Title: PORTABLE/ POTABLE WATER RECOVERY AND DISPENSING APPARATUS

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TECHNICAL FIELD

This invention relates to a portable, potable water dispenser capable of recovering liquid water for human use from the humidity of environmental air and sanitizing it for human use. The water generator of this invention draws in moisture-laden air from the surroundings and recovers liquid water by cooling the stream of air below its dew point. The unit can be powered from mains, single/ 3-phase, or portable generators, AC, 110-220 V, 50-60 Hz, or from DC power, 6-60 V batteries. The apparatus includes optional air filters which remove suspended pollen or dust particles so that contaminants and undesirable impurities from the environmental air are not carried into the dew-forming section. The apparatus also includes optional heating, cooling. The most important feature of the of the basic unit and its variants are filtration and sterilization systems which provide purified liquid water free from contaminants and volatile organic compounds (VOC) as defined by NSF Standard 53. The external envelope of the present apparatus is a compact, attractive, furniture-type wheeled design and one embodiment is further adapted to prevent entry of insects. The water generators of this invention employ ruggedized design and construction and certain embodiments are intended to operate untended for extended periods in harsh, military-type environments such as peacekeeping actions, fires, earthquakes and weather disasters/ emergencies. Other embodiments are intended to operate in land-transport vehicles, e.g., bus, train, seagoing vessels, recreational vehicles, business or home office environments. Further hybrid embodiments lend themselves to incorporation into icemakers, refrigerators, drink coolers, water coolers, etc. Still further compact, luggage-type embodiments can be provided for travel or sports use. Additionally,various embodiments can be fitted with an input port for impure water for priming, for increased output capacity and for operation under conditions when environmental temperature and/ or humidity do not allow enough water to be generated.

BACKGROUND OF THE INVENTION

The consensus of most medical experts is that the water supply is the single most critical factor to human health. Over 400,000 people were stricken, 4,000 hospitalized and over 100 people died in Milwaukee in 1993 from Cryptosporidium, a bacterial contaminant in their city-treated drinking water. Natural Resources Defense Council estimates that in the US alone more than 900,000 become ill each year from water-borne disease and as many as 900 will die. There is also an increasing awareness that "bottled water" itself may be no safer than municipally treated water. Some citizens feel protected by household-type water filters. However, of the over 2,000 types/ styles/ sizes of filters now being sold to the public for additional treating of city water, only a few remove significant amounts of parasites, viruses, bacteria, pesticides and heavy metals. While

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contaminated water is harmful to adults, infants and young children are at much greater risk from drinking impure water, particularly water with high levels of heavy metals or radioisotopes. While the situation is bad in parts of the United States, it is worse in many other developed countries and absolutely frightening in third-world countries. In developing nations, there is often at least intermittent electricity but no source for potable, or human drinking water. For clinics and hospitals in such remote areas, doctors and technicians need purified water for scrubbing and to prepare medicines. In the case of remote villages in developing countries, there is a need for a unit which generates and dispenses purified water, is easily moved, is relatively inexpensive to manufacture and which can operate from a variety of different types of electrical power with a minimum of maintenance.

The most common potable water dispenser for use in the home and office is the 20-liter glass or plastic bottle placed on a gravity-flow dispensing stand. The bottles usually provide processed spring or well water and are generally sold with a representation of compliance with state and local health codes for potable water. One major drawback to "bottled water" is the fact that filled containers are heavy, approx. 25-30 Kg, and awkward to change. Another problem is that algae can build up in the user's stand; this necessitates periodic cleaning to maintain water safety. Relative to dissolved and suspended contaminants and undesired impurities, "bottled water" may be no safer than municipal water.

At this time, the USA market for portable, potable water sources requires: (a) generation of high-quality water which is certifiably free of all impurities which are health hazards even to infants and children, (b) no necessity for storing and moving heavy bottles, (c) no requirement for expensive, complex maintenance procedures/ cleaning, (d) low operating cost, (e) no special wiring/ plumbing for installation and (f) attractive, office-furniture styling.

BACKGROUND ART

Current US Environmental Protection Agency (EPA) standards for impurities in primary and secondary drinking water are included as p.32-34 of the publication, "Drinking Water Treatment Units Certified by NSF International", NSF International, Ann Arbor, MI (1995). These 1995 drinking water-standards of US Environmental Protection Agency, ANSI/NSF-53, are included by reference. The specific analytical chemistry methods for each impurity covered by NSF-53 are described in EPA publications in US Federal Register.

There are several US patents which disclose reverse-cycle refrigeration as the cooling means for a water generator:

US3675442, issued Jul 1972 to Swanson, Swanson-442

US4204956, issued May 1980 to Flatow, Flatow-956

US5149446, issued Jan 1991, to JJ Reidy, Reidy-446;

US5106512, issued Apr 1991 to JJ Reidy, Reidy-512;

US5227053, issued Jul 1993 to Brym, Brym-053

US5259203, issued Nov 1993 to DR Engel et al, Engle-203; and

US5301516, issued Apr 1994 to F Poindexter, Poindexter-516.

US5517829, issued May 1996 to Michael, Michael-829

US5553459, issued Sep 1996 to Harrison, Harrison-459

None of the water generators disclosed in these publications are designed primarily as a dispenser and, none are designed as portable units. Swanson-442, provides a large, heavy apparatus, and specifically teaches that small, portable units are relatively inefficient.

None of these publications disclose the following features or embodiments:

Compact, wheeled, office-equipment housing

Integral, external fluid-delivery valves and controls

Ion generator for discharged air stream

Insect-resistant port covers/ screens, access doors, edge joints

Ultrasonic pest deterrent

Ozone generator for water sterilization treatment

Handle grips for easy movement by lifting or rolling

Medical/ food-handling-type tubing and joints for water handling subsystems

Chemically-inert, thermally-conductive dew-collector surface films

Working fluids in heat absorbers which comply with 1996-edition DOE, EPA and ASHRAE standards/ regulations (such as refrigerant fluid 406A)

Ruggedized, long-life components and sub-systems

Safe, convenient dispensing height for hot or cold water

Electrostatic air filter with whistle alarm for blocked condition

Attached liquid container dispenser

Night lights for controls and delivery valves for low-light situations.

Air-heating strip and fan on compressor (for outside units).

The publications noted above disclose: (a) industrial water-condensation units designed to be permanently-attached to building air ducts, or (b) water purifiers, not portable dispensers.

Reidy-512 discloses a fixed-position, large-volume, high-rate water generator suitable for supplying drinking water to an entire office building, laundry, etc. The device is described as "having ducts for bringing this supply of ambient air to the device and for releasing the air back outside the device after it has been processed". The attached, permanent "ductwork" is characterized further as "extending through an outside wall of the structure or dwelling". While sensors, indicators, interlocks, alarms for the UV lamps, air filters and water filters are mentioned briefly in Reidy-512, other major components of the apparatus are usually characterized by single-word descriptions such as "air filter element", "evaporator coils", "condenser coils", etc.

In both of Reidy's patents, the drain is located on the base of his water generator, a position which makes the drains completely unsuitable for dispensing water unless the machine is placed on legs or mounted in a cabinet. Reidy-512 teaches two passes of water past ultraviolet light tube to kill bacteria whereas the present apparatus provides for automatic, continuous recirculation of the water in the final delivery reservoir through a UV bacteriostat zone. Reidy-512 has a number of

additional limitations and shortcomings: the user must set the humidistat and thermostat. Reidy makes no provision for insect proofing of the cabinet. The water filter of Reidy-512 is located under the collection pan and severely limited in both flow rate and minimum pore size by the gravity-feed pressure head. In the present apparatus, water flows through a filter under pressure from a pump; this allows for high rates and small-pore, filter/ adsorption media such as a porous-carbon block. Poindexter-516 has no germicidal light nor a remote collection diverter valve. A drain is shown in Fig. 2 but none in Fig. 1. The drain is shown on the bottom of the apparatus which, if on the floor, is essentially inoperable and, if raised on a stand, makes a top-heavy unit which would require permanent wall anchors.

Engle-203 is essentially two tandem dehumidifiers. A second-stage compressor with its condenser coil immersed in the storage tank produces heated water. One familiar with the art realizes that such heated water would never reach 75 C as does the heated water in the present apparatus. A further problem of locating the condenser coil in the storage tank is that it prevents removal of the tank for cleaning without opening the refrigerant system. Still further maintenance problems arise from the positioning of drains, i.e., there are no external dispensing valves and the drain valves are poorly located for replacing the valves because of the limited access inherent in their location. Poindexter-516 claims a stainless-steel air-cooling coil and collection pan which adds significantly to the cost of manufacturing and does not specify the specific type of stainless steel, 314L, which is required for water handling in production facilities. The specification goes into great detail on the types of chemicals usable to clean areas which contact the water. In the present apparatus, the storage containers are completely removable and the condensate is sanitized by passing under the germicidal light several times.

Harrison-459 uses a UV lamp tube to treat the discharge water stream; this indicates that bacteria and or algae may be growing within the unit or its plumbing connections. This unit also must be primed initially with approx. 10 liters of start-up water which can be a source of initial contaminants, such as volatile organic compounds, VOC, which are neither removed nor broken down by either UV radiation or granular carbon charcoal. Whether this technology is compliant with NSF-53 remains a question. In his device, the compressor operates to maintain a cold set-point temperature within the water reservoir, i.e., the compressor operates to cool the fluid remaining in the reservoir even when the device is not actively producing water condensate. In contrast, the present invention saves energy by shutting off when it is not producing water. Further, the present invention may include a wheeled, furniture-type, user-friendly cabinet complete with carrying handles, disposable cups, related holders, diverter valve and air-filter-blockage alert. Also, since the present invention is fitted with a gravity discharge line, it is possible to draw water even in the event of a power failure. Harrison's unit, which employs an electric solenoid valve, would not be able to deliver water in the absence of mains power.

Swanson-442 suffers from many of the same deficiencies as Harrison-459; further, it also lacks an air filter or a UV disinfecting system. While Swanson's discharge device is shown on one figure, the location and operating parameters are not specified.

Brym-053 provides a UV-activated catalyst water purifier/ dispenser for tap water (well or public supply) which can be installed below the counter or enclosed in a cabinet. This unit merely treats water supplied to it, and in the process, a certain portion of the incoming flow is diverted to waste. Michael-829 is primarily a device for producing and filtering "drinking" water across "activated charcoal" and a "plastic mesh micropore filter". It is not portable and is not compliant with NSF-53 re VOC removal. Further, it has no provision for continuous circulation of water to maintain purity.

All the prior patents cited above use a typical refrigerant deicer system to keep their evaporators from freezing under low condensate flow rates, which can occur with cool ambient air. For example, on sheet 5 of the Reidy-512 patent is an illustration that shows water production stopping at about 10 C. This limitation occurs because: (a) obtaining condensate is inefficient, (b) condensation is not cost effective at such low temperatures and (c) the evaporator tends to freeze over at lower temperatures. This limitation also occurs because of the design of the water generating device using a typical hot-gas bypass deicer. All of the devices cited are large-capacity refrigerant gas dehumidifiers. The refrigerant gas from the compressor cools an evaporator coil and when ambient air is passed by the coil, moisture condenses out and drips to a collector below. When operated over extended periods or in cooler temperatures, the evaporator tends to freeze over due to low flow rate of condensate. In this situation, the compressor is designed to switch over to hot-gas bypass mode. A thermostat and/or humidistat control assists in determining when the compressor switches over. This on/off cycle during cooler temperatures drastically reduces production of water until the compressor eventually stops when temperature of incoming air is too low.

DISCLOSURE OF THE INVENTION

For an embodiment of the present apparatus designed for open-air use, it is critical to be able to operate for long periods without human adjustments. Rather than have the heat absorber cycle off/ on and wait for the dew-forming surface to defrost when operating in cooler temperatures, a heat strip and additional fan are designed into the heat-absorber systems of the present apparatus. When the dew-forming surface is about to start freezing, the air-heating strip is switched on and heat absorber 1 continues to run, and water production is not interrupted. As a further benefit, the incoming ambient air is warmed; generally, the warmer the ambient air, the more moisture that can be extracted from it. The heating strip also protects the apparatus, including collection reservoirs, from sudden unexpected freezing when ambient air drops below 0 deg. C. The resistance-heating strip and fan, rather than a hot-gas bypass valve, distinguishes the present invention from the other devices.

The water generator of the present invention operates within a closed housing and water dispensing subsystems deliver directly to the external dispensing valve. It is not necessary to open the housing every time a small quantity of water is desired. The housing panels and various openings of the present invention are fitted with tight-sealing flanges to prevent insect infestation and environmental contamination of the water. Any dispenser that is designed to work in remote, harsh environments must be designed so that the outside envelope is infrequently opened and then only for

maintenance. Each opening incident exposes the interior of the housing to infestation by all types of crawling and flying insects such as flies, mosquitoes and to entry of airborne contaminants such as blowing dust, etc.

For embodiments intended for use in a home or office, certain of the insect and dust-sealing features may be omitted and the cabinet implemented with attractive, furniture-type styling. To make the present water generator-dispenser more desirable for office or home use, the unit can be fitted with optional subsystems for producing water at three temperatures, i.e., hot, cold and ambient. This is accomplished by adding a secondary heat absorber source. Heat absorber-2 is placed under the bottom surface of the storage tank and an insulated, separator-baffle is added to the storage tank to separate ambient-temperature water from cold water. A cold-water-temperature sensor and switch assembly controls the operation of heat absorber-2 to maintain the predetermined temperature of the cold water zone, below the insulating baffle, at approx. 5 C.

To produce hot water, a heated, food-type stainless steel tank with an insulating jacket is added. The hot water tank is in fluid communication with the heated-fluid delivery control valve and the ambient temperature water in the storage tank. Water at a temperature of up to about 75 C can be delivered from the heated fluid delivery control valve.

Also, an optional diverter valve may be installed to allow pumping into a container outside the housing.

The water generator/ dispenser of the present invention fills a long-felt need for emerging countries and indeed many places in the world. A physician familiar with United Nations hospital and clinic programs in Africa had particular praise for the present dispenser's potential to solve their peculiar problems when operating in extremely remote areas. Further, a product development organization has indicated a desire to produce the office and home models for the USA. There is an immediate and critical need for the apparatus in many areas of the world, including USA. The design synergism of the present invention is evident from commercial response to the concept.

The objects and advantages of the present invention are:

(a) providing a means for obtaining and dispensing potable water from an apparatus that is consistent with the decor of an office or home yet requires no permanent external plumbing or air duct,

(b) providing an apparatus for heating and chilling potable water collected from the atmosphere,

(c) providing an apparatus which can operate indoors or outdoors so as to be available to operate in remote areas,

(d) providing an apparatus which can easily be assembled from sealed, ruggedized modules,

(e) providing a wheeled-cabinet apparatus that is portable, i.e., can be rolled about on packed earth, pavement, bare floor or carpeted surfaces,

(f) providing an apparatus which can be operated from DC current supply by attaching solar-electrical generating panels or by variable-frequency, variable AC voltages, single- or 3-phase mains power, 50/ 60 Hz or AC electrical power generated from wind-driven generators,

(g) providing an apparatus that has minimal chance of water contamination due to volatile organic compounds, VOCs, insects or rodents,

(h) providing an apparatus of simple, modular construction and designed for operation over extended periods without operator attention,

(i) producing high-quality, purified water, by preparing the unit with medical-grade tubing and including an inert surface coating on the dew-forming surface,

(j) producing liquid-water condensate at air temperatures just above freezing by use of an air-heating strip,

(k) dispensing potable water at a convenient height for adults or children or persons in wheelchairs,

(l) producing contaminant-free potable water while running unattended in open air for extended periods of a month or more above freezing temperatures,

(m) producing high-quality, potable water in varied environments such as offices, houses, or jungles.

(n) providing a water generator/ dispenser which is easily portable both indoors and outdoors,

(o) providing options for dispensing potable water at three different temperatures, ambient, approximately 5 C and approximately 80 C.

(p) producing potable water near or below the cost per liter of bottled water,

(q) producing high-quality potable water within latest ASHRAE and US federal standards for cooling and refrigerant apparatus,

(r) providing a water generator/ dispenser that can be easily transported by two adults using integral carrying handles,

(s) providing a water generator/ dispenser in which the exhausted air is filtered to remove dust, pollen, and airborne particles,

(t) providing a water dispenser from which incoming air is charged with negative ions to facilitate particle separation,

(u) providing a water generator/ dispenser which will not produce or deliver condensate if either the air filter is removed or the subsystem for killing microorganisms fails,

(v) providing a water generator/ dispenser in which the electrostatic filter emits an audible whistle alarm when it needs cleaning.

Still further objects and advantages will become apparent from a consideration of the ensuing description and drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1(a) is a block diagram showing the individual, functional components, sub-assemblies, controls, interlocks, alarms and interconnections which comprise the present invention and alternative embodiments which deliver cooled and/ or heated water in addition to room-temperature water.

FIG. 1(b) is a schematic drawing showing the safety logic and functional interlocks to enable water delivery from the present invention.

FIG. 1(c) is a schematic drawing showing the safety logic and functional interlocks to enable water collection by the present invention.

FIG. 1(d) is a vertical section view through heat absorber 1 showing the element-profile shape of the cooled heat-exchange surface, particularly the pointed drop guide for rapid draining of liquid dew from the lowest point.

FIG. 1(e) is a horizontal section across two adjacent spaced-apart, vertical cooling elements showing the generally-horizontal air flow vector between the opposing surfaces and the thickness of minimum and maximum-thickness liquid-dew layers, especially the formation of surface waves due to momentum transfer from the air stream.

FIG. 2 is a cut-away perspective view, with one vertical panel removed, showing diagrammatically the front and left side of the basic embodiment of the present invention.

FIG 3. is a diagrammatic rear view of the basic embodiment of the present invention.

FIG 4. is a cut-away front view, with one vertical panel removed, showing diagrammatically the major components and subsystems of the basic embodiment of the present invention.

FIG 5. is a cut-away perspective view, with one vertical side panel removed, depicting a second alternative embodiment of the present invention showing the addition of components to collect and dispense both room-temperature and chilled water.

FIG 6. is a cut-away rear view depicting diagrammatically the interior (as viewed from the rear) of a second alternative embodiment of the present invention showing the addition of components to collect and dispense chilled water and ambient-temperature water.

FIG 7. is a cut-away front-diagrammatic view depicting the front of the second alternative embodiment of the present invention which collects and dispenses potable water, showing the addition of components to produce and dispense chilled and ambient-temperature water.

FIG 8. is a cut-away perspective view showing a third embodiment of the present invention which prepares and dispenses potable water at three predetermined temperatures, i.e., ambient, chilled and heated.

FIG 9. is a cut-away rear view showing diagrammatically the interior of the third model of an apparatus that collects and dispenses potable water at ambient, chilled and heated temperatures.

FIG. 10 is a cut-away front view showing diagrammatically the interior of the third model of an apparatus that collects and dispenses ambient, chilled and heated potable water.

FIG 11. is an exploded perspective view showing diagrammatically the front alcove assembly portion of the outside envelope of the basic embodiment of the present invention.

FIG. 12 is exploded perspective view showing diagrammatically the cold fluid tank, quick disconnects, heated fluid tank assembly, including connections, insulated jacket and the secondary heat absorber for an embodiment which collects and dispenses ambient, chilled and heated potable water.

FIG. 13 is an exploded perspective view showing diagrammatically the details of bacteriostat, including the activated-carbon block VOC filter, for the basic embodiment of the present invention.

FIG. 14 is a schematic view of an alternative embodiment of a cut-down water generator with side-type external reservoir and flow controls.

FIG. 15 is a schematic view of an an alternative embodiment of a cut-down water generator with overhead-type external reservoir and flow controls.

FIG 16 is a schematic view of a retrofitted typical bottled-water dispenser attached to a cut-down water generator positioned along side and connected to supply potable water into existing unit.

Components to retrofit typical existing bottled-water dispenser units can be provided as a model-type unique kit or a universal kit.

FIG. 17a is a schematic front view showing common refrigerant-fluid connections and circulation between a typical refrigeration-type appliance and a hybrid or combination embodiment of the present water generator.

FIG. 17b is a schematic side view showing common refrigerant-fluid connections and circulation between a typical refrigeration-type appliance and a hybrid or combination embodiment of the present water generator. This figure also indicates the flow of environmental air into and out of the water generator as well as a rear-mounted, free-convection condenser for the refrigerator appliance portion.

FIG. 18a is a schematic view of the refrigerant flow loop within a hybrid appliance which has the following functions: refrigerator/ freezer, automatic icemaker, potable water dispenser and water generator according to the present invention. This appliance generates its own water for making ice and dispensing by condensation of water vapor from room air.

FIG. 18b is a schematic view of the potable water flow loop within the hybrid appliance shown in FIG. 18a.

FIG. 19a is a front-elevation exterior view of a hybrid appliance for making ice, dispensing water and generating all its own water using a water generator according to the present invention. This appliance generates its own water for making ice and dispensing by condensation of water vapor from room air.

FIG. 19b is a schematic cut-away view of the appliance shown in FIG. 19a showing the potable water flow loop.

FIG. 20a is an example of an electrical control circuit diagram for the pump, switches, sensors, valves, indicators for Example M18, an embodiment of the present invention integrated into a vehicle air conditioning unit.

FIG. 20b is a schematic diagram of the water-flow and control systems of a water generator embodiment shown in Example M18.

FIG. 20c is a schematic view of the switches and indicator light display for the embodiment shown in Example M18.

BEST MODES FOR CARRYING OUT THE INVENTION

Table 1. includes a listing of all special and standard nomenclature used in this specification; the column headed "Indicia" shows the reference number of each feature or element and the column headed "Figure" indicates the figure where is feature or element is first shown. The water collection and treatment processes of the present invention are shown in Figs. 1(a)-1(c). Figs. 1(d) and 1(e)

show design details of the dew-collecting surfaces of heat absorber 1. The general configuration of the basic water collection system is shown in Figs. 2 - 4. The working components are enclosed in a housing (21) with a top cover, four vertical side panels and a base. The housing (21) incorporates a bracketed opening in the rear cover panel opening through which is inserted an electronic air filter (38). The air filter (38) contains a whistling, audible warning device (38-A) which signals when the air filter needs to be cleaned. Other known warning devices may also be used. An additional fail-safe switch (38-B) prevents operation of the system when the air filter (38) is not in place.

The housing (21) incorporates a front wall alcove opening and assembly (37) which consists of an alcove shell, grid and waste water receptacle; see also Fig. 11 for an exploded detail. Spilled water from the alcove drain collector may be recycled into the water-recirculation loop. Above the alcove is an optional low-light-level lamp, or "night light" (35). The alcove also contains a fluid delivery control (36) for dispensing ambient temperature water. The rear panel of the housing (21) has an inlet opening into the air filter (38) that includes a whistling alarm device (38-A). The front panel of the housing (21) provides an opening for air exhaust. This opening has an insect-resistant screen (49) on the interior of the housing (21) outlet port.

Table 1. Descriptive Nomenclature and Indicia

Indicia	Description, function	Figure
21	housing,case,cabinet	2
22	heat absorber-1	2
23	strip heater	2
24	extended-area of fins	2
25	water, condensate collector	2
26	chamber,condensate pump assy	2
26-A	transparent tube	2
27	air ionizer	2
28	UV lamp fail-safe switch	2
28-A	UV lamp fail-safe alarm	4
29	UV bactericide lamp	2
30	water storage reservoir	2
30-A	ambient-temp. water zone	9
31	water filter assy	2
32	diverter valve	2
32-A	diverter valve outlet	2
33	storage reservoir float switch,lid	2
34	insulat.jacket, storage reservoir	2
35	night light	2
36	delivery valve,ambient temp water	2
36-A	delivery valve, cold water	8
36-B	delivery valve, hot water	8
37	wall alcove assy	2
38	electrostatic filter	2
38-A	whistle alarm	2
38-B	fail-safe switch,filter	2
39	ozone generator	2
40	defrost sensor, heat absorber	2
40-A	multi-speed intake fan assy.	2
41	casters,wheels	2
42	ultrasonic pest control device	2
43-A	cold water temp sensor, switch	6
44	heat absorber 2,cold plate	5
45	floating, insulating separator	5
46	hot water tank assy	9
46-A	hot water temp control, switch	12
47	dispenser, cups, cold, RT fluid	6
47-A	dispenser, cups, hot fluid	9
49	insect screen	3
50	manual on-off control	4
51	multi-speed fan switch	4
52	quick-disconnect assy	9
52-A	male quick-connect, ambient	9
52-B	female quick-connect, ambient	9
52-C	male quick-connect, hot water	9
52-D	female quick-connect, hot water	9
141	external reservoir	14
142	seal plug	14
143	flexible external tube	14

Indicia	Description, function	Figure
144	vent w.barrier	14
145	manual valve	14
146	Low Volt. solenoid valve	14
146-A	Low Volt. transformer	14
147	Low Volt. leads	14
148	flexible sheath	14
149	level sensor	14
151	counter force	15
152	mass sensor	15
153	pivoting support plate	15
161	seal adapter	16
162	level sensor	16
163	water tube	16
164	vent tube	16
165	flexible zone, sheath	16
171	branching valve, interface	17a
172	splitter valve, interface	17a
201	UV radiation module	18b
202	float switch,pump enable, level control, collector	18b
203	"OR" valve,solenoid	18b
204	icemaker	18b
205	valve, icemaker branch,solenoid	18b
206	valve,reservoir,pump enable,level control/ reservoir	18b
207	vent w. bacterial barrier	18b
208	supply, pressure head	18b
209	return, gravity head	18b
220	refrigerant compressor	18a
221	refrigerant condenser	18a
222	"reciprocal AND" valve1 w. branch flow controls	18a
223	"reciprocal AND" valve2 w. branch flow controls	18a
224	refrigerant accumulator	18a
225	freezer/ icemaker evaporator	18a
226	high-pressure refrigerator line	18a
227	low-pressure refrigerator line	18a
230	icemaker cabinet front elevation	19a
231	ice-access door, right-hinged w. handle, left edge	19a
232	exterior grip handles, left, right side panels	19a
233	exterior potable water faucet	19a
234	holder/ dispenser for disposable cups	19a

Indicia	Description, function	Figure
235	air inlet w. grille, filter	19a
236	supporting surface, floor	19a
240	icemaker cabinet,front/ interior	19b
241	manual trim valve,recirculation flow cont.	19b
242	water, pressure supply	19b
243	water, pressure return, recirculation	19b
244	water, pressurized reservoir	19b
245	ext. potable water faucet	19b
246	reservoir inlet check valve	19b
247	flow control valve to icemaker, solenoid	19b
303	cold water switch	20a
304	hot water switch	20a
305	cold water safety interlock	20a
306	hot water safety interlock	20a
307	LED cold water dispaly	20a
308	LED hot water display	20a
309	vehicle power,ignition,cold	20a
310	water-syst.elect.safety fuse	20a
311	water-syst.main switch	20a
312	reservoir fluid lev.sensor/switch	20a
313	circ.pump/UV LED indicator	20a
314	circulation pump	20a
315	power circuit for UV source	20a
316	LED display UV source	20a
317	UV source and switch	20a
318	heater-power interlock,no water	20a
319	thermostat control (triangle)	20a
320	LED display, heater "on"	20a
321	thermostat.-cont. heat element	20a
322	LED display, temp satisfied	20a
323	switch for LED display	20a
325	cold water delivery valve	20b
326	hot water delivery valve	20b
327	hot water check valve	20b
328	housing for heater	20b
329	NSF-53 comp.carbon-block filter	20b
330	check valve,pressurized system	20b
331	valved reserv.drain line	20b
333	enclosure, UV source	20b
334	valved impure,priming water input	20b
335	condensate diverter valve	20b
336	veh.condensate,unpressurized	20b
337	veh. AC heat-exch. cover	20b
339	sealed UV window, reservoir	20b
340	condensate reservoir	20b

Indicia	Description, function	Figure
341	UV reflective foil, exterior	20b
342	condensate inlet to reservoir	20b
343	condensate overflow	20b
344	reservoir outlet line to pump	20b
345	check valve,pressurizing	20b
346	hot water flow line	20b
347	cold water flow line	20b
350	hot water enable switch,console	20c
351	cold water enable switch,console	20c
352	instruction manual,retrofit kit	20b
353	driver console	20b
354	retrofit kit	20b
355	periodic recirculation chamber	20b
356	timing and valve-seq. controller	20b
357	controllable check valve,timing	20b
358	recirculation lines	20b
359	on/off switch for timing, (356)	20b
360	additive and metering dispenser	20b
361	flap-check valve,condensate dischg.	20b
363	pressurized portion of system	20b

Operation of the apparatus is initially controlled by the manual on/off switch (50) located on the back side of the housing (21). The variable-speed fan control switch (51) is adjacent to the on/off switch (50) on the back of the housing (21).

Air Flow and Treatment. Air entering the housing first passes through the replaceable air filter (38) and across the self-contained ionizing device (27). Air then is drawn past a heating strip and fan assembly (23), then across heat absorber-1 (22) and film-coated, dew-forming surfaces (24) by the multi-speed intake fan assembly (40-A), which is controlled by the multi-speed fan control switch (51). Liquid condensate flows by gravity into the enclosed sump (25) and pump system reservoir (26). The pump system (26) has a self-contained switch and liquid-level sensor which shuts off heat absorber-1 (22) when the reservoir is filled. From the pump reservoir, condensate flows through a section of tubing (26-A) and is recirculated through a bacteriostat subsystem ,i.e., a pump, carbon block VOC filter (31) and a ultraviolet germicidal light for killing bacteria (29). This subsystem is controlled by a fail-safe switch (28) connected to a fail-safe indicator light (28-A), as shown in more detail in FIG. 13. The bacteriostat indicator light (28-A) is located on the back panel of the housing (21).

As shown in Fig. 1(d), heat absorber-1 includes an array of extended-surface elements which are in good thermal connection with heat-sink contact zones at predetermined locations. The heat-sink points are mechanical-thermal connections adapted to remove heat from the extended surface and transfer it into an external environment. A variety of known heat-sink technics can be used to cool the extended surfaces, including classic boiling fluids contained in tubes, thermoelectric elements, and heat pipes. The heat-sink points are located at intervals of approx. 40- 100 mm along the vertical direction of the extended area. The section profile of the bottom of the collector tray may be rectangular or half circle.

As shown in Fig. 1(e) the extended surface elements are generally parallel and spaced apart a predetermined distance to avoid bridging over of surface waves due to heavy or maximum condensate flows and high air-flow velocities. The minimal condensate film thickness is indicated by dashed lines; this thickness corresponds to the condition when the air heaters are activated and operating at maximum power to prevent icing over.

Water in the reservoir is recirculated through the bacteriostat subsystem, including the activated-carbon VOC final filter system assembly (31). The final water filter is fitted with a replaceable activated-carbon VOC adsorbent cartridge which is capable of removing organic contaminants, cysts and heavy-metal compounds. Processed water is then held in fluid reservoir-1, (30), which includes a form-fitted insulating jacket (34); through use of a diverter valve (32), processed water can also be delivered through a diverter valve outlet (32-A) to a large external collection container. The water level in the fluid tank (30) is controlled by the electrically-operated sensor switch and lid assembly (33), which causes the pump (26) to cease operation when the fluid tank (30) is filled.

Ambient temperature water is dispensed from a compartment within the fluid tank (30) via the ambient fluid delivery control (36). Disposable liquid containers, e.g., paper cups, suitable for cold water, are provided from attached dispenser (47) mounted on the side of the housing.

Fluid reservoir-1 (30) is removable from the housing for cleaning without removing its insulated jacket (34). This is accomplished by pulling aside the level sensor and lid assembly (33), which remains in the unit. The ambient fluid delivery control (36) remains affixed to the fluid tank (30). The fluid tank (30) can be cleaned using cleaning materials appropriate to its materials of construction and in accordance with public health requirements governing use of cleaning materials for food handling and potable water systems. By design of the present invention, mechanical removal of fluid reservoir-1 (30) is simple, and can be accomplished without disturbing the permanent tubing connections.

Additional and Optional Features. The housing (21) may be fitted with an optional ozone generator (39) adjacent to the departing air stream to further add to air quality. The housing (21) also contains an optional ultrasonic pest control device (42) which operates continuously. To provide for mobility of the apparatus, four casters or rollers (41) suitable to the weight and size of the present invention are affixed to the four corners of the lower side of the base of the housing (21). Two carrying handles, suitable to the weight and size of the present invention, are fixed, one on each side of the housing (21) at a height appropriate for transport by two adults.

ALTERNATIVE EMBODIMENTS.

Model 2. As shown in FIGS 5-7, another embodiment of the present invention, Model 2, contains all elements of the basic model and also dispenses chilled water at a nominal temperature of 5 C in addition to ambient temperature water. The chilled water is produced by incorporating a secondary heatsink, heat absorber-2, (43), which is controlled by the cold water temperature sensor and switch assembly (43-A). The heat-exchange probe (44) of heat absorber 2 is positioned between the insulation jacket (34) and the cold fluid tank (30A). An insulated baffle (45) is located in the cold fluid storage tank (30A) allowing for ambient water to be stored above the baffle and chilled water to be stored below the baffle. Chilled water is dispensed via the chilled fluid delivery control (36-A).

Model 3. As shown in Figs. 8,9 and 10 another embodiment of the present invention, Model 3, includes all of the elements of the basic model and Model 2, but also dispenses heated water at a nominal temperature of 75 C. Ambient-temperature water is supplied via a plumbing "tee" connection behind the ambient fluid delivery control (36) and connected to the hot water tank assembly (46) by means of a "quick" disconnect connection assembly (52), which is described below. The hot water tank assembly (46) includes a sealed stainless steel tank of the appropriate grade and type of stainless steel utilized for food handling, provided with an electric heater and insulating jacket (46). Temperature of the hot water is controlled by a heated water temperature control sensor and fuse assembly (46-A). A dispenser (47-A) for disposable liquid containers, suitable for hot water, is attached to the side of the housing. As described earlier, a quick-disconnect system (52) links the hot water tank (46) to the ambient fluid delivery control system by means of a "tee" connection. The same quick- disconnect system (52) links the heated fluid delivery control (36B) to the hot water tank assembly (46) to enable easy removal of the cold fluid tank (30) for cleaning, without the need for manual connections and disconnection of plumbing. As shown in FIG. 11, the quick-disconnect system (52) consists of a pair of receiver adapters, as follows: male adapter (52-A) connects with

female receiver (52-B) to carry ambient temperature water into the hot water tank assembly (46). A male adapter (52-C) connects with female receiver (52-D) linking the hot water storage tank (46) with the heated fluid delivery control (36B). The tube divider (46-B) physically separates the adapter system tubing and connections. This quick-disconnect system allows for removal and reinstallation of the main water cold fluid tank (30) without manual interference with the refrigeration system, the water tubing or the hot water tank fittings.

OPERATION OF THIS INVENTION.

In this invention, heat absorber-1 (22) produces condensate on an inert-coated surface (24). This system is explained below. Incoming air is filtered by an electrostatic filter assembly, including the filter (38), a filter warning whistle (38-A) and the air-filter fail-safe switch (38-B).

An ionizer (27) puts a negative electrical charge onto particulate matter in the incoming air stream to assist in the trapping of particulates in the electrostatic filter. If desired for operation in a home or office, an optional ozone generator (39) can be included; this addition allows the present invention to function as a charged-particle generator and room-air purifier.

Condensate collected from the air flow across the extended area cooling surface (24) flows downward by gravity to a temporary collector for condensate (25) and is further conducted by gravity flow into a pumping reservoir assembly (26). In this assembly there is a self-contained float switch which actuates the condensate pump when a predetermined water level is reached. The condensate is conducted through UV-transparent tubing (26-A) prepared to comply with medical and human food-handling requirements. The condensate is subsequently exposed in multiple passes to a bacteriostat, or apparatus for killing bacteria, such as an ultraviolet germicidal light, (29) or other known UV source capable of producing radiation for effective killing of water-borne bacteria, viruses and organisms. The bacteriostat (29) is monitored by the fail-safe switch (28). Multiple passes through the UV and carbon block VOC filter portions is accomplished by activating the recirculation pump at least once at predetermined time intervals in the range 1-12 hours, for a predefined flow or time duration in the range 1-50 times the reservoir volume or 1- 200 minutes at a specific flow rate. By this repeated process, water is intermittently and continually recirculated across the VOC filter and UV portions of the purification circuit whenever the water generator is in use. The flow duration may be defined by the volume circulated or by time. A fail-safe indicator light (28-A) on the exterior of the housing (21) confirms proper operation of the bacteriostat. If the bacteriostat is not enabled, as indicated by the light being "on", operation of the entire machine is stopped.

The condensate is pumped under positive pressure through an activated-carbon VOC adsorber purification filter assembly, and then pumped into fluid tank (30), or (30A) for Model 2 or 3, made of plastic or stainless steel as is common for food-service contact. The fluid tank is encased by a form-fitted insulation jacket (34) made of a nontoxic material, such as closed-cell polymer foam. A fluid delivery control (36) is installed into the storage fluid tank (30) using nontoxic sealants suitable for contact with potable water intended for human consumption. The fluid tank (30) is removable for cleaning. The fluid delivery controls (36, 36-A, 36-B) are at an ergonomically-correct level above the

floor, making water easily accessible for children or persons in wheelchairs. A holder (47) for disposable cold-liquid containers is shown in close proximity to the fluid delivery controls (36).

A major improvement in the design of the present invention is the elimination of the standard deicing system and including in its place a heat strip and fan assembly (23). An electric-powered heating element and defrost sensor (40) senses when the heat-exchange surface of heat absorber-1 (24) is about to freeze over. Rather than turning off heat absorber-1 (22), as in typical old-art refrigeration systems, the temperature sensor (40) activates the heat strip and fan (23) which warms air passing over the cold surfaces (24) just enough to keep the accumulated liquid dew from freezing. The warmed air usually allows more moisture to be extracted from the incoming air flow.

Because the open-air embodiment of the present invention can operate for long periods without human tending, a manually operated diverter valve (32) allows the potable water to be pumped to a remote cistern. Diverting the water flow does not prevent dispensing water from the storage cold fluid tank, provided that the tank contains water.

The cold and ambient fluid delivery control (36-A) and (36) extend from the fluid reservoir-1 (30) through the front of the housing (21) into a common dispensing alcove assembly (37) containing a grill-type drain insert to collect waste water. A night light (35) above the alcove provides illumination for water dispensing during periods of darkness or low light levels.

An optional ultrasonic pest control device (42) and extraordinary attention to sealing the housing (21) with nonporous, nontoxic sealants allows the open-air version of the present invention to operate for extended periods of a month or more indoors or outdoors without human tending.

Model 2 contains all subsystems which allow it to produce and dispense chilled water in addition to the ambient temperature water. The chilled water is dispensed at a nominal temperature of 5 C. Chilling of the collected purified water is accomplished is by adding a secondary cooling device, heat absorber-2 (43). The cooling surface (44) is positioned between the insulation jacket (34) and the bottom of the fluid reservoir-1 (30). To avoid cooling all of the liquid in the fluid reservoir-1, because this model also dispenses ambient temperature liquid, an insulated baffle (45) is placed in the fluid reservoir-1 (30A) allowing for ambient water to be stored above and cold water to be stored below. The cold water below the baffle is delivered through the cold-fluid delivery control (36-A); The ambient-temperature water is delivered through the ambient temperature fluid delivery control (36). Both fluid delivery controls protrude from the fluid reservoir-1 (30) through the front of the housing (21) into the dispensing alcove assembly (37).

Because the fluid reservoir-1 (30) is removable for cleaning without dismantling the internal mechanisms, the present design represents a significant improvement over old-art systems.

Model 3 of the present invention includes subsystems which permit it to produce and dispense heated water in addition to ambient-temperature water and chilled water. Heated water is dispensed at a nominal temperature of 75 C.

Heating of the water is accomplished by adding a heated water tank assembly (46) comprising a stainless steel tank in compliance with food-handling codes, a heater, an insulated jacket and a electrical, fused water-temperature control assembly (46-A). Ambient temperature water is drawn

into the hot water tank through a quick-disconnect "tee" fitting behind the ambient temperature fluid delivery control (36). Hot water is dispensed through the hot fluid delivery control (36-B), which is connected to the hot water tank assembly (46). The quick-disconnect receiver-adapter assembly system (52) allows easy removal of the fluid reservoir-1 (30) for cleaning, without the need for manual connections and disconnections. The ambient temperature water portion of the assembly consists of a quick disconnect male adapter (52-A) that mates with the quick disconnect female receiver (52-B) to supply incoming water to the water heater tank (46). The heated water portion of the assembly consists of a quick disconnect male adapter (52-C) that mates with the quick disconnect female receiver adapter (52-D) to supply heated water to the hot fluid delivery control (36-B).

This unique disconnect concept represents a significant design improvement over old-art systems.

EXAMPLES

Examples M1 and M2 below give technical parameters for the design and inert surface coating of the extended heat-exchange area of heat absorber 1, i.e., the air cooling and dew-collecting surface.

Example M1 - Extended heat exchange area. Incoming ambient air at a velocity of 1-10 meters/sec is cooled below its dew point by circulation across an array of generally-vertical, spaced-apart, cooled surfaces shaped and oriented to drain collected liquid dew dropwise from a pointed zone on the bottom edge. The active extended cooling area for both sides of each element in the array is in the range 100- 500 cm2; the total active area of the array is in the range of 1- 4 m2. The general outline shape of the dew-forming elements is shown in Fig. 1(d). The height dimension of each cooling element is in the range of 15- 40 cm; the element width dimension is in the range of 3- 10 cm. The height dimension is measured generally parallel to the gravity vector; the width dimension is measured generally perpendicular to the gravity-force vector. Each element is formed from one or more sheets of high thermal conductivity material of thickness in the range 0.2- 1.5 mm. The average center-line spacing of adjacent cooling elements is in the range 3- 10 mm. For increased convective heat transfer, the profile may be either parallel - planar elements, as shown in Fig.1(e) or parallel - corrugated elements. Parallel - corrugated elements may be prepared by 3D forming of planar elements to include an array of ridges and valleys arranged parallel to the vertical or at an acute angle in the range 1- 15 deg. to the vertical. As shown in Fig.1(e), surface waves formed on the maximum-thickness draining liquid condensate layer do not bridge across the element spacing. It has been found that dew-bridging results in liquid trapping and ice-blockage of the air-flow channels between elements. Heat absorption from the extended area can be accomplished by a variety of cooling means thermally connected to the area; such cooling methods include refrigerant-expansion coils, thermoelectric coolers, heat pipes, etc. The design of heat absorber 1 includes defining the number, size and placement of cooling conductors to cool the extended surface elements. In the case of cooling by a boiling liquid in contained tubes, the tubes are oriented generally horizontal and perpendicular to the extended surface plane. Several refrigerant tubes of 3- 6 mm diameter spaced apart at a distance of 40- 100 mm have been found to provide effective cooling. Extended surface

elements may be formed from thermally-conductive metals, alloys, ceramics/ glasses and polymer composites including Al, Al-alloys, Cu, Cu-alloys, Al-filled amide or olefin polymers and ceramics.

Example M2 - Inert surface coating. To prevent chemical interaction of the dew condensate with the exposed cold surfaces of heat absorber 1, all such exposed, cooled surfaces are coated with a continuous, thin, inert, food-grade film of polymer such as siloxane, PTFE, urethane, olefin, etc. All exposed surfaces of the heat absorber which come into contact with liquid dew are cleaned to remove surface contaminants such as grease, oxides and other adventitious residues prior to the initiation of the coating process. An inert coating of thickness in the range 0.01- 0.2 mm is then applied by known methods such as spraying, dipping, electrostatic coating, etc.,. After application and curing, the film coating is then cleaned to remove any volatile or extractable components which might contaminate the dew or water being produced.

Example M3 - Air Filters, Alarms and Interlocks. The first line of defense against insect penetration into the unit are woven-wire screens covering the entire area of both the inlet and outlet air ports. The screen mesh openings range from 0.3 mm to approx. 1.0 mm in diameter. The depth and screen elements of the air filter apparatus are prepared and sized to achieve approx. 99.99 % filtration of all solid particles of diameter greater than 1 micrometer for an air flow rate of 4- 9 m3/ min. The filter apparatus may also be fitted with a pressure-drop sensor which will permit buildup of collected particles of approx. 65% of the limit capacity of the element before an alarm condition is signaled; the optional filter-overload alarm may be an intense, high-frequency acoustic whistle or other known alarm device.

The air filter may also be fitted with gas-ion generators, alpha- or beta- particle emitters, such as radioisotopes, electrostatic charging devices, such as agitated filament arrays or high- voltage corona wires, which facilitate retention of smaller, less-dense airborne particles. The air filter may also be fitted with an optional interlock switch which prevents operation of the entire generator if the element is incorrectly positioned or an incorrect size is used.

Bacteriostat System and Interlocks. The bacteriostat system includes two stages: (a) an active killing stage for microorganisms and (b) an activated-carbon VOC adsorption stage for removing undesirable and toxic organic impurities which are present as vapors in the ambient air and will be dissolved in the condensate water produced. The killing stage may employ electromagnetic radiation, such as UV or gamma, of selected intensity and wavelength, to kill adventitious bacteria and viruses which are present in the condensate water. Alternatively, the killing stage may employ one or more physiologically-tolerated oxidizing chemical species such as ozone or hydrogen peroxide for killing bacteria. It is of course important to provide an exposure chamber which allows the condensate water to be exposed to or circulated through the killing zone. Either the UV source or the chemical generator may be fitted with positive interlocks which shut down the delivery pump if the device is not operating within control ranges of wavelength, intensity or sterilization-agent dispensing rate.

Example M4 - UV germicidal lamps. The simplest killing stage includes a high-intensity, short wavelength ultraviolet lamp, UV sterilizing device, and fusible link interlock with the recirculation

pump. Should the UV lamp fail to operate at an effective wavelength and intensity, electrical interlocks prevent the circulation pump from operating; in this event, no water can be delivered from the generator. The UV generator can be: (a) mounted into the cover of the reservoir for direct exposure or (b) mounted adjacent to a section of low-pressure tubing which transmits the effective radiation wavelengths through the water. In addition to quartz, known UV-transmitting glasses, polymers or ceramics may be used for the UV-lucent tube zone. The treatment zone or chamber must also be fitted with UV reflectors to maintain a high intensity level of the effective wavelengths and prevent accidental personnel or user UV exposure during maintenance work. For the UV lamp tube, the GE model T5 has been found to give good results. Several other types of UV sources can be adapted to operate with the present invention; these include electronic solid-state UV devices, natural sunlight light pipes, and fluorescent/ chemiluminescent sources.

Alternative Ozone or Ultrasonic Water Treatments. As an alternative to the UV sterilization device, an ozone generator or an intense ultrasonic field may also be used for water sterilization. The ozone systems operate by electrochemical formation of microbubbles of O3 in the condensate water. Known piezoelectric or magnetostrictive ultrasonic probes can be fitted to a section of tubing or mounted to immerse the probe into the reservoir tank.

Example M5 - Ozone Gas Generators for Air Freshening. Gaseous ozone is thought to assist in removal of undesirable vapors and aerosols from the ambient air. An optional ozone generator can be mounted in the air-handling section of the present invention. Several alternative ozone generators have been evaluated for conditioning the air being circulated through and discharged from the present water generator; the most cost-effective seems to be the Bora model from Alpine Ind. Alternatively, other electrochemical generators can be used to generate or release sterilizing gases; one example is the release of halogen gases based upon metered injection of compounds which decompose spontaneously or which can be electrochemically dissociated in liquid solution.

Example M6 - Air Ionization Pre-Treatment. Electrostatic charged-particle generators of various types such as polonium strips and Sanyo HAF 3000 ion generators have been evaluated and found to work well with the present air filter for removing aerosol particulate contaminants. Charged particles emitted from the generator impart a charge to the particles which makes them easier to filter. Such modules are connected to the main controls with a fail safe circuit to prevent operation if the ionizer is not operating within control limits. Alternative embodiments of the present invention using other sources of charged particles including alpha particles, beta particles, and charged ions may be used. For example, isotope mixtures and/ or decomposition-result alloys of radioactive metals such as radium and polonium are useful charged-particle sources; since such emitters can be made with controlled particle fluxes, small area sources are also possible.

Example M7 - Activated Carbon Block Filter. The simplest and least expensive adsorber for volatile organic compounds, VOCs, includes a porous activated-carbon block VOC filter; such a filter is connected in series with the UV sterilization device. At a flow of 0.8 to 2 liter/ min, the cartridge is capable of trapping 1- 2 micrometer diameter suspended particles, removing taste and color bodies and reducing dissolved toxic hydrocarbons to acceptable levels for safe drinking water according to

ANSI/NSF-53. Before this filter becomes substantially blocked, an integrated output flowmeter indicates the cumulative volume of water treated by the VOC filter. Preferrably, this indicator or display can be seen from the rear exterior of the unit. Known mechanical, electromechanical or electronic volume-measuring devices are used todisplay the remaining design capacity of VOC filter. Water is continually recirculated through the UV and activated carbon units when the generator is "on". A number of known carbon-block filters are found to perform reliably to NSF-53 standards; one acceptable filter is the Amtek C240 MMB. In regular operation, water delivered from any output valve, including, cold, ambient, hot and the diverter valves will have passed repeatedly through the VOC filter and the bacteriostat unit.

Example M8 - Alternative working fluids in compression refrigerator cooler for heat absorber-1. Approved working fluids for high-efficiency reverse-cycle equipment fall into two main classes: high temperature and low temperature. So-called low-temperature refrigerant fluids, such as 406A operate at lower temperatures and lower pressures; use of such fluids can be significant for units operating in air-conditioned spaces.

Example M9 - Alternative heat sinks for units operating in air-conditioned spaces. For esthetic reasons it may also be desirable to reject heat from heat absorber1 or heat absorber2 into: (a) the frame and/ or surface skin of the enclosure or (b) the liquid condensate water collected below heat absorber-1. When a mechanical refrigeration system is used for heat-absorber-1, it is also possible to provide a thermal/ mechanical linkage from a portion of it's evaporator section and it's condenser, for the purpose of modulating the temperature of the exhausted air. In this embodiment, it is possible to use a lower flow rate of cooling air and thereby reduce the level of fan noise which is projected into the local environment.

Example M10 - Alternative controls for units used in air-conditioned spaces.

The resistance-heating strip deicer, as used for units operated outdoors, can be replaced by known thermostat/ humidistat controls as typical for reverse-cycle appliances. This option is of interest for units used in a controlled environment.

Example M11 - Instead of the internal reservoir for holding water to be dispensed, it is possible to use an external reservoir such as a 20-liter glass bottle or other container. The system dispensing controls for such an embodiment may be modified to connect with an appropriate ancillary liquid level or fluid-mass sensor for the external container to regulate water generation when the container is filled to capacity.

Example - M11A. Ancillary external reservoir. Version M11A , shown in Fig.14, is an embodiment with no internal reservoir and a large-volume, covered vessel located on the floor beside the unit. This embodiment is a "cut-off" version of the simple embodiment shown in Fig. 2 wherein the housing is truncated by a horizontal plane at approximately the vertical height of the bottom of the alcove assembly, approx 0.8 to 1.5 m above the base plane. The water output flow from the water generator is regulated by the a solenoid valve (146) which is in turn controlled by a liquid level sensor (149) which is attached to the seal plug (142). The sensor and solenoid valve may be known low-voltage electric devices designed and certified for safe immersion in water or use in wet

environments; alternatively the sensor and slave valve may be simple known fluid/ mechanical devices. For ease of use, it is envisioned that the flexible external tube (143) and flexible low-voltage leads (147) may be enclosed in a flexible sheath (148) or tied together with known bands and methods. Although the external reservoir (141) is shown here as a vertical bottle standing closeby on the base plane and fitted with a tight-fit removable seal plug (142) adapted to prevent entry of liquids or gases from the exterior into the inlet port of the reservoir, it may also be possible to locate it at some distance 2-10 m at the same level, e.g., in another room or building. It may also be possible to locate it above or below the base-plane level , up to approx. 5 m level difference, by the addition of known precautions such as non-siphon check valves. Although the embodiment shown in Fig. 14 shows electrical/ electronic sensors (149) and control valves (146), it is also possible to use magnetic, optical, acoustic, or mechanical level sensors and related water-flow control valves. Although the external-line valve (145) is shown as a simple manual valve, it is also possible to use an auto interlock device to detect: (a) whether the external reservoir is correctly connected, (b) whether the unit is powered, or (c) whether the water-generation switch is "on".

Example M11 - B. External/ overhead storage bottle weighing. Version M11B, shown in Fig. 15, is an embodiment with no internal reservoir and an adjustable weight or mass-sensing device mounted on its top surface, which supports an external vessel. The top surface is a "cut-off" embodiment similar to that shown in Fig. 14. The mass-sensing element serves to shut off the solenoid valve when the container it supports is filled to capacity. By adjusting the zero point and sensitivity of the mass-sensor, containers of differing empty weights and internal capacity can be used, i.e., 4-liter, 8-liter, 20-liter. The external container is placed on a weighing plate (153) secured to the top surface of the truncated housing. A pivoting weighing plate shown in Fig. 15 is subject to the downward load of the reservoir and its contents and to counterforces (151) which keep the weighing plate approx. level, i.e., at an angle of less than 5 deg. Alternative support embodiments for a non-pivoting weighing plate may include arrays of 1-10 compliant elastomer elements or spring elements. Further, the counterforce (151) can be applied at a plurality of points to support the weighing plate (153), i.e., the counterforce may be provided by 1- 10 resilient elements of differing or variable characteristics to allow for use of containers of different sizes or tare weights.The simple flat plate (153) shown in Fig. 15 can be replaced by a shaped weighing platform having an engagement or retention zone for the bottom of the reservoir, e.g., a recess or pocket, an array of projections, a tie down strap, or snap-in anchor latches for an externally- grooved reservoir. The electronic weighing sensor (152) shown in Fig. 15 is connected by low-voltage leads to the solenoid valve (154); when the container is filled to capacity, its total weight reaches the predetermined value built into the counterforce (151) and the weighing plate triggers the sensor (152). It is also possible that the signals from sensor (152) can provide valuable control outputs to regulate the operation of the water generator, i.e., if the reservoir contains at least a predetermined quantity of water and the time of day falls in the period 1700 to 0600, the logical management algorithm may be programmed to defer operation of the generator. The manual water flow control valve shown in Fig. 15 can also be replaced by a solenoid and electrical/ electronic sensors to detect: (a) whether the external

reservoir is correctly connected, (b) whether the unit is powered, or (c) whether the water-generation switch is "on".

Example M11 - C. Retrofit kit for typical bottled-water dispensers. Version M11C, shown in Fig. 16 is a retrofit embodiment which can be installed to modify a typical gravity dispenser as commonly used for standard bottled water. Such dispensers can be easily converted to use water generated by the present invention by installing a vertical water delivery tube to the rubber seal collar; this tube is fitted with integral water level sensor located at the uppermost end. For such cases, the water generator with a reduced-volume internal reservoir may be located adjacent to or beneath the existing water dispenser. It is envisioned that a vertical, water-delivery tube of appropriate material for potable water, will be installed as a modification of the existing bottled-water dispenser. The length of the vertical tube and the specific position of the water-level sensor can both be adjusted to accommodate different sizes of supply bottles and different seal collar designs. The water level sensor serves to shut off the solenoid valve of the water generator when the water bottle on the dispenser is filled to capacity. The sensor and solenoid valve may be low-voltage electric devices designed for immersion in water or wet environments; alternatively the sensor and solenoid valve may be simple fluid/ mechanical devices. As shown in Fig. 16, the level sensor (162) is installed at the uppermost end of the water inlet tube (163) and the air-vent tube (164). The mod. kit also can also include a seal adapter plug (161) if the existing collar does not lend itself to retrofit. For the possible cases in which the existing collar and piping are extremely difficult to connect, the retrofit kit can include an embodiment with flexible connections between the existing system and the new seal adapter (161). The flexible zone and sheath (165) consists of sheathed, flexible connections to the level sensor (162), vent tube (164) and water tube (163). To anticipate the case wherein it is desired to use an already-retrofitted bottled-water dispenser with either the water generator or purchased supply bottles, one embodiment of the conversion kit can be provided with a lengthened flexible zone. This will permit insertion of the seal adapter (161) along with the elongated tubes (163) , (164) into a typical filled supply jug held with its mouth facing upward beside a typical cabinet, the length of the flexible zone is in the range 0.2 to 1 m. When the jug is lifted into position on the cabinet, the excess length can be concealed inside the typical cabinet. When the level sensor (162) detects that the jug is filled to a predetermined level, it sends a signal back to the solenoid control valve of the water generator through the low-voltage leads; this signal stops the flow of water into inlet of the water tube (163). It is envisioned that a "cut-off" embodiment of the present water generator similar to that shown in Fig. 14 is placed beside the existing bottled-water dispenser. Any embodiment of the present invention can be fitted with an external port for providing impure water into the recirculation loop in case of low temperature or humidity in the local environment. This operation provision will also enable the unit to dispense a much greater volume of potable water than would ordinarily be possible by condensation alone.

Similarly, an additional alternative system to dispense and meter drinking-water additives such as colorants, flavoring, medicaments, vitamins, mineral supplements, etc. can be added near the end of the RT or cold-water delivery line on any embodiment of the present invention.

Example M12 - Water generator for use in vehicles subject to violent motions and tilt angles. Since automobiles, recreational vehicles and seagoing vessels may need an emergency source of drinking water, it is of interest to provide an embodiment of the present invention which is tolerant during operation of tilts up to 30 degrees in combination with movements which generate centrifugal forces in opposition to normal gravitational forces. It is envisioned that the present invention may be fitted with two changes to meet these needs: (a) gimbal-suspended, sealed condensate collector and (b) enclosed, sealed potable water reservoir with an appropriate vent. Relative to preventing or suppressing spillage from the drip collector under violont pitching motions, porous, hydrophobic foam elements may be attached to the upper wall zone of the tray to cover any gap between it and the edges of the heat-exchange plates or fins. Similarly, the collector tray may also be prepared with internal baffles plates extending perpendicular from the bottom or sides to suppress splashing.

Example M13 - Combination refrigerator and water generator . Since the present invention uses certain systems which are already present in a typical household refrigerator-freezer, a further embodiment of the water generator is to incorporate it with the cooling and auto icemaking subsystems of a refrigerator to produce a hybrid appliance which both cools food and generates its own mineral-free potable water for dispensing directly as icewater or for automatic preparation of mineral-free ice cubes. It is envisioned that at least three approaches to these alternative embodiments are possible: (a) to incorporate or integrate the water generator of the present invention with such appliances during original manufacture, (b) attach an embodiment of the water generator of the present invention as a field-modification to such units using permanent couplings/ mountings/ manifolds attached to prepared electronic and fluid interfaces installed at original manufacture, or (c) connect the water generator of the present invention with the cooling systems of such units using a modification kit including permanent or quick-disconnect fittings/ mountings. The difference between approach (b) and approach (c) is that the fluid fittings and electrical circuits from the modification kit is attached at predefined points, but not to factory-installed fittings or interfaces, to existing systems of the appliance; it is anticipated that approach (c) may be done "on site" or in a repair shop. Alternatively, it is also possible to make a combination-hybrid appliance which is the combination of the water generator of the present invention within the cabinet of an appliance such as a refrigerator-freezer, icemaker or room air conditioner. In such embodiments, the water generator may be: (a) provided with its own independent cooling systems in addition to the systems normally provided for the basic appliance or (b) integrated into or interconnected with the reverse-cycle system of the appliance so that only one compresser is used.

Figs. 17a and 17b show front and side views respectively of one possible embodiment of the present invention as integrated with a vapor-compression refrigeration-type appliance such as a refrigerator-freezer, icemaker, room air conditioner or a local air-handler. This corresponds to option (b) above. These figures show the outlines of the enclosure of a typical refrigeration-type appliance, and the flow diagram for the liquid and vapor refrigerant through the compressor, expansion valve and condenser. One embodiment of the present water generator is also shown as an integrated sub-

system including indicia for its key elements as they can be placed in this embodiment. For this illustrative embodiment, the water generator is shown on the right side of the main appliance; air from the space is drawn into the front of the water generator portion and exhausted toward the rear. While the alcove (37) and delivery valves (36), (36A), (36B) are shown facing toward the right in this example, they may also face toward the front of the main appliance. In this example configuration, the main compressor and main condenser carry the extra cooling load imposed by operation of the water generator, and its water cooler. The integrated water generator section would need only heat absorber-1 (22) and heat absorber-2 (44) for its cooling requirements; both these are connected to draw liquid refrigerant from the main system. Fig. 17a shows phantom views of the reservoir (30), heat absorber-2 (44) and heat absorber-1 (22); the extended-area fins are shown in a cut-away view with a portion of the water-generator housing front-wall removed. The branching valve (171) may be included in the integral interface and installed during manufacture of the main appliance; the attached or integrated water generator system may be fitted with a mating interface and splitter valve (171) which is connected to divide the liquid flow from (171) between heat absorbers-1 and -2 of the water generator. As shown in Fig. 17b, the extended-area fins of heat absorber-1 are shown in cut-away view with a portion of the water-generator housing sidewall removed. As can be seen, the fins are arranged as a parallel stack with their flat faces parallel to the side face of the main appliance. The water condensate collector is shown schematically as (25); the intake fan and motor to circulate room air across the cooled surfaces of heat absorber-1 are indicated as (40A). Essential systems of the water generator as described herein are enclosed within the housing (21); optional and other ancillary systems described can also be included within the enclosure (21). Further, it is possible for such integrated water generators, to use housings of smaller size and different shapes/ proportions as needed to assure high efficiency and consumer acceptance of the combined or hybrid appliances.

Example M14 - Combination water generator with: ice makers, air conditioners and dehumidifiers. The water generator of the present invention can be mechanically combined within the cabinet of appliances such as icemakers, airconditioners and dehumidifiers. In the case of the icemaker, the water generator may be operated to supply all or a large portion of the water requirements; for large-capacity units, the VOC filter loop of the present water generator can be used to purify the regular tap-water supplied to the unit. Since the water generator of the present invention uses certain systems which are already present in typical ice makers, air conditioners and dehumidifiers, it is cost-effective to add a certain level of marginal capacity in their cooling systems, generate potable water and provide it at one or more selected temperatures by means of permanent or quick-disconnect fittings/ mountings. It is envisioned that at least three approaches to these alternative embodiments are possible: (a) to incorporate or integrate the water generator of the present invention with such appliances during original manufacture, (b) attach an embodiment of the water generator of the present invention as a field-modification to such units using permanent couplings/ mountings/ manifolds attached to prepared electronic and fluid interfaces installed at original

manufacture, or (c) connect the water generator of the present invention with the cooling systems of such units using a modification kit including permanent or quick-disconnect fittings/ mountings. The difference between approach (b) and approach (c) is that the fluid fittings and electrical circuits from the modification kit may be attached at predefined points to existing systems of the appliance; it is anticipated that approach (c) may be done "on site" or in a repair shop. The resulting hybrid appliance is thus capable of generating potable water which is compliant with NSF-53 purity standards as well as performing its normal function. In a temperate climate, disposal of water condensate from such units (dehumidifiers, air conditioners) requires special drain piping and provision for manual emptying of the collector. It is envisioned that the drained condensate from appliances such as an air conditioner may be recycled into the recirculation circuit of the present invention to provide additional potable water above the capability of the unit itself.

Example M15. Evaporative-cooled spaces. In an arid climate, the water generator of the present invention can be placed near a pool or other body of water or in an interior space which is cooled by water-evaporation air conditioning equipment for production of high-purity potable water.

Example M16. Stand-alone refrigerator with ice maker and integrated water generator -- no water connection required. This example is an extension of Example M13 above, which discloses an embodiment of this invention integrated with or into a refrigerator/ icemaker which requires a water supply for making ice, but generates its own potable water for dispensing. It is envisioned that the water generator of this invention may be added : (a) as a field modification to a typical refrigerator/ icemaker or (b) a factory-integrated version. The resulting hybrid appliance has the capability of generating its own potable water which is available delivered as potable-water ice or dispensed as liquid potable water. Fig 18a shows a schematic refrigerant-flow diagram of one such embodiment. This particular embodiment includes two "AND" valves , (222) and (223), which are controlled to allow flow of refrigerant to heat absorber-1 (22) and/ or (225) the evaporators of the refrigerator, i.e., the freezer compartment and the icemaker, if fitted. These "AND" valves permit operation of the water generator alone or the regular systems alone, or any combination of partial flows partitioned according to user control settings or demand sensed automatically by the system. Alternatively, an interconnected series of 3-port reversing valves and tubing manifolds can be used to accomplish the same degree of independent operation of the water generator and the regular systems. Either "AND" or reversing refrigerant valves provide for efficient switching of the basic reverse-cycle apparatus between the usual refrigerator/ icemaker functions and the additional functions of the water generator and its optional dispensor reservoirs. Either of these illustrative circuits will also be extremely conservative relative to energy consumption and energy efficiency. Fig. 18b shows the schematic potable-water flow circuit including UV bacteriostat (201) and charcoal-type VOC filter (31) for removal of adsorbable/ absorbable dissolved or dispersed contaminants. The filter (31) in this embodiment may be any known type of disposable filter which is able to reduce dissolved and dispersed impurities to low levels required by NSF Std.53. The filter may include screen, depth and

porous adsorbent elements or stages prepared from known materials. Continual recirculation is provided by the pump (26) and the recirculation control (202); this sensor can be set to cause recirculation for a preset time duration at any predetermined time interval, even if the level in the collector (25) is at the "full" level. The UV radiation module (201) can include any type of known UV source including gas plasma tubes, lasers, and solid-state UV sources. As shown, the return flow (209) passes through the active-radiation field of the UV bacteriostat (201). The wavelength, radiant energy level and water flow rate are adjusted to provide sufficient UV exposure for effective killing of bacteria An additional feature of this embodiment is the auto-defrost water-recovery system which recycles melted frost from the freezer evaporator into the potable water circuit; the potable water circuit includes an "OR" valve (203) which is controlled to collect melted frost from the freezer during auto-defrost operations. This circuit includes a vented reservoir (207) and (30) respectively and a gravity-flow path (209).

Example M17. Stand-alone icemaker with integrated water generator -- no water connection required. This example is an extension of Example M13 above, which discloses an embodiment of this invention integrated with or into a icemaker which does require a water supply for making ice. Fig. 19a shows the front elevation view of a hybrid icemaker/ potable-water dispenser (230) which generates its own water supply by means of an integrated embodiment of the present invention. This unit may be floor supported as shown, or may rest upon a supporting surface (236), is moveable by one or two persons taking hold of the lifting handles (232). The general arrangement includes a hinged door (231) into the internal ice compartment; the icemaker freezes solid ice shapes and they fall into the holding bin as they are produced. The internal components include the water generator of the present invention connected into the refrigeration system of the icemaker. Such a unit may be made as a factory-version icemaker or a field retrofit kit added to an existing standard icemaker. The unit may have an one or more optional external delivery faucets for liquid potable water (233) at predetermined temperatures, e.g., room temp, cooled, or heated. For convenience, the unit may also be fitted with an optional protective holder/ dispenser means (234) to deliver clean, fresh, disposable drinking cups. In this illustrative embodiment, a protective intake grille (235) is shown in front of the intake-air filter of the water generator. Fig. 19b shows a schematic view of one illustrative embodiment of the potable-water loop within the illustrative appliance of Fig. 19a. In this cut-away, sectional view, the shell of the cabinet is denoted as (240); one or more optional external faucets for dispensing potable water at one or more selected temperatures is indicated by (233). The cabinet is shown resting upon the floor or a supporting surface (236). The refrigeration system of the icemaker provides fluid to the heat abosrber of the water generator (22) under the system control with user adjustments. Filtered environmental air is circulated across (22) and cooled; resulting liquid water condensate is collected in the collector (25). The electric pump (26) operates in response to control signals generated by the level controller,(202); this controller can enable pump operation to deliver condensate fluid to the pressurized reservoir (244): (a) upon call from the icemaker supply valve (247) (b) upon demand from the external potable-water dispensers (245) or at predetermined time

intervals for the purpose of continual recirculation and resterilization of the reservoir contents through the UV radiation module (201). The UV exposure module (201) may be fitted with any UV source which produces effective wavelengths and intensities for sufficient time duration to effect killing of bacteria in the water stream; such UV sources include but are not limited to gas-plasma tubes, solid-state emitters, fluorescent emitters, natural sources, etc. This illustrative loop also includes a trim valve (241) which controls the water flow rate; for the simplest embodiment, it can be a known metering valve which may be manually preset to a selected max. flow when the pump is enabled for periodic recirculation or in any case when the water flow rate exceeds the sum of demands. Alternatively, this trim valve may include attached or integrated electromechanical or electronic sub-systems such as sensors/ actuators/ drivers responsive to digital/ analog user inputs to the control system(s)/ algorithm(s). The filter (31) in this embodiment can be any known type of disposable filter which is able to reduce dissolved and dispersed impurities to low levels required by NSF Std.53. The filter may include screen, depth and porous adsorbent elements or stages prepared from known materials including but not limited to non-woven fabric, porous elements in the form of membranes, granules and other formed-media shapes and rings, saddles, etc., as well as bonded, porous charcoal preforms. Continuing intermittent recirculation is provided by the pump (26) and the recirculation control (202); this sensor can be set to cause recirculation for a preset time duration at any predetermined time interval, even if the level in the collector (25) is at the "full" level. The UV radiation module (201) can include any type of known UV source including gas plasma tubes, lasers, and solid-state UV sources. As shown, the pressurized return flow (243) passes through the active-radiation field of the UV bacteriostat (201). The wavelength, radiant energy level and water flow rate are adjusted to provide sufficient UV exposure for effective killing of bacteria As mentioned above the recirculation flow rate is limited by the trim valve (241). This illustrative embodiment includes a pressurized reservoir (244) fitted with a gas-filled bladder or an airspace as shown; the reservoir water-inlet check valve (246) prevents water from flowing backwards from the reservoir and into the supply channel (242). The level of liquid water in the reservoir is controlled by (206) which senses the level and/ or pressure; it is responsive to system control signals for maintaining the water level/ pressure according to demand for ice or potable water or preset system commands for periodic recirculation of water already in the reservoir.

Example M-18. Vehicle Potable Water Apparatus.

This embodiment is an example of a version of the present invention to produce potable drinking water from condensate available from auto or truck air conditioning systems or from other vehicular conveyances, such as trailers, mobile homes, cabin cruisers, etc., and dispensing hot and/ or cold potable water safely. See Fig 20(a) - (c).

It consists of an enclosed reservoir (340) made of a UV-transparent polymer material, such as polycarbonate or acrylics, or is provided with a UV-transparent window (390) that is resistant to UV or oxygen degradation. The reservoir is provided with a safety-interlocked, enclosed (333) UV source (317) which may be located exterior to the reservoir and abutting either : (a) the

UV-transparent window (390) or (b) a UV-transparent portion of the top or side walls. The UV source (317) is selected to provide a sufficient intensity and effective wavelength range for killing any live organsims present in the water being exposed within the reservoir. Another embodiment is to locate the UV source with a fluid-sealed, safety-interlocked, UV-transparent tube which traverses the reservoir interior. The reservoir has a fluid-level control sensor (312) that shuts off the circulation pump when low fluid is sensed in the reservoir. When the water level is low, the sensor shuts off the entire system. The light-emitting diode (LED) indicator display (308) also goes out at the driver's console (353) signalling a low water level. The reservoir has a drain valve (331) located at the lowest point for draining the system in the winter. In the case of a UV-opaque metal or alloy reservoir, it's inner surface may be polished or otherwise treated to increase it's reflectivity for UV wavelengths. If made of transparent polymer material, the exterior of the reservoir may also be wrapped with a UV-reflective metallic foil (341) to increase the killing effectiveness and power-efficiency of the source.

The reservoir has one inlet for the incoming condensate (342) from the vehicle AC evaporator drain pan. It has two outlets. One outlet connects to the circulation pump (344) and the other outlet (343) connects to the overflow condensate. Upstream, on the incoming condensate line, is a controllable diverter valve (335) which allows condensate to go either to the reservoir or be discharged. This latter mode may be for seasons when the potable water system is not being used, such as in the winter, or for repairs or some other reason.

The circulation pump may be located outside the reservoir or within in the reservoir. It is electrically connected so that it can operate only if the vehicle ignition switch is "on" (309), and either the hot (303) or cold (304) switch is "on" and the radiation source (317) fully operative. Downstream from the circulation pump is a check valve (345) that operates to keep the portion of the system downstream from it pressurized (363) when the circulation pump is stoped.

After leaving the circulation pump, the UV-radiation-treated water continues through a porous, carbon-block absorber filter (329) tested to meet NSF 53 standard for removing volatile organic compounds (VOC). After passing through the VOC filter, the water flow branches at the periodic-recirculation chamber (355); one branch connects to the hot water flow line (346) and the other branch connects to the cold water line (347). An additional line recirculates through the solenoid check valve (357) and flows past the UV source and the filter (329) and back into the recirculation chamber. The recirculating system control allows treated water to be periodically recirculated past the integrated radiation source (317) and the solid block VOC filter (329). This recirculation takes place when the circulation pump (314) is activated by a timing and valve sequence control (356). Controllable check valve (356) opens when the timer sequencer starts recirculating the water.

A dispenser (360) and related control sensor may be added to the hot or cold delivery lines, beyond the recirculating chamber, to allow delivery and accurate metering of certain desirable drinking water additives such as colorants, flavoring, vitamins, mineral supplements, herbal extracts, fluorine and other known therapeutic compositions. The recirculation assures that

the water remains pure in the lines even after the vehicle air conditioning system has not operated for extended periods. The energizing circuit for the timer-sequencer is electrically connected directly to the vehicle battery so that water is recirculated even when the vehicle is parked. Switch (359) disconnects the timer-sequencer from the battery when circulation is not desired such as in the winter or in extended storage. The hot water flow goes through a heater (328) with a heating element (321) and thermostat temperature-control switch (319). When the hot water switch (303) is turned "on", the heater is turned "on", the LED indicator display (307) comes "on" showing the heater is "on". The hot water safety interlock (305) is also energized. Switch (318) also prevents heater (328) from coming "on" if there is no water in the heater. When the water reaches the appropriate temperature (about 80 degrees C), it turns "on" the LED indicator display (320). Hot water for beverage service can then be dispensed by operating the controllable delivery valve (326) provided the arming switch, (350), on the driver console (353) is "on". The interlock (306) ensures that no hot water can be dispensed by children or others unless the driver energizes both the main on-off switch (311) and the hot-water safety interlock switch (305). Once both these switches are "on", water will be maintained at about 80 degrees C by the thermostatic control (319). A check valve (327) in the line between the recirculation chamber and the heater (328) prevents hot water from leaking back into the cold water portion (347).

The cold water flow line (347) is flexible, medical-grade tubing; this line pases through a portion of the cover (337) of the vehicle AC evaporator chamber and is thermally connected to the to the vehicle's air conditioner cooling section (338). To increase the heat-exchange area, this line is formed with several loops and exits through the cold water safety interlock (306) and connects thence to the controllable delivery valve (325). Similarly, this delivery outlet may be branched or direct-connected to an external drinking-water supply tank, such as provided in a typical recreational vehicle. In case of low environmental temperature or humidity, it is also possible to introduce impure water into this system at port (334); alternatively, the unit may be primed with impure water to provide potable water in a minimal time interval after start-up. No water can be obtained unless: (a) the cold-water arming switch, (351), on the driver console (353) is "on" and (b) the safety interlock switch (304) is "on" at the driver's console. When these conditions are satisfied, the LED indicator display (308) is lighted. Also, no water can be dispensed if the vehicle ignition is "off" (309). If the ignition is "on", no water can be dispensed if the safety interlock switch (304) is "off" at the driver console. The controllable delivery valves are installed far enough apart in the vehicle that children playing could not reach both.

When installed as a retrofit kit (353) a manual (352) guides the installer so that safety interlocks are installed correctly. The retrofit kit contains all of the parts listed above.

Persons skilled in the art may conceive of other alternative embodiments and combinations of additional features and subsystems to those disclosed and still not depart from the broad scope of the present invention as claimed below.

CLAIMS:

1. A portable, potable water recovery and dispensing apparatus comprising:

a portable enclosure (21) having insect preventive openings and insect-tight integrity, and including within said enclosure (21),

a. an inlet port and an outlet port, said inlet and outlet ports being covered with insect-resistant screens (49),

b. filtration means (38) being adapted to remove and trap particulates of diameter larger than 1-100 micrometers dispersed in ambient air sealingly connected upstream of said air-circulation means,

c. air circulation means for circulating ambient air from said inlet port to said outlet port, said air circulation means comprising an internal, ducted, electric, rotary air-circulation means (40-A) of controllable, variable flow volume of ambient air sealingly connected downstream of said filtration means (38),

d. water condensing means comprising an enclosed cooling means (22) sealingly connected downstream of said filtration means (38) and upstream to said air-circulation means (40-A) including dew-forming surfaces (24) adapted to cool the boundary-layer air adjacent to said dew-forming surfaces (24) to a temperature at least 1-10 deg. C below the equilibrium dewpoint of the inlet air stream, thereby forming liquid-water on said dew-forming surfaces (24), said surfaces (24) being formed and positioned for gravity flow of said liquid water into an enclosed dripoff collection vessel (25),

e. an enclosed fluid reservoir (30) sealingly connected to said dripoff collection vessel (25) of material appropriate for storage of high-purity drinking water and fitted with an outlet connection whereby most of the water held therein can be withdrawn,

f. bacteriostat loop means sealingly connected to said fluid-reservoir (30) and comprising a closed-loop, recirculation channel and pump whereby water in said fluid reservoir (30) is pumped at a predetermined flow rate through an activated-carbon porous VOC filter absorber (31) connected in series with an active stage for killing micro-organisms,

g. a first delivery channel sealingly connected to said closed-loop recirculation channel and extending through said enclosure (21) for external dispensing of purified water from said fluid reservoir (30), and

h. means within said enclosure (21) for monitoring integrity and proper operation of components therein.

2. An apparatus according to claim 1 further comprising first additional means located within said enclosure (21) and connected to said closed-loop recirculation channel for providing, holding and dispensing from said enclosure chilled, purified water at a predetermined temperature in the range of 5-20 deg. C.

3. An apparatus according to claim 2 characterized in that

a. said cooling means (22) comprises a closed-system compression refrigeration unit filled with a refrigerant and including an evaporator, said evaporator of said unit also being fitted with an upstream electric-resistance air heater (23) which is automatically regulated by thermal sensors (40) located in the air downstream of said cooling means (22) to prevent the formation of ice on said dew-forming surfaces (24) of said cooling means (22),

b. said cooling means (22) is adapted to cool a flowing stream of filtered air to at least a temperature below its dewpoint using a temperature-controlled flow of said refrigerant in one or more closed channels thermally connected to said dew-forming surfaces (24) being arranged in an array located in said air stream,

c. said cooling means (22) is maintained in an ice-free state below the dewpoint temperature of said air stream by automatic, controlled heating of incoming air using said upstream electric-resistance air heater (23), and

d. said first additional means of providing, holding and dispensing cooled water is a temperature-controlled auxiliary evaporator of said closed-system, compression refrigeration unit located in thermal contact with the bottom surface of a thermally insulated, closed reservoir vessel also fitted with a horizontally-oriented, fluid-convection-inhibiting, thermally-insulating separator baffle (45) located vertically above said reservoir bottom surface and adapted to trap and deliver cooled water from below said baffle (45).

4. An apparatus according to any preceding claim further comprising second additional means located within said enclosure (21) and connected to said closed-loop

recirculation channel for providing, holding and dispensing from said enclosure heated, purified water at a predetermined temperature in the range of 60-80 deg. C.

5. An apparatus according to any preceding claim characterized in that said active stage for killing micro-organisms is a UV treatment zone (29) whereby the water is continually exposed to radiation of sufficient energy and appropriate wavelength to kill adventitious bacteria and viruses.

6. An apparatus according to claim 5 characterized in that said UV treatment zone (29) includes a UV source that is one of: solid-state UV emitter, gas-plasma tube UV emitter and black-body emitter and said activated-carbon porous VOC filter-absorber (31) is one of: a filter capable of clearing all stated VOC compounds to NSF-53 compliance levels, a filter capable of clearing the 20 most-toxic-to-humans VOC compounds to NSF-53 compliance levels and a filter capable of clearing at least 1 human-toxic VOC compound to NSF-53 compliance levels.

7. An apparatus according to any preceding claim characterized in that said integrity and operational monitoring means comprises,

a. analog or digital signalling sensors on one or more of: incoming air temperature, proper seating of inlet air filter, pressure drop of air across inlet filter, air flow rate immediately upstream of dew-forming surfaces (24), ice formation on dew-forming surfaces (24), UV intensity, accumulated flow volume through activated-carbon porous VOC filter absorber (31) and reservoir liquid level and

b. operational interrupt controls adapted to inhibit water dispensing if one or more signals from said signalling sensors does not fall within the predetermined value ranges for potable water.

8. An apparatus according to any preceding claim characterized in that said filtration means includes an air filter (38) and an additional particle-generation means (39) immediately upstream of said inlet filter (38), and

said particle-generation means (39) is one or more of: electrodes for generating charged particles and radioisotope sources for emitting charged particles.

9. An apparatus according to any preceding claim further comprising a metering dispenser, actuatable externally by a user and connected to said first delivery channel adapted to meter and dispense physiologically-safe levels of one or more known, compatible, healthful additives selected from: agents to improve the taste, flavour or colour of the water dispensed; agents which impart a therapeutic or protective benefit including vitamins, minerals, herbal extracts and trace minerals; agents which alter the pH such as acids or alkalis; agents which impart a selected colour including natural and synthetic food dye, and agents which impart an effervescent characteristic including dissolved gases such as N_2, O_2 and CO_2.

10. An apparatus according to any preceding claim further comprising a diverter valve (32) within said enclosure (21) for diverting high-purity potable water to an external collection container.

11. A portable, potable water recovery and dispensing apparatus comprising:

a portable enclosure (21) having insect preventive openings and insect-tight integrity, and including within said enclosure (21),

a. an inlet port and an outlet port, said inlet and outlet ports being covered with insect-resistant screens,

b. filtration means being adapted to remove and trap particulates of diameter larger than 1-100 micrometers dispersed in ambient air sealingly connected upstream of said air-circulation means,

c. air circulation means for circulating ambient air from said inlet port to said outlet port, said air circulation means comprising an internal, ducted, electric, rotary air-circulation of controllable, variable flow volume of ambient air sealingly connected downstream of said filtration means,

d. water condensing means comprising an enclosed cooling means sealingly connected downstream of said filtration means and upstream to said air-circulation means including dew-forming surfaces adapted to cool the boundary-layer air adjacent to said dew-forming surfaces to a temperature at least 1-10 deg. C below the equilibrium dewpoint of the inlet air

stream, thereby forming liquid-water on said dew-forming surfaces, said surfaces being formed and positioned for gravity flow of said liquid water into an enclosed dripoff collection vessel, and

e. bacteriostat loop means sealingly connected to said external collection container (141) and comprising a closed-loop, recirculation channel and pump whereby water in said external collection container (141) is pumped at a predetermined flow rate through an activated-carbon porous VOC filter absorber (31) connected in series with an active stage for killing micro-organisms,

an external collection container (141) outside said enclosure (21) sealingly connected to said dripoff collection vessel of material appropriate for storage of high-purity drinking water and fitted with an outlet connection whereby most of the water held therein can be withdrawn,

a first delivery channel sealingly connected to said closed-loop recirculation channel and extending through said enclosure (21) for external dispensing of purified water from said external collection container (141), and

means within said enclosure (21) for monitoring integrity and proper operation of components therein.

12. An apparatus according to claim 11 further comprising an external dispensing valve and characterized in that additional filling controls are fitted to said external collection container (141) adapted to actuate said external dispensing valve and allow high-purity potable water to be automatically provided to said external collection container (141) whenever said external collection container (141) is not filled.

13. An apparatus according to claim 12 characterized in that water delivery to said external collection container (141) is controlled by solenoid flow-control valves (146) and connected sensors adapted to measure one or more of the gross weight of the external collection container (141) and water therein and the level of the water within the external collection container (141), water delivery being interrupted whenever one of said gross weight and level reaches a predetermined value and restored whenever it falls below said predetermined value.

14. An apparatus according to claim 13 characterized in that said external collection container (141) has a volumetric capacity in the range 5-50 litres and is supported on the upper surface of the enclosure (21) on a pivoting, spring-biased plate (153), said sensors being electronic weight sensors connected to said plate (153) and calibrated both for the empty weight of said external collection container (141) and the stiffness characteristic of said spring-bias element.

15. An apparatus according to claim 13 characterized in that said external collection container (141) has a volumetric capacity in the range of 5-50 litres and is adjacent to and not supported by said enclosure (21) within a distance of 1-5m, said sensors being liquid level sensors calibrated for the size of the external collection container (141).

16. An apparatus according to claim 13 characterized in that said external collection container (141) is the overhead-inverted bottle container of a bottled-water cooler dispenser located adjacent to said enclosure (21), said external collection container (141) having a volumetric capacity in the range of 5-50 litres and said sensors being liquid level sensors calibrated for the size of the external collection container (141).

17. An apparatus according to claim 16 characterized in that impure water can be charged into said bacteriostat loop means from the exterior of said enclosure (21) by means of an additional tube which discharges into said dripoff collection vessel, is attached to said enclosure (21), extends outside said enclosure (21) and is fitted with a removable closure cap whereby said charged impure water is subsequently purified by continual recirculation and subsequently delivered into said bottled-water cooler dispenser thus allowing quick startup or operation under conditions of low temperature or humidity.

18. An apparatus according to any of claims 1 to 10 claim further comprising means for the formation and automatic dispensing of ice shapes without reliance upon any external source of water, the apparatus further comprising,

a. a known reverse-cycle icemaking apparatus including controls, compressor, refrigerant lines and an icemaker-evaporator adapted to form shaped pieces of water ice from provided liquid water and release said shaped pieces into a delivery bin within a cooled compartment of the icemaking apparatus, a water input line, a high-pressure liquid refrigerant line (226) and a low-pressure refrigerant vapour line (227) provided within said enclosure (21),

b. a second delivery channel sealingly connected between said closed-loop recirculation channel and said water input line of said known reverse-cycle icemaking apparatus, and

c. an external dispensing line, fitted with a user-operable terminal shutoff valve located at a point outside said enclosure (21), sealingly connected to said closed-loop recirculation channel and to said water input line of said icemaking apparatus and extending through a portion of the cooled compartment of said icemaking apparatus, wherein said liquid refrigerant line (226) of said icemaking apparatus provides a controlled flow of liquid refrigerant to said cooling means (22) and resulting refrigerant vapour discharged from said cooling means (22) is redirected to said refrigerant vapour line (227) of said icemaking apparatus under control of said integrity and operational monitoring means.

19. An apparatus according to claim 18 characterized in that said icemaking apparatus is housed in its own separate cabinet (240) and its high- and low-pressure refrigerant lines are fitted with factory-installed interconnect flanges which matingly interconnect with flanges provided in said enclosure (21) to deliver refrigerant to and return from said cooling means (22) under control of said integrity and operational monitoring means, and in that said enclosure (21) is mounted on the exterior of said cabinet (240).

20. An apparatus according to claim 18 characterized in that said icemaking apparatus is housed in its own separate cabinet and its high- and low-pressure

refrigerant lines are field-fitted with thermally-insulating interconnections which deliver refrigerant to and return from said cooling means (22) under control of said integrity and operational monitoring means, wherein said enclosure (21) is one of: mounted on the exterior of said cabinet and placed adjacent to said cabinet.

21. An apparatus according to any of claims 1 to 10 for use in a vehicle and powered by the electrical system of the vehicle, said dripoff collection vessel (25) further comprising: one or more spill-suppressive means, such means being selected from flanges extending above the liquid level a distance sufficient to prevent spillage should said dripoff collection vessel (25) or said enclosure (21) be suddenly tilted to an angle of 30 degrees from horizontal, a fitted top cover having a vertically-extending vent tube, an array of splash or spill resistant internal flanges attached to its walls, a fitted non-wettable porous, foam-type top cover and a freely-moving gimbal mounting.