



- (51) International Patent Classification:
F25C 1/12 (2006.01)
- (21) International Application Number:
PCT/US2011/067159
- (22) International Filing Date:
23 December 2011 (23.12.2011)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
61/427,763 28 December 2010 (28.12.2010) US
- (71) Applicant (for all designated States except US): **MAN-ITOWOC FOODSERVICE COMPANIES, LLC** [—/US]; 2400 South 44th Street, Manitowoc, WI 54220 (US).
- (72) Inventors; and
- (75) Inventors/Applicants (for US only): **OLSON, William, E., Jr.** [US/US]; 2247 Wiltshire Court, Bellevue, WI 54311 (US). **MILLER, Richard, T.** [US/US]; 7230 Huebner Lane, Manitowoc, WI 54220 (US). **BLAHA, Brad, A.** [US/US]; 1611 25th Street, Two Rivers, WI 54241 (US).
- (74) Agent: **GREELEY, Paul, D.**; Ohlandt, Greeley, Ruggiero & Perle, L.L.P., One Landmark Square, 10th Floor, Stamford, CT 06901-2682 (US).
- (81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

[Continued on next page]

(54) Title: ICE-MAKING MACHINE WITH AIR STERILIZATION FEATURE

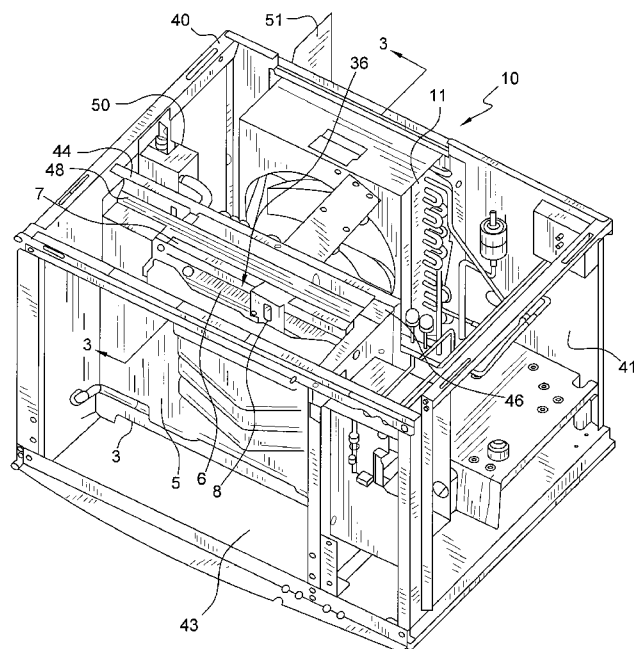


FIG. 1

(57) Abstract: An ice-making machine includes an ice-forming mold in a food zone of the icemaking machine; a refrigeration system including a compressor, a condenser, an expansion device, and an evaporator in thermal contact with said ice-forming mold, thus producing a combined evaporator and ice-forming mold; and a bulkhead wall separating an equipment compartment from the food zone. A bulkhead space is located between the bulkhead wall and the combined evaporator and ice-forming mold. The bulkhead space is part of the food zone. Air in contact with ice being formed by the ice-making machine can circulate to the bulkhead space. The icemaking machine further includes a source of antimicrobially active gas and an air circulation system that causes the antimicrobially active gas to circulate through the bulkhead space.



(84) **Designated States** (*unless otherwise indicated, for every kind of regional protection available*): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Declarations under Rule 4.17:

- *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*
- *of inventorship (Rule 4.17(iv))*

Published:

- *with international search report (Art. 21(3))*

ICE-MAKING MACHINE WITH AIR STERILIZATION FEATURE

BACKGROUND

[0001] The present invention relates to an ice-making machines, and particularly to automatic ice-making machine with an air sterilizing feature, and methods of operation of ice-making machines with an air sterilization feature.

[0002] Automatic ice-making machines have a tendency to foster the growth of microbiological contaminates such as bacteria, yeast, and mold due to their nature as a wet environment with thermally cyclic conditions. To address this, particle-generating devices have been developed that deliver ions, ozone, or a mixture of the two into the food zone of an automatic ice-making machine to help sterilize the air in the device and prolong the periods between sanitizing of the device. However, such devices and methods of operation have not been entirely successful in the past, in part because not all areas of the food zone have been treated.

[0003] In many ice-making machines, equipment such as electrical components and often a compressor are contained within an equipment compartment. The space outside of the equipment compartment, and particularly the space where ice is formed, is known as the food zone, because anything within that zone may come into contact with the ice, which will later come into contact with food. A bulkhead wall is typically used in the ice-making machine to divide the equipment compartment from the food zone.

[0004] Most ice-making machines form ice on an ice-forming mold that is in thermal contact with the evaporator portion of the refrigeration system. Typically the evaporator and ice-forming mold are mounted near the bulkhead wall. The space between the bulkhead wall and the evaporator/ice-forming mold (hereinafter called the bulkhead space) is part of the food zone. However, previous designs for sterilizing air inside of the ice-making machine have not recognized or dealt with the air that is found in the bulkhead space.

[0005] Prior to the development of the present invention, there had been efforts within the inventors' company to deal with keeping any contaminants in the

bulkhead space from reaching other parts of the food zone. One idea was to seal the bulkhead space to keep air in the remainder of the food zone from migrating into and out of this space. However, such efforts have created other unintended consequences, the problems from which outweighed the benefits of sealing the bulkhead space.

[0006] Thus there is a benefit in having a sterilization system that can reduce the growth of microbiological contaminants in the bulkhead space.

BRIEF SUMMARY

[0007] A method of inhibiting growth of microbiological contaminants in the bulkhead space of an ice-making machine has been invented.

[0008] In a first aspect, the invention is a method of inhibiting growth of microbiological contaminants in a food zone within an ice-making machine, wherein the ice-making machine comprises an ice-forming mold in the food zone; a refrigeration system including a compressor, a condenser, an expansion device, and an evaporator in thermal contact with said ice-forming mold, thus producing a combined evaporator and ice-forming mold; a bulkhead wall separating an equipment compartment from the food zone; and a bulkhead space located between the bulkhead wall and the combined evaporator and ice-forming mold, the bulkhead space being a part of the food zone, such that air in contact with ice being formed by the ice-making machine can circulate to the bulkhead space; the method comprising: providing a source of an antimicrobially active gas; and directing the antimicrobially active gas to flow through the bulkhead space to thereby distribute the antimicrobially active gas throughout the bulkhead space.

[0009] In a second aspect, the invention is an ice-making machine comprising an ice-forming mold in a food zone of the ice-making machine; a refrigeration system including a compressor, a condenser, an expansion device, and an evaporator in thermal contact with said ice-forming mold, thus producing a combined evaporator and ice-forming mold; a bulkhead wall separating an equipment compartment from the food zone; a bulkhead space located between the bulkhead wall and the combined evaporator and ice-forming mold, the bulkhead space being a part of the food zone, such that air in contact with ice being formed by the ice-making machine can circulate to the bulkhead space; a source of antimicrobially active gas; and an air circulation

system that causes the antimicrobially active gas to circulate through the bulkhead space.

[0010] The preferred embodiment of the invention uses an ionizing or ozone generating device housed within the equipment compartment. Antimicrobially active gas is directed from that device into the food zone. The device also withdraws air out of the bulkhead space, creating a negative pressure. Antimicrobially active gas from the rest of the food zone then migrates into the bulkhead space where the antimicrobially active gas inhibits growth of microbiological contaminants.

[0011] These and other advantages of the invention, as well as the invention itself, will be more easily understood in view of the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] Figure 1 is a top, front perspective view of an automatic ice-making machine incorporating a preferred embodiment of the invention, with the one side cabinet wall, the front cabinet door and the top cabinet wall removed for sake of clarity.

[0013] Figure 2 is a top, rear perspective view of the automatic ice-making machine of Figure 1.

[0014] Figure 3 is a cross-sectional view taken along line 3-3 of Figure 1.

[0015] Figure 4 is a schematic drawing of the water system of the ice-making machine of Figure 1.

[0016] Figure 5 is a schematic diagram of the refrigeration system of the ice-making machine of Figure 1.

[0017] Figure 6 is a cross-sectional view like Figure 3, but of an ice-making machine using an alternate embodiment of the invention.

[0018] Figure 7 is a perspective view of the ionizing device located in the automatic ice-making machine of Figure 1.

[0019] Figure 8 is a side view of the ionizing device of Figure 7.

[0020] Figure 9 is a cross-sectional view taken along line 9-9 of Figure 8.

[0021] Figure 10 is a cross-sectional view taken along line 9-9 of Figure 8 with the bulb, housing and ballast hidden.

[0022] Figure 11 is an exploded of the ionizing device of Figure 7.

DETAILED DESCRIPTION OF THE DRAWINGS AND THE PRESENTLY PREFERRED EMBODIMENTS

[0023] The present invention will now be further described. In the following passages, different aspects of the invention are defined in more detail. Each aspect so defined may be combined with any other aspect or aspects unless clearly indicated to the contrary. In particular, any feature indicated as being preferred or advantageous may be combined with any other feature or features indicated as being preferred or advantageous.

[0024] Several terms used in the specification and claims have a meaning defined as follows.

[0025] The term “food zone” means the areas inside of the ice-making machine that are contacted by ice made by the machine, or by water that is converted into ice or splashes onto ice made by the machine. The food zone also includes the space where air readily circulates that comes into contact with the surfaces that are used to form ice or contact water used to form ice.

[0026] The term “equipment compartment” is meant to designate the portions of the ice-making machine where mechanical and electrical components that are not intended to contact water are housed. Typically, electronic controls, refrigerant valves, refrigerant tubing, a pump motor, a water inlet valve and a water dump valve are housed within the equipment compartment. Further, in many ice making machines a compressor, a condenser and a condenser fan are also located in the equipment compartment.

[0027] The term “bulkhead wall” means the interior divider that separates the equipment compartment from the food zone. The bulkhead wall is typically made from one or more vertical dividers, but the floor of the equipment compartment may also constitute a bulkhead wall where a portion of the equipment compartment extends over a water trough in the food zone.

[0028] The term “ice-forming mold” means the structure on which ice is formed during normal operation of an ice-making machine. Typically water in contact with the ice-forming mold is frozen into a desired shape. For example, many

ice-forming molds include a grid structure, and ice cubes are formed within the grid cells. Other ice-forming molds may make rounded or pillow shaped pieces of ice, or even slab ice shapes which are thereafter divided. The ice-forming mold is cooled by losing heat to the evaporator portion of the refrigeration system in the ice-making machine. Thus the evaporator is in thermal contact with the ice-forming mold. For example, tubing downstream of a thermal expansion valve forming the evaporator section of a refrigeration system may be brazed onto the back of an ice-forming mold, opposite of the ice-forming surface, to make a combined evaporator and ice-forming mold. Typically the ice-forming surface is oriented in a vertical fashion, and water flows over the surface. Some ice-forming molds are oriented so that water is sprayed up into cups in which the ice cubes are formed.

[0029] The term “bulkhead space” means the space located between the bulkhead wall and the combined evaporator and ice-forming mold. The bulkhead space is typically a part of the food zone because air in contact with ice being formed by the ice-making machine can circulate to the bulkhead space. The bulkhead walls may be wider or taller than the combined evaporator and ice-forming mold. In that instance the bulkhead space includes the portion of the space next to the bulkhead wall that is contiguous with the space directly between the bulkhead wall and the combined evaporator and ice-forming mold. Most ice-making machines have been designed to segregate the bulkhead space from the rest of the food zone. For example, the combined evaporator and ice-forming mold may extend to one or both cabinet side walls, and be sealed at the side walls to prevent water from migrating behind the ice-forming mold. A trim piece may be used to separate the area at the top of the ice-forming mold between the bulkhead space and the rest of the food zone. However, typically the bulkhead space at the bottom of the ice-forming mold is not closed off from the rest of the food zone, and air in the vicinity of the water trough can migrate upwardly into the bulkhead space.

[0030] The term “antimicrobially active gas” means a gas (typically air) that contains one or more chemical species at concentrations effective to impede the growth of microbiological contaminants. Many such species result from treating air containing oxygen and possibly water vapor with a U.V. light or high voltage

electrical charge, and include ozone (triatomic oxygen), hydroxyl radicals, hydroxyl ions, hydrogen peroxide, atomic oxygen, atomic oxygen ions, diatomic oxygen ions, H⁺ ions, HOO⁻ (hydroperoxyl radicals) and nitrogen ions. Other chemical species that can be used to make antimicrobially active gas include chlorine, chlorine dioxide and ammonia.

[0031] The preferred ice-making machine of the present invention is very similar to a model S-0450 ice machine sold by Manitowoc Ice, Inc., Manitowoc, Wisconsin. Many parts of the machine are the same as those shown in U.S. Patents No. 6,681,580; No. 6,907,744; No. 6,993,929; No. 7,032,406, No. 7,284,391 and No. 7,340,913 (each of which are incorporated herein by reference), and are therefore not shown or discussed in detail.

[0032] The preferred ice-making machine 10 of the present invention has three major systems: a refrigeration system, a water system and an air sterilization system. These systems are housed in a cabinet 40. Components and systems of a first embodiment of an automatic ice-making machine 10 utilizing the present invention are shown in Figures 1-5. Figure 4 is a schematic drawing of the water system. Figure 5 is a schematic diagram of the refrigeration system.

[0033] As shown in Figure 4, the preferred water system, which is conventional for Manitowoc-brand cube ice machines, includes a water supply or inlet 1. A water level probe 2 is used to control the depth of water in a sump or water trough 3. A circulating pump 4 draws water out of the sump and pumps it up to a distributor 7. Water falls from the distributor 7 over the ice-forming mold, sometimes also known as an evaporator plate 6. A water curtain 5 keeps water from splashing out of the front of the water compartment and directs water that does not freeze back into the sump 3. An ice thickness sensor or probe 8 is used to monitor the build-up of the ice bridge on the front of the ice-forming mold 6. When the machine goes into a harvest mode, a solenoid valve 9 is opened to allow water from the sump to enter a drain line. Alternatively, the drain line and solenoid 9 can be located after the pump, so that the water in the sump is pumped out to the drain. Figure 1 shows several of these components, although the water level probe 2, water line and circulating pump 4 are obscured in the perspective view of Figure 1.

[0034] The preferred refrigeration system is also conventional in its overall components and arrangement, as shown in Figure 5. The refrigeration system includes a compressor 14, a condenser 11 (which may be air or water cooled), an expansion device 13, such as an expansion valve, an evaporator 12 and interconnecting lines 15, 20 and 26 therefore. The evaporator 12 is preferably made with refrigerant channels formed in a serpentine shape, such as serpentine coils of tubing 38. A hot gas solenoid valve 30, drier 21 and, on water cooled units, a receiver 17 are also preferably included in the refrigeration system. Figures 1 and 2 show several of these components, although the compressor 14 and expansion device 13 are obscured in the perspective view of Figure 2, but the hot gas solenoid valve 30 can be seen, along with the water inlet solenoid valve 42 and the water dump solenoid valve 9. Figures 1 and 2 also show the location of the electrical controls housed in the equipment compartment 41. An air baffle 51 is shown installed on the back of the machine, used to prevent air from the condenser fan from recirculating. The present invention can also be used on an ice-making machine utilizing cool vapor defrost. The refrigeration system for such a machine is shown in U.S. Patent No. 6,196,007. In that machine, the compressor is located in a separate machine cabinet.

[0035] The ice-forming mold is preferably part of a combined evaporator and ice-forming mold, also referred to as an evaporator assembly 36, best seen in Figures 1 and 3. The ice-forming mold itself is made up of an evaporator pan 32 and dividers 34. The evaporator tubing coils 38 are attached in thermal contact to the back side of the evaporator pan 32, which is preferably flat, to make up the evaporator assembly 36. The back side of the evaporator pan forms the back surface of the ice-forming mold 6 (Figure 3). The dividers 34, also sometimes referred to as grids, divide the area inside of the evaporator pan into pockets 33 in which individual ice cubes are frozen. The ice-forming mold has an open front face. Water runs down over this front face and wicks to the inside of the pockets 33 during the freeze mode. Water freezing over the edges of the dividers 34 forms ice bridges between the cubes frozen in the individual pockets. The thickness of the ice bridges and the ice cubes themselves are monitored by the ice thickness sensor 8 in a conventional manner. When the ice bridge reaches a desired thickness, the ice machine control system,

which is also conventional, triggers the ice machine to enter the harvest mode. As shown in Figure 3, the horizontal dividers are sloped so that the pockets 33 have a bottom surface that is sloped downwardly at the front, open face of the ice-forming mold 6. This is conventional, and in this regard gravity is used to release ice cube slabs from the ice-forming mold 6 during the defrost cycle.

[0036] The equipment compartment 41 is separated from the food zone 43 by bulkhead walls 44 and 46. Figure 3 shows the bulkhead space 45, in between bulkhead wall 44 and evaporator assembly 36. As evident from Figure 3, air in contact with ice being formed on ice-forming mold 6 can circulate to the bulkhead space 45. The bulkhead space is generally closed off from the remainder of the food zone along at least one side of the ice-forming mold. In this case, as is typical, it is closed off from the remainder of the food zone along three sides: the top and both vertical sides. As best seen in Figures 1 and 3, a trim piece 48 detachably connected to the ice-forming mold 6 generally closes off the bulkhead space from the remainder of the food zone along the top side of the ice-forming mold 6.

[0037] The air sterilization system used in ice machine 10 includes a source of antimicrobially active gas; and an air circulation system that causes the air containing antimicrobially active gas to circulate through the bulkhead space. While the source of antimicrobially active gas could be located outside of the cabinet, in the ice machine 10 the source of antimicrobially active gas comprises an ionizing device 50 located in the ice-making machine. The preferred ionization device creates antimicrobially active gas in air that passes through the device.

[0038] There are two preferred methods of directing antimicrobially active gas to circulate through the bulkhead space 45. The first is by withdrawing air from the bulkhead space near the at least one side that the bulkhead space is generally closed off from the remainder of the food zone while providing a source of antimicrobially active gas adjacent the bulkhead space opposite the at least one side, and allowing the antimicrobially active gas to flow into the bulkhead space as air is withdrawn. The second method is by introducing the antimicrobially active gas into a region of the bulkhead space distant from an outlet of the bulkhead space and causing the incoming air containing antimicrobially active gas to displace air already in the bulkhead space.

[0039] The first method is preferably accomplished with the embodiment of Figures 1-5, with the ionizing device 50 located in the equipment compartment 41, and using an intake tube 56 connected to the ionizing device 50 to withdraws air out of the bulkhead space 45, with the intake tube 56 penetrating through the bulkhead wall 44. A discharge tube 52 from the ionizing device 50 is used to discharge antimicrobially active gas from the ionizing device 50. That discharge tube 52 also penetrates through the bulkhead wall 44. The discharge tube from the ionizing device also passes through the trim piece 48 to discharge the antimicrobially active gas on the side of the combined evaporator and ice-forming mold 6 opposite the bulkhead space 45.

[0040] The air circulation system comprises a housing containing a fan, tubing 52 for discharging antimicrobially active gas, and tubing 56 connected to the housing through which air is drawn into the housing. As seen in Figure 3, the tubing 52 has an outlet 54 into the food zone 43, and tubing 56 has an inlet 58 located in the bulkhead space 45. The fan in the housing causes air to be drawn in from the bulkhead space 45, and discharges antimicrobially active gas into the food zone 43. However, because of the negative pressure created in the bulkhead space 45, the antimicrobially active gas travels as shown by arrows 60 to where it can enter the bottom of the bulkhead space 45. Thus the air sterilization system directs the antimicrobially active gas to flow though the bulkhead space 45 to thereby distribute the antimicrobially active gas throughout the bulkhead space 45.

[0041] The embodiment of Figure 6 also uses the first method of directing antimicrobially active gas to circulate through the bulkhead space. The ice machine 110 is very similar to the ice machine 10 of Figures 1-5. The same reference numbers with an addend of 100 are thus used in Figure 6 to designate the corresponding parts of ice machine 110. The major difference in the embodiment of ice machine 110 is that the ionizing device 150 is located in the food zone 143, and the tube 156 that withdraws air out of the bulkhead space 145 into an ionizing device 150 penetrates through the trim piece 148. The antimicrobially active gas is discharged from the ionizing device from port 152 directly into the food zone 143, as shown by arrows 160.

[0042] As seen in Figures 7-11, ionizing device 50 comprises a housing 70 (which includes a port cover 71), an ion generator 72 and a fan 74 (including a combined fan housing and intake port 73). The fan 74 forces air to i) be drawn into the housing 70 through intake 75, ii) pass the ion generator 72 and iii) discharge from the housing 70 through exhaust 76. The ion generator may be in the form of a bulb that produces U.V. light, surrounded by a U.V. chamber 77 through which the fan directs the flow of air. The ionizing device 50 may also include a ballast 78, as well as bulb fitting 81 and bulb mounts 82 and 83, a fan mount 84, and power source leads 85. Preferably the air is drawn from the bulkhead space 45 into the ionizing device 50 via a tube 56, and the ionizing device ionizes the air in the ionizing device and then discharges that air into the food zone. The ionizing device is connected to the bulkhead space by intake tube 56 that penetrates through the bulkhead wall, and discharges antimicrobially active gas through a discharge tube 52 that penetrates through the bulkhead wall 44. As used herein, the terms “tube” and “tubing” include not only a hollow body of material used for conveying gases, but any fitting that includes a passageway that continues the passageway in the tubing proper. Thus the tubes 52 and 56 can penetrate through the bulkhead wall 44 by connecting to a fitting mounted in the bulkhead wall that includes passageways through the bulkhead wall, with the tubing 52 and 56 fit over barbed connectors (not shown) on the fitting.

[0043] Another possible ion generator comprises a pair of opposite-polarity electrodes and produces hydroperoxyl radicals. One of the electrodes is a negative electrode and the other electrode is an electrode that is cycled at positive electrical potential. As air moves across the cycled positive electrode, water molecules in the airflow are split into O_2 molecules and H^+ ions, and as the air further moves past the negative electrode, electrons are absorbed by the airflow and convert the O_2 molecules and H^+ ions into O_2^- ions and H atoms, which then join to form HOO- (hydroperoxyl radicals). One electrode is a ceramic plate electrode that is cycled at positive electrical potential from 0kV to approximately +2.95kV at a frequency of 230Hz. One electrode is a metal pin electrode that is at a constant negative potential of approximately -4.0kV.

[0044] Rather than generating ions, the antimicrobially active gas can be made by generating ozone in air or adding chlorine gas to air. A number of patents describe ways of generating ozone in air passing through a housing, such as U. S. Patent No. 6,428,756; and U.S. Patent Publications No. 2007/0163283 and No. 2009/0142225, each of which is hereby incorporated by reference. A ozone generating device that can be used in the present invention is sold by BioZone Scientific International Inc., Linnoitustie 4 B, 02600 Espoo Finland under the trademark "ICEZONE".

[0045] It should be understood that various changes and modifications to the presently preferred embodiments described herein will be apparent to those skilled in the art. For example, some ice-making machines utilize remote condensers, in which case the condenser is not located in the same cabinet as the compressor and the ice-forming mold. Other ice machines may have dual evaporators, meaning that they have two ice-forming mold/evaporator combinations in the same food zone. However, in both of these types of machines, there is still a bulk head wall separating the food zone from the equipment compartment, and a bulkhead space between the combined ice-forming mold and evaporator and that bulkhead wall to which the present invention may be applied. Such changes and modifications can be made without departing from the spirit and scope of the present invention and without diminishing its intended advantages. It is therefore intended that such changes and modifications be covered by the appended claims.

Claims

1. A method of inhibiting growth of microbiological contaminants in a food zone within an ice-making machine, wherein the ice-making machine comprises an ice-forming mold in the food zone; a refrigeration system including a compressor, a condenser, an expansion device, and an evaporator in thermal contact with said ice-forming mold, thus producing a combined evaporator and ice-forming mold; a bulkhead wall separating an equipment compartment from the food zone; and a bulkhead space located between the bulkhead wall and the combined evaporator and ice-forming mold, the bulkhead space being a part of the food zone, such that air in contact with ice being formed by the ice-making machine can circulate to the bulkhead space; the method comprising:

- a) providing a source of antimicrobially active gas; and
- b) directing the antimicrobially active gas to flow through the bulkhead space to thereby distribute the antimicrobially active gas throughout the bulkhead space.

2. The method of claim 1 wherein the bulkhead space is generally closed off from the remainder of the food zone along at least one side of the ice-forming mold, and the antimicrobially active gas is directed through the bulkhead space by withdrawing air from the bulkhead space near said at least one side while providing a source of antimicrobially active gas adjacent the bulkhead space opposite said at least one side, and allowing the antimicrobially active gas to flow into the bulkhead space as air is withdrawn.

3. The method of claim 2 wherein the air withdrawn from the bulkhead space is drawn into an ionizing device via a tube, and the ionizing device ionizes components in the air in the ionizing device and then discharges that air into the food zone.

4. The method of claim 3 wherein the ionizing device is located in the equipment compartment, and the tube that draws air out of the bulkhead space penetrates through the bulkhead wall, and a tube is used to discharge the

antimicrobially active gas from the ionizing device, that discharge tube penetrating through the bulkhead wall.

5. The method of claim 4 wherein a trim piece connected to the ice-forming mold generally closes off the bulkhead space from the remainder of the food zone along said at least one side of the ice-forming mold, and the discharge tube from the ionizing device also passes through the trim piece to discharge the air on the side of the combined evaporator and ice-forming mold opposite the bulkhead space.

6. The method of claim 3 wherein a trim piece connected to the ice-forming mold generally closes off the bulkhead space from the remainder of the food zone along said at least one side of the ice-forming mold, and the ionizing device is located in the food zone, and the tube that draws air out of the bulkhead space penetrates through the trim piece.

7. The method of claim 6 wherein the antimicrobially active gas is discharged from the ionizing device directly into the food zone.

8. The method of claim 3 wherein the ionizing device comprises a housing, an ion generator and a fan, and the fan forces air to i) be drawn into the housing, ii) pass the ion generator and iii) discharge from the housing.

9. The method of claim 1 wherein the antimicrobially active gas is directed through the bulkhead space by introducing the antimicrobially active gas into a region of the bulkhead space distant from an outlet of the bulkhead space and causing the incoming air containing the antimicrobially active gas to displace air already in the bulkhead space.

10. An ice-making machine comprising:
a) an ice-forming mold in a food zone of the ice-making machine;
b) a refrigeration system including a compressor, a condenser, an expansion device, and an evaporator in thermal contact with said ice-forming mold, thus producing a combined evaporator and ice-forming mold;

- c) a bulkhead wall separating an equipment compartment from the food zone;
- d) a bulkhead space located between the bulkhead wall and the combined evaporator and ice-forming mold, the bulkhead space being a part of the food zone, such that air in contact with ice being formed by the ice-making machine can circulate to the bulkhead space;
- e) a source of antimicrobially active gas; and
- f) an air circulation system that causes the antimicrobially active gas to circulate through the bulkhead space.

11. The ice-making machine of claim 10 wherein the bulkhead space is generally closed off from the remainder of the food zone along at least one side of the ice-forming mold, and the air circulation system causes the antimicrobially active gas to circulate through the bulkhead space by withdrawing air from the bulkhead space near said at least one side while providing a source of antimicrobially active gas adjacent the bulkhead space opposite said at least one side, and allowing the antimicrobially active gas to flow into the bulkhead space as air is withdrawn.

12. The ice-making machine of claim 10 wherein the air circulation system comprises a housing containing a fan and tubing connected to the housing through which air is drawn into the housing.

13. The ice-making machine of claim 12 wherein the tubing connected to the housing through which air is drawn into the housing has an inlet located in the bulkhead space.

14. The ice-making machine of claim 10 wherein the source of antimicrobially active gas comprises an ionizing device located in the ice-making machine.

15. The ice-making machine of claim 14 wherein the ionizing device is located in the equipment compartment.

16. The ice-making machine of claim 14 wherein the ionizing device is located in the food zone.

17. The ice-making machine of claim 15 wherein the ionizing device is connected to the bulkhead space by an intake tube that penetrates through the bulkhead wall, and discharges the antimicrobially active gas through a discharge tube that penetrates through the bulkhead wall.

18. The ice-making machine of claim 17 wherein the bulkhead space is generally closed off from the remainder of the food zone along at least one side of the ice-forming mold by a trim piece connected to the ice-forming mold, and the discharge tube from the ionizing device also passes through the trim piece to discharge the antimicrobially active gas on the side of the combined evaporator and ice-forming mold opposite the bulkhead space.

19. The ice-making machine of claim 16 wherein the bulkhead space is generally closed off from the remainder of the food zone along said at least one side of the ice-forming mold by a trim piece connected to the ice-forming mold, and an intake tube penetrates through the trim piece and is used to withdraw air out of the bulkhead space into the ionizing device.

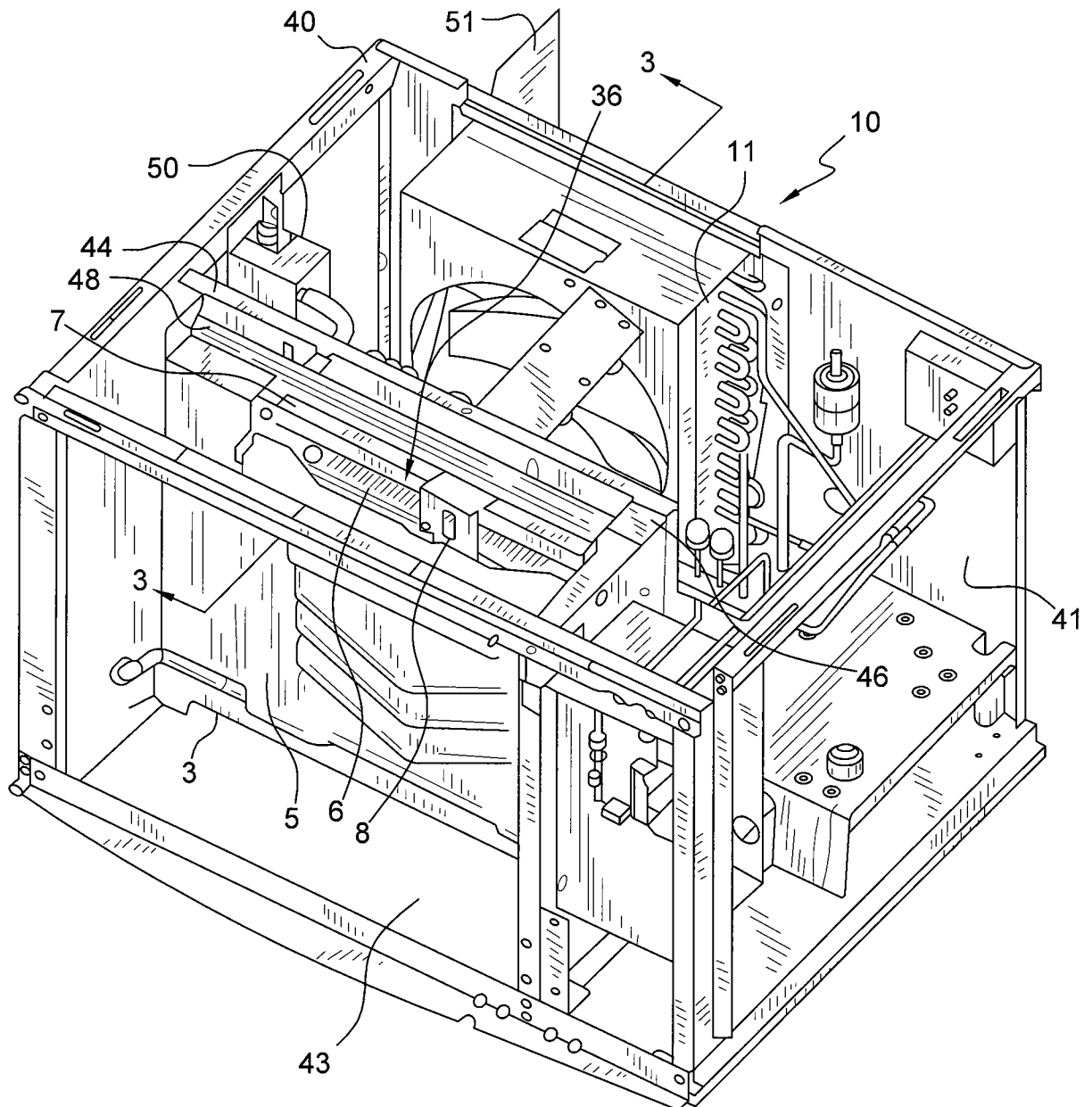


FIG. 1

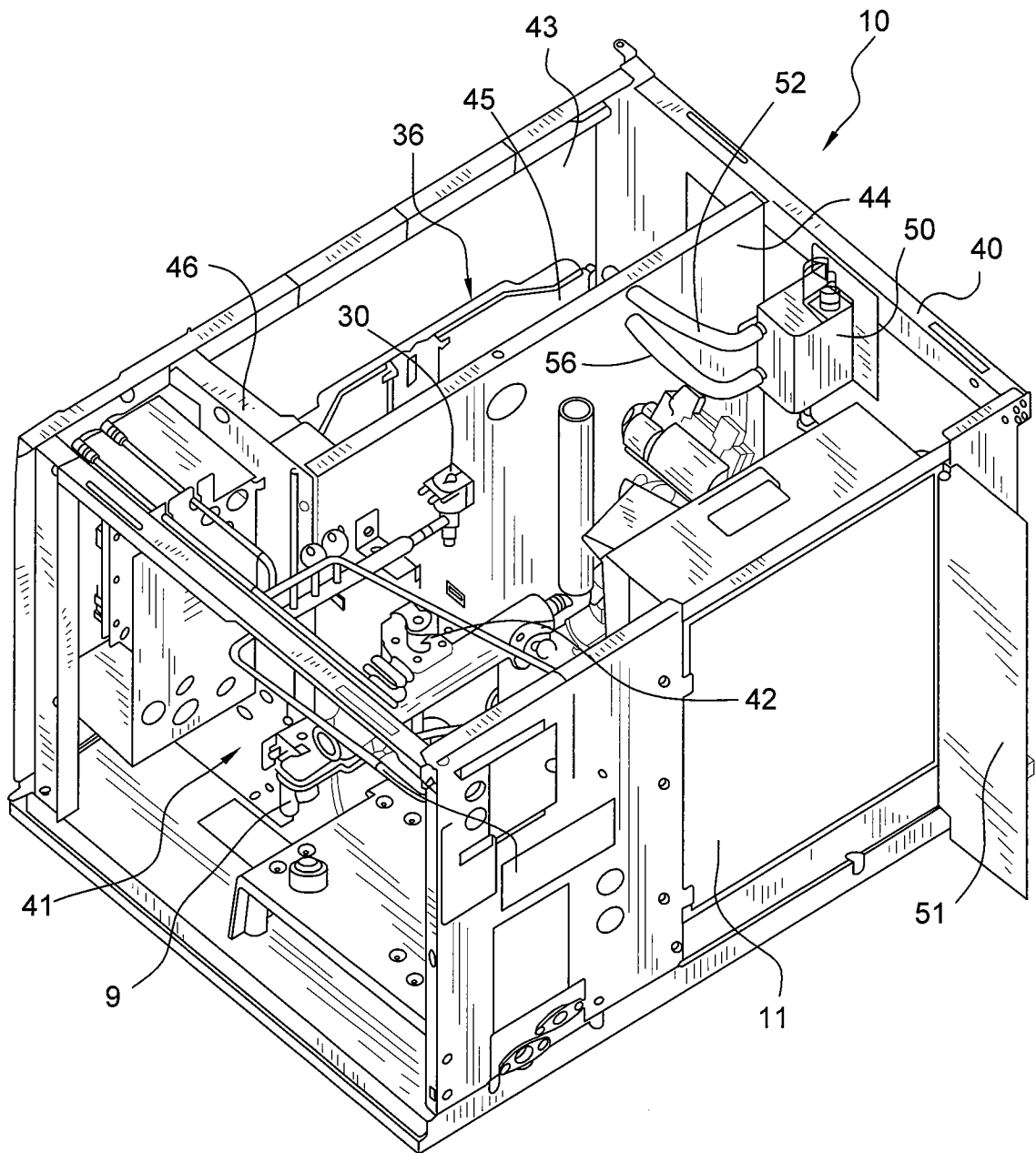


FIG. 2

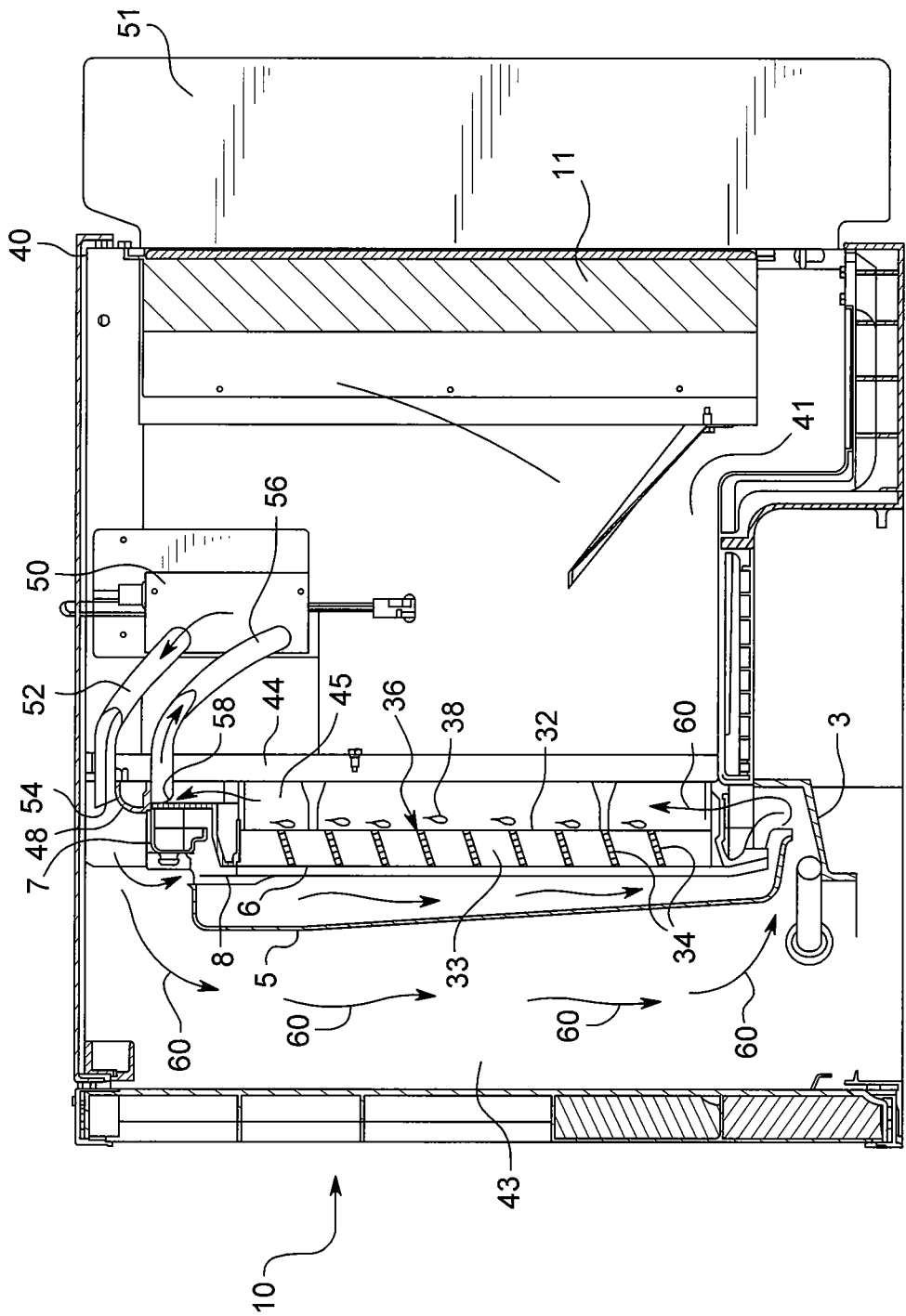


FIG. 3

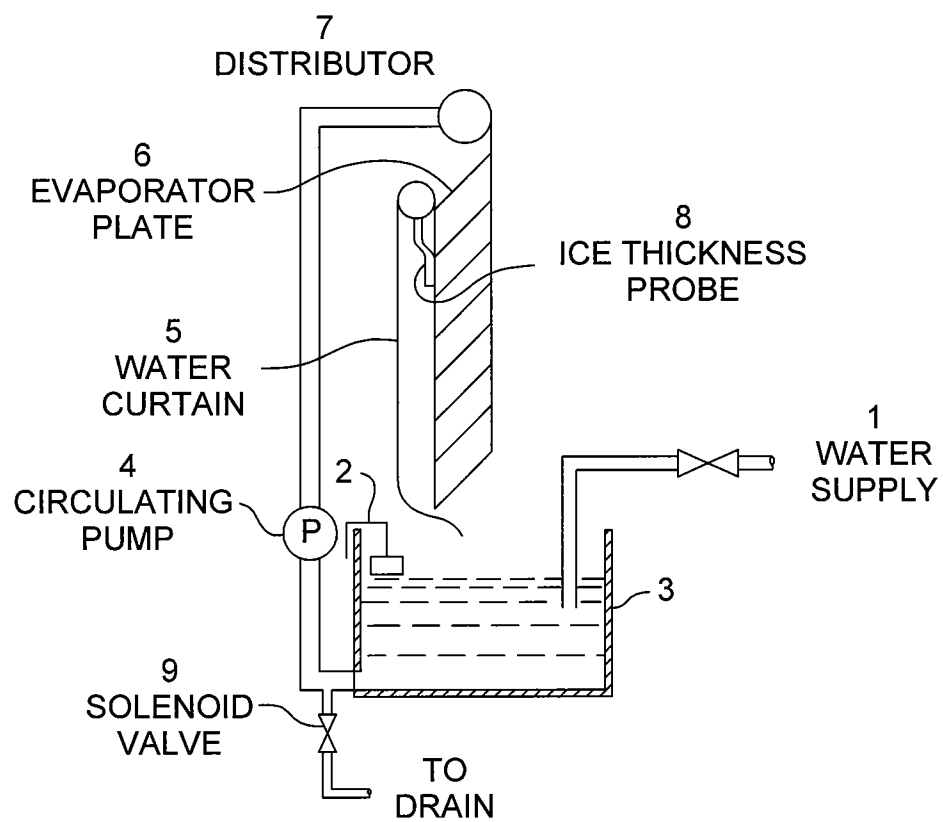


FIG. 4

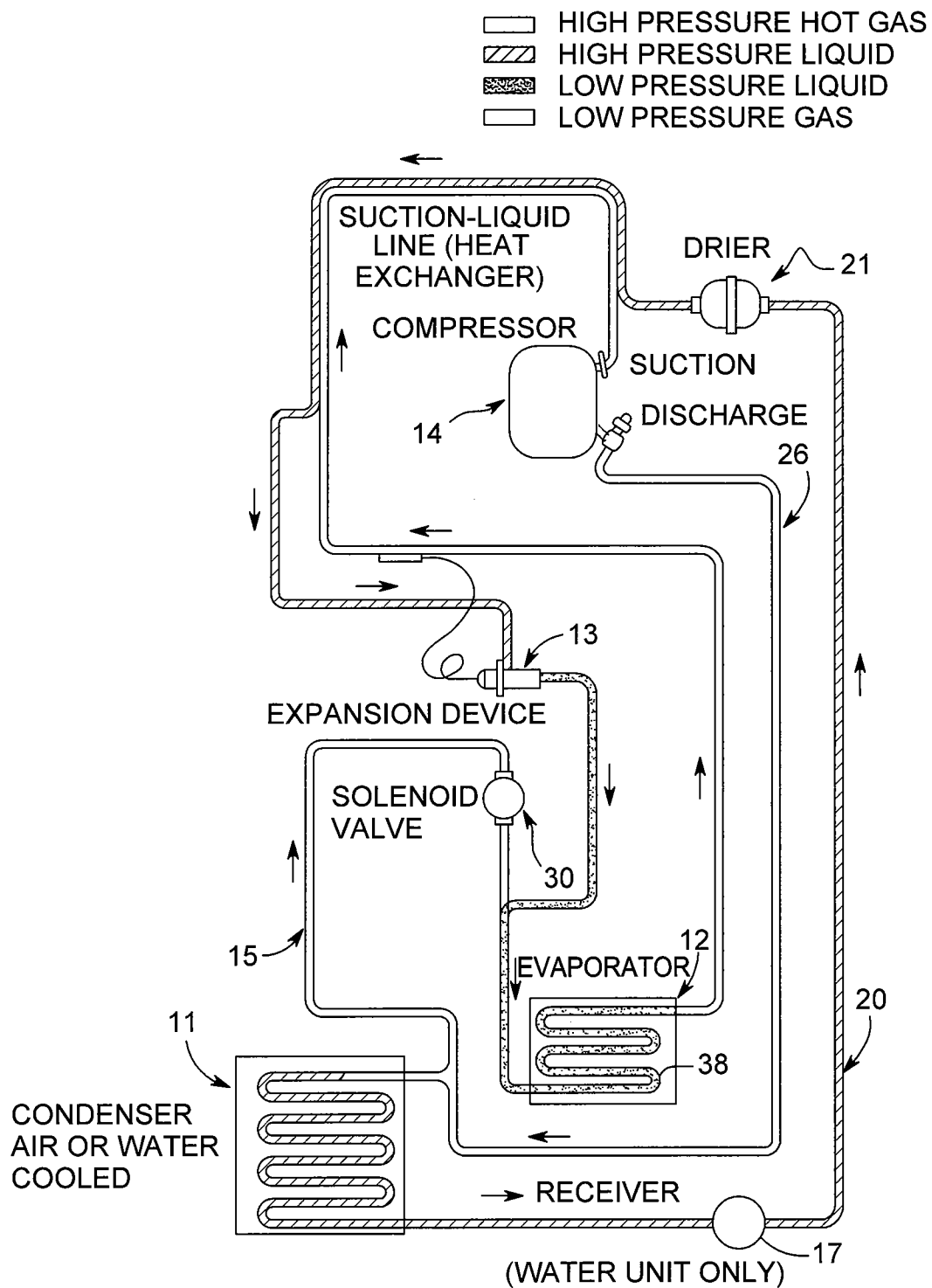
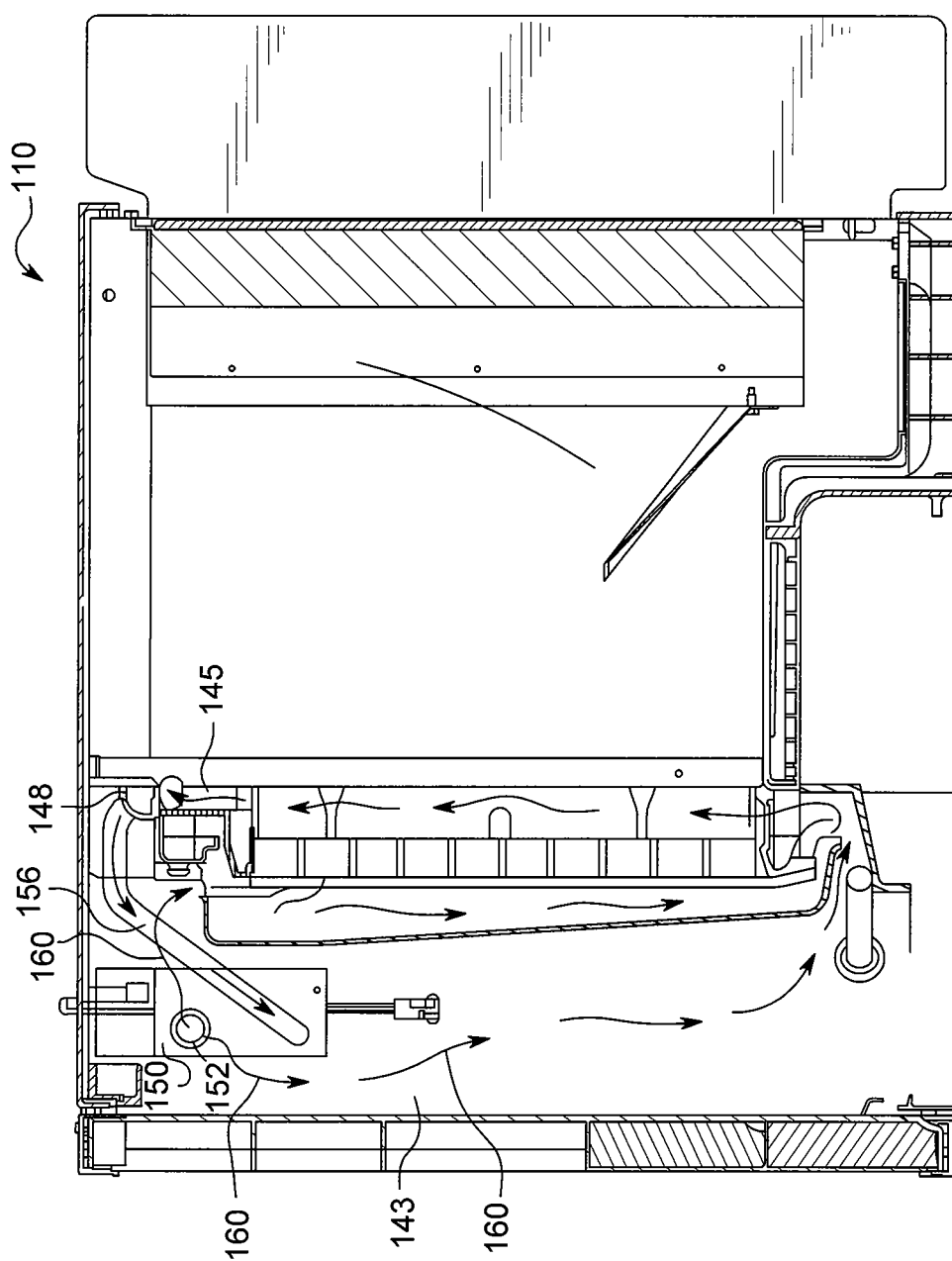


FIG. 5



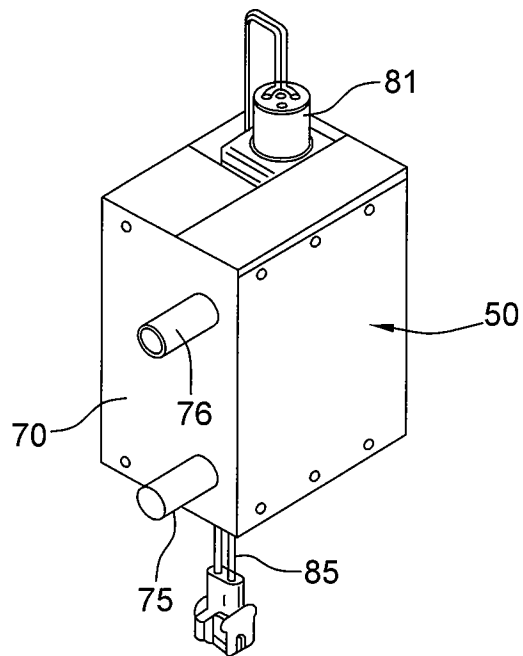


FIG. 7

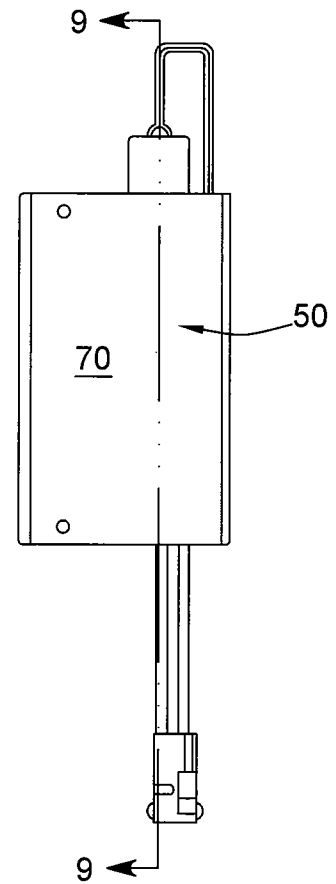


FIG. 8

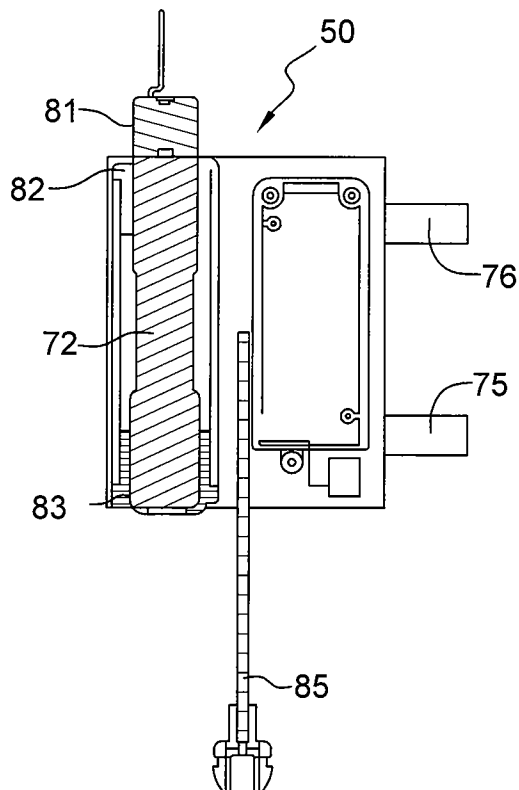


FIG. 9

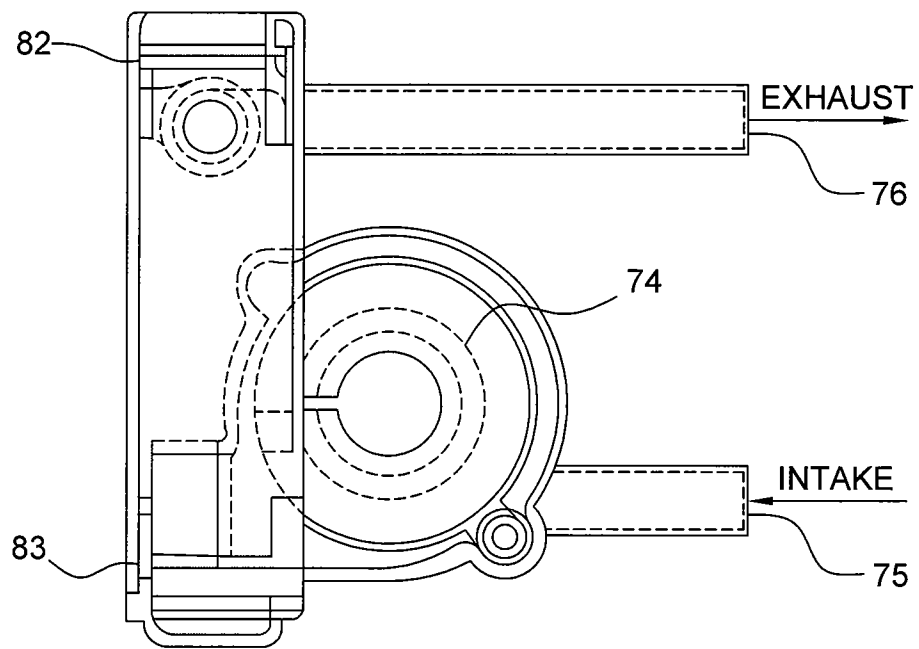


FIG. 10

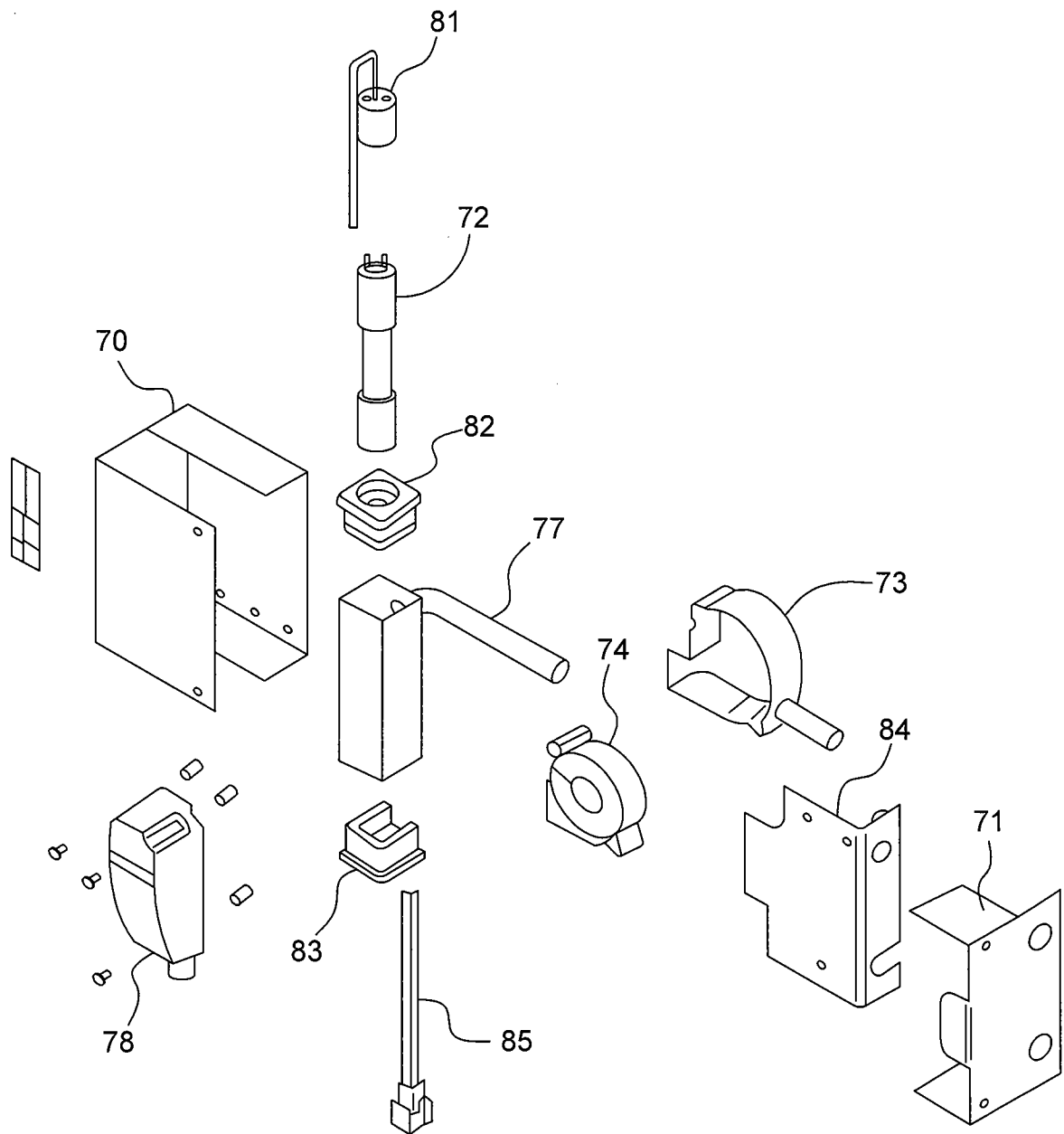


FIG. 11

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2011/067159

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - F25C 1/12 (2012.01)

USPC - 62/352

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)

IPC(8) - F25B 5/02; F25C 1/00, 1/12, 5/00 (2012.01)

USPC - 62/285, 340, 352

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

PatBase, Google Patents

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2003/0046942 A1 (SHEDIVY et al) 13 March 2003 (13.03.2003) entire document	1, 10
----- Y		----- 2-9, 11-19
Y	US 6,109,043 A (LU et al) 29 August 2000 (29.08.2000) entire document	2-9, 11
Y	US 4,974,375 A (TADA et al) 04 December 1990 (04.12.1990) entire document	3-8, 12-19
Y	US 6,182,453 B1 (FORSBERG et al) 06 February 2001 (06.02.2001) entire document	8

☐ Further documents are listed in the continuation of Box C.

* 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

10 April 2012

Date of mailing of the international search report

19 APR 2012

Name and mailing address of the ISA/US

Mail Stop PCT, Attn: ISA/US, Commissioner for Patents
P.O. Box 1450, Alexandria, Virginia 22313-1450

Facsimile No. 571-273-3201

Authorized officer:

Blaine R. Copenheaver

PCT Helpdesk: 571-272-4300
PCT OSP: 571-272-7774