ceiling embedded air conditioning apparatus may have a decorative panel visible from the room, or fully concealed within the ceiling void. The ceiling suspended air conditioning apparatus may have an installation option of a drain pump.

[0026] The air conditioning apparatus of this embodiment is now described with reference to a ceiling embedded air conditioning apparatus having the decorative panel visible from the room, as an example.

[0027] Fig. 1 to Fig. 9 illustrate the first embodiment. Fig. 1 illustrates a perspective view of a ceiling embedded air conditioning apparatus 100 (an indoor unit) mounted on the ceiling of a room 45, when viewed from inside the room 45. Fig. 2 illustrates a horizontal cross section of the ceiling embedded air conditioning apparatus 100. Fig. 3 illustrates a conceptual view of the ceiling embedded air conditioning apparatus 100 showing an arrangement of a drain pump 4, etc. Fig. 4 illustrates a vertical cross section of the ceiling embedded air conditioning apparatus 100. Fig. 5 illustrates an internal structure of a drain pan 5 having a sterilizing device 1 installed therein. Fig. 6 illustrates how the drain pump 4, a discharge electrode 2, etc. are fixed to a housing 20. Fig. 7 illustrates a perspective view showing how the discharge electrode 2, etc. are fixed to the drain pump 4. Fig. 8 illustrates a schematic structure of the sterilizing device 1. Fig. 9 illustrates an external view of a high-voltage electrode 2a, showing the shape.

[0028] A configuration of an example of the ceiling embedded air conditioning apparatus 100 is now described with reference to Fig. 1 to Fig. 4.

[0029] As illustrated in Fig. 1, the ceiling embedded air conditioning apparatus 100 (an indoor unit) is embedded in the ceiling void of the room 45 with a substantial square decorative panel 47, fitted at the bottom, being visible from the room 45. The decorative panel 47 is formed to include a substantial square grille 38 (an air inlet opening) at a central portion and four air outlet openings 48 along the sides of the housing 20. The grille 38 is communicated with an air inlet opening of the ceiling embedded air conditioning apparatus 100. The air outlet openings 48 are communicated with air outlet openings 40 of the body of the air conditioning apparatus (see Fig. 4). The air outlet openings 48 are formed to include vanes 49 to control the direction of blown off air.

[0030] As illustrated in Fig. 2, the cross sectional shape of the housing 20 is substantial square, like the case of the decorative panel 47. The housing 20 is formed to include the air outlet openings 40 of the body of the air conditioning apparatus along the sides. A blower 30 is installed in a central portion of the housing 20. The blower 30 is surrounded by a heat exchanger 7 (formed in the shape of a substantial C) that is arranged in the shape of a substantial ring.

[0031] The housing 20 having the substantial square cross section is formed to include the drain pump 4 arranged at one corner. The drain pump 4 is provided to discharge drain water in the drain pan 5 outside the housing 20. The drain pan 5 receives condensed water from the heat exchanger 7.

[0032] As illustrated in Fig. 3, the drain pump 4 is installed at one corner of the housing 20, and the discharge electrode 2 as a component part of a sterilizing device, which will be described later, is installed in the vicinity of the drain pump 4.

[0033] The housing 20 is also formed to include a substrate 14 on which a high-voltage power supply 3, which will be described later, is installed. The high-voltage power supply 3 applies high-voltage pulses to the discharge electrode 2 as a component part of the sterilizing device.

[0034] As illustrated in Fig. 4, the blower 30 (a centrifugal fan) is installed in a central portion of the housing 20. The blower 30 includes a fan 30a (a turbo fan) that is formed to have an air intake opening on the underside, and a fan motor 30b that drives the fan 30a.

[0035] The fan motor 30b is installed on the ceiling side of the housing 20. A Bell mouth 50 that guides air to the fan 30a is arranged below the fan 30a.

[0036] The heat exchanger 7 is arranged in the shape of a substantial ring around the fan 30a (formed in the shape of a substantial C). The drain pan 5 is arranged below the heat exchanger 7. The heat exchanger 7 forms a refrigerating cycle together with a compressor in an outdoor unit not shown that compresses a refrigerant, etc. The heat exchanger 7 exchanges heat between room air sucked in via the grille 38 by the fan 30a and a refrigerant in the refrigerating cycle, and produces cool or warm air.

[0037] The air outlet openings 40 of the body of the air conditioning apparatus are formed outside the drain pan 5 along the four sides thereof to connect the secondary side of the heat exchanger 7 and the room. The air outlet openings 40 are communicated with the air outlet openings 48 of the decorative panel 47.

[0038] The vanes 49 are provided at the air outlet openings 48 to adjust the blow direction of cool or warm air generated by the heat exchanger 7. The shape of the vanes 49 is substantially the same as the shape of the air outlet openings 48. The vanes 49 may substantially cover the air outlet openings 48 in a design-oriented manner when the vanes 49 are closed.

[0039] The substantial square grille 38 is installed at the opening in the central portion of the decorative panel

47. The grille 38 may be engaged with the decorative panel 47 by nails or the like, for example.

[0040] Fig. 5 illustrates an internal structure of the drain pan 5 having the sterilizing device 1 installed therein. The temperature of air produced by the ceiling embedded air conditioning apparatus 100, during a cooling or dehumidifying operation, becomes lower than the temperature of room air to be exchanged by the heat exchanger 7. This causes water to be condensed on the surface of the heat exchanger 7. Here, the condensed water is referred to as drain water 6.

[0041] The drain water 6 is stored in the drain pan 5, and discharged outside the housing 20 by the drain pump 4.

[0042] The sterilizing device 1 is installed in the drain pan 5 where the drain water 6 is stored. The sterilizing device 1 is formed to include the discharge electrode 2 and the high-voltage power supply 3. The discharge electrode 2 is formed to include a pair of the high-voltage electrode 2a, coated with an insulator (a resin), and a ground electrode 2b, facing the high-voltage electrode 2a at a predetermined distance. The high-voltage power supply 3 applies high-voltage pulses to the discharge electrode 2. The sterilizing device 1 may include at least one pair of the discharge electrode 2.

[0043] The discharge electrode 2 may be arranged so that at least the tip portion goes below the surface of the drain water 6. Therefore, the tip portion of the discharge electrode 2 is placed lower than an intake opening 4a of the drain pump 4.

[0044] The drain pan 5 may also include a drain water level sensor 8 that detects the water level of the drain water 6.

[0045] Fig. 6 illustrates how the drain pump 4, the discharge electrode 2, etc. are fixed to the housing 20. As illustrated in Fig. 6, the heat exchanger 7 and the drain pan 5 are fixed to the housing 20, which is formed to include an outer plate 9 and a thermal insulator 10. The drain pump 4 is fixed to the housing 20 (e.g., on the top surface) by means of a drain pump fixing member 11 for fixing the drain pump 4 to the housing 20.

[0046] The pair of the high-voltage electrode 2a and the ground electrode 2b facing the high-voltage electrode 2a at a predetermined distance of the discharge electrode 2 is fixed by using an electrode installing member 12 in order to keep a relative height relation with the intake opening 4a of the drain pump 4. The electrode installing member 12 is combined with the drain pump 4. The discharge electrode 2 is arranged so that at least the tip portion is lower than the intake opening 4a of the drain pump 4 in order to allow the tip portion to go below the surface of the drain water 6.

[0047] Fig. 7 illustrates a perspective view of how the discharge electrode 2, etc. are fixed to the drain pump 4. The drain pump fixing member 11 is fixed to the drain pump 4. The drain pump fixing member 11 is fixed to the housing 20 (on the top panel, for example) via cuts 11a formed on the drain pump fixing member 11, by using a

fixing means such as screws or the like.

[0048] The pair of the high-voltage electrode 2a and the ground electrode 2b facing the high-voltage electrode 2a at a predetermined distance of the discharge electrode 2 is fixed to the electrode installing member 12 by using a fixing means such as screws or the like. The electrode installing member 12 is fixed to the drain pump fixing member 11 by using a fixing means such as screws or the like.

[0049] The drain water level sensor 8 detecting the water level of the drain water 6 is also fixed to the drain pump fixing member 11.

[0050] As illustrated in Fig. 8, the sterilizing device 1 is formed to connect the discharge electrode 2 that includes the pair of the high-voltage electrode 2a and the ground electrode 2b to the high-voltage power supply 3 generating high-voltage pulses.

[0051] The high-voltage electrode 2a is formed to connect the high-voltage power supply 3 to the electrode 2a-1 via the high-voltage wire 2a-3. The electrode 2a-1 is molded with a molding resin 2a-2 all over together with a connecting portion to the high-voltage wire 2a-3.

[0052] It is desirable that the electrode 2a-1 is made of a highly corrosion resistant metal for underwater use. More specifically, a metal such as titan or tungsten would be preferred, for example. The electrode 2a-1 is around 0.2mm thick.

[0053] It is also desirable that the molding resin 2a-2 is made of a resin that is highly resistant to humidity and heat, and withstands high-voltage. More specifically, a thermoset resin such as an epoxide resin would be preferred, for example.

[0054] With the electrode 2a-1, for example, the tip portion is exposed in water, but does not protrude from the molding resin 2a-2. The tip of the high-voltage electrode 2a may be cut off on the discharge side to expose a tip portion, for example. When the whole surface of the sides of the high-voltage electrode 2a is covered with the molding resin 2a-2 (an insulator), then electricity is discharged at the tip portion. When high-voltage pulses of negative electrode are applied to the discharge electrode 2, then the electric line of force generated between the high-voltage electrode 2a and the ground electrode 2b flows in a vertical direction from the high-voltage electrode 2a towards the ground electrode 2b. In this case, the electric line of force cannot radiate in all directions because the tip portion of the high-voltage electrode 2a is flat, and not pointed. Furthermore, the whole surface of the sides of the high-voltage electrode 2a is covered with the molding resin 2a-2. The end surface of the tip portion of the high-voltage electrode 2a and the end surface of the tip portion of the molding resin 2a-2 are formed on the same surface. Thus, the tip portion of the high-voltage electrode 2a is formed to contribute to electric discharge. Corrosion of the high-voltage electrode 2a may also be prevented in the case of negative polarity of electric discharge. Alternatively, however, positive polarity of high voltage pulses is also possible if the high-

voltage electrode 2 is formed to prevent corrosion.

[0055] The structure of the ground electrode 2b, the other one of the pair, is substantially identical to that of the high-voltage electrode 2a. More specifically, the ground electrode 2b is formed to connect the high-voltage power supply 3 to an electrode 2b-1 via a wire 2b-3. The surface of the electrode 2b-1, together with the connecting portion to the high-voltage wire 2b-3, is molded with a molding resin 2b-2. The electrode 2b-1 is around 1.0mm thick.

[0056] The electrode 2b-1 is exposed in water at a tip portion, for example. The tip portion protrudes from the molding resin 2b-2 by some millimeters.

[0057] The ground electrode 2b does not get voltage as high as the high-voltage electrode 2a gets. Therefore, the wire 2b-3 is not necessarily high voltage resistant. It is required, however, to have the qualities of corrosion resistance of the electrode 2b-1 and humidity resistance of the molding resin 2b-2 equivalent to those of the high-voltage electrode 2a. For this reason, the electrode 2b-1 and the molding resin 2b-2 may be made of the same material as that of the high-voltage electrode 2a.

[0058] Fig. 9 illustrates an external view of the high-voltage electrode 2a, showing the shape. The shape of the ground electrode 2b is identical to the shape illustrated in the figure.

[0059] The high-voltage electrode 2a and the ground electrode 2b are thus molded with the molding resin 2a-2 and the molding resin 2b-2, respectively. Alternatively, however, the molding resin 2a-2 may be formed to include an engaging member 2a-4 in the shape of a boss, nail or the like, as illustrated in Fig. 9. This may facilitate mounting the molding resin 2a-2 on the electrode installing member 12 (see Fig. 6 and Fig. 7), and also contribute to a reduction in the number of fixing members required.

[0060] An operation of the sterilizing device 1 is now described.

[0061] With the drain pan 5 having the drain water 6 stored therein, the high-voltage power supply 3 applies negative electrode high-voltage pulses of 2kV/cm to 50kV/cm and 100Hz to 20,000Hz between the high-voltage electrode 2a and the ground electrode 2b, and thus electricity is discharged. The electric discharge of the high-voltage electrode 2a causes dielectric breakdown. The energy of the dielectric breakdown causes water to evaporate. When water is evaporated by the shock wave, vapor bubbles occur.

[0062] These bubbles, occurring in the vicinity of the high-voltage electrode 2a, are drawn towards the ground electrode 2b by the following factors: the accumulation of charged particles, such as electrons, generated by the electric discharge; the shock wave caused by the vapor generation; the transfer of electrons caused by the electric field formed between the high-voltage electrode 2a and the ground electrode 2b; and the negatively charged bubbles. A jet flow is thus caused by the bubbles flowing from the high-voltage electrode 2a side to the ground electrode 2b side.

[0063] The bubble-based jet flow, starting from the high-voltage electrode 2a, engulfs the drain water 6 including bacteria, fungi, microorganisms, etc. all together, and flows towards the high-voltage electrode 2a. Then, plasma equipped at the tip portion of the high-voltage electrode 2a may destroy incoming bacteria, fungi, microorganisms, etc. effectively.

[0064] Advantageous features of the sterilizing device 1 may be summarized as follows:

- (1) Electricity is discharged in the drain water 6. Therefore, no oxygen dissociation is involved, preventing ozone from occurring. Thus, there is no unpleasant odor of ozone generated around;
- (2) An electric circuit is formed only in the drain water 6. Therefore, there is no danger of fire;
- (3) The sterilizing device 1 may be available almost permanently in principle; and
- (4) The sterilizing device 1 is effective on any type of bacteria, fungi, etc. and never allows resistant bacteria, fungi, etc. to occur.

[0065] A description is now given of how the sterilizing device 1 of the ceiling embedded air conditioning apparatus 100 is used. It may be desirable to operate the sterilizing device 1 for a long time if it is only the drain water 6 that is sterilized. Such a continuous running of the sterilizing device 1 is however considered a waste of electricity. The durability of electronic parts on the substrate 14 on which the high-voltage power supply 3 is mounted is limited. The same is true with the discharge electrode 2. Therefore it is required to operate the sterilizing device 1 for a required period of time in an effective manner.

[0066] The running time of the sterilizing device 1 may be controlled in association with the operation of the ceiling embedded air conditioning apparatus 100 by a controller (e.g., a microcomputer having predetermined operation programs installed therein) mounted on the substrate 14.

[0067] For example, the sterilizing device 1 may be operated intermittently in cooling or dehumidifying mode in which the drain water 6 is produced by the heat exchanger 7.

[0068] The ratio of the running time of the sterilizing device 1 to the operating time of the air conditioning apparatus 100 during a cooling or dehumidifying operation is determined by the amount of bacteria, fungi, etc. in multiplication. In the case of the ceiling embedded air conditioning apparatus 100 (an indoor unit), the sterilizing ability of electric discharge normally surpasses the fecundity of bacteria, fungi, etc. when the sterilizing device 1 is operated for half the operating time of the ceiling embedded air conditioning apparatus 100 or longer during a cooling or dehumidifying operation. In this situation, bacteria, fungi, etc. cannot multiply. Given this fact, the sterilizing device 1 may be controlled so that the ratio of the operating time of the sterilizing device 1 to the oper-

ating time of the ceiling embedded air conditioning apparatus 100 during a cooling or dehumidifying operation is 50% or higher.

[0069] More specifically, the sterilizing device 1 may be operated for three hours or longer (e.g., four hours) in cooling or dehumidifying mode in which the drain water 6 is produced by the heat exchanger 7. Then, the operation of the sterilizing device 1 may be suspended for a subsequent period of less than three hours (e.g., two hours). This cycle may be repeated.

[0070] The bacteria, fungi, etc. multiply in the drain water 6 after the end of a cooling or dehumidifying operation when return water from drain pipes (not shown) increases the amount and temperature of the drain water 6. Given this fact, the drain water 6 may be continued to be sterilized by operating the sterilizing device 1 for a predetermined period of time even after the end of a cooling or dehumidifying operation. This may effectively prevent bacteria, fungi, etc. in the drain water 6 of the drain pan 5 from multiplying.

[0071] The period of the continuous operation of the sterilizing device 1 after the end of a cooling or dehumidifying operation may be determined by the amount of return water from the drain pipes in the drain water 6. In the case of the ceiling embedded air conditioning apparatus 100 (an indoor unit), the sterilizing device 1 may be operated to sterilize the drain water 6 for three hours or longer (defined as a predetermined period of time, e.g., six hours). This may normally reduce the number of bacteria, fungi, etc. in the drain water in the drain pan 5 by two or more digits. This may prevent bacteria, fungi, etc. from multiplying to the extent of causing the drain pump 4 to be clogged.

[0072] In many cases, the indoor unit of an air conditioner equipped with the drain pump 4 is also equipped with the drain water level sensor 8 that detects the water level of the drain water 6. Therefore, the drain water level sensor 8 may be used to operate the sterilizing device 1. For example, the sterilizing device 1 may be started to operate when the level of the drain water 6 reaches as deep as a predetermined level or higher.

[0073] As aforementioned, the ceiling embedded air conditioning apparatus 100 equipped with the sterilizing device 1 may have the following effects: The sterilizing device 1 is thus formed to discharge electricity in the drain water 6. This may result in destroying bacteria, fungi, etc. in the drain water 6 of the drain pan 5. Hence, the problem of clogging in the drain pump 4 caused by viscosity related to bacteria, fungi, and the like may be solved.

[0074] Secondly, the molding resins 2a-2 and 2b-2 of the high-voltage electrode 2a and the ground electrode 2b are thus formed to include the engaging member 2a-4 in the form of a boss, a nail, or the like. This may result in facilitating the fixing of the high-voltage electrode 2a and the ground electrode 2b to the electrode installing member 12. This may also result in a reduction in the number of fixing members required.

[0075] Next, the sterilizing device 1 may be controlled

so that the ratio of the operating time of the sterilizing device 1 to the operating time of the air conditioning apparatus 100 in cooling or dehumidifying mode is 50% or higher, during a cooling or dehumidifying operation. This may result in preventing electricity from being wasted by a continuous running of the sterilizing device 1 for a long time, which may allow users to save money on electricity. This may also result in increasing durability of electronic parts on the substrate 14 and the discharge electrode 2.

[0076] Next, the drain water 6 may be continued to be sterilized by operating the sterilizing device 1 for a predetermined period of time even after the end of a cooling or dehumidifying operation. This may effectively prevent bacteria, fungi, etc. in the drain water 6 of the drain pan 5 from multiplying. This may also be effective on any type of bacteria, fungi, etc.

Embodiment 2.

[0077] According to the first embodiment, the high-voltage electrode 2a and the ground electrode 2b of the sterilizing device 1 are thus installed in the drain pump 4, which is designed on the assumption that the sterilizing device 1 is installed on the ceiling embedded air conditioning apparatus 100 in the manufacturing stage. According to a second embodiment, however, the high-voltage electrode 2a and the ground electrode 2b of the sterilizing device 1 are designed on the assumption that the sterilizing device 1 is installed, after the ceiling embedded air conditioning apparatus 100 has been installed, from the outside of the ceiling embedded air conditioning apparatus 100. The second embodiment is now described.

[0078] Fig. 10 illustrates how the discharge electrode 2, etc. is installed in the ceiling embedded air conditioning apparatus 100 after the ceiling embedded air conditioning apparatus 100 has been installed.

[0079] As illustrated in Fig. 10, an installation hole 13 is made on site on the outer plate 9 of the housing 20 of the ceiling embedded air conditioning apparatus 100. The housing 20 is made of the outer plate 9 and the thermal insulator 10. The discharge electrode 2 is supported by the electrode installing member 12. The installation hole 13 is provided to allow the discharge electrode 2 to be installed from the outside of the housing 20.

[0080] The electrode installing member 12 may be installed by a fixing means such as screws or the like to the outer plate of the housing 20, for example.

[0081] As aforementioned, the discharge electrode may thus be installed from the outside of the air conditioning apparatus after the air conditioning apparatus has been installed. This may allow the discharge electrode to be installed without uninstalling the air conditioning apparatus. Hence, the discharge electrode may be reinstalled later in response to drain clogging caused by a predetermined period of use of the air conditioning apparatus.

Embodiment 3.

[0082] According to the first and second embodiments, the high-voltage electrode 2a and the ground electrode 2b are separately molded with the molding resin 2a-2 and the molding resin 2b-2, respectively. Alternatively, however, the discharge electrode 2 may be formed to combine the high-voltage electrode 2a and the ground electrode 2b on the side where the high-voltage wire 2a-3 and the wire 2b-3 are connected, while the tip portions of the electrodes are separated at a creepage distance from each other on the other side.

[0083] Fig. 11 illustrates the discharge electrode 2 formed to combine the high-voltage electrode 2a and the ground electrode 2b.

[0084] As illustrated in Fig. 11, the discharge electrode 2 is formed to put a molding resin 2c all over the electrode 2a-1 of the high-voltage electrode 2a and the electrode 2b-1 of the ground electrode 2b together with the connecting portions to the high-voltage wire 2a-3 and the wire 2b-3.

[0085] The electrode 2a-1 may be exposed in water at the tip portion, for example, but does not protrude from the molding resin 2c. The electrode 2b-2 may be exposed in water at the tip portion, for example. The top portion protrudes from the molding resin 2c by some millimeters.

[0086] The electrode 2a-1 (a tip portion) of the high-voltage electrode 2a and the electrode 2b-1 (a tip portion) of the ground electrode 2b may be spaced at a creepage distance L, 10mm or longer, from each other. In this case, electricity may be discharged in water without tracking on the molding resin 2c.

[0087] Thus, the discharge electrode 2 may be formed to combine the high-voltage electrode 2a and the ground electrode 2b on the side where the high-voltage wire 2a-3 and the wire 2b-3 are connected, as long as the electrode 2a-1 (a tip portion) of the high-voltage electrode 2a and the electrode 2b-1 (a tip portion) of the ground electrode 2b are spaced apart from each other at the creepage distance.

[0088] As aforementioned, the high-voltage electrode 2a and the ground electrode 2b are thus integrated. This may result in a reduction in the number of component parts required.

[0089] The invention being thus described, it will be obvious that the same may be varied in many ways. Such variations are not to be regarded as a departure from the spirit and scope of the invention, and all such modifications as would be obvious to one skilled in the art are intended to be included within the scope of the following claims.

Claims

1. An air conditioning apparatus (100) comprising,
a heat exchanger (7);

a drain pan (5) that receives condensed water from the heat exchanger; and
a drain pump (4) that discharges drain water from the drain pan,

characterized in that:

the air conditioning apparatus further comprises a sterilizing device (1) that is installed in the drain pan, the sterilizing device comprising:

at least one pair of a discharge electrode (2) that is formed to include a high-voltage electrode (2a) and a ground electrode (2b) that faces the high-voltage electrode at a predetermined distance; and
a high-voltage power supply (3) that applies high-voltage pulses to the discharge electrode.

2. The air conditioning apparatus according to claim 1, wherein the discharge electrode is arranged in the vicinity of the drain pump, and installed so that at least a tip portion of the discharge electrode goes below the surface of the drain water.

3. The air conditioning apparatus according to claim 1 or 2, wherein the discharge electrode is fixed to the drain pump.

4. The air conditioning apparatus according to any one of claims 1 to 3, further comprising:

a housing (20) that is formed to include an outer plate (9) and an installation hole (13) made on the outer plate,

wherein the discharge electrode, being supported by an electrode installing member (12), is installed in the housing through the installation hole after the air conditioning apparatus has been installed.

5. The air conditioning apparatus according to claim 4, wherein the electrode installing member is fixed on the housing by a fixing means.

6. The air conditioning apparatus according to any one of claims 1 to 5, wherein the discharge electrode is installed so that at least the tip portion of the discharge electrode is lower than an intake opening of the drain pump to allow the tip portion to go below the surface of the drain water.

7. The air conditioning apparatus according to any one of claims 1 to 6 further comprising:

a controller that controls the air conditioning ap-

paratus,

wherein the controller controls the sterilizing device to operate intermittently during a cooling or dehumidifying operation.

8. The air conditioning apparatus according to claim 7, wherein the sterilizing device is controlled so that the ratio of the operating time of the sterilizing device to the operating time of the air conditioning apparatus during a cooling or dehumidifying operation is 50% or higher.

9. The air conditioning apparatus according to any one of claims 1 to 6 further comprising:

a controller that controls the air conditioning apparatus,

wherein the controller controls the sterilizing device to operate continuously for a predetermined period of time after the end of a cooling or dehumidifying operation.

10. The air conditioning apparatus according to any one of claims 1 to 6 further comprising:

a controller that controls the air conditioning apparatus, and
a drain water level sensor (8) that detects the water level of the drain water,

wherein the controller controls the sterilizing device to start operating when the drain water level sensor detects a predetermined water level.

11. The air conditioning apparatus according to any one of claims 1 to 10, wherein the high-voltage electrode and the ground electrode are molded with a molding resin (2b-2).

12. The air conditioning apparatus according to claim 11, wherein the high-voltage electrode and the ground electrode are fixed to the drain pump via an engaging member (2a-4) formed on the molding resin.

13. The air conditioning apparatus according to any one of claims 1 to 12, wherein the high-voltage electrode and the ground electrode are formed separately.

14. The air conditioning apparatus according to any one of claims 1 to 12, wherein the high-voltage electrode and the ground electrode are combined while tip portions of the high-voltage electrode and the ground electrode are spaced at a predetermined creepage distance from each other.

Fig. 1

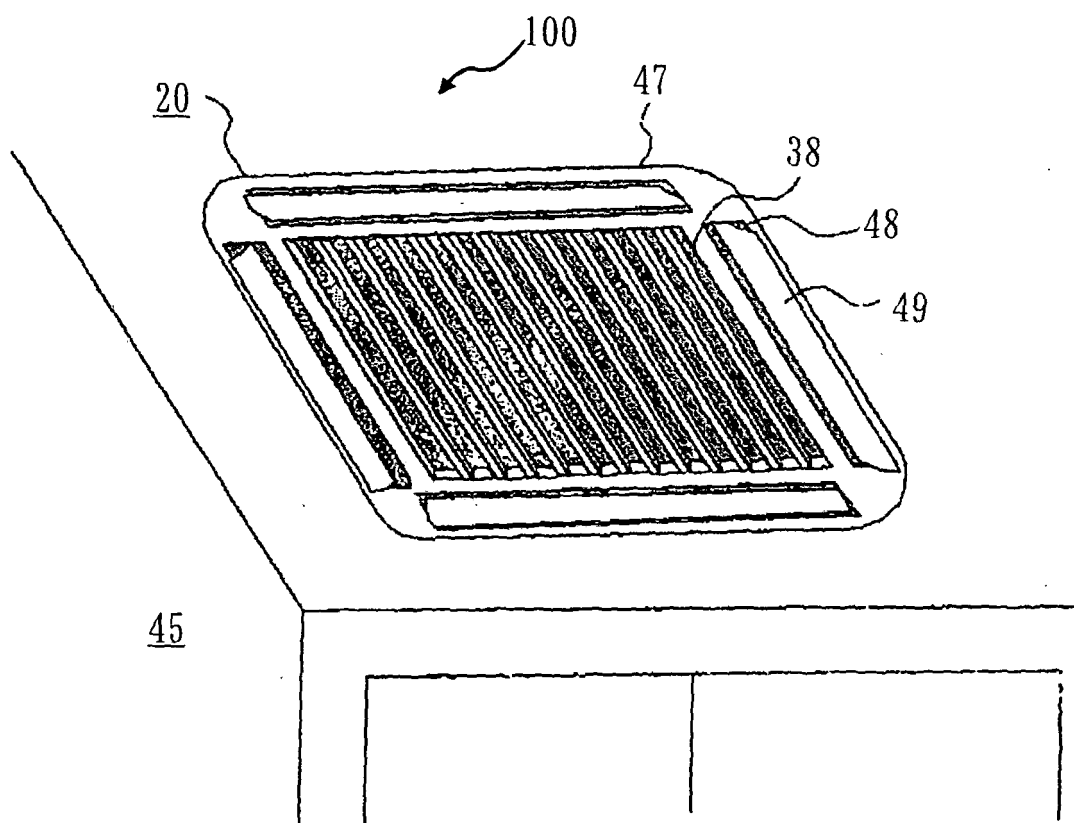


Fig. 2

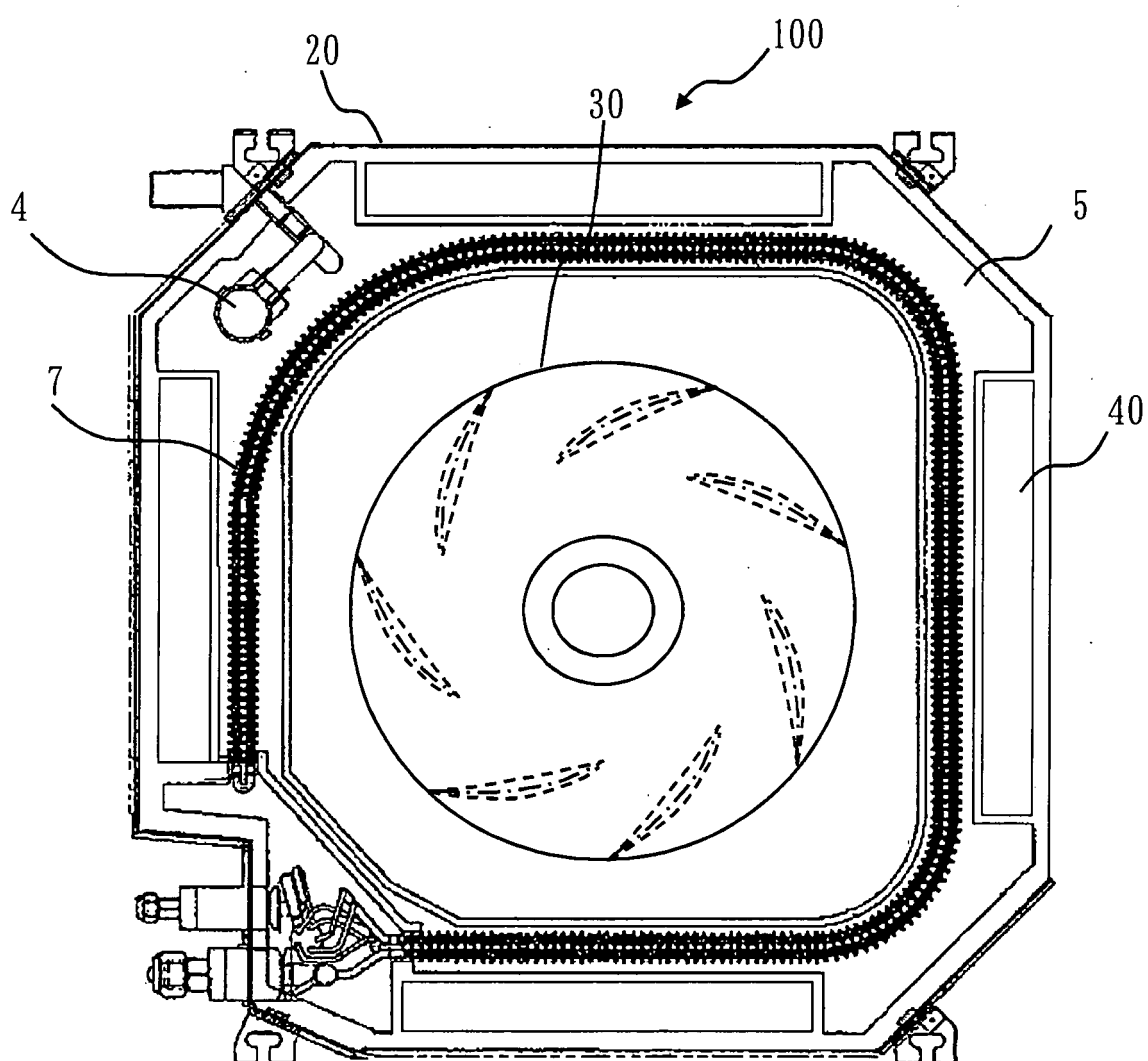


Fig. 3

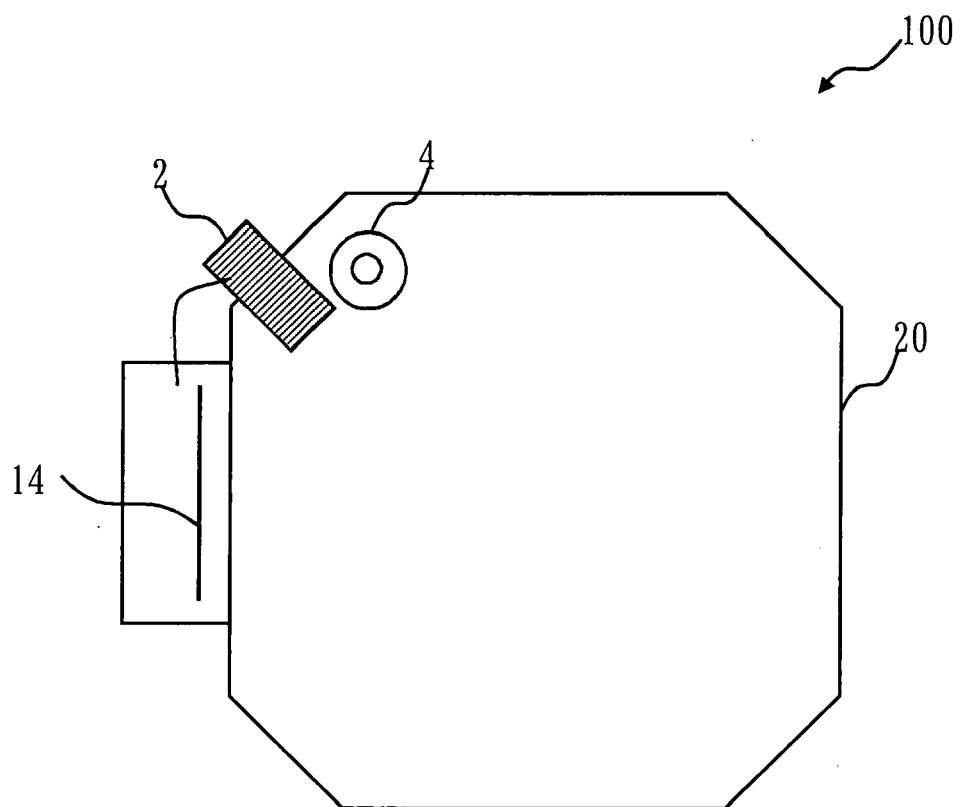


Fig. 4

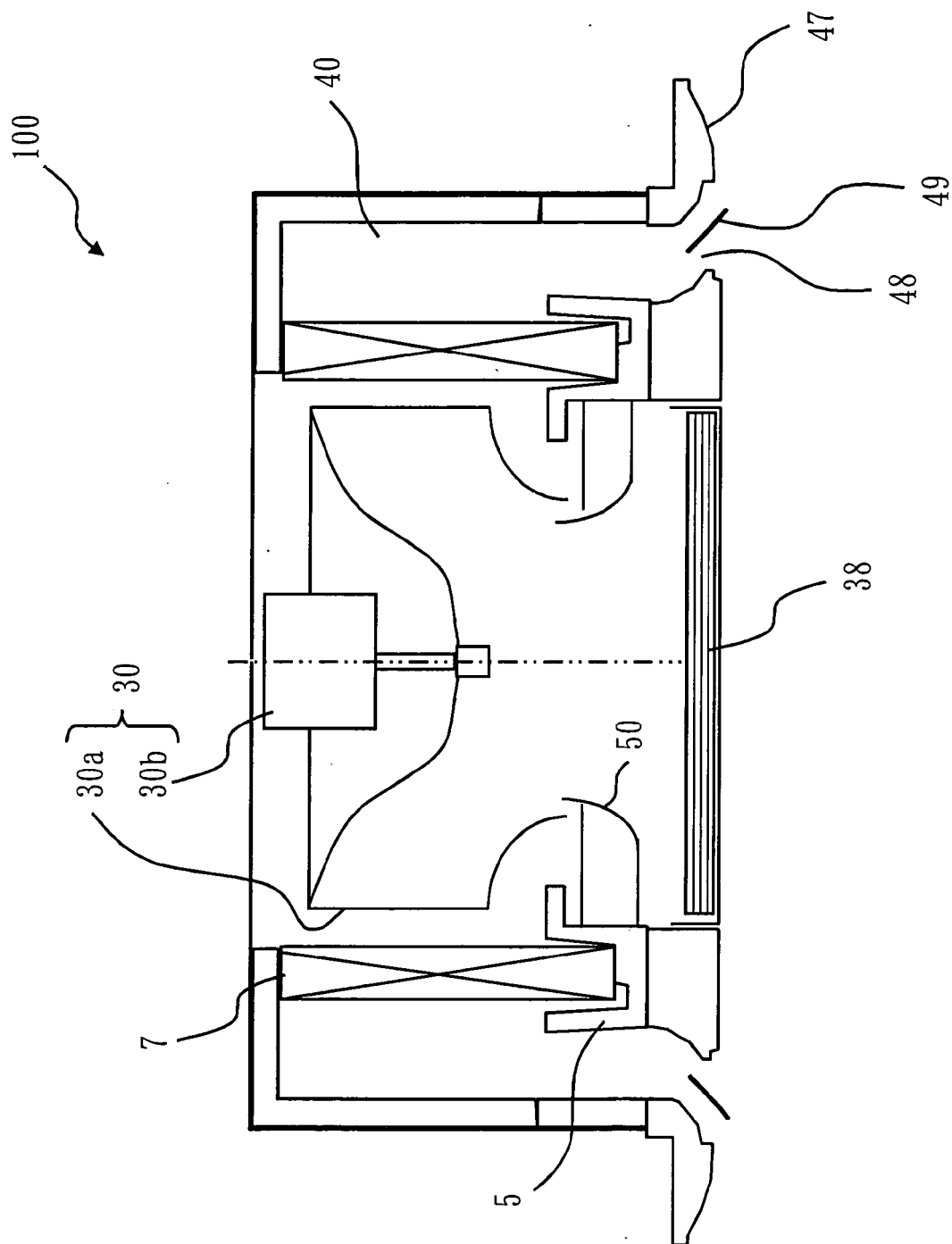


Fig. 5

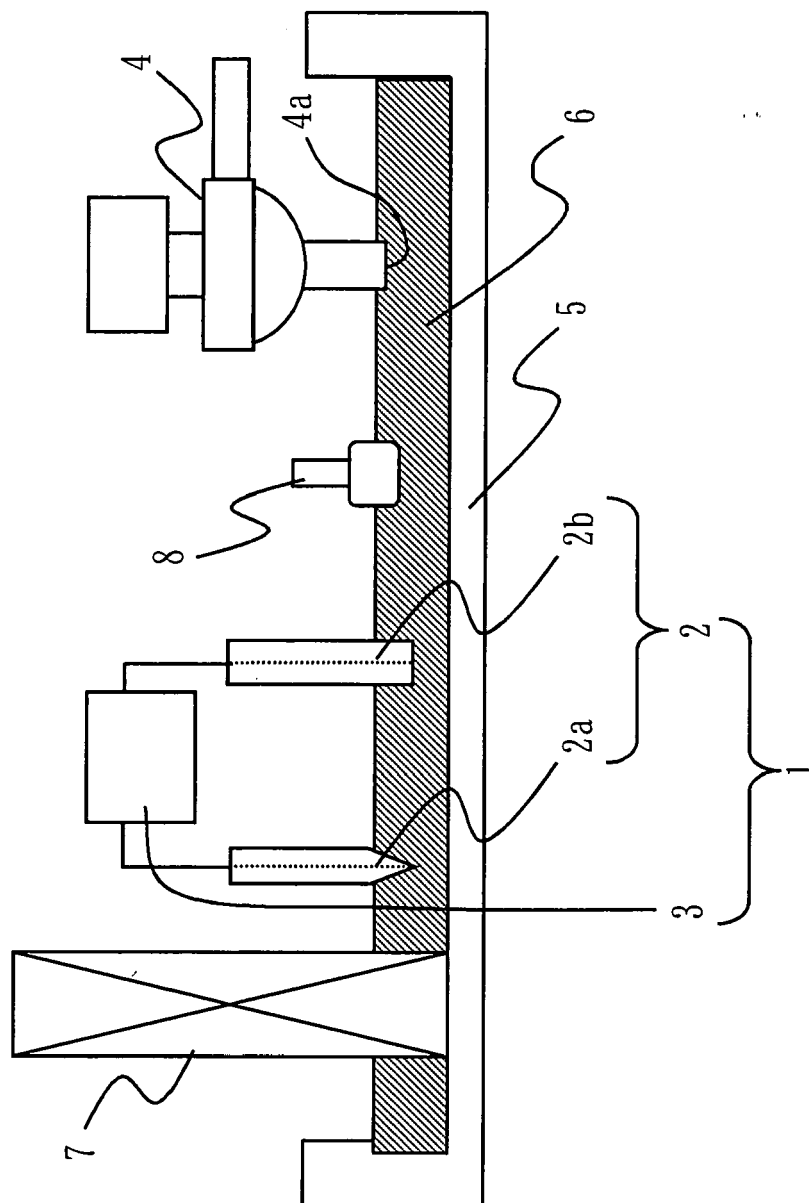


Fig. 6

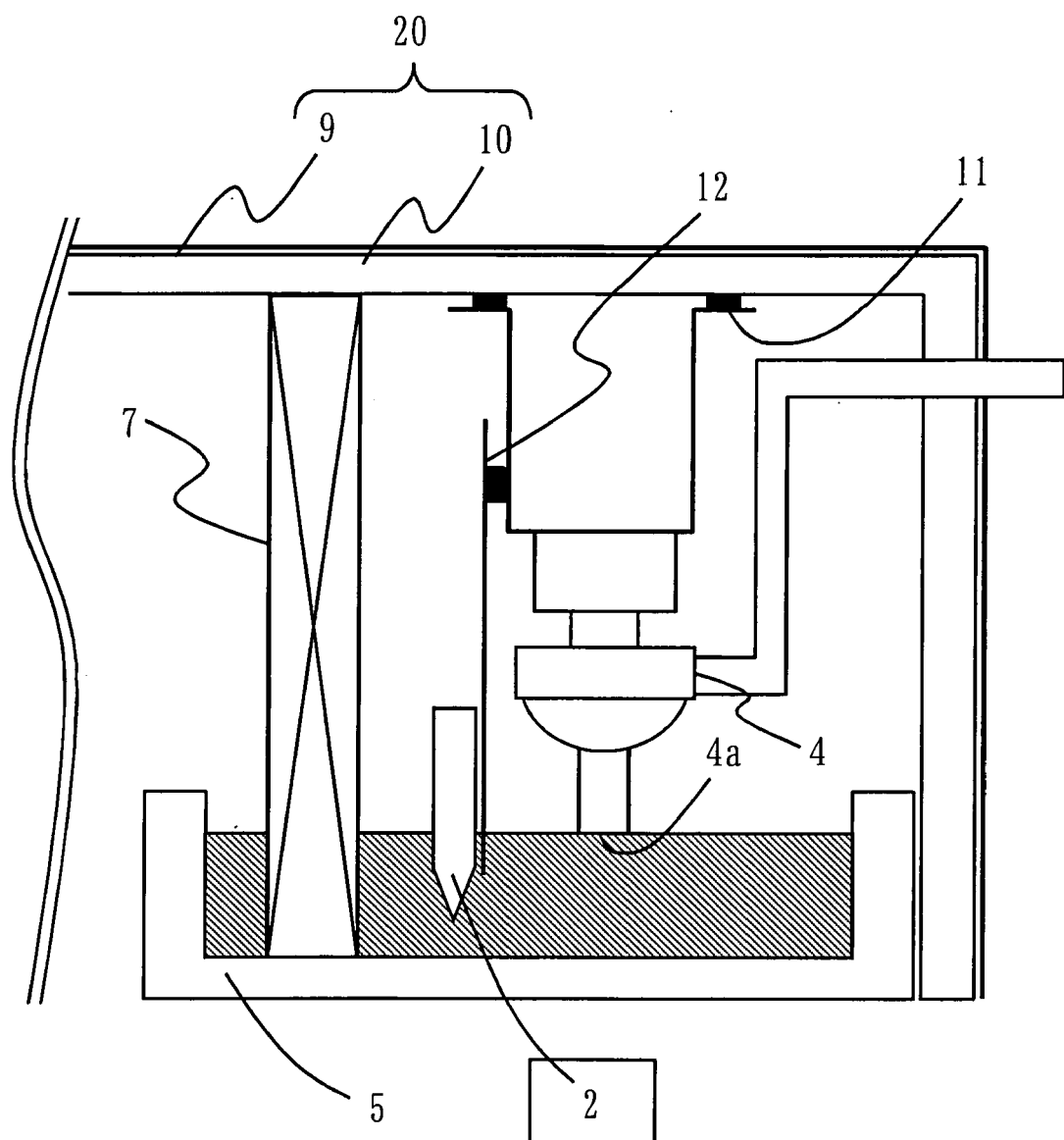


Fig. 7

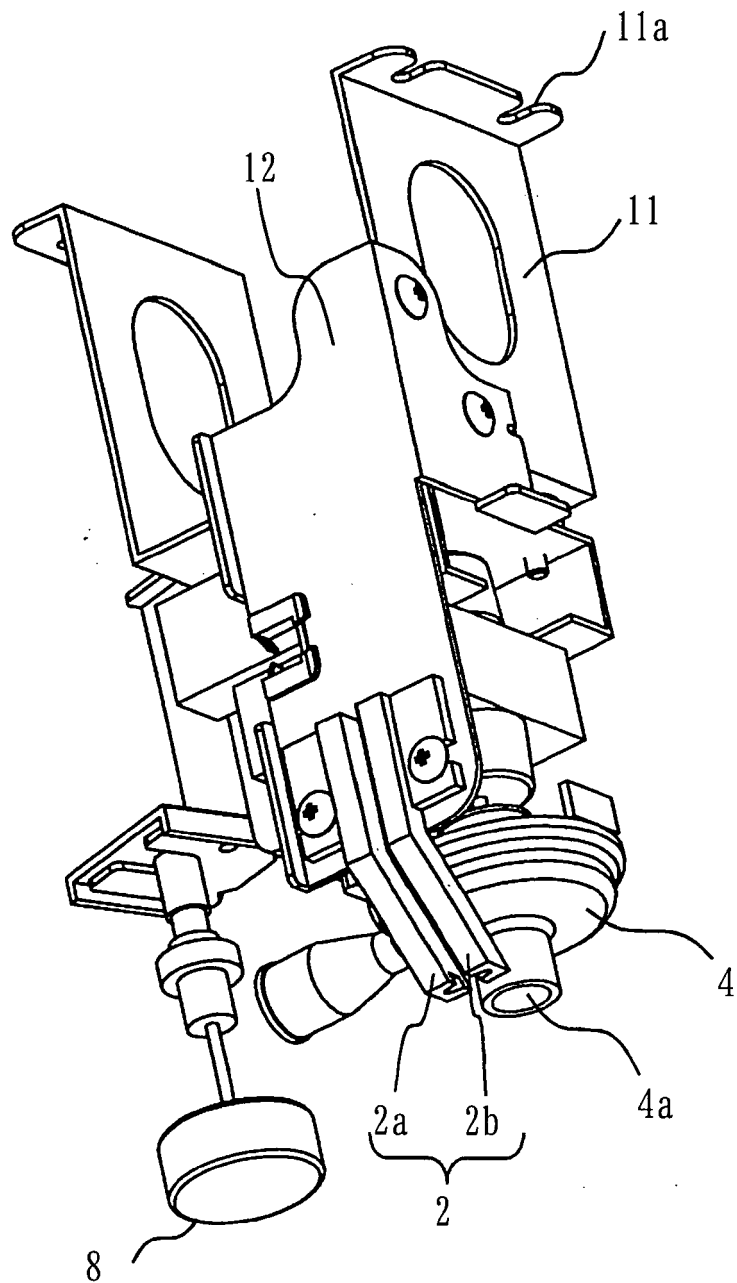


Fig. 8

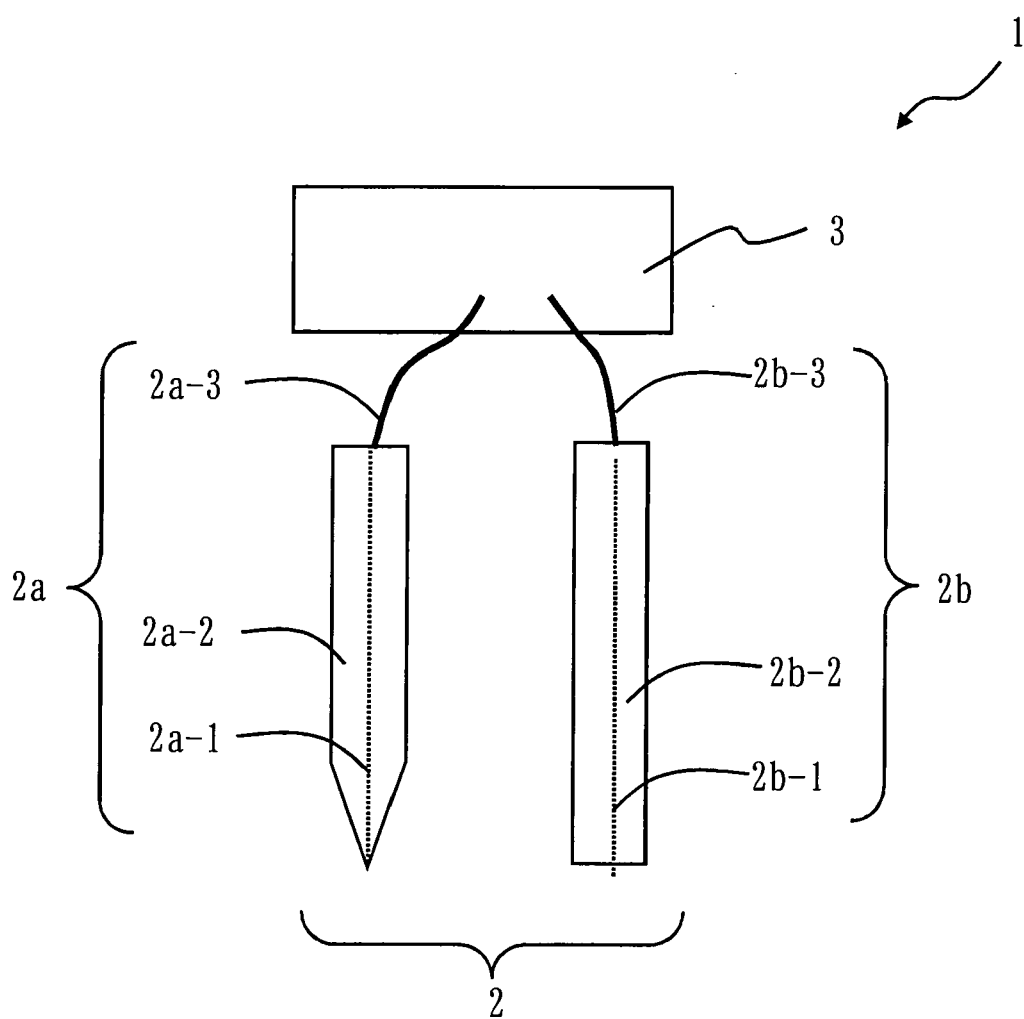


Fig. 9

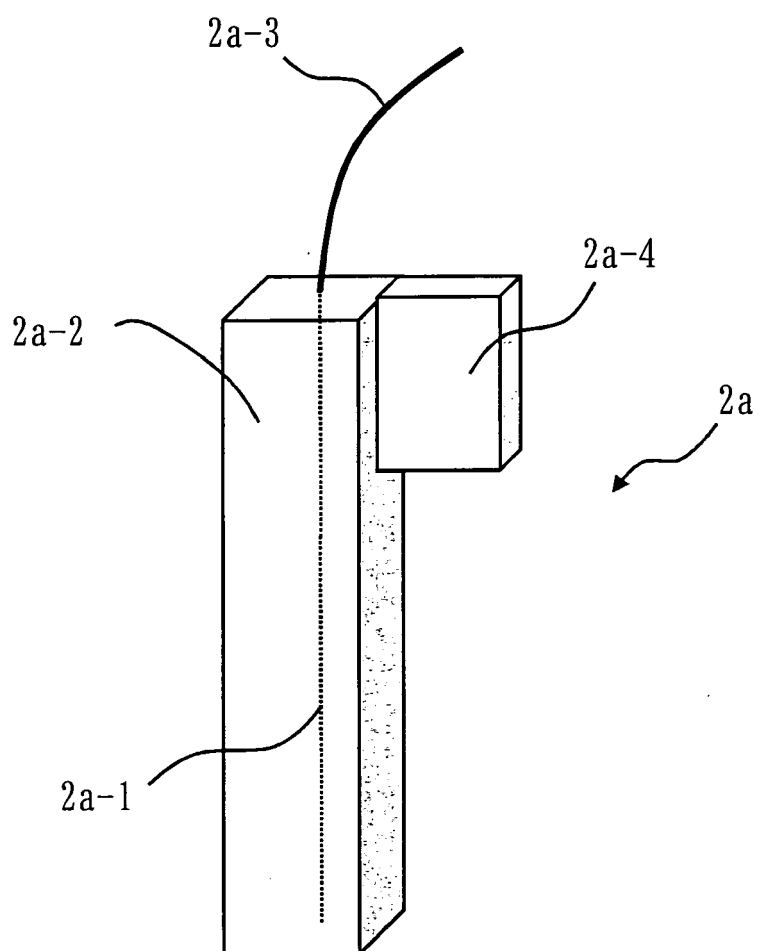


Fig. 10

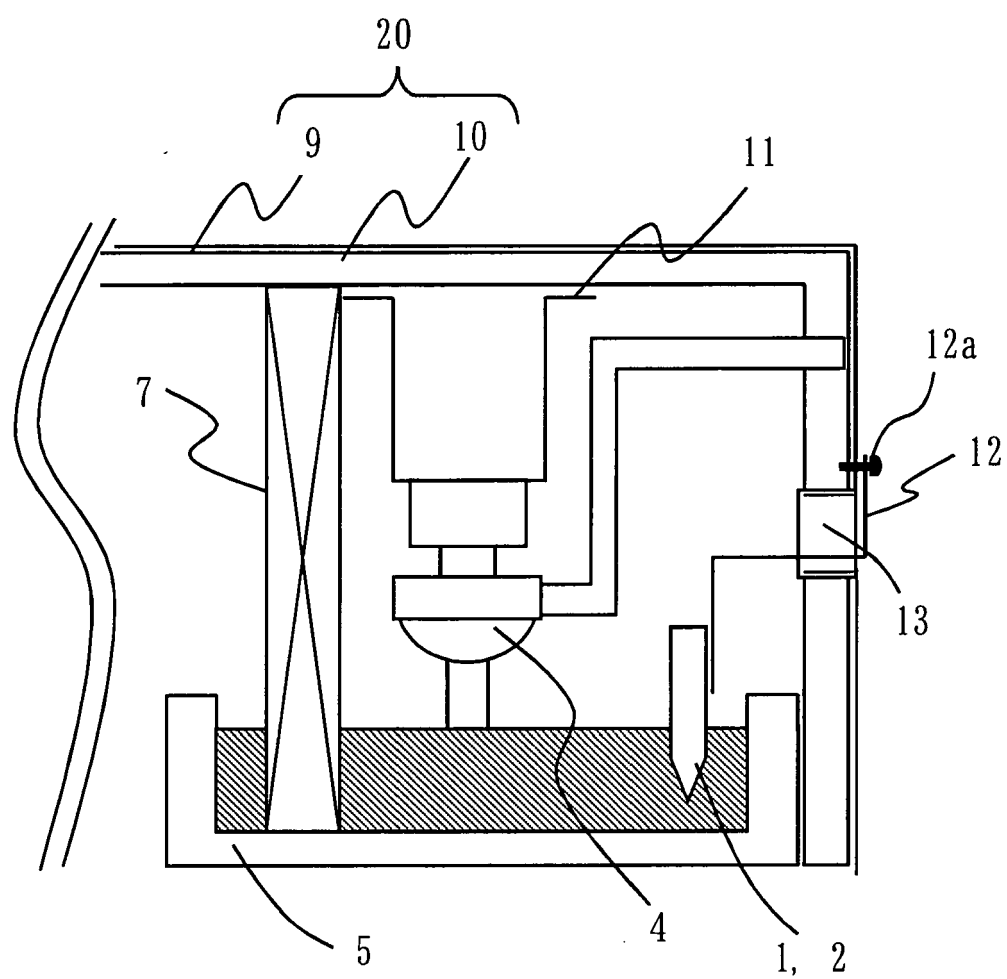
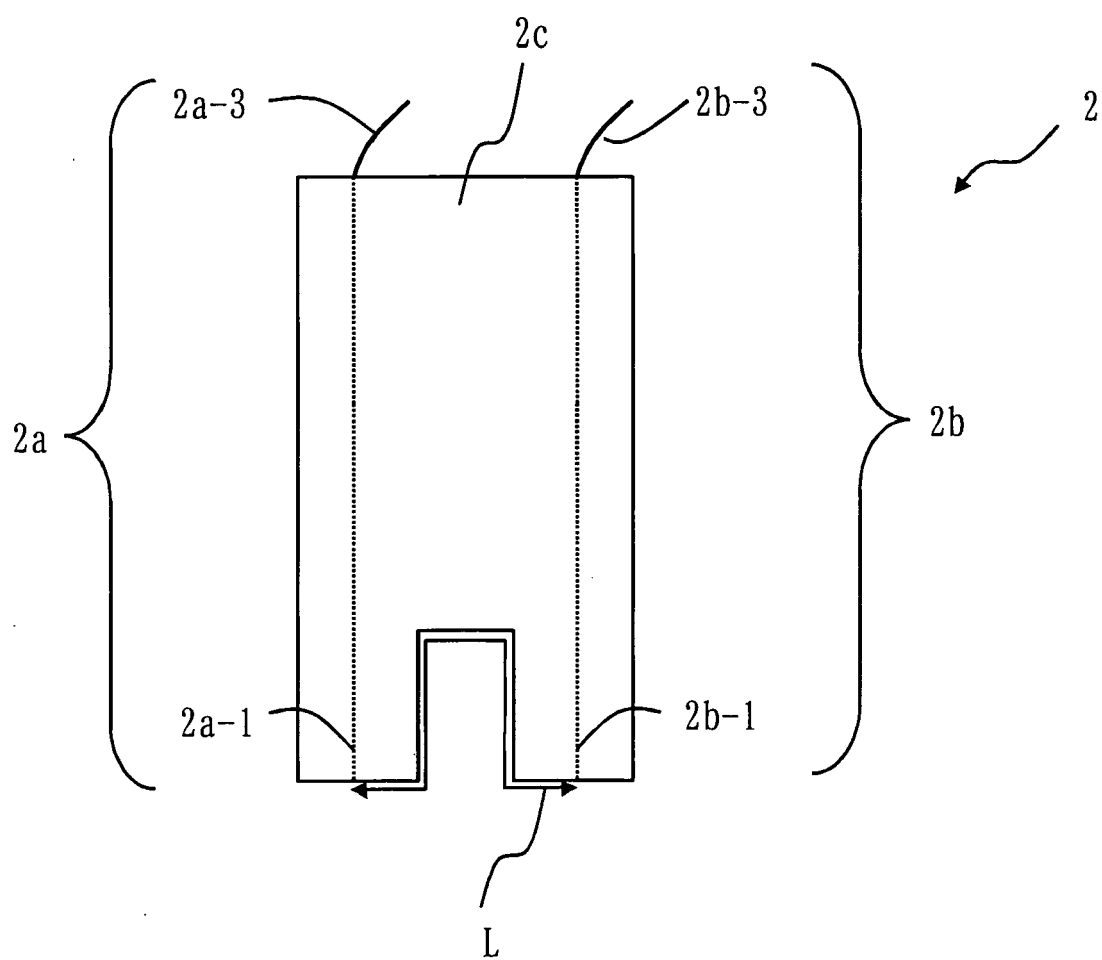


Fig. 11





EUROPEAN SEARCH REPORT

Application Number
EP 09 25 0208

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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The present search report has been drawn up for all claims			
Place of search The Hague		Date of completion of the search 11 September 2009	Examiner Moreno Rey, Marcos
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	

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