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(54) **Title**: METHODS AND MEANS FOR ECONOMICALLY ASSURING IMPROVED POTABLE WATER QUALITY MANAGEMENT FOR AIRCRAFT AND OTHER APPLICATIONS

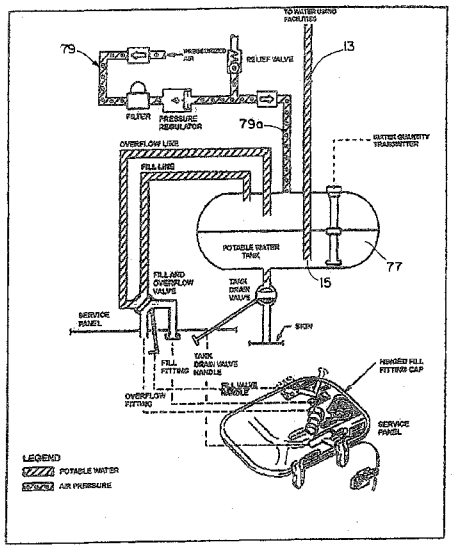

FIG. 1

(57) **Abstract**: A potable water distribution system for use in aircraft, as well as a potable water system for boats, recreational vehicles/caravans, residential homes, dental offices, laboratories, vending machines, and the like, permits sanitizing of the system without opening filter and/or purification units and removing filtering and/or purifying cartridges from the filter and/or purification units during the sanitizing process. The invention includes an apparatus for filtering water, the apparatus having a valve head and a filtration/purification canister removably mountable thereon. Connecting the canister to the valve head automatically opens a check valve in the valve head to permit water to flow from the valve head into and through the canister, and then back to and through the valve head to an outlet port. Disconnecting the canister from the valve head automatically closes the check valve, stopping the flow of water. A bypass valve is provided in the valve head to permit a sanitizing solution to flow through the valve head and along the lines of the water distribution system to sanitize the system, while bypassing the canister. The outlet port may be directly connected to an appliance that uses water, to eliminate possible contamination that may occur when water is brought indirectly from the outlet port to the appliance instead.

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METHODS AND MEANS FOR ECONOMICALLY ASSURING IMPROVED POTABLE WATER QUALITY MANAGEMENT FOR AIRCRAFT AND OTHER APPLICATIONS

FIELD OF THE INVENTION

This invention relates to potable water distribution systems for, for example, aircraft, and more particularly concerns potable water sanitizing systems for potable water distribution systems for, for example, aircraft. This invention further relates to apparatuses for filtering and/or conditioning and/or purifying a fluid such as water, and more particularly concerns such apparatuses that use pressure vessels holding a cartridge, loose media, or the like for filtering and/or conditioning and/or purifying a fluid such as water.

BACKGROUND OF THE INVENTION

Aircraft Potable Water - Adequate hydration is particularly important for comfortable air travel, especially aboard modern, very large, long range aircraft capable of flights of 20 or more hour duration. Typically, water is distributed to galleys, lavatories, and drinking water outlets of the aircraft to provide drinking water to passengers, to provide water for food and beverage preparation, and to provide water for personal hygiene (e.g., face and hand rinsing, teeth cleaning, etc.) during flights.

Aircraft typically are crowded with thousands of passengers, including babies, small children, handicapped people, possibly ill people, and others, from varied backgrounds, passing through a commercial passenger aircraft during a single week. Both passengers and crews contribute to microorganism populations aboard aircraft, and special precautions must be taken to minimize and avoid the possibility of bacteria, viruses, pathogenic cysts, and other microorganisms being transferred among passengers through the water distribution system.

Further, water is supplied to aircraft from many locations and varies widely in taste and sanitary quality.

In addition to point-of-use effective on-board drinking water microfilters/purifiers, a primary sanitation defense mechanism against bacteria and viruses is to maintain an adequate residual of chlorine, preferably free chlorine, within water storage and distribution systems. Further, effective on-board point-of-use drinking water microfilters/purifiers reliably remove parasitic cysts (leading causes of water borne disease worldwide) such as Giradia and Crypto which are not controlled by chlorination.

Aircraft Water Distribution and Management - Typically, an aircraft water distribution system comprises a water storage tank supplying a centralized distribution line with various branches or legs extending from the central distribution line to many locations throughout the aircraft. Part of a typical aircraft water distribution system is illustrated schematically in Fig. 1 (EPA Proposed ADWR Exhibit 2.1). For example, water is distributed to galleys, lavatories, and other locations as needed for food and beverage preparation and for personal hygiene during flights. Galleys include many "service points" such as coffee makers, water boilers, and drinking water outlets. Similarly, lavatories often include drinking water outlets and may be used for face and hand rinsing, cleaning teeth and short term personal medication. As illustrated in Fig. 2 (EPA Proposed ADWR Exhibit 2.2), there are many possible opportunities for aircraft drinking water systems/supplies to become contaminated with microorganisms even if hygienically safe when loaded aboard an aircraft.

Typically, water filter/purifier units, each comprising a housing pressure vessel and a filtration and/or purification element, usually a cartridge, are installed in or near galleys and lavatories as part of the aircraft water distribution system to improve water quality and safety for

consumption and for food and beverage preparation. Purifiers (water filter/purifiers having a purification element) must be independently certified to meet the EPA Guide Standard Protocol for Microbiological Purifiers relative to bacteria, viruses and cysts. Structured Matrix™ purifiers, sold by General Ecology, Inc., also provide excellent filtration. Filters, such as General Ecology, Inc.'s "Structured Matrix™ microfilters or simple, fine, or coarse carbon and/or sediment systems, may be sophisticated, but such filters cannot legally be referred to as microbiological purifiers before being verified that they meet the EPA Guide Standard Protocol for Microbiological Purifiers. Space in galley and lavatory compartments is expensive and severely limited. Currently, water filter/purifier units usually are installed in "out of the way", often difficult to access locations behind other more frequently accessed equipment and behind bulkheads.

Sanitation Practices – Possible microorganisms of concern are pathogenic bacteria, cysts and viruses. Chlorine resistant pathogenic cysts such as Crypto require special consideration and protective measures, such as providing point-of-use water filter/purifier units (e.g., water purifiers along the aircraft water distribution system to remove pathogenic cysts from the water moving through them). Such water filter/purifier units also remove bacteria, viruses, and other microorganisms from the water moving through them. Further, to overcome the challenges of virus and bacteria transmission via water systems and colonization within an aircraft potable water distribution system, airlines often try to assure that there is an adequate chlorine residual within the aircraft water supply. Even so it is necessary to periodically "sanitize" the aircraft water distribution system, typically with a 2+ hours soak of high concentration (100 ppm) chlorine solution. This sanitation process requires time and labor intensive removal of filtration/purification cartridges from units installed in galleys, fountains, and lavatories

throughout the aircraft prior to the sanitization process. After removing cartridges, pressure vessels must be reassembled to allow complete distribution of the sanitizing solution through the water distribution system and to prevent leakage of this highly corrosive and oxidizing sanitizing solution during the two hours sanitization soak.

Cartridge removal is required for at least two reasons: 1) because a high concentration of chlorine is detrimental to most filtration/purification cartridges, and 2) more importantly, because microorganisms might be sheltered in crevices and imperfections at sealing surface interfaces (ideal locations for biofilm formation) of the water filter/purifier units compromising effectiveness of the sanitizing process, thereby allowing recolonization of the distribution system. Even though sanitization is recognized as effective, typically because of the relatively high cost of the sanitizing process and the revenue lost due to the downtime of the aircraft during the sanitizing process, sanitization is performed infrequently – possibly every six months or at a convenient "A Check" or more extensive maintenance intervals when other maintenance is carried out.

After chlorine flushing and soaking for two hours, following current practices, the pressure vessels once again are opened and the same cartridges (or new replacement cartridges) are installed. Potable water is flushed throughout the aircraft water distribution system to thoroughly remove the extremely high concentration sanitizing solutions. Several hours may be required to sanitize an aircraft resulting in costs averaging upwards to hundreds of dollars per unit. More efficient, lower cost sanitization would allow more frequent sanitization and provide possibly higher quality potable water with better economy and depending on procedures without replacing cartridges with each sanitizing procedure.

System Draining and Refilling - Water must be drained from aircraft during periods of non-use (such as overnight) in cold climates. Proposed EPA regulations require much more frequent draining and filling of water storage tanks in an effort to improve aircraft drinking water quality and safety. Draining and filling water systems requires "vacuum breaks" at equipment locations to allow water to be properly released and "vents" to allow air to escape in order to assure proper functioning of filters, purifiers, and other equipment. Although the very latest filter/purifier units include automatic vacuum breaks and venting, most aircraft units require manual actuation often resulting in inadequate water draining and filling.

Also, under the proposed EPA regulations, it is likely that accessing and actuating manual vents and vacuum breaks, sometimes previously ignored, may become a significantly higher maintenance cost item due to difficult access to the water filter/purifier units and aircraft "out of service" revenue costs.

Microorganism Growth - Even with periodic sanitization, bacteria may colonize various branches (legs) of water distribution systems. Bacteria multiply rapidly, sometimes doubling in number in approximately 16 minutes. Therefore, a small number of bacteria may quickly reach infectious concentrations in water intended to be consumed, especially downstream of improperly installed/serviced filters/purifiers employed to remove chlorine, foul tastes, and odors. Further, water filter/purifier units installed in semi-remote locations along the water distribution system often require longer than desired distribution lines to specific service points (e.g., locations where the water is discharged from the water distribution system). These distribution lines provide unnecessary opportunities for previously purified water to be recontaminated from inadvertent inoculation, short term bacteria multiplication or biofilm

formation/shedding that may have taken place in such distribution lines downstream of the water filter/purifier units.

SUMMARY OF THE INVENTION

It is an object of the invention to provide a potable water distribution system for use in such things as aircraft, boats, recreational vehicles, residential homes, and the like, which has a sanitizing system for sanitizing the potable water distribution system.

Another object of the invention is to provide methods for sanitizing a potable water distribution system for use in such things as aircraft, boats, recreational vehicles, residential homes, and the like, and to provide apparatus used in conjunction therewith.

It is object of the invention to provide a bypass apparatus used in conjunction with the inventive potable water distribution system.

It is an object of the invention to provide an apparatus for filtering and/or conditioning and/or purifying a fluid such as water.

It is another object of the invention to enable and introduce a new concept to provide more efficient, more cost effective, improved water quality management aboard passenger aircraft, and for other applications. For example, and more specifically with respect to passenger aircraft applications, the concept is to provide water filter and water purifier systems installed at various aircraft cabin crew readily accessible service locations (service points) within galleys and lavatories of the aircraft, preferably at or near where the water that is filtered and/or conditioned and/or purified for immediate use. This invention provides for various types of filtering and purifying processes being available in interchangeable self-contained canisters (e.g., pressure vessels 15, each containing filtration and/or purification media 16) attached to interfacing "valve heads" integrated into the water distribution system at appropriate cabin crew readily accessible

locations. Stored water can then be filtered and/or purified immediately at the time and place of use as it is discharged from the potable water distribution system.

Another object of the invention is to provide an aircraft potable water distribution system having valve heads installed locally at various cabin crew readily accessible service locations or service points within galleys and lavatories of the aircraft, to connect an outlet port of at least one of the valve heads directly to an appliance such as a coffee maker or other water-using equipment located in the galley of the aircraft to reduce possible exposure of the water that has been filtered and/or conditioned and/or purified to contaminants that may be encountered if water were to be indirectly brought from the outlet port of the valve head to the appliance instead.

Still another object of the invention is to provide an apparatus and aircraft potable water distribution system that allows non-technical flight attendants servicing, that is, removal of filtration/purification cartridges, and replacement thereof, on a frequent basis as an extension of normal routines, without requiring professional maintenance crew attendance and support.

These and other objects of the invention are accomplished by our invention which is described below.

The invention provides a means for moving or circulating a sterilizing rinse and soak fluid throughout appropriately equipped aircraft, for example, without opening filter and/or purification units and removing cartridges during the process. Preferably, this sterilizing rinse fluid used to sanitize the aircraft potable water distribution system may be introduced to the aircraft potable water distribution system and removed after the desired soak period through standard aircraft water filling and draining ports outside the aircraft or recirculated to the sanitizing solution origin point/pump.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a schematic representation of an aircraft onboard water system.

Fig. 2 is a schematic illustrating potential contamination pathways within an aircraft water system supply and transfer chain.

Fig. 3 is a schematic representation of a typical layout of a potable water distribution system in an aircraft.

Fig. 4 is a schematic representation of a potable water recirculation system of an aircraft.

Fig. 5 is a view in partial cross-section of a bypass apparatus 25 connected to a filtering and/or conditioning and/or purifying device 19, illustrating the flow path of fluid from a distribution line through the bypass apparatus 25 and the filtering and/or conditioning and/or purifying device 19 when the bypass valve 47 of the bypass apparatus is closed. Fig. 5 also includes a cutaway view of a portion of the cartridge 23.

Fig. 6 is a view in partial cross-section of a bypass apparatus 25 connected to a filtering and/or conditioning and/or purifying device 19, illustrating the flow path of fluid from a distribution line through the bypass apparatus 25 when the bypass valve 47 of the bypass apparatus is open. Fig. 6 also includes a cutaway view of a portion of the cartridge 23.

Fig. 7 is a view in partial cross section of a bypass apparatus 25 connected to a filtering and/or conditioning and/or purifying device 19, illustrating the flow path of fluid from a distribution line through the bypass apparatus 25 when the bypass valve 47 of the bypass apparatus is open, and illustrating schematically control of the bypass apparatus 25 by an actuator such as a solenoid.

Fig. 8 is a view in cross-section of a bypass apparatus 25, constructed in accordance with the invention.

Fig. 9 is a view in perspective of a bypass apparatus 25, constructed in accordance with the invention.

Fig. 10 is a view in cross-section taken along the lines and arrows 10-10 shown in Fig. 9, illustrating the bypass valve 47 in a blocking position in the third passageway 45 of the bypass apparatus 25.

Fig. 11 is a view in cross-section taken along the lines and arrows 10-10 shown in Fig. 9, except that the handle 57 has been rotated outwardly to move the bypass valve 47 into a non-blocking position in the third passageway 45 of the bypass apparatus 25.

Fig. 12 is an exploded view of the bypass apparatus 25 shown in Fig. 9.

Fig. 13 is a plan view of the second end portion 123 of the first member 27a of the body 27 of the bypass apparatus 25.

Fig. 14 is an exploded view illustrating a typical handle 57 and the components attached thereto.

Fig. 15 is a view in perspective illustrating an alternative embodiment of the invention.

Fig. 16 is a top plan view of the alternative embodiment of the invention shown in Fig. 15, with the bypass apparatus portion 25' of the combined device 143 being shown in cross-section.

Fig. 17 is a view in side elevation of the alternative embodiment of the invention shown in Fig. 15, with the bypass apparatus portion 25' of the combined device 143 being shown in cross-section.

Fig. 18 is an exploded view of the first end portion of a valve head 313, constructed in accordance with the invention.

Fig. 19 is an exploded view of the second end portion of the valve head 313, constructed in accordance with the invention.

Fig. 20 is a top plan view of an apparatus 311 of the invention.

Fig. 21 is a view in cross section taken along the lines and arrows 21-21 shown in Fig. 20.

Fig. 22 is a view in partial cross section taken along the lines and arrows 22-22 shown in Fig. 20, except that the canister or pressure vessel 315 is shown as a partial view in perspective and exploded away from the valve head 313.

Fig. 23 is a partial view in cross section taken along the lines and arrows 23-23 shown in Fig. 20.

Fig. 24 is a bottom plan view of the valve head member 313a of valve head 313.

Fig. 25 is a top plan view of the valve head member 313b of valve head 313.

Fig. 26 is a top plan view of a canister (the pressure vessel 315 containing a cartridge 316) of the invention.

Fig. 27 is a partial view in cross section showing an automatic venting device 539 formed in the bowl of an alternative embodiment of the pressure vessel, constructed in accordance with the invention.

Fig. 28 is an exploded view of the automatic venting device 539 shown in Fig. 27.

Fig. 29 is an enlarged view of a portion of the apparatus 311 shown in Fig. 21.

Fig. 30 is a view in bottom plan of the end cap 483 which has a hollow tube 487 that functions as the outlet port from the canister (the pressure vessel 315 having the cartridge 316 mounted therein).

Fig. 31 is a view in cross section taken along the lines and arrows 31-31 shown in Fig. 30.

Fig. 32 is a view in partial cross section showing an alternative bypass valve 561, in which the bypass valve 561 is in a closed position blocking flow through the third passageway 399 formed in the valve head 313. For purposes of clarity, various details relating to the valve head 313 are not shown in this figure so as to highlight the details relating to the bypass 561.

Fig. 33 is a view in partial cross section showing an alternative bypass valve 561, in which the bypass valve 561 is in a opened position to permit flow of fluid through the third passageway 399 formed in the valve head 313. For purposes of clarity, various details relating to the valve head 313 are not shown in this figure so as to highlight the details relating to the bypass 561.

Fig. 34 is a view in cross section of an end cap used to cover the second end portion of the valve head 313 when a canister is not connected to the valve head 313 to block dirt and other debris from having easy access to the second end portion 371 of the valve head 313.

Fig. 35 is a view in front elevation of a pressure vessel 315 that is provided with a reinforcement member 519 secured around the sealed seam portion 517 of the pressure vessel 315.

DETAILED DESCRIPTION

Turning to the drawings, there is shown in Figs. 3 and 4 a potable water distribution system 11 of the invention. For illustrative purposes, the inventive potable water distribution system 11 is shown in the drawings in connection with its use in aircraft. However, the potable water distribution system 11 may be used in connection with other applications, such as in drinking water systems of recreational boats and yachts, commercial boats, recreational vehicles/

caravans, residential homes, and water vending, cooling, warming and dispensing machines (such as those used in hospitals, schools, homes and factories). The inventive potable water distribution system 11 also may be applied to water systems in dental offices and laboratories.

The potable water distribution system 11 has a distribution line 13 that has an inlet port 15 (Fig. 1). The distribution line13, as illustrated in Figs. 3 and 4 may have a main portion 13a and branch portions 13b which together form the distribution line 13. The distribution line 13 has at least one outlet port 17. In the embodiment of the invention illustrated in the drawings with respect to use of the inventive potable water distribution system 11 in aircraft, outlet ports 17 are located along the distribution line 13 at fountains, service points in galleys, and lavatories throughout the aircraft.

Turning to Figs. 5-7, the potable water distribution system also has at least one filtering and/or conditioning and/or purifying device 19 mounted along the distribution line 13 for filtering and/or conditioning and/or purifying a fluid received from the distribution line 13 before said fluid exits from the potable water distribution system 11 through an outlet port 17. The filtering and/or conditioning and/or purifying device 19 may comprise a housing pressure vessel (usually stainless steel, but sometimes made from a polymer or polymers) that holds a cartridge, or loose media, or the like for filtering and/or conditioning and/or purifying a fluid such as water. In the embodiment of the invention illustrated in the drawings with respect to use of the inventive potable water distribution system 11 in aircraft, a plurality of filtering and/or conditioning and/or purifying devices 19 are mounted along the distribution line 13 at fountains, service points in galleys, and lavatories throughout the aircraft to provide water for food and beverage preparation and to provide water for personal hygiene (e.g., face and hand rinsing, teeth cleaning, etc). In the embodiment illustrated in the drawings, each filtering and/or conditioning

and/or purifying device 19 comprises a pressure vessel 21 that holds a cartridge 23 for filtering and/or conditioning and/or purifying the fluid moving through the filtering and/or conditioning and/or purifying device 19. The filtering and/or conditioning and/or purifying device 19, as well as the cartridge 23 therefor, may be obtained from General Ecology, Inc., of Exton, Pennsylvania. A preferred filtering and/or conditioning and/or purifying 19 is General Ecology's VERSA-PURE® AC3 filtration and purification system. The cartridge 23 may be configured to provide what the user desires for optimum service related to the application. For instance, the cartridge 23 may be configured to provide microbiological purification as independently certified to now current EPA Protocol for Microbiological Purifiers, or to provide scale control and taste and odor removal, or to provide taste and odor removal along with larger pathogen removal, etc. As shown in Figs. 5 to 7, preferably, the filtering and/or conditioning and/or purifying device 19 includes a backflow prevention valve 24 at the outlet portion of each cartridge 23 to prevent possible backwards flow into the clean/purified water interior of the cartridge 23. When the bypass valve 47 (described below) is open, preferably a sanitizing solution having preferably 100 parts per million sanitizing agent, for example, may be provided to flow in continuous circuit through the third passageway 45 (described below), between the first passageway 29 and the second passageway 37 of each bypass apparatus 25 (described below) and return to the chlorination origin point/pump via the distribution line 13. Alternatively, after the sanitizing procedure has been completed, the sanitizing solution may be flushed from the distribution line 13 to waste. When the bypass valve 45 is open, the third passageway 45 connecting the first passageway 29 to the second passageway 37 has a lower resistance to flow of fluid through it than the resistance to flow of fluid through the filtering and/or conditioning and/or purifying device 19. When chlorine is used as the sanitizing agent,

since chlorine is highly soluble, it diffuses into the inlet port 35 of the filtering and/or conditioning and/or purifying device 19 and, additionally, into the outlet port 41 of the filtering and/or conditioning and/or purifying device 19 to the face of the backflow prevention check valve 24 installed within the outlet portion of the cartridge 23. This valve 24 prevents excessive adsorption of chlorine within the interior of the cartridge 23. Further, because of the pressure gradient across cartridge 23, particularly across a purification cartridge such as General Ecology's RSA3 cartridge, properly controlled pressures allow a limited forward flow of the chlorine sanitizing rinse through the cartridge 23 during initial fill of the distribution system 11.

The pressure vessel 21 preferably is provided with an automatic venting device 22 for venting air contained in the pressure vessel 21.

The potable water distribution system 11 preferably is provided with a valve downstream from each filtering and/or conditioning and/or purifying device 19 for controlling when water which has been treated in the corresponding filtering and/or conditioning and/or purifying device 19 may exit the distribution line 13 through an outlet port 17 in, for example, a galley at "service points" such as coffee makers, water boilers, and drinking water outlets connected to a branch portion 13b of the distribution line 13, or to, for example, drinking water outlets located in lavatories.

Preferably, a bypass apparatus 25 is provided for each filtering and/or conditioning and/or purifying device 19, and each bypass apparatus 25 is mounted between the distribution line 13 and the filtering and/or conditioning and/or purifying device 19 for bypassing fluid (e.g., a sanitizing solution, or water containing a sanitizing agent) moving in the distribution line 13 past the filtering and/or conditioning and/or purifying device 19.

Preferably, as illustrated in Figs. 5 to 14, the bypass apparatus 25 has a body 27 (preferably made from metal) having a first passageway 29 extending through it. An inlet port 31 is formed at an inlet end portion of the first passageway 29 and is connected to the distribution line 13 to receive fluid therefrom.

An outlet port 33 is formed at an outlet end portion of the first passageway 29, and the outlet port 33 of the first passageway 29 is connected to an inlet port 35 of the filtering and/or conditioning and/or purifying device 19 to permit fluid to flow from the outlet port 33 of the first passageway 29 into the inlet port 35 of the filtering and/or conditioning and/or purifying device 19.

The body 27 also has a second passageway 37 extending through it.

An inlet port 39 is formed at an inlet end portion of the second passageway 37, and is connected to an outlet port 41 of the filtering and/or conditioning and/or purifying device 19 to permit fluid to flow from the outlet port 41 of the filtering and/or conditioning and/or purifying device 19 to the inlet port 39 of the second passageway 37.

An outlet port 43 is formed at an outlet end portion of the second passageway 37, and the outlet port 43 of the second passageway 37 is connected to a fluid receiving line (which is a portion of the distribution line 13), to permit fluid to flow from the outlet port 43 of the second passageway 37 into the fluid receiving line. The fluid receiving line receives fluid that has been treated in the filtering and/or conditioning and/or purifying device 19 and leads to an outlet port 17 from the distribution line 13.

Further, as particularly shown in Fig. 13, the body 27 is provided with a third passageway 45 that extends between the first passageway 29 and the second passageway 37.

Referring to Figs. 9 to 14, a bypass valve 47 preferably is positioned in the body 27, and the bypass valve 47 has a portion that when positioned in a blocking position in the third passageway 45, as shown in Fig. 10, blocks flow of fluid through the third passageway 45 and that when withdrawn from a blocking position in the third passageway 45, as shown in Fig. 11, opens the third passageway 45 to permit flow of fluid through the passageway 45. Specifically, in one preferred embodiment of the invention, as shown in Figs.10, 11, and 13, the bypass valve 45 is positioned in a bore 48 that extends into the body 27 to the third passageway 45. In this preferred embodiment, the bypass valve 47 has a shaft 49 having a first end portion 49a and a second end portion 49b. A sealing member 51 (preferably an o-ring) is mounted on the first end portion 49a of the shaft 49 for sealing between the shaft 49 and a portion of the wall 45a that defines the third passageway 45 to sealingly close the third passageway 45 when the first end portion 49a of the shaft 49 is positioned in a blocking position, as shown in Fig. 10, in the third passageway 45. A biasing member 53 (preferably a spring) is positioned in the bore 48 to engage the shaft 49 for pushing the shaft 49 into a position that closes the third passageway 45. A sealing member 54 (preferably an o-ring) is provided around a portion of the shaft 49 to seal between the shaft 49 and the wall 48a that defines the bore 48. A portion of the shaft 49 rides in a bushing 56 positioned at the entrance of the bore 48, and a plate 58 having an opening therethrough that receives a portion of the bushing 56, is screwed onto the surface of the body 27 to prevent the portion of the bushing 56 contained in the bore 48 from being pulled from the bore 48 and the shaft 49 from being pulled completely from the bore 48.

The second end portion 49b of the shaft 49 preferably is threaded and receives a cylindrical lug 55 having a threaded bore extending therethrough. A handle 57 is pivotally mounted on the second end portion 49b of the shaft 49, specifically around the lug 55. The

handle 57 is installed onto the second end portion 49b of shaft 49 around the lug 55 by moving the lug 55 when it is attached to the second end portion 49b of the shaft 49 into the underside of the handle 57 such that the ends of the lug 55 are captured in a pair of recesses 59 formed in the side flanges 61, and a handle locking insert 63 is positioned at the first end portions 65 of the side flanges 61 such that a portion of the handle locking insert 63 is positioned between the first end portion s 61. The handle locking insert 63 is secured in place with a threaded bolt 67 that extends through an opening 69 in the handle 57 into a threaded bore 71 formed in the handle locking insert 63, thereby securing the second end portion 49b of the shaft 49 and the lug 55 secured thereto to the handle 57.

The handle 57 has a cam 73 formed thereon, and when the handle 57 is positioned in a first position, as shown in Fig. 10, the biasing member 53 pushes the shaft 49 into a position that closes the third passageway 45, and when the handle 57 is positioned in a second position, as shown in Fig. 11, by pivoting the handle 57 on its cam 73, the first end portion 49a of the shaft 49 is pulled into a position that opens the third passageway 45 by withdrawing the first end portion 49a of the shaft 49 from a blocking position in the third passageway 45.

Alternatively, other types of actuators may be used to open and close the third passageway 45, and these actuators include solenoids (e.g., electrical solenoids and pneumatic solenoids), and other mechanical and electromechanical devices known in the art. Preferably, the actuators are of a type that may be controlled either locally (e.g., on site) or remotely via electrical connections or via wireless transmissions to receivers connected to the actuators for receiving wireless signals and triggering the actuators to open and close the third passageway 45. Wireless actuating and monitoring of the bypass valve(s) 47 may be controlled either by personnel or by computer or other programmer actuator/controllers. An example of an

alternative actuator is shown schematically in Fig. 7, where a solenoid mechanism 75 is linked to the bypass valve 47 for opening and closing the third passageway 45. Preferably, the solenoid mechanism 75 is of the type that may be controlled remotely. Further, the solenoid mechanism 75 preferably has a receiver for receiving a wireless signal and triggering the solenoid mechanism 75 to move the shaft 49 into a blocking position in the third passageway 45 when it is not desired to bypass the filtering and/or conditioning and/or purifying device 19 and to move the shaft 49 into a non-blocking position in the third passageway 45 to permit fluid to flow through the third passageway 45 when it is desired to bypass fluid past the filtering and/or conditioning and/or purifying device 19.

The actuators may be configured (e.g. via wire connections or via wireless transmissions to wireless receivers connected to the actuators) to permit each bypass valve 47 to be opened or closed individually and/or opened or closed as a group. For example, in the aircraft embodiment of the invention illustrated in the drawings, either single or multiple bypass valves 47 may be actuated and controlled remotely within or outside the aircraft, or locally within a given galley, lavatory, or fountain area.

Preferably, each actuator is wired to or wirelessly connected to (e.g., connected via a signal transmitted from the actuator to a remote receiver) a locally and/or remotely positioned LED light or other signaling indicator 76 to provide an indication of proper operation and positioning of each of the bypass valves 47. For example, in the aircraft embodiment of the invention illustrated in the drawings, the indicator(s) 76 may be located locally within given areas of the aircraft or outside the aircraft.

The potable water distribution system 11 may further include a water supply 77 that is fed into the distribution line 13. In the embodiment of the invention illustrated in the drawings

with respect to use of the inventive potable water distribution system 11 in aircraft, the water supply 77 comprises a tank of water, as shown in Fig. 1. However, in general, the water supply 77 may comprise all types of water sources from which water may be fed into the distribution line 13. Such water supplies 77 include tanks of water and municipal water lines.

In a particularly preferred embodiment of the invention, the water supply 77 comprises water containing a sanitizing agent, where the water containing the sanitizing agent is effective to sanitize against undesirable contaminants it may encounter when introduced into the distribution line 13. The sanitizing agent preferably comprises chlorine, and preferably free chlorine, or an organic sanitizing agent or a combined chlorine residual. The sanitizing agent is used to cleanse and sanitize the distribution line 13, and in some embodiments of the invention, to cleanse and sanitize the distribution line 13 and the water supply 77. In particular, the sanitizing agent is used to reduce/remove undesirable contaminants such as bacteria, viruses, molds, fungus, mildew, algae, and other microorganisms and plants. Preferably, the sanitizing agent is present in the water supply 77 in the range of about 1 part per million to about 2 parts per million.

In other preferred embodiments, the sanitizing agent may be introduced into water from the water supply 77 as the water is moved into the distribution line 13 to produce a sanitizing solution having sanitizing agent present preferably in a range of about 1 part per million to about 150 parts per million. The concentration of the sanitizing agent in the sanitizing solution depends on the method of sanitizing chosen to be practiced. This may be accomplished by metering into the water as it enters the distribution line 13 a sanitizing agent, either in dry or liquid form, via a feed line connected to the first end portion of the distribution line 13 near its inlet port 15. For example, for sanitizing during a flight, a sanitizing agent may be mixed into

water from the water supply tank 77 as water from the water supply tank 77 is fed into the distribution line 13 to form a sanitizing solution having preferably 1 to 10 parts per million sanitizing agent, and more preferably 3 to 10 parts per million sanitizing agent, the sanitizing solution being flushed from the distribution line 13 to waste after the sanitizing steps having been completed. Further, for example, for on-ground sanitizing of a potable water distribution system 11 of an aircraft, a sanitizing agent may be mixed into water from a water supply 77 to form a sanitizing solution preferably having 50 to 150 parts per million sanitizing agent (which fights against biofilm similar film formation) that is fed into the distribution line 13, the sanitizing solution being flushed from the system 11 after an appropriate period of soaking of the distribution line 13 with the sanitizing solution has occurred.

In another embodiment of the invention, a sanitizing solution effective to sanitize the potable water distribution system 11 may be introduced to the distribution line 13 separately from the water supply 77. In this embodiment, the sanitizing solution may comprise water containing a sanitizing agent as described above, or it may be some other cleansing/sanitizing product that is easily flushed through the distribution line 13 after sanitizing with it has been completed. In this embodiment, the sanitizing solution may be introduced into the distribution line 13 using a pump to pump sanitizing solution from a sanitizing solution supply through a flow line into the distribution line 13. Preferably, the concentration of the sanitizing agent in the sanitizing solution is in a range of about 1 to 150 parts per million. Again, the concentration of the sanitizing agent in the sanitizing solution depends on the method of sanitizing chosen to be practiced. For example, for sanitizing during a flight, a sanitizing agent may be mixed into water from the water supply tank 77 to form a sanitizing solution having preferably 1 to 10 parts per million sanitizing agent, and more preferably 3 to 10 parts per million sanitizing agent, the

sanitizing solution being flushed from the distribution line 13 to waste after the sanitizing steps having been completed. Further, for example, for on-ground sanitizing of a potable water distribution system 11 an aircraft, a sanitizing agent may be mixed into water from a water supply 77 to form a sanitizing solution preferably having 50 to 150 parts per million sanitizing agent (which fights against biofilm or other film formation), the sanitizing solution being flushed from the system 11 after a 2 hour or more soaking of the distribution line 13.

Similarly, in another embodiment, a sanitizing agent may be metered directly into the water supply 77 (e.g., a water supply tank 77 in an aircraft) to obtain a water supply 77 having a concentration of preferably 1 to 2 parts per million sanitizing agent.

Also, preferably, the potable water distribution system 11 has means 79 for moving fluid into and through the distribution line 13. In the embodiment of the invention illustrated in the drawings, and specifically illustrated schematically in Fig.1, with respect to use of the inventive potable water distribution system 11 in aircraft, such means 79 may be the pressurized air system of the aircraft tied into the potable water distribution system 11. Pressurized air from the pressurized air system of the aircraft may be feed into the water supply tank 77 via a pressurized air line 79a to pressurize the water supply line 77 to push fluid from the water supply tank 77 into the distribution line 13. Alternatively, such means 79 in aircraft may be a fluid flow line from the water supply tank 77 and a pump connected thereto for pumping fluid from the water supply tank 77 to the distribution line 13.

In general, examples of such means 79 include a fluid flow line from a water supply tank 77 and a pump connected thereto for pumping water from the water supply tank 77 to the distribution line 13, a fluid flow line extending from an elevated water supply tank 77 for moving water from the elevated water supply tank 77 to the distribution line 13 by gravity, and

fittings for connecting the distribution line 13 to a municipal water line to permit the pressurized water in the municipal water line to move into the distribution line 13.

Referring to the bypass apparatus 25, as shown in Figs. 5 to 13, its body 27 preferably is machined from a metal such as stainless steel or aluminum preferably coated and sealed with a hard aluminum oxide coating for scratch resistance and long life. Preferably, the body 27 includes a first member 27a and a second member 27b, which, as shown in Fig. 12, are held together by threaded bolts 81 that extend through bores 83 formed in and extending through the first member 27a and into aligned threaded bores 85 formed in the second member 27b.

The first passageway 29 preferably is defined by a bore 87 formed in and extending through the first member 27a of the body 27 and a bore 89 formed in and extending through the second member 27b of the body 27, the bores 87 and 89 being in alignment with one another.

An inlet tube 91 preferably is positioned in the bore 87 of the first member 27a of the body 27, and is provided with an annular recess 93 around its circumference that receives a sealing member 95 (preferably an o-ring) for sealing between the inlet tube 91 and the wall 87a that defines the bore 87 in the first member 27a of the body 27. The first end portion 91a of the inlet tube 91 in configured to connect to the distribution line 13. The second end portion 91b of the inlet tube 91 preferably is provided with four side openings 96, preferably in the shape of arches, in the wall of the inlet tube 91 to permit fluid to flow from the first passageway 29 into and through the third passageway 45 when the bypass valve 47 is open.

The end of the inlet tube 91 at its second end portion 91b preferably abuts against the end of the first end portion 97a of an outlet tube 97 preferably positioned in the bore 89 of the second member 27b of the body 27. The outlet tube 97 is provided with an annular recess 99 around its circumference that receives a sealing member 101 (preferably an o-ring) for sealing between the

outlet tube 97 and the wall 89a that defines the bore 89 in the second member 27b of the body 27. Preferably, the inside surface of the outlet tube 97 is configured to receive the inlet port 35 of the filtering and/or conditioning and/or purifying device 19.

The second passageway 37 preferably is defined by a bore 103 formed in and extending through the first member 27a of the body 27 and a bore 105 formed in and extending through the second member 27b of the body 27, the bores 103 and 105 being in alignment with one another.

An inlet tube 107 preferably is positioned in the bore 105 of the second member 27b of the body 27, and is provided with an annular recess 109 around its circumference that receives a sealing member 111 (preferably an o-ring) for sealing between the inlet tube 107 and the wall 105a that defines the bore 105 in the second member 27b of the body 27. The first end portion 107a of the inlet tube 107 is configured to connect to the outlet port 41 of the filtering and/or conditioning and/or purifying device 19. The second end portion 107b of the inlet tube 107 preferably is provided with four side openings 113, preferably in the shape of arches, in the wall of the inlet tube 107 to permit fluid to flow from the third passageway 45 through the openings 113 into the second passageway 37 when the bypass valve 47 is open.

The end of the inlet tube 107 at its second end portion 107b preferably abuts against the end of the first end portion 115a of an outlet tube 115 preferably positioned in the bore 103 of the first member 27a of the body 27. The outlet tube 115 is provided with an annular recess 117 around its circumference that receives a sealing member 119 (preferably an o-ring) for sealing between the outlet tube 115 and the wall 103a that defines the bore 103 in the first member 27a of the body 27. Preferably, the inside surface of the outlet tube 115 is configured to connect to the distribution line 13.

As shown in Figs.12 and 13, a slot 121 is formed in the surface of the second end portion 123 of the first member 27a next to and in communication with the bore 87 that defines the portion of the first passageway 29 in the first member 27a. This slot 121 is the first of three portions of the third passageway 45. The slot 121 connects to and communicates with the second portion 125 (shown in Fig. 13) of the third passageway 45 when the bypass valve 47 is open, the second portion 125 of the third passageway 45 being formed by a portion of the bore 48. A slot 127 also is formed in the surface of the first end portion 123 of the first member 27a next to and in communication with the bore 103 that defines the portion of the second passageway 37 in the first member 27a. This slot 127 is the third portion of the third passageway 45. The slot 127 connects to and communicates with the second portion 125 of the third passageway 45 when the bypass valve 47 is open. Accordingly, when the bypass valve 47 is open, fluid may bypass the filtering and/or conditioning and/or purifying device 19 by moving from the inlet tube 91 to the slot 121 through the openings 96 formed in the inlet tube 91, from the slot 121 to the second portion 125 of the third passageway 45, from the second portion 125 of the third passageway 45 to the slot 127, from the slot 127 into the outlet tube 115 through the openings 113, and then through the outlet tube 115 to the distribution line 13.

The surface of the second end portion 123 of the first member 27a of the body 27 is provided with a first groove 129 that surrounds the second end portion 131 of the bore 87 and the slot 121 connected thereto. The groove 129 receives a sealing member 133 (preferably an o-ring) for sealing between the second end portion 123 of the first member 27a and the surface of the first end portion 135 of the second member 27b.

Likewise, the surface of the second end portion 123 of the first member 27a of the body 27 is provided with a second groove 137 that surrounds the second end portion 139 of the bore

103 and the slot 127 connected thereto. The groove 137 receives a sealing member 141 (preferably an o-ring) for sealing between the second end portion 123 of the first member 27a and the surface of the first end portion 135 of the second member 27b.

Referring to the bypass apparatus 25 and the filtering and/or conditioning and/or purifying device 19 described above, in a preferred alternative embodiment, they may be integrally connected to one another as illustrated in Figs. 15 to 17 forming a combined device 143. In this embodiment, the body 27' of the bypass apparatus 25' is integrally connected to a wall 21a' of the pressure vessel 21' of the filtering and/or conditioning and/or purifying device 19'. The component parts of the bypass apparatus portion of the combined device 143 are the same or substantially the same as the component parts of the bypass apparatus 25, and the component parts of the filtering and/or conditioning and/or purifying device portion of the combined device 143 are the same or substantially the same as the component of the filtering and/or conditioning and/or purifying device 19. Accordingly, components in the combined device 143 that are the same as components in the bypass apparatus 25 and the filtering and/or conditioning and/or purifying device 19 have been given the same reference numbers, and components in the combined device 143 that are substantially the same as components in the bypass apparatus 25 and the filtering and/or conditioning and/or purifying device 19 have been identified with the same reference numbers followed by a single quote mark (e.g., a prime). Regarding the bore that forms the portion of the third passageway 45' between the first passageway 29' and the portion of the third passageway 45' formed from the bore 80, and the bore that forms the portion of the third passageway 45' between the second passageway 37' and the portion of the third passageway 45' formed from the bore 80, they may be formed by drilling, followed by filling the drill hole between the outer surface of the bypass portion of the combined

device 143 and the first passageway 29' with a plug having a sealing member and by filling the drill hole between the outer surface of the bypass portion of the combined device 143 and the second passageway 37' with a plug having a sealing member. Alternatively, the bypass portion of the combined device 143 may comprise a first member 27a' and a second member 27b' bolted together, with slots 121' and 127' and grooves 129 and 137 formed in the first member 27a' and sealing members 133 and 141 positioned in the grooves 129 and 137 sandwiched between the first member 27a' and the second member 27b' in a fashion similar to the body 27 of the bypass apparatus 25.

In use, the potable water distribution system 11 provides potable water for consumption by its users, as well facilitating sanitizing of the system 11.

When fluid (e.g., water or water containing a sanitizing agent) flows through the distribution line 13 when the bypass valve 47 is closed, fluid from the distribution line 13 flows into the inlet port 31 of the first passageway 29, through the first passageway 29, and into the filtering and/or conditioning and/or purifying device 19 from the outlet port 33 of the first passageway 29. Then, in the filtering and/or conditioning and/or purifying device 19, fluid moves through the cartridge 23 of the filtering and/or conditioning and/or purifying device 19 to filter and/or condition and/or purify the fluid to obtain potable water which is discharged form the outlet port 41 of the filtering and/or conditioning and/or purifying device 19 into and through the second passageway 37 to the distribution line 13 downstream of the filtering and/or conditioning and/or purifying device 19 to an outlet port 17.

When it is desired to sanitize, the bypass valve 47 is activated to open the bypass valve 47 to allow sanitizing solution to flow into the first passageway 29 from the distribution line 13, and from the first passageway 29 into an through the third passageway 45 to the second

passageway 37, and then from the second passageway 37 through its outlet port 43 into the distribution line 13 downstream of the filtering and/or conditioning and/or purifying device 19 to an outlet port 17, thereby exposing the distribution line 13 downstream of the filtering and/or conditioning and/or purifying device 19 to the sanitizing solution.

The portion of the distribution line 13 downstream of the filtering and/or conditioning and/or purifying device 19 is not exposed to a sufficient amount of sanitizing solution to effectively sanitize this portion of the distribution line 13 when water having, for example, 10 parts per million of a sanitizing agent in it moves through the distribution line 13 when the bypass valve is closed, because the filtering and/or conditioning and/or purifying device 19 filters out much, if not all, of the sanitizing agent leaving only potable water moving from the filtering and/or conditioning and/or purifying device 19 into this portion of the distribution system 13.

However, if a sanitizing solution, having an amount of sanitizing agent in it that is higher than what the cartridge 23 of the filtering and/or conditioning and/or purifying device 19 is able to filter out, is moved through the filtering and/or conditioning and/or purifying device 19 rather than bypassed around it, then it is possible to sanitize the portion of the distribution line 13 downstream of the filtering and/or conditioning and/or purifying device 19 with a sanitizing solution passed through the filtering and/or conditioning and/or purifying device 19 if the concentration of sanitizing agent moving through the filtering and/or conditioning and/or purifying device 19 is sufficiently high enough to effectively sanitize this portion of the distribution line 13. When this happens, after the distribution line 13 is flushed and drained, the cartridge 23 may be removed and replaced with a replacement cartridge 23, or, the entire

filtering and/or conditioning and/or purifying device 19, if disposable, may be removed and replaced with a replacement filtering and/or conditioning and/or purifying device 19.

In one preferred method of providing potable water using the potable water distribution system 11, water or water containing a sanitizing agent is flowed into the distribution line 13 as needed. If water containing the sanitizing agent is used, the sanitizing agent is present in the water in an amount effective to sanitize against undesirable contaminants it may encounter in the distribution line 13, but at a concentration level not higher than what may be effectively treated in the filtering and/or conditioning and/or purifying device 19. The water or the water containing the sanitizing agent is flowed from the distribution line 13 into the filtering and/or conditioning and/or purifying device 19 to filter and/or condition and/or purify water containing the sanitizing agent introduced into the device 19 to produce potable water. Then, potable water is flowed from the filtering and/or conditioning and/or purifying device 19 into the distribution line 13 downstream of the filtering and/or conditioning and/or purifying device 19 to an outlet port 17 of the distribution line 13. When it is desired to sanitize the distribution line 13, the bypass valve 47 in the bypass apparatus 25 is activated to enable a sanitizing solution (e.g., water containing a sanitizing agent, having, for example, 2 parts per million of sanitizing agent, fed directly from a water supply 77, or water containing a high concentration of sanitizing agent such as 100 parts per million (or some other sanitizing solution) fed into the distribution line 13 from a sanitizing solution supply) to bypass the filtering and/or conditioning and/or purifying device 19 and flow into the distribution line 13 downstream of the filtering and/or conditioning and/or purifying device 19 to an outlet port 17 of the distribution line 13. While the bypass valve 47 is open, the sanitizing solution is flowed from the distribution line 13 upstream of the filtering and/or conditioning and/or purifying device 19 past the filtering and/or conditioning and/or purifying

device 19 into the distribution line 13 downstream of the filtering and/or conditioning and/or purifying device 19 to an outlet port 17 of the distribution line 13. Next, the sanitizing solution is allowed to remain in the distribution line 13 for a desired period of time (e.g., preferably from 2 minute to 2 hours or more, and in one embodiment preferably from 2 minutes to 10 minutes) to sanitize the distribution line 13, particularly the distribution line 13 downstream of the filtering and/or conditioning and/or purifying device 19. Next, the distribution line 13 is flushed by moving fluid (e.g., water (or water containing a sanitizing agent at a concentration level that may effectively be treated by the filtering and/or conditioning and/or purifying device 19) from the water supply 77), through the distribution line 13, and out each outlet port 17 of the distribution line 13, followed by deactivating the bypass valve 47 of the bypass apparatus 25 to close the bypass valve 47 to stop bypassing of the filtering and/or conditioning and/or purifying device 19. Or, after allowing the sanitizing solution to remain in the distribution line 13 for a desired period of time, the bypass valve 47 may be deactivated to close the bypass valve 47 to stop bypassing of the filtering and/or conditioning and/or purifying device 19, followed by flushing the distribution line 13 by moving fluid (e.g., water (or water containing a sanitizing agent at a concentration that may effectively be treated by the filtering and/or conditioning and/or purifying device 19) from the water supply 77, through the distribution line 13, and out each outlet port 17 of the distribution line 13. After the sanitizing steps have been completed, water, or water containing a sanitizing agent at a concentration that may be effectively treated by the filtering and/or conditioning and/or purifying device 19, may be flowed as needed into the distribution line 13 and from the distribution line 13 into the filtering and/or conditioning and/or purifying device 19 to produce potable water, followed by potable water being flowed from the filtering and/or

conditioning and/or purifying device 19 into the distribution line 13 downstream of the filtering and/or conditioning and/or purifying device 19 to an outlet port 17 of the distribution line 13.

In accordance with invention, and particularly in accordance with the method set out immediately above this paragraph, in-flight periodic sterilization of an aircraft potable water distribution system 11 while airborne is provided for. For example, long range flights on larger aircraft of over 20 hours (such as flights from Hong Kong to New York, for example) have now been made and may become more frequent. Distribution system sterilization using low concentrations of chlorine or other sterilizing solutions during extended flights may take place in accordance with the invention, providing higher reassurance of safe drinking water throughout the flight. The inventive process may be carried out sequentially or throughout the distribution system 11. A water supply tank 77 storing the water supply for the aircraft may be provided with a sanitizing agent, the sanitizing agent being effective to sanitize against undesirable contaminants it may encounter in the distribution line 13, and being at a concentration in the water supply tank 77 for the aircraft that may effectively be treated by the filtering and/or conditioning and/or purifying device 19, and such water from the water supply tank 77 may serve two purposes- (1) the source of what is feed into the filtering and/or conditioning and/or purifying device 19 to produce potable water to be transmitted therefrom to the outlet ports 17 for use by aircraft crew and passengers, and (2) the source of the sanitizing solution that is transmitted to the distribution line 13 downstream of the filtering and/or conditioning and/or purifying device 19 by opening the bypass valve 47 to bypass the filtering and/or conditioning and/or purifying device 19. Alternatively, rather than merely using the water supply 77 if it contains a sanitizing agent, a highly concentrated sanitizing solution (e.g., one having 100 parts per million sanitizing agent) may be fed into the distribution line13 from an independent

sanitizing solution supply to be transmitted to the distribution line 13 downstream of the filtering and/or conditioning and/or purifying device 19 by opening the bypass valve 47 to bypass the filtering and/or conditioning and/or purifying device 19 to sanitize the distribution line 13 downstream of the filtering and/or conditioning and/or purifying device 19. Then, the distribution line 13 may be flushed and the bypass valve 42 closed to permit water, or water containing a sanitizing agent at a concentration that may be effectively treated by the filtering and/or conditioning and/or purifying device 19, from the water supply tank 77 to again flow into the distribution line 13, to and through the filtering and/or conditioning and/or purifying device 19, and then to the water outlets 17 of the distribution line 13 as potable water for use by aircraft crew and passengers. Accordingly, a relatively small quantity of high concentration sterilizing solution may be used to cleanse and reassure safe drinking water throughout flights, without encumbering the aircraft with otherwise complicated, heavy chlorine, ozone, UV or other equipment.

In one preferred method of sanitizing the potable water distribution system 11, the bypass valve 47 of the bypass apparatus 25 is activated to open the bypass valve 47 to bypass fluid in the distribution line 13 past the filtering and/or conditioning and/or purifying device 19. Next, the distribution line 13 is filled throughout with a sanitizing solution, such as water containing a sanitizing agent, and the sanitizing solution is allowed to remain in the distribution line 13 for a desired period of time (e.g., preferably 2 minutes to 2 hours or more). After the sanitizing solution has been allowed to remain in the distribution line 13 for the desired period of time, the distribution line 13 is flushed (preferably with water or water containing sanitizing agent at a concentration that may effectively be treated by the filtering and/or conditioning and/or purifying device 19), and the bypass valve 47 of the bypass apparatus 25 is deactivated to close the bypass

valve 47 to stop fluid from the distribution line 13 from bypassing the filtering and/or conditioning and/or purifying device 19. In this preferred method, the step of deactivating the bypass valve 47 to close the bypass valve 47 to stop fluid from the distribution line 13 from bypassing the filtering and/or conditioning and/or purifying device 19 may occur before or after the flushing step.

In another preferred method of sanitizing the potable water distribution system 11, the bypass valve 47 of the bypass apparatus 25 is activated to open the bypass valve 47 to bypass fluid in the water distribution line 13 past the filtering and/or conditioning and/or purifying device 19. Next, the water distribution line 13 is filled throughout with a sanitizing solution. The sanitizing solution is allowed to remain in the water distribution line 13 for a desired period of time (e.g., preferably 2 hours or more). Then, the water distribution line 13 is flushed and drained, and the filtering and/or conditioning and/or purifying element (e.g., the cartridge 23) from the filtering and/or conditioning and/or purifying device 19 is removed and replaced with a replacement filtering and/or conditioning and/or purifying element. In this preferred method, the bypass valve 47 of the bypass apparatus 25 is deactivated to close the bypass valve 47 prior to introducing water (or water containing a sanitizing agent at a concentration that may effectively be treated by the filtering and/or conditioning and/or purifying device 19) to the water distribution line 13 after the replacement filtering and/or conditioning and/or purifying element has been installed. In an alternative method to the method of sanitizing the potable water distribution system 11 immediately set out above, the same steps are followed, except rather than removing the filtering and/or conditioning and/or purifying element from the filtering and/or conditioning and/or purifying device 19 and installing a replacement filtering and/or conditioning and/or purifying element into the filtering and/or conditioning and/or purifying

device 19, a disposable filtering and/or conditioning and/or purifying device 19 is used, and at the end of the method the entire disposable filtering and/or conditioning and/or purifying device 19 is removed and replace with a replacement disposable filtering and/or conditioning and/or purifying device 19.

In still another preferred method of sanitizing a potable water distribution system having a water distribution line 13 having an inlet port 15 and at least one water outlet port 17, and having a filtering and/or conditioning and/or purifying device 19 mounted along the water distribution line 13 for filtering and/or conditioning and/or purifying water received from the water distribution line 13 before said water exits the potable water distribution system through a water outlet port 17 of the water distribution line 13, the distribution line 13 is filled throughout with a sanitizing solution effective to sanitize against undesirable contaminants it may encounter when introduced into distribution line 13. The sanitizing solution is allowed to remain in the water distribution line 13 for a desired period of time (e.g., preferably 2 hours or more). Then, the water distribution line 13 is flushed and drained, and the filtering and/or conditioning and/or purifying element (e.g., the cartridge 23) from the filtering and/or conditioning and/or purifying device 19 is removed and replaced with a replacement filtering and/or conditioning and/or purifying element. In an alternative method to the method of sanitizing the potable water distribution system 11 immediately set out above, the same steps are followed, except rather than removing the filtering and/or conditioning and/or purifying element from the filtering and/or conditioning and/or purifying device 19 and installing a replacement filtering and/or conditioning and/or purifying element into the filtering and/or conditioning and/or purifying device 19, a disposable filtering and/or conditioning and/or purifying device 19 is used, and at the end of the method the entire disposable filtering and/or conditioning and/or purifying device

19 is removed and replace with a replacement disposable filtering and/or conditioning and/or purifying device 19.

In one preferred embodiment of the invention, a bypass valve 45 is mounted within the horizontal profile of a filtering and/or conditioning and/or purifying device 19, such as General Ecology's Versa-Pure AC3 filtration and purification system. This valve 45, when in open position, allows bypass of sterilizing chlorine or other solutions while at the same time allowing diffusion into both the inlet and outlet of the filtering and/or conditioning and/or purifying device 19 without removing the cartridge 23. When in closed position, the valve 45 prevents bypass but allows desired forward flow from the exterior to the interior of the cartridge 23, such as General Ecology's Versa-Pure cartridge, thereby providing the desired purification and/or microfiltration action. The valve 45 is normally closed, preventing by-pass of fluid. Positive actuation compressing the biasing member 53 is used to allow by-pass to occur.

Potable water may be uploaded from many different locations with possible wide variations in water safety and quality. Aircraft equipped with bypass valves 47 and with relatively small quantity of concentrated chlorine or other solutions, may dilute large quantities of unsafe water with concentrated chlorine to assure potability.

Water occasionally is drained from aircraft during periods of non-use such as overnight in cold climates. Typically, the same distribution lines used to drain aircraft are used to upload potable water for the next flight thereby potentially inoculating the water distribution system 11 with microorganisms. An on-board, easily activated sterilizing sanitizing solution may be employed in accordance with the invention to assure a sanitary water distribution system 11 immediately before or during filling with potable water, thereby eliminating short interval/overnight contamination concerns about water safety.

Use of the bypass feature to bypass around filtering and/or conditioning and/or purifying devices 19 permits the distribution lines 13 downstream of the filtering and/or conditioning and/or purifying devices 19 to be selectively sanitized both on long flights and during ground maintenance intervals. That is, if it is desired to sanitize at a particular time, one or some, but not all of the portions of the distribution line 13 downstream of the filtering and/or conditioning and/or purifying devices 19, this may be accomplished by opening only the bypass valves 47 that immediately proceed those portions of the distribution lines 13 downstream of filtering and/or conditioning and/or purifying devices 19 chosen to be sanitized. For example, with respect to ground maintenance, portions of the distribution line 13 downstream of the filtering and/or conditioning and/or purifying devices 19 that lead to lavatories may be sanitized (with cartridge 23 changes occurring afterward) with a sanitizing solution having 100 parts per million of a sanitizing agent every 30, 60, or 90 days, and portions of the distribution line 13 downstream of the filtering and/or conditioning and/or purifying devices 19 that lead to galleys and fountains may be sanitized with a sanitizing solution having 100 parts per million of a sanitizing agent every 6 months, which leads to big savings in aircraft systems maintenance programs.

This invention provides significant water management cost savings while at the same time improving drinking water safety and quality.

Turning now to Figs. 18-35, there is shown an inventive apparatus 311 for filtering and/or conditioning and/or purifying a fluid, such as water. (Purification, per EPA regulations, requires performance meeting the EPA Guide Standard Protocol for Microbiological Purifiers; filtration and conditioning may be almost anything else that is useful, such as taste and odor removal, scale control, etc.)

Referring particularly to Figs. 18, 19, 21, and 29, apparatus 311 includes an automatic valving unit 313 for a pressure vessel 315 that holds a cartridge 316, or loose media, or the like for filtering and/or conditioning and/or purifying a fluid, such as water. The automatic valving unit 313 (also referred to herein as "valve head 313"), when desired, automatically provides for fluid flow into the pressure vessel 315 when the pressure vessel 315 is in use and, when desired, automatically discontinues fluid flow from the valve head 313 when the pressure vessel 315 is disconnected from the valve head 313.

The valve head 313, which preferably is machined from a metal such as stainless steel or aluminum preferably coated and sealed with a hard aluminum oxide coating for scratch resistance and long life, preferably includes a first end member 313a and a second end member 313b, which are held together by threaded bolts 312 that extend through bores 314 formed in and extending through the first end member 313a and into aligned threaded bores 318 formed in the second end member 313b.

As shown in Figs. 21 and 29, the valve head 313 has a first passageway 317 extending through it and adapted to be connected to a fluid transmission line, such as a water supply line of an aircraft potable water distribution system. Preferably, the valve head 313 has a threaded inlet port 319 at the entrance of the first passageway 317 that receives a threaded female fitting of the fluid transmission line.

Referring particularly to Figs. 29 and 19, a first check valve 321 is positioned on an annular ledge 322 formed in the first passageway 317 of the valve head 313 for blocking flow of fluid through the first passageway 317 when the valve 321 is closed. Preferably, the first check valve 321 includes a valve housing 323 (preferably made of a suitable polymeric material) having an annular ring-shaped base portion 325 that has an annular inner wall surface 327. An annular ledge 329 is formed on the inner wall surface 327 creating a valve seat 331.

A movable valve disc 333 (preferably made of a suitable polymeric material) is contained within the valve housing 323 that closes the valve 321 when the valve disc 333 rests against the valve seat 331 and that permits flow of fluid through the valve 321 when the valve disc 333 is not resting against the valve seat 331. The valve housing 323 also includes a plurality of arms 335 that extend away from the base portion 325 of the valve housing 323 and over the opening in the valve housing 323 formed by the annular ring-shaped base portion 325 to form a cage-like structure that contains the valve disc 333 in the valve housing 323. As shown in Figs. 19, 21, and 29, the valve disc 333 has a guide pin 337 formed on and extending upstream from its upstream face that is engaged by and slides in a guide pin holder 339 (a small hollow cylinder) formed on the ends of the arms 335 where the arms 335 meet over the opening in the annular ring-shaped base portion 325 to keep motion of the valve disc 333 on a line that permits proper seating of the valve disc 333 on the valve seat 331.

An outlet port 341 is formed at the outlet end portion of the first passageway 317 of the valve head 313.

Referring to Figs. 21 and 29, the pressure vessel 315 has an inlet port 343 that is in fluid communication with the outlet port 341 formed at the outlet end portion of the first passageway 317 in the valve head 313 when the pressure vessel is connected to the valve head 313. The

pressure vessel 315 has a first passageway 345 extending from the inlet port 343 of the pressure vessel 315 to the cartridge 316, or loose media, or the like, through which the fluid passes to filter and/or condition and/or purify the fluid, and a second passageway 347 extending from the cartridge 316, or loose media, or the like to an outlet port 349 of the pressure vessel 315.

The valve head 313 also is provided with a second passageway 351 extending through it and adapted to be connected to a fluid receiving line (such as a water faucet of an aircraft potable water distribution system or an apparatus such as a coffee maker used on an airplane) at an outlet port 353 of the second passageway 351. Preferably, the outlet port 353 has a threaded fitting that is received in a threaded female fitting of the fluid receiving line.

The valve head 313 has an inlet port 355 formed at an inlet portion of the second passageway 351 in the valve head 313 that is in fluid communication with the outlet port 349 of the pressure vessel 315 when the pressure vessel 315 is connected to the valve head 313.

Referring to Figs. 22, 29, and 19, connecting/disconnecting means is provided for connecting the pressure vessel 315 to the valve head 313, when desired, to permit flow of fluid from the first passageway 317 in the valve head 313 to the inlet port 343 of the pressure vessel 315, and for disconnecting the pressure vessel 315 from the valve head 313, when desired, to stop flow of fluid from the first passageway 317 in the valve head 313. Preferably, the connecting/disconnecting means comprises a bayonet-style mount, including a plurality of grooves 357 (three such grooves 357 being used in the embodiments of the invention shown in the drawings) formed on the neck 359 of the pressure vessel 315, and a corresponding number of pins 361 (three such pins 361 being used in the embodiments of the invention shown in the drawings) mounted on the valve head 313. Each groove 357 has a first end portion 363 where a corresponding pin 361 may be inserted and moved along the groove 357 by turning the pressure

vessel 315 around its central axis until the pin 361 reaches a second end portion 365 of the groove 357, thereby securing the pressure vessel 315 to the valve head 313. A plurality of spring-loaded plungers or detents 367 (two such plungers 367 being used in the embodiments of the invention shown in the drawings) are screwed into threaded bores 369 formed in the second end member 313b of the valve head 313 which push against the first end portion 373 of the neck 359 of the pressure vessel 315 when the pressure vessel 315 is connected to the valve head 313.

Alternatively, instead of grooves 357 and pins 361, the connecting/disconnecting means may comprise threads formed on the outer surface of the neck 359 and matching threads formed on the valve head 313, such as that disclosed in Williams U.S. Patent No. 5,695,168, which is incorporated herein in its entirety by reference.

Referring again to Figs. 19, 21, and 29, actuating means is provided for automatically opening the valve 321 when the pressure vessel 315 is connected to the valve head 313. Preferably, the actuating means includes a pin 379 that is positioned in the first passageway 317 of the valve head 313 between the valve disc 333 and the outlet port 341 at the outlet end portion of the first passageway 317 of the valve head 313. The pin 379 has a first end portion 381 and a second end portion 383, the first end portion 381 engaging the valve disc 333 by being received in a bore 385 formed in the downstream face of the valve disc 333, and the second end portion 383 being held by a pin holder 387 (positioned between valve 321 and an annular ledge 389 in the first passageway 317) in which the pin 379 is free to slide back and forth along the center axis of the pin 379. A radially extending ridge 391 is provided on the pin 379 to abut against a portion of the pin holder 387 to prevent the pin 379 from falling completely out of the first passageway 317 through the outlet port 341. The cross-section of the pin 379, even at the ridge 391, is smaller than the cross-section of the first passageway 317 so that fluid may flow through

the first passageway 317 where the pin 379 is positioned when the valve 321 is open. Also, when the valve 321 is open, fluid may pass through the first passageway 317 where the pin holder 387 is located by passing between the spacing flanges 392 (three such spacing flanges 392 being used in the embodiments of the invention shown in the drawings), which surround and position a tubular section 393 (which holds the second end portion of the pin 379 in a sliding relationship) in the first passageway 317 in alignment with the valve disc 333.

The length of the pin 379 is such that when the pressure vessel 315 is connected to the valve head 313, the first end portion 373 of the neck 359 of the pressure vessel 315 pushes against the pin 379 causing the first end portion 381 of the pin 379 to push the valve disc 333 off and sufficiently away from the valve seat 331 to open the valve 321 to permit flow of fluid through the valve 321 and passageway 317.

Referring to Figs. 22, 21, and 29, preferably, the actuating means also includes a cam or bump 375 formed on the first end portion 373 of the neck 359 of the pressure vessel 315, such cam 375 being located on the first end portion 373 of the neck 359 such that when the pressure vessel 315 has been connected to the valve head 313 (that is, when the pressure vessel 315 has been rotated into engagement with the valve head 313 such that the pins 361 have reached the second end portion 365 of the grooves 357), such cam 375 is aligned and in contact with the second end portion 383 of the pin 379 to push against the pin 379 causing the first end portion 381 of the pin 379 to push the valve disc 333 off and sufficiently away from the valve seat 331 to open the valve 321 to permit flow of the fluid through the valve 321 and the first passageway 317. In the embodiment of the invention shown in the drawings and especially in Fig. 22, the first end portion 373 of the neck 359 of the pressure vessel 315 has three such cams or bumps 375 spaced 120° apart from each other in a circle formed by the first end portion 373 of the neck

359 so that the pressure vessel 315 may be rotated onto the valve head 313 with either the first pin 361 engaging the first groove 357, the second pin 361 engaging the second groove 357, and the third pin 361 engaging the third groove 357, or the first pin 361 engaging the second groove 357, the second pin 361 engaging the third groove 357, and the third pin 361 engaging the first groove 357, or the first pin 361 engaging the third groove 357, the second pin 361 engaging the first groove 357, and the third pin 361 engaging the second groove 357, resulting in one of the three cams or bumps 375 being aligned with and pushing against the second end portion 383 of the pin 379 to cause the first end portion 381 of the pin 379 to push the valve disc 333 off and significantly away from the valve seat 331 to open the valve 321 to permit flow of fluid through the valve 321 and the first passageway 317 when the pressure vessel 315 has been connected to the valve head 313.

In the embodiments of the invention illustrated in the drawings, six indents 394 are formed in the first end portion 373 of the neck 359 spaced 60° apart from each other in a circle formed by the first end portion 373 of the neck 359, with three of the indents 394 being located adjacent to a corresponding bump or cam 375. When the pressure vessel is fully twisted onto the valve head 313 such that one of the bumps or cams 375 is aligned with and pushing against the second end portion 383 of the pin 379, one of the plungers 367 clicks into the indent 394 located adjacent to that bump or cam 375 that is aligned with and pushing against the second end portion 383 of the pin 379, and the other plunger 367 clicks into the indent 394 that is positioned directly across the neck 359 from the indent 394 that is adjacent to the bump or cam 375 that is aligned with and pushing against the second end portion 383 of the pin 379, to provide a tactile sensation or feel to the person twisting the pressure vessel 315 onto the valve head 313 indicating that the pressure vessel 315 has been properly connected to the valve head 313.

A second check valve 395 is positioned on an annular ledge 397 formed in the second passageway 351 of the valve head 313 for blocking backflow of fluid from the second passageway 351 of the valve head 313, especially when the pressure vessel 315 is not connected to the valve head 313. Preferably, the second check valve 395 includes a valve housing 323 which contains a movable valve disc 333, as described above for the first check valve 321. The flow of fluid from the pressure vessel 315 pushes the movable disc 333 of the second check valve 395 off the valve seat 331 of the second check valve 395 and moves it in the downstream direction away from the valve seat 331 of the second valve 395 to permit fluid flowing from the pressure vessel 315 to flow through the second valve 395 and through the second passageway 351 of the valve head 313 to the fluid receiving line connected to the outlet port 353 of the second passageway 351 of the valve head 313. However, backflow of fluid through the second passageway 351 of the valve head 313 is blocked by the second check valve 395 due to any backflow of fluid pushing the moveable disc 333 of the second check valve 395 onto the valve seat 331 of the second check valve 395, thereby causing the second check valve 395 to close.

Preferably, but optionally, the valve head 313 also has a third passageway 399 formed in it that extends from the first passageway 317 at a position upstream of the first check valve 321 to the second passageway 351 downstream of the second check valve 395, and a bypass valve 401 positioned in the valve head 313 that has a portion 403 that when extended into the third passageway 399 blocks flow of fluid through the third passageway 399 and that when withdrawn from the third passageway 399 opens the third passageway 399 to permit fluid to flow through the third passageway 399. Referring to Figs. 19, 22, 24, and 25, preferably, the third passageway 399 extends from the first passageway 317 at a position 317a located at the second end portion of the first end member 313a of the valve head 313 into the second end

member 313b. The bypass valve 401 preferably includes a shaft 405 having a first end portion 407, a second end portion that forms the portion 403 of the bypass valve 401, and threading 409 on a portion of the shaft's length. A thread engaging member 411, such as a pin, a nubbin disc, or the like (a nubbin disc being shown in the drawings preferably secured to the valve head 313 in a recess 413 in the first end portion of the first end member 313a) is provided to engage the threading 409 of the shaft 405, and a handle 415 is mounted on the first end portion 407 of the shaft 405 for rotating the shaft 405 in a first direction to move the second end portion 403 of the shaft 405 from the third passageway 399 to permit flow of fluid through the third passageway 399 and for rotating the shaft 405 in a direction opposite to the first direction to move the second end portion 403 of the shaft 405 into the third passageway 399 to block flow of fluid through the third passageway 399. The bypass valve 401 preferably is positioned in a bore 416 that extends through the first end member 313a of the valve head 313 and into engagement with the third passageway 399 formed in the valve head 313. A first o-ring 417, positioned in an annular groove 419 that extends around the shaft 405, is provided to seal between the shaft 405 and the wall that forms the bore 416 to prevent the fluid from escaping from the valve head 313 through the bore 416. A second o-ring 421, positioned in an annular grove 423 that extends around the shaft 405 in its end portion 403, is provided to seal between the shaft 405 and the wall that forms the third passageway 399 when the portion 403 is positioned in the third passageway 399 to prevent fluid from flowing in the third passageway 399 past the portion 403.

The third passageway 399 continues beyond the location of the bypass valve 401 along a groove 425 (Figs. 22 and 24) formed in the second end portion of the first end member 313a of the valve head 313 that leads to the second passageway 351 in the valve head 313 downstream of the second check valve 395. A groove 427 (Fig. 24) also is formed in the second end portion of

the first end member 313a of the valve head 313 that surrounds the groove 425, and an o-ring 429 is received in the groove 427 to seal between the second end portion of the first end member 313a and the first end portion of the second end member 313b around the groove 425 and to seal between the second end portion of the first end member 313a and the first end portion of the second end member 313b around the second passageway 351 along where the groove 425 intersects the passageway 351.

A groove 431 (Fig 24) also is formed in the second end portion of the first end member 313a of the valve head 313 that receives an o-ring 433 that seals the first passageway 317 between the first end member 313a and the second end member 313b.

Referring to Figs. 23 and 18, optionally, but preferably, the valve head 313 also has a fourth passageway 439 extending through it, and an automatic venting/vacuum breaking device 441 positioned therein for venting air contained in the apparatus 311 and for breaking any unwanted vacuum formed in the apparatus 311. The fourth passageway 439 has an inlet port 439a and an outlet port 439b. A groove 435 is formed in the second end portion of the first end member 313a of the valve head 313 that receives an o-ring 437 that seals the fourth passageway 439 between the first end member 313a and the second end member 313b. The automatic venting/vacuum breaking device 441 includes a vent sleeve 443 positioned in a chamber 445 formed along the fourth passageway 439. Vent sleeve 443 has a cylindrical wall 447 having an inwardly extending flange or ledge 449 formed at the downstream end portion of the vent sleeve 443, and a plurality of cutouts 451 (two being used in the embodiments of the invention shown in the drawings) formed in the wall 447 extending from the downstream end portion of the vent sleeve 443 toward the upstream end portion of the vent sleeve 443. The ledge 449 of the vent sleeve 443 has an upstream end portion 449a and a downstream end portion 449b, and each such

end portion 449a and 449b preferably is chamfered. An o-ring 453 is positioned immediately downstream of the downstream end portion 449b of the ledge 449 and is blocked by the downstream end portions 449b of the ledge 449 from falling into the chamber 443. A ball 455 preferably having a density slightly greater than the density of the fluid (e.g., if water is the fluid, a preferred specific gravity for the ball 455 is about 1.1) is positioned in the vent sleeve 443 and permits venting of air contained in the apparatus 311 and breaking of any unwanted vacuum in the apparatus 311 until the fluid pushes the ball 455 into engagement with a portion of the o-ring 453 creating a seal between the ball 455 and the o-ring 453 and the o-ring 453 and the wall of the fourth passageway 439, thereby closing the fourth passageway 439. The diameter of the passageway 439 at chamber 445, the diameter of the cylindrical vent sleeve 443, and the diameter of the ball 455 are greater than the diameter of the passageway 439 upstream of the chamber 445.

A screen 452, positioned in a recess 454 formed in the first end portion of the first end member 313a and held therein by the cover plate 535 positioned thereover, and a screen 456, positioned in the chamber 445 upstream of the vent sleeve 443, are provided to reject possible interfering debris or particulates.

Referring to Fig. 21, the pressure vessel 315 includes a cover 459 having a top wall 461 and a side wall 463, which has a lower end portion on which a cover rim 465 is formed. The pressure vessel 315 also includes a bowl 467 having a bottom wall 469 and a side wall 471, which has an upper end portion on which a bowl rim 473 is formed.

In the embodiments of the invention illustrated in the drawings, the means for filtering and/or conditioning and/or purifying a fluid comprises a cartridge 316. As shown in Fig. 21, preferably, the cartridge 316 comprises a cylindrical microfiltration matrix 477 for filtering

and/or conditioning and/or purifying a fluid passing through it. The matrix 477 has a cylindrical channel 479 along its center axis that receives the fluid after it has passed through the matrix 477, the channel 479 comprising part of the second passageway 347 of the pressure vessel 315. An end cap 481 is secured to the bottom end of the matrix 477, and an end cap 483 is secured to the top end of the matrix 477. To secure the cartridge 316 inside the pressure vessel 315, the bowl 467 is provided with a stabilizing stub 475 formed in the bottom wall 469 of the bowl 467 that receives a recess 485 formed in the end cap 481 to prevent the cartridge 316 from swaying back and forth inside the pressure vessel 315 during use.

Referring to Figs. 21, 29, 30, and 31, the end cap 483 comprises a hollow tube 487 having a first end portion 489, a second end portion 491, and a passageway 493 extending through the tube 487 from the first end portion 489 (where it receives fluid from the channel 479) to the second end portion 491, the passageway 493 also comprising part of the second passageway 347 of the pressure vessel 315. The tube 487 has an exterior surface portion 495 onto which is integrally formed therewith a flange portion 497 that engages the top end of the matrix 477. The tube 487 has an annular groove 499 formed at its second end portion 491 that receives an o-ring 501 for sealing between the tube 487 and the hollow cylindrical inlet port 355 to the second passageway 351 in the valve head 313 (thereby establishing a sealed connection between the outlet port 349 of the pressure vessel 315 and the inlet port 355 to the second passageway 351 in the valve head 313) when the pressure vessel 315 is connected to the valve head 313. Preferably, the second end portion 491 of the tube 487 is provided with an antimicrobial surface, such as by impregnating the second end portion 491 with antimicrobial materials such as those sold by AgION Technologies, Inc., of Wakefield, MA.

The tube 487 also has another annular groove 503 formed in the second end portion 491 that receives a plurality of fingers or projections 505 (four fingers 505 being used in the embodiments of the invention shown in the drawings) integrally formed with the neck 359 and extending inwardly from the wall 359a of the neck 359 for positioning the tube 487 so that it extends along the central axis of the neck 359 and secures the cartridge 316 against both horizontal and vertical movement in the pressure vessel 315. Also, projections or lugs 507 are provided in the top wall 461 of the cover 459 which abut against the flange portion 497 of the end cap 483 to secure the cartridge 316 against vertical movement in the pressure vessel 315.

The groove 503 also receives the center portion of a flexible disc 509, that extends outwardly from the tube 487 and engages a portion of the neck 359 formed in the cover 459 to form a flapper valve 511 across the first passageway 345 of the pressure vessel 315. When fluid is flowing from upstream to downstream in the first passageway 345 of the pressure vessel 315, the fluid pushes against the flexible disc 509 causing it to flex in the downstream direction away from the neck wall 359a to open the first passageway 345 to permit fluid to flow into the pressure vessel 315. The flapper valve 511 prevents backflow of fluid from the first passageway 345 of the pressure vessel 315, because any flow of fluid back flowing from downstream to upstream in the first passageway 345 of the pressure vessel 315 pushes against the flexible disc 509 causing it to flex into engagement with the neck wall 359a formed in the cover 459 to close the flapper valve 511, thereby blocking backflow of fluid from the first passageway 345 of the pressure vessel 315.

Preferably, a compressible column 513, such as one made of a polyfoam material and preferably one comprising a polyfoam sealed compressible core column, is mounted in the pressure vessel 315, preferably by bonding the end portion of the column 513 in a receptacle 515

of the end cap 481, and the column 513 extends from the receptacle 515 into the channel 479 such that there is still space for fluid to flow through the channel 479 between the matrix 477 and the compressible column 513. The compressible column 513 provides protection against damage to the pressure vessel 315 and/or the matrix 477 if the fluid to be filtered and/or conditioned and/or purified freezes while in the pressure vessel 315, by providing space for the fluid to expand into if the fluid (for example, water) is the type of fluid that expands during freezing. The compressible column 513 also provides protection for the pressure vessel 315 against possible millisecond and microsecond pressure spikes.

Referring again to Figs. 21, 29, 30, and 31, the tube 487 also has a plurality of fins or flanges 514 (four such fins 514 being used in the embodiments shown in the drawings) formed on its interior surface portion in the first end portion 489 of the tube 487 that extend inwardly into the passageway 493 towards its central axis. Fluid may flow along the passageway 493 past the fins 514. Further, the tube 487 is provided with a plurality of cutouts 512 (four such cutouts 512 being used in the embodiments shown in the drawings) made thereon to permit fluid that has been filtered and/or conditioned and/or purified in the pressure vessel 315 to flow into the tube 487 from the channel 479 through the cutouts 512. If the column 513 ever breaks loose from the receptacle 515 and abuts against the first end portion 489 of the tube 487, the fins 514 block the column 513 from entering the tube 487, and the cutouts 512 permit fluid to continue to flow into the tube 487 even if the column 513 abuts against the first end portion 489 of the tube 487.

The tube 487 also is provided with a plurality of ribs 516 (eight such ribs 516 being used in the embodiments shown in the drawings) formed in its first end portion 489 on the exterior surface portion 495 adjacent to the flange portion 497 for engaging the matrix 477 along a

portion of the channel 479 extending therethrough and for centering the tube 487 in the channel 479.

The cover 459 and the bowl 467 preferably are made from a polymeric material, and after the cartridge 316 is positioned on the cover 459 and the bowl 467, the cover 459 and the bowl 467 are joined together along their respective rims 465 and 473, preferably by spin welding, to form a sealed seam portion 517.

Preferably, a reinforcement member 519 (Fig. 35) is secured around the pressure vessel 315, preferably around the side walls 463 and 471 of the pressure vessel 315 at and near the seam portion 517 of the pressure vessel 315 for reinforcing the pressure vessel 315, and preferably the seam portion 517 and the side walls 463 and 471 of the pressure vessel 315 at the seam portion 517. For example, the reinforcement member 519 may comprise fibers, such as carbon fibers or fiberglass or aramid fibers (e.g., Kevlar fibers) wrapped around the pressure vessel 315 and held together with epoxy or polyurethane or other binder. The reinforcement member 519 also may comprise reinforcing metal or other clamping device.

Referring to Figs. 20, 23, and 18, preferably, a mounting bracket 521 is provided for mounting the valve head 313 in place where it is desired to be used. The mounting bracket 521 preferably has a plate 523 that connects to the valve head 313, and a flange portion 525 extending at a right angle from the end portion of the plate 523 having holes 527 extending therethrough that receive screws, threaded bolts, or the like for mounting the bracket 521 to the place where it is desired to use the valve head 313. In the embodiments of the invention shown in the drawings, the plate 523 has a ring-like portion 529 that sits on an annular ledge 531 formed in the outer periphery of the first end portion 533 of the valve head 313, and a cover plate 535, which has openings through the cover plate 535 to permit the shaft portions of the threaded

bolts 312, the inlet port 319, the outlet port 353, and the first end portion 407 of the shaft 405 of the bypass valve 401 to pass through, is positioned over the first end portion 533 of the valve head 313 sandwiching the nubbin disc 411 and the ring-like portion 529 of the bracket 521 between the cover plate 535 and the first end portion 533 of the valve head 313. The cover plate 535 is secured by the threaded bolts 312 to the valve head 313. Because the ring-like portion 529 of the bracket 521 sits on the annular ledge 531 formed in the outer periphery of the first end portion 533 of the valve head 313, the valve head 313 may be rotated around its central axis within the ring-like portion 529 of the bracket 521 to facilitate connecting the inlet port 319 to the fluid transmission line and the outlet port 353 to the fluid receiving line.

Preferably, in addition to a height difference, a color-coded, snap-on ring 537 (Figs. 18 and 29) is mounted around the outlet port 353 of the valve head 313 for distinguishing the outlet port 353 from the inlet port 319 of the valve head 313, to facilitate correct identification of the outlet port 353 so that the outlet port 353 is the port that is connected to the fluid receiving line.

In use, the pressure vessel 315 may be connected to the valve head 313 by rotating the pressure vessel 315 into the valve head 313 such that, in accordance with the first embodiment of the invention shown in the drawings, the pins 361 mounted on the valve head 313 move along the sloped grooves 357 formed on the neck 359 of the pressure vessel 315, until the pins 361 reach the second end portions 365 of the grooves 357 where the plungers 367 click into corresponding indents 394 indicating that the pressure vessel 315 has been properly connected to the valve head 313.

When the pressure vessel 315 has been connected to the valve head 313, the cam 375 aligned with the pin 379 pushes against the second end portion 383 of the pin 379 moving the pin 379 upstream in the first passageway 317 in the valve head 313, causing the first end portion 381

of the pin 379 to push the valve disc 333 off and substantially away from the valve seat 331 to open the valve 321 to permit fluid to flow through the valve 321 and the first passageway 317.

After flowing through the first passageway 317, the fluid exits the outlet port 341 of the first passageway 317 of the valve head 313 and enters the first passageway 345 formed in the pressure vessel 315 though the inlet port 343, and then moves along the first passageway 345 to the outside of the matrix 477 and then through the matrix 477 to the channel 479 of the second passageway 347 formed in the pressure vessel 315. Next, the fluid flows from the channel 479 into and through the passageway 493 formed in the tube 487, and exits the pressure vessel 315 from the outlet port 349 formed at the end of the tube 487 and enters into the second passageway 351 formed in the valve head 313 through the inlet port 355. Then, the fluid pushes the movable disc 333 of the second check valve 395 off the valve seat 331 of the second check valve 395 and moves it in a downstream direction away from the valve seat 331 of the second valve 395 to permit fluid to flow through the second valve 395 and through the second passageway 351 of the valve head 313 to a fluid receiving line connected to the outlet port 353.

Twisting the pressure vessel 315 off the valve head 313 discontinues flow of fluid through the first passageway 317 since the pin 379 is no longer being pushed by the pressure vessel 315 to lift the valve disc 333 of the valve 321 off the valve seat 331 of the valve 321 and the fluid flowing into the first passageway 317 pushes the valve disc 333 of the valve 321 back onto the valve seat 331 of the valve 321 to close valve 321.

Backflow of fluid from the second passageway 347 of the pressure vessel 313 is blocked by the check valve 395 since such backflow pushes the valve disc 333 of the valve 395 against the valve seat 331 of the valve 395 to close the valve 395.

Air contained in the apparatus 311 may escape through the automatic venting device 441. Such air may move into the fourth passageway 439 from outlet port 341, which may contain air when the pressure vessel 315 is being placed in service, and which may receive air from the passageway 317 of the valve head 313 and from the inlet port 343 of the pressure vessel 315 including air moving into the inlet port 343 from the pressure vessel 315. As fluid begins to flow through apparatus 311, the fluid pushes the air through the fourth passageway 439, around the ball 455 as the air is pushed through the automatic venting device 441, and out the outlet port 439b. As air is moved into the chamber 445, a portion of the air moves past the ball 455 by traveling along the cutouts 451. When the air that travels along the cutouts 451 reaches the end of the cutouts 451 and moves inwardly into the vent sleeve 443 , the air hits the inwardly extending ledge 449 of the vent sleeve 443, rebounding off the ledge 449 back toward the ball 455 from downstream of the ball 455 to prevent the ball 455 from prematurely abutting against the o-ring 453 to close the fourth passageway 439 until most, if not all, of the air has been vented through the outlet port 439b. Although the preferred density of the ball 455 is slightly greater than the density of the fluid being filtered and/or conditioned and/or purified, the force/pressure of the fluid pushing against the ball 455 causes the ball 455 to be pressed into engagement with the o-ring 453 to close the outlet port 439b after the air has been vented through the outlet port 439b.

When it is desired to sanitize the fluid distribution system (e.g., an aircraft potable water distribution system) that the valve head 313 is connected to, the bypass valve 401 may be opened to permit any sanitizing fluid used to sanitize the fluid distribution system to flow from the fluid distribution system via the fluid transmission line to the valve head 313, through the valve head 313, and then back to the fluid distribution system via the fluid receiving line. The handle 415 of

the bypass valve 401 may be turned to cause the second end portion 403 of the shaft 405 to move from the third passageway 399 to permit the sanitizing fluid entering the first passageway 317 to flow from the first passageway 317 into and through the third passageway 399, and then into the second passageway 351 downstream of the second check valve 395, and then back to the fluid distribution system via the fluid receiving line from outlet port 353. The check valve 395 prevents backflow of the sanitizing fluid into the second passageway 351 upstream of the check valve 395.

Preferably, when sanitizing fluid used to sanitize the fluid distribution system is being directed through valve head 313 by opening the bypass valve 401, the pressure vessel 315 is not connected to the valve head 313. With the pressure vessel 315 not connected to the valve head 313, the first check valve 321 is pushed closed by the sanitizing fluid entering the first passageway 317, and the sanitizing fluid flows through the valve head 313 as described above when the second end portion 403 has been removed from the third passageway 399, and then back into the fluid distribution system. However, even if the pressure vessel 315 is connected to the valve head 313 (thereby opening the first check valve 321) when sanitizing fluid is being directed through the valve head 313 by opening the bypass valve 401, a majority of the sanitizing fluid moves through the valve head 313 via the third passageway 399 as described above, rather than past the first check valve 321 to and through pressure vessel 315, and then from the pressure vessel 315 to and through the second passageway 351 of the valve head 313, because there is a substantially greater resistance to flow through the pressure vessel 315 due to the matrix 477 than there is for flow through an opened third passageway 399.

In a preferred embodiment of the invention relating to providing filtered and/or conditioned and/or purified water, especially purified water, from a potable water distribution

system of, for example, an aircraft, valve heads 313 are installed locally at various cabin crew readily accessible service locations (service points) within galleys and lavatories of the aircraft, and the potable water distribution system is connected to each of the valve heads 313. Preferably, the valve heads 313 are positioned at or near where the water that is filtered and/or conditioned and/or purified in the pressure vessels 315 attached to the valve heads 313 is discharged from the potable water distribution system. With this arrangement, the valve head 313 may be easily accessed to install filtration/purification canisters (e.g., pressure vessels 315 each containing filtration/conditioning/purification means such as a cartridge 316, loose media, or the like) onto the valve heads 313, and to remove filtration/purification canisters (e.g., pressure vessels 315 each containing filtration/conditioning/purification means such as a cartridge 316, loose media, or the like) that have been used and install fresh canisters (e.g., pressure vessels 315 each containing filtration/conditioning/purification means such as a cartridge 316, loose media, or the like) in their place. Also, in contrast to prior art aircraft potable water distribution systems where water is passed through a cluster of more remote or centralized filters/purifiers to remove chlorine, foul tastes, and odors, and then sent along branches or legs of the potable water distribution system to be discharged from the branches or legs for use, possibly becoming contaminated from bacteria growing in the branches or legs, under this preferred embodiment of our invention, the water is filtered and/or conditioned and/or purified at or very near the point where it is discharged from the valve head 313 and actual used, thereby reducing the chances of contamination of the water after it has been filtered and/or conditioned and/or purified due to bacteria growing in the branches or legs or other possible contamination between the remote or centralized filters/purifiers and the point of discharge from the potable water distribution system. Further, when the valve heads 313 dispense water directly into an appliance, such as a coffee

maker or hot water generating device for heating water for tea, access that contaminants have to the water after it has been filtered and/or conditioned and/or purified is even further limited.

Turning now to Figs. 27 and 28, there is shown an alternative embodiment of the invention. In this embodiment of the invention, the valve head 313 described above is mounted in an inverted position to that shown in the first embodiment of the invention to allow fluid to be directed downwardly such that the pressure vessel 315' connected to the valve head 313 extends above rather than below the valve head 313. Pressure vessel 315' is substantially the same as pressure vessel 315 described above, except pressure vessel 315' is oriented neck-side down when connected to the valve head 313 and the pressure vessel 315' is provided with an automatic venting device 539 for venting air and breaking any unwanted vacuum.

The pressure vessel 315' is provided with a third passageway 541 extending through the bottom wall 469 of its bowl 467, and the automatic venting device 539 is positioned in the passageway 541. The automatic venting device 539 has substantially the same structure and operates the same way as the automatic venting device 441 described above. Like the automatic venting device 441, the automatic venting device 539 includes a vent sleeve 443 positioned in a chamber 543 formed along the third passageway 541. The vent sleeve 343 of the automatic venting device 539 has a cylindrical wall 447 having an inwardly extending ledge 449 formed at the downstream end portion of the vent sleeve 443, and a plurality of cutouts 451 (two being used in the vent sleeve 443 illustrated in Figs. 27 and 28) formed in the wall 447 extending from the downstream end portion of the vent sleeve 443 toward the upstream end portion of the vent sleeve 443. The ledge 449 of the vent sleeve 443 has an upstream end portion 449a and a downstream end portion 449b, and each such end portion 449a and 449b preferably is chamfered. An o-ring 453 is positioned immediately downstream of the downstream end portion

449b of the ledge 449 and is blocked by the downstream end portion 449b of the ledge 449 from falling upstream into the chamber 543. A vent seal 545 sits over and against the o-ring 453, the vent seal 545 having a recess 547 that receives the downstream portion of the o-ring 453 and a central opening 545a extending through the vent seal 545 through which air from the third passageway 541 vents. The vent seal 545 preferably is provided with tabs 546 which are received by recesses 548 formed in the annular ridge 557 formed in the bowl 467 of the pressure vessel 315'. A ball 455 preferably having a density slightly greater than the density of the fluid (e.g., if water is the fluid, a preferred specific gravity for the ball 455 is about 1.1) is positioned in the vent sleeve 443 and permits venting of air and breaking of any unwanted vacuum until the fluid pushes the ball 455 into engagement with the o-ring 453 creating a seal between the ball 455 and the o-ring 453 and the o-ring 453 and the vent seal 545, thereby closing the third passageway 541.

The diameter of the third passageway 541 at the chamber 543 and the diameters of the cylindrical vent sleeve 443 and the ball 455 of the automatic venting device 539 are greater than the diameter of the third passageway 541 upstream of the chamber 543.

A screen 456, positioned in the chamber 543 upstream of the vent sleeve 443 of the automatic venting device 539, and a screen 452, positioned in a recess 549 formed in the downstream side end portion of the vent seal 545 and held therein by a vent cap 551 positioned thereover, are provided to reject possible interfering debris or particulates.

An o-ring 553 sits around an annular ridge 555 formed in the downstream side of the vent seal 545 to seal between the vent seal 545 and the annular ridge 557 formed in the bowl 467 of the pressure vessel 315' that defines the outlet port 559 of the third passageway 541.

The vent cap 551, which has a central opening 551a extending therethrough through which air from the third passageway 541 vents, is secured over the annular ridge 557 securing the screen 452 in the recess 549 of the vent seal 545, as well as securing the automatic venting device 539 in place in the third passageway 541.

The embodiment of the invention shown in Figs. 27 and 28 facilitates providing fluid that has been filtered and/or conditioned and/or purified directly to a device in which the fluid is to be used, rather than providing the fluid to an intermediate location before it is subsequently transferred to the device in which the fluid is to be used. For example, if the fluid that is being filtered and/or conditioned and/or purified is water, rather than connecting the outlet port 353 of the valve head 313 to a water receiving line that leads to a water faucet in the galley of an airplane, drawing water from the faucet into a container, and pouring the water from the container into an apparatus, such as a coffee maker, that uses the water, the outlet port 353 may be connected directly down onto the coffee maker. Accordingly, with this setup, there is less of a chance that the water, which has been filtered and/or conditioned and/or purified by moving through the matrix 477, becomes contaminated from coming into contact with contaminants like bacteria after leaving the outlet port 353.

Turning now to Figs. 32 and 33, there is shown an alternative embodiment of the bypass valve of the invention. Rather than using bypass valve 401 described above, a bypass valve 561 may be used. Like the bypass valve 401, the bypass valve 561 is positioned in the valve head 313 along the third passageway 399. The bypass valve 561 has a shaft 563 having a first end portion 565 and a second end portion 567. A sealing member 569, preferably an o-ring, is mounted on the first end portion 565 of the shaft 563 for sealing between the shaft 563 and a portion of the wall 571 of the third passageway 399 to sealing close the third passageway 399

when the first end portion 565 of the shaft 563 is positioned in the third passageway 399 such that the sealing member 569 is in sealing engagement with the third passageway wall 571. The bypass valve 561 has a biasing member 573, which preferably comprises a spring mounted around the shaft 563, for pushing the shaft 563 into the position shown in Fig. 32 that closes the third passageway 399. A handle 575 is pivotally mounted on the second end portion 567 of the shaft 563 and has a cam 577 formed thereon. When the handle 575 is positioned in a first position shown in Fig. 32, the biasing member 573 pushes the shaft 563 into a position that closes the third passageway. When the handle 575 is positioned in a second position, as shown in Fig. 33, by pivoting the handle 575 on its cam 577, the first end portion 565 of the shaft 563 is pulled into a position that opens the third passageway 399 by withdrawing the first end portion 565 of the shaft 563 from a blocking position in the third passageway 399, thereby permitting fluid to flow through the passageway 399.

The bypass valve 561 preferably is positioned in a bore 579 that extends through the first end member 313a of the valve head 313 and into engagement with the third passageway 399 formed in the valve head 313. An o-ring 583 is provided in an annular groove 585 that extends around the shaft 563 to seal between the shaft 563 and the wall 581 that forms the bore 579 to prevent fluid from escaping from the valve head 313 through the bore 579. To retain the bypass valve 561 within the bore 579, a plate 587, which has a first end portion 587a, a second end portion 587b, and an opening extending therethrough which the second end portion 567 of the shaft 563 extends, is positioned in the recess 413, and cover plate 535 is secured over the peripheral edge portion of the second end portion 587b of the plate 587. The first end portion 587a of the plate 587 projects into the opening in the cover plate 535 to provide a surface against which the handle 575 may be rotated on its cam 577.

Preferably, an end cap 591 is provided, to be secured onto the valve head 313 when a pressure vessel 315 is not secured to the valve head 313 to maintain a sanitary condition inside the valve head by blocking dirt, debris, or other contaminants from having easy access to the second end portion 371 of the valve head 313, including the outlet port 341 from the first passageway 317 of the valve head 313 and the inlet port 355 to the second passageway 351 of the valve head 313. As shown in Fig. 34, preferably, the end cap 591 has a solid body 593 having a neck portion 595 formed on its first end portion for connecting the cap 591 onto the valve head 313 and four flanges 597 formed on its second end portion to facilitate gripping of the end cap 591 when rotating the end cap 591 into position on the valve head 313 and when rotating end cap 591 off of the valve head 313. Like the neck 359 of the pressure vessel 315, the neck portion 595 has three grooves 357 that receive the pins 361 of the valve head 313 when the end cap 591 is screwed onto the valve head 313. Alternatively, these grooves 357 and pins 361 may be replaced with threads formed on the outer surface of the neck portion 595 and matching threads formed on the valve head 313. The neck portion 595 also is provided with an annular recess 598 that defines a cylindrical column 599 that is received in the inlet port 355 of the second passageway 351 when the end cap 591 is secured onto the valve head 313. The cylindrical column 599 is provided with an annular groove 601 that extends around the column 599, and an o-ring 603 is positioned in the groove 601 for sealing between the column 599 and the inlet port 355 when the end cap 591 is secured onto the valve head 313. Also, an annular groove 605 is provided around the neck portion 595, and an o-ring 607 sits in the annular groove 605 for sealing between the neck portion 595 and the second end portion of the valve head 313. A further application of the end cap 591 is to block the flow of fluid from the first passageway 317 in the valve head 313 if it is desired to do so, such as in the event that the first check valve

321 is damaged or otherwise malfunctioning and does not close when the pressure vessel 315 is removed from the valve head 313.

Under the invention, water may be filtered and/or conditioned and/or purified at the point of use of the filtered and/or conditioned and/or purified water and at the time of use of the filtered and/or conditioned and/or purified water, significantly reducing chances of the filtered and/or conditioned and/or purified water becoming contaminated before it is used.

In addition to its applicability to aircraft potable water distribution systems, the invention may be applied in drinking water systems of recreational boats and yachts, commercial boats, recreational vehicles/caravans, residential homes, and water vending, cooling, warming and dispensing machines (such as those used in hospitals, schools, homes and factories). The invention also maybe applied to water systems in dental offices and laboratories.

The invention provides exceptional effectiveness (regarding water treatment results and cost effectiveness) and flexibility, and often weight reduction for aircraft and other uses with respect to providing filtered and/or conditioned and/or purified water. The apparatus 311 of the invention is easy to operate, requires little maintenance, and is dependable.

The apparatus 311 is very compact, light weight, long lasting, easily refurbished for extra-long service and embodies a slim-line design.

The filtration/purification canister (e.g., pressure vessel 315 containing filtration/conditioning/purification means such as a cartridge 316, loose media, or the like) may be provided with a light-weight composite construction. Due to its size/structure, the filtration/purification canister holds approximately 50% less unusable "transition water" (water retained in the canister necessary for the canister to function optimally) than prior art

filters/purifiers, thereby making more of the water in the water distribution system available for use.

The invention provides point of use and time of use advantages. For instance, in an aircraft, the invention provides a potable water distribution system having valve heads 313 installed locally at various cabin crew readily accessible service locations or service points within galleys and lavatories of the aircraft, preferably at or near where water that is filtered and/or conditioned and/or purified is discharged from the potable water distribution system. Further, the invention provides for directly connecting the outlet port 353 of the valve head 313 to an appliance such as a coffee maker used in the aircraft galley, which reduces possible exposure of the filtered and/or conditioned and/or purified water to contaminants that may be encountered if such water were to be indirectly brought from the outlet port 353 of the valve head 313 to the appliance instead.

The invention provides for positioning the apparatus 311 of the invention in convenient, easily accessible locations. For instance, with respect to an aircraft water distribution system, in contrast to the prior art, the apparatuses are provided at various cabin crew readily accessible service locations in the galleys and lavatories of the aircraft at or near where water that is to be filtered and/or conditioned and/or purified is to be discharged from the potable water distribution system.

The cartridge 316 may be obtained from General Ecology, Inc., of Exton, Pennsylvania, and may be configured to provide what the user desires for optimum service related to the application. For instance, the cartridge 316 may be configured to provide microbiological purification as independently certified to now current EPA Protocol for Microbiological

Purifiers, or to provide scale control and taste and odor removal, or to provide taste and odor removal along with larger pathogen removal, etc.

In accordance with the invention, antimicrobial surfaces may be provided to various components of the apparatus 311, such as to the tube 487, to assist in preventing backwards directed growth of bacteria, mildew and fungus into the canister, especially during short term periods of open non-use.

Backflow prevention provided in the valve head 313 prevents spillage from the valve head 313 when the canister is removed from the valve head 313. Further, this backflow prevention prevents reverse water flow into the purified/filtered water side of the canister.

The valve 511, which preferably is made from a flexible elastomeric material, helps prevent backflow from the canister, thereby limiting spillage when the canister is removed from the valve head 313.

Due to the two-piece construction of the body (first end member 313a and second end member 313b) of the valve head 313 and the simple means of holding the valve head 313 together, the valve head 313 may be easily disassembled and inexpensively refurbished for exceptionally long life using readily available hand tools, if necessary, with common replacement components to replace items such as o-rings, check valves, etc. Accordingly, the valve head 313 of the invention is long lasting.

The apparatus 311 of the invention is provided with an automatically venting feature for venting air and breaking vacuum in the apparatus 311.

In addition to being capable of being mounted such that the canister is positioned on the valve head 313 below the valve head 313, the valve head 313 may be mounted in an inverted

position such that the outlet port 353 of the valve head 313 points downwardly to facilitate direct feed into appliances, such as coffee makers.

The apparatus 311 of the invention provides for exceptionally quick and easy one-handed canister changes by non-technical, untrained personnel.

Canisters (e.g., pressure vessels 315 each containing filtration/conditioning/purification means such as a cartridge 316, loose media, or the like) are disposable and can be completely incinerated. The pressure vessel 315 of the canister provides a barrier against contact with the internal, contaminated section of a used canister when it is being removed from the valve head and discarded.

The apparatus 311 is provided with an automatic valving features, which discontinues flow from the outlet port 341 of the valve head 313 when the canister is disconnected from the valve head 313, and that activates flow of fluid (e.g., water) through the valve head 313 into the canister when the canister is connected to the valve head 313.

A simple quarter turn of the manual bypass valve of the invention facilitates periodic overall sanitizing processes of the distribution system without removing canisters. The invention permits manual bypass with or without a canister in place on the valve head 313. Also, an individual apparatus 311 of a series of apparatuses 311 may be bypassed, if desired (such as when the individual apparatus 311 leads to a fluid receiving line that is leaking), by simply activating the bypass valve allowing continuing operation of the remainder of the water distribution system.

The canisters are protected from breaking if freezing occurs by the compressible column 513. Accordingly, draining of the canisters is not necessary if freezing temperatures exist. Further, the canisters function normally after thawing.

The canisters are heat resistant up to a survival temperature of 185° F for two hours.

The bayonet-style canister mount with its "capture" positions provides tactile feedback via the spring plungers 367 that engage indents 394 formed in the neck 359 of the canister when the canister is properly seated on the valve head 313. The first check valves 321 is not activated (pushed into an open position) until the canister in proper position on the valve head 313.

Canisters (e.g., pressure vessels 315 each containing filtration/conditioning/purification means such as a cartridge 316, loose media, or the like) of the invention are ready to use immediately after being installed with normally minimal purge of water to expel air and small amounts of residual manufacturing materials.

The end cap 591, an optional feature, is available to protect the water distribution system from contaminants and debris when a canister is not installed on a valve head 313. The end cap 591 also provides a means to shut down a particular valve head 313 that it is connected to, while allowing uninterrupted use of the remainder of the water distribution system. It is NOT necessary to use the end cap 591 for disinfecting the system- the bypass valve is sufficient to avoid damaging the canister.

The valve head 313 may be rotated throughout 360° to accommodate installation constraints, and the valve head 313 may be installed with the valve head 313 being positioned above or below the canister.

Because the invention provides for easy, quick, and cost effective replacement of the filtration/purification canisters (pressure vessels 315 each containing a cartridge 316) onto the valve heads 313, preferably, the filtration/purification canisters (pressure vessels 315 each containing a cartridge 316) may be removed from the valve heads 313 and replaced with new filtration/purification canisters (pressure vessels 315 each containing a cartridge 316) before each

flight of the aircraft or before the first flight of the day for the aircraft, to avoid using a contaminated or spent filtration/purification canisters (pressure vessels 315 each containing a cartridge 316). In contrast, due to the cost and difficulty of changing filtration/purification canisters in prior art systems, changes of filtration/purification canisters in prior art systems are not typically done more often than every 90 days or so by a maintenance crew.

CLAIMS

1. A potable water distribution system, comprising

a distribution line having an inlet port and at least one outlet port,

a filtering and/or conditioning and/or purifying device mounted along the distribution line for filtering and/or conditioning and/or purifying a fluid received from the distribution line before said fluid exits from the potable water distribution system through an outlet port of the distribution line,

valve means connected to the distribution line for controlling when fluid may exit the potable water distribution system through an outlet port of the distribution line, and

an apparatus mounted between the distribution line and the filtering and/or conditioning and/or purifying device for bypassing fluid moving in the distribution line past said filtering and/or conditioning and/or purifying device,

the apparatus comprising

a body having a first passageway extending through it,

an inlet port formed at an inlet end portion of the first passageway, the inlet port of the first passageway being connected to the distribution line to receive fluid therefrom,

an outlet port formed at an outlet end portion of the first passageway, the outlet port of the first passageway being connected to an inlet port of the filtering and/or conditioning and/or purifying device to permit fluid to flow from the outlet port of the first passageway into the inlet port of the filtering and/or conditioning and/or purifying device,

the body having a second passageway extending through it,

an inlet port formed at an inlet end portion of the second passageway, the inlet port of the second passageway being connected to an outlet port of the filtering and/or conditioning and/or

purifying device to permit fluid to flow from the outlet port of the filtering and/or conditioning and/or purifying device to the inlet port of the second passageway,

an outlet port formed at an outlet end portion of the second passage, the outlet port of the second passageway being connected to a fluid receiving line leading to an outlet port of the distribution line to permit fluid to flow from the outlet port of the second passageway into the fluid receiving line,

the body having a third passageway extending between the first passageway and the second passageway, and

a bypass valve having a portion that when positioned in a blocking position in the third passageway blocks flow of fluid through the third passageway and that when withdrawn from a blocking position in the third passageway opens the third passageway to permit fluid to flow through the third passageway.

2. The system of claim 1, further including

a water supply comprising water containing a sanitizing agent, the water containing the sanitizing agent being effective to sanitize against undesirable contaminants it may encounter when introduced into the distribution line, and

means for moving fluid into and through the distribution line and the filtering and/or conditioning and/or purifying device attached thereto.

3. The system of claim 2, the water supply comprising a tank of said water.

4. The system of claim 1, further including

a water supply,

means for moving fluid into and through the distribution line and the filtering and/or conditioning and/or purifying device attached thereto, and

means for introducing a sanitizing agent into water from the water supply as the water is moved into the distribution line.

5. The system of claim 1, further including

means for moving fluid into and through the distribution line and the filtering and/or conditioning and/or purifying device attached thereto, and

means for moving a sanitizing solution into the distribution line.

6. The system of claim 1, further including

a water supply,

means for moving fluid into and through the distribution line and the filtering and/or conditioning and/or purifying device attached thereto, and

means for adding sanitizing agent to the water supply.

7. The system of claim 1, further including

an actuator linked to the bypass valve for opening and closing the bypass valve.

8. The system of claim 7, the actuator being controlled remotely.

9. The system of claim 7,

the actuator having means for receiving a wireless signal to activate or deactivate the actuator remotely.

10. The system of claim 7, further including

an indicator linked to the actuator to indicate when the bypass valve is open or closed.

11. An apparatus for bypassing fluid moving in a water distribution line of a potable water distribution system past a filtering and/or conditioning and/or purifying device mounted along the water distribution line for filtering and/or conditioning and/or purifying fluid received from the water distribution line, comprising

a body having a first passageway extending through it,

an inlet port formed at an inlet end portion of the first passageway, the inlet port of the first passageway being adapted to be connected to the water distribution line to receive fluid therefrom,

an outlet port formed at an outlet end portion of the first passageway, the outlet port of the first passageway being adapted to be connected to an inlet port of the filtering and/or conditioning and/or purifying device when the filtering and/or conditioning and/or purifying device is connected to the apparatus to permit fluid to flow from the outlet port of the first passageway into the inlet port of the filtering and/or conditioning and/or purifying device,

the body having a second passageway extending through it,

an inlet port formed at an inlet end portion of the second passageway, the inlet port of the second passageway being adapted to be connected to an outlet port of the filtering and/or conditioning and/or purifying device when the filtering and/or conditioning and/or purifying device is connected to the apparatus to permit fluid to flow from the outlet port of the filtering and/or conditioning and/or purifying device to the inlet port of the second passageway,

an outlet port formed at an outlet end portion of the second passageway, the outlet port of the second passageway being adapted to be connected to a fluid receiving line leading to an outlet port from the distribution line to permit fluid to flow from the outlet port of the second passageway into the fluid receiving line,

the body having a third passageway extending between the first passageway and the second passageway, the third passageway being defined by a third passageway wall, and

a bypass valve having a portion that when positioned in a blocking position in the third passageway blocks flow of fluid through the third passageway and that when withdrawn from a

blocking position in the third passageway opens the third passageway to permit fluid to flow through the third passageway.

12. The apparatus of claim 11, the bypass valve including

a shaft having a first end portion and a second end portion,

a sealing member mounted on the first end portion of the shaft for sealing between the shaft and a portion of the third passageway wall to sealingly close the third passageway when the first end of the shaft is positioned in a blocking position in the third passageway,

a biasing member mounted on the shaft for pushing the shaft into a position that closes the third passageway, and

a handle pivotally mounted on the second end portion of the shaft, the handle having a cam formed thereon,

wherein when the handle is positioned in a first position, the biasing member pushes the shaft into a position that closes the third passageway, and when the handle is positioned in a second position by pivoting the handle on its cam, the first end portion of the shaft is pulled into a position that opens the third passageway by withdrawing the first end portion of the shaft from a blocking position in the third passageway.

13. The apparatus of claim 11, further including

an actuator linked to the bypass valve for opening and closing the bypass valve.

14. The apparatus of claim 13, the actuator being controlled remotely.

15. The apparatus of claim 13,

the actuator having means for receiving a wireless signal to activate or deactivate the actuator remotely.

16. The apparatus of claim 11,

the body being integrally connected to a wall of a pressure vessel of a filtering and/or conditioning and/or purifying device.

17. A method of sanitizing a potable water distribution system, the potable water distribution system having a distribution line having an inlet port and at least one outlet port, the potable water distribution system having a filtering and/or conditioning and/or purifying device mounted along the distribution line for filtering and/or conditioning and/or purifying a fluid received from the distribution line before said fluid exits from the potable water distribution system through an outlet port of the water distribution line, and the potable water distribution system having a bypass apparatus for bypassing fluid moving in the water distribution line past said filtering and/or conditioning and/or purifying device, the bypass apparatus having a bypass valve, comprising the steps of

activating the bypass valve of the bypass apparatus to bypass fluid in the distribution line past the filtering and/or conditioning and/or purifying device,

filling the distribution line throughout with sanitizing solution,

letting the sanitizing solution remain in the distribution line for a desired period of time,

flushing the distribution line, and

deactivating the bypass valve of the bypass apparatus to stop fluid from the distribution line from bypassing the filtering and/or conditioning and/or purifying device.

18. The method of claim 17, wherein the distribution line is flushed with water containing a sanitizing agent.

19. The method of claim 17, wherein the deactivation step occurs after the flushing step.

20. The method of claim 18, wherein the deactivation step occurs before the flushing step.

21. The method of claim 18, wherein potable water distribution system includes an actuator linked to the bypass apparatus for activating and deactivating the bypass valve of the bypass apparatus.

22. The method of claim 21, the actuator having means for receiving a wireless signal to activate and deactivate the actuator remotely,

and further including the step of

sending a wireless signal to the signal receiving means of the actuator to activate or deactivate the actuator.

23. A method of sanitizing a potable water distribution system, the potable water distribution system having a water distribution line having an inlet port and at least one water outlet port, the potable water distribution system having a filtering and/or conditioning and/or purifying device mounted along the water distribution line for filtering and/or conditioning and/or purifying water received from the water distribution line before said water exits from the potable water distribution system through a water outlet port of the distribution line, and the potable water distribution system having a bypass apparatus for bypassing fluid moving in the water distribution line past said filtering and/or conditioning and/or purifying device, the bypass apparatus having a bypass valve, comprising the steps of

activating the bypass valve of the bypass apparatus to bypass fluid in the water distribution line past the filtering and/or conditioning and/or purifying device,

filling the water distribution line throughout with a sanitizing solution,

letting the sanitizing solution remain in the water distribution line for a desired period of time,

flushing the water distribution line,

draining the water distribution line, and

removing a filtering and/or conditioning and/or purifying element from the filtering and/or conditioning and/or purifying device and installing a replacement filtering and/or conditioning and/or purifying element into the filtering and/or conditioning and/or purifying device.

24. The method of claim 20, further including the step of

deactivating the bypass valve of the bypass apparatus prior to introducing water to the water distribution line after the replacement filtering and/or conditioning and/or purifying element has been installed.

25. The method of claim 23,

wherein potable water distribution system includes an actuator linked to the bypass apparatus for activating and deactivating the bypass valve of the bypass apparatus.

26. The method of claim 25,

the actuator having means for receiving a wireless signal to activate and deactivate the actuator remotely,

and further including the step of

sending a wireless signal to the signal receiving means of the actuator to activate or deactivate the actuator.

27. A method of sanitizing a potable water distribution system, the potable water distribution system having a water distribution line having an inlet port and at least one water outlet port, the potable water distribution system having a filtering and/or conditioning and/or purifying device mounted along the water distribution line for filtering and/or conditioning and/or purifying water received from the water distribution line before said water exits from the potable water

distribution system through a water outlet port of the water distribution line, and the potable water distribution system having a bypass apparatus for bypassing fluid moving in the water distribution line past said filtering and/or conditioning and/or purifying device, the bypass apparatus having a bypass valve, comprising the steps of

activating the bypass valve of the bypass apparatus to bypass fluid in the water distribution line past the filtering and/or conditioning and/or purifying device,

filling the water distribution line throughout with a sanitizing solution,

letting the sanitizing solution remain in the water distribution line for a desired period of time,

flushing the water distribution line,

draining the water distribution line, and

removing the filtering and/or conditioning and/or purifying device from the system, and

replacing the removed filtering and/or conditioning and/or purifying device with a replacement filtering and/or conditioning and/or purifying device.

28. The method of claim 27,

wherein potable water distribution system includes an actuator linked to the bypass apparatus for activating and deactivating the bypass valve of the bypass apparatus.

29. The method of claim 28, the actuator having means for receiving a wireless signal to activate and deactivate the actuator remotely,

and further including the step of

sending a wireless signal to the signal receiving means of the actuator to activate or deactivate the actuator.

30. A method of providing potable water, comprising the steps of

(a) providing a potable water distribution system, the potable water distribution system having a distribution line having an inlet port and at least one outlet port, the potable water distribution system having a filtering and/or conditioning and/or purifying device mounted along the distribution line for filtering and/or conditioning and/or purifying a fluid received from the distribution line before said fluid exits from the potable water distribution system through an outlet port of the water distribution line, and the potable water distribution system having a bypass apparatus for bypassing fluid moving in the water distribution line past said filtering and/or conditioning and/or purifying device, the bypass apparatus having a bypass valve,

(b) flowing water as needed into the distribution line,

(c) flowing the water from the distribution line into the filtering and/or conditioning and/or purifying device to filter and/or condition and/or purify the water to produce potable water,

(d) flowing potable water from the filtering and/or conditioning and/or purifying device into the distribution line downstream of the filtering and/or conditioning and/or purifying device to an outlet port of the distribution line,

(e) when it is desired to sanitize the distribution line, activating the bypass valve in the bypass apparatus to open the bypass valve to enable fluid moving through the distribution line to bypass the filtering and/or conditioning and/or purifying device and flow into the distribution line downstream of the filtering and/or condition and/or purifying device to an outlet port of the distribution line,

(f) while the bypass valve is open, flowing a sanitizing solution from the distribution line upstream of the filtering and/or conditioning and/or purifying device past the filtering and/or

conditioning and/or purifying device into the distribution line downstream of the filtering and/or conditioning and/or purifying device to an outlet part of the distribution line,

(g) after step (f) has been completed, letting the sanitizing solution remain in the distribution line for a desired period of time,

(h) after step (g) has been completed, flushing the distribution line, followed by deactivating the bypass valve of the bypass apparatus to close the bypass valve to stop fluid from bypassing the filtering and/or conditioning and/or purifying device,

(i) or, instead of step (h), after step (g) has been completed, deactivating the bypass valve of the bypass apparatus to close the bypass valve to stop fluid from bypassing the filtering and/or conditioning and/or purifying device, followed by flushing the distribution line, and

(j) after step (e) to (i), continuing steps (b) to (d).

31. The method of claim 30, wherein the water being flowed into the distribution line in step (b) and the water being flowed from the distribution line into the filtering and/or conditioning and/or purifying device in step (c) contains a sanitizing agent, the sanitizing agent being effective to sanitize against undesirable contaminants it may encounter in the distribution line, and wherein the sanitizing agent is at a concentration in said water that may effectively be treated by the filtering and/or conditioning and/or purifying device.

32. The method of claim 30,

wherein the water being flowed into the distribution line in step (b) contains a sanitizing agent, the sanitizing agent being effective to sanitize against undesirable contaminants it may encounter in the distribution line, and wherein the sanitizing agent is at a concentration in said water that may effectively be treated by the filtering and/or conditioning and/or purifying device, and

wherein the sanitizing solution of step (f) is water containing a sanitizing agent, the sanitizing agent being effective to sanitize against undesirable contaminants it may encounter in the distribution line, and wherein the sanitizing agent is at a concentration in said water that may effectively be treated by the filtering and/or conditioning and/or purifying device.

33. A method of sanitizing a potable water distribution system, the potable water distribution system having a water distribution line having an inlet port and at least one water outlet port, and the potable water distribution system having a filtering and/or conditioning and/or purifying device mounted along the water distribution line for filtering and/or conditioning and/or purifying water received from the water distribution line before said water exits from the potable water distribution system through a water outlet port of the distribution line, comprising the steps of

filling the water distribution line throughout with a sanitizing solution,

letting the sanitizing solution remain in the water distribution line for a desired period of time,

flushing the water distribution line with water,

draining the water distribution line, and

removing a filtering and/or conditioning and/or purifying element from the filtering and/or conditioning and/or purifying device and installing a replacement filtering and/or conditioning and/or purifying element into the filtering and/or conditioning and/or purifying device.

34. A method of sanitizing a potable water distribution system, the potable water distribution system having a water distribution line having an inlet port and at least one water outlet port, and the potable water distribution system having a filtering and/or conditioning and/or purifying

device mounted along the water distribution line for filtering and/or conditioning and/or purifying water received from the water distribution line before said water exits from the potable water distribution system through a water outlet port of the distribution line, comprising the steps of

filling the water distribution line throughout with a sanitizing solution,

letting the sanitizing solution remain in the water distribution line for a desired period of time,

flushing the water distribution line with water,

draining the water distribution line, and

removing the filtering and/or conditioning and/or purifying device from the system, and

replacing the removed filtering and/or conditioning and/or purifying device with a replacement filtering and/or conditioning and/or purifying device.

35. An apparatus for filtering and/or conditioning and/or purifying a fluid, comprising

a valve head having a first passageway extending through it and being adapted to be connected to a fluid transmission line,

a first check valve positioned in the first passageway of the valve head for blocking flow of fluid through the first passageway when the valve is closed,

the first check valve including a valve housing, the valve housing having an annular ring having an annular inner wall surface, the annular inner wall surface having an annular ledge formed thereon creating a valve seat, and a movable valve disc contained within the valve housing that closes the first check valve when the valve disc rests against the valve seat and that permits flow of fluid through the first check valve when the valve disc is not resting against the valve seat, the valve disc having a guide pin formed on and extending upstream from its

upstream face that is engaged by and slides in a guide pin holder to keep motion of the valve disc on a line that permits proper seating of the valve disc on the valve seat when the first check valve is closed, the guide pin holder being positioned upstream of the annular ring,

an outlet port formed at an outlet end portion of the first passageway in the valve head,

a pressure vessel,

means positioned in the pressure vessel for filtering and/or conditioning and/or purifying a fluid,

the pressure vessel having an inlet port that is in fluid communication with the outlet port formed at the outlet end portion of the first passageway in the valve head when the pressure vessel is connected to the valve head,

the pressure vessel having a first passageway extending from the inlet port of the pressure vessel to the means for filtering and/or conditioning and/or purifying a fluid,

the pressure vessel having a second passageway extending from the means for filtering and/or conditioning and/or purifying a fluid to an outlet port of the pressure vessel,

the valve head having a second passageway extending through it and adapted to be connected to a fluid receiving line at an outlet port of the second passageway of the valve head,

the valve head having an inlet port formed at an inlet end portion of the second passageway of the valve head,

the inlet port formed at the inlet end portion of the second passageway in the valve head being in fluid communication with the outlet port of the pressure vessel when the pressure vessel is connected to the valve head,

connecting/disconnecting means formed on the valve head and the pressure vessel for connecting the pressure vessel to the valve head, when desired, to permit flow of fluid from the

first passageway in the valve head to the inlet port of the pressure vessel, and for disconnecting the pressure vessel from the valve head, when desired, to stop flow of fluid from the first passageway of the valve head to the inlet port of the pressure vessel,

actuating means for automatically opening the first check valve in the valve head when the pressure vessel is connected to the valve head,

the actuating means including a pin positioned in the first passageway of the valve head between the valve disc and the outlet port at the outlet end portion of the first passageway of the valve head, the pin having a first end portion that engages the valve disc, and the pin having a second end portion,

the actuating means further including an end portion of the pressure vessel that engages the second end portion of the pin when the pressure vessel is connected to the valve head causing the pin to push against and lift the valve disc of the first check valve off the valve seat of the first check valve to open the first check valve, and

a second check valve positioned in the second passageway of the valve head for blocking backflow of fluid from the second passageway of the valve head when the pressure vessel is not connected to the valve head.

36. The apparatus of claim 35,

the second check valve including

a valve housing, the valve housing having an annular ring having an annular inner wall surface, the annular inner wall surface having an annular ledge formed thereon creating a valve seat, and

a movable valve disc contained in the housing that closes the second check valve when the valve disc rests against the valve seat and that permits flow of fluid through the second check

valve when the valve disc is not resting against the valve seat, the valve disc having a guide pin formed on and extending downstream from its downstream face that is engaged by and slides in a guide pin holder to keep motion of the valve disc on a line that permits proper seating of the valve disc on the valve seat when the second check valve is closed, the guide pin holder being positioned downstream of the annular ring of the second check valve.

37. The apparatus of claim 35,

the valve head having a third passageway formed therein and extending from the first passageway at a position upstream of the first check valve to the second passageway downstream of the second check valve, and

a bypass valve positioned in the valve head that has a portion that when extended into the third passageway blocks flow of fluid through the third passageway and that when withdrawn from a blocking position in the third passageway opens the third passageway to permit fluid to flow therethrough.

38. The apparatus of claim 37,

the bypass valve including

a shaft having a first end portion, a second end portion, and threading on a portion of its length,

a thread engaging member secured on the valve head for engaging the threading of the shaft,

a handle mounted on the first end portion of the shaft for rotating the shaft in a first direction to move the second end portion of the shaft from the third passageway and for rotating the shaft in a direction opposite to the first direction to move the second end portion of the shaft into the third passageway, and

a sealing member mounted on the second end portion of the shaft.

39. The apparatus of claim 37,

the bypass valve including

a shaft having a first end portion and a second end porting,

a sealing member mounted on the first end portion of the shaft for sealing between the shaft and a portion of the third passageway wall to seal close the third passageway that the first end of the shaft is positioned in the third passageway,

a biasing member mounted on the shaft for pushing the shaft into a position that closes the third passageway, and

a handle pivotally mounted on the second end portion of the shaft, the handle having a cam formed thereon,

wherein when the handle is positioned in the first position, the biasing member pushes the shaft into a position that closes the third passageway, and when the handle is positioned in a second position by pivoting the handle on its cam, the first end portion is pulled into a position that opens the third passageway by withdrawing the first end portion of the shaft from a blocking position in the third passageway.

40. The apparatus of claim 35,

the valve head having a fourth passageway extending therethrough for venting purposes, the fourth passageway being defined by a wall,

an automatic venting/vacuum breaking device positioned in the fourth passageway for automatically venting air contained in the apparatus and for breaking any unwanted vacuum formed in the apparatus,

the automatic venting/vacuum breaking device including a vent sleeve positioned in a chamber formed along the fourth passageway, the vent sleeve having a downstream end portion and an upstream end portion, the vent sleeve having a cylindrical wall having an annular inwardly extending ledge formed at the downstream end portion of the vent sleeve, the vent sleeve having a plurality of cutouts in its cylindrical wall extending from the upstream end portion of the vent sleeve toward the downstream end portion of the vent sleeve, the ledge having an upstream side and a downstream side,

an o-ring seal positioned downstream of the ledge, and

a ball having a density slightly greater than the density of the fluid being filtered and/or conditioned and/or purified by the apparatus, the ball being positioned in the vent sleeve,

the venting/vacuum breaking device remaining in an open position until the ball is pushed by the fluid into engagement with a portion of the o-ring creating a seal between the ball and the o-ring and the o-ring and the portion of the fourth passageway wall, thereby closing the fourth passageway.

41. The apparatus of claim 35,

the connecting/disconnecting means comprising a twist-on structure.

42. The apparatus of claim 35,

the pressure vessel having a neck,

the connecting/disconnecting means comprising

a bayonet-style mount including a plurality pins mounted on the valve head, and a plurality of grooves formed on the neck, each groove having a first end portion where a corresponding pin from the plurality of pins mounted on the valve head may be inserted and

moved along the groove by turning the pressure valve until a second end portion of the groove is reached, thereby securing the pressure vessel to the valve head.

43. The apparatus of claim 35,

the actuating means including a raised cam formed on the end portion of the pressure vessel that engages the second end portion of the pin when the pressure vessel is connected to the valve head causing the pin to push against and lift the valve disc of the first check valve off the valve seat of the first check valve to open the first check valve,

44. The apparatus of claim 42, further including

a plurality of indents formed in the end portion of the pressure vessel , and

a plurality of spring-loaded plungers mounted on the valve head which click into the corresponding indents and push against the end portion of the pressure vessel when the pressure vessel is connected to the valve head.

45. The apparatus of claim 35,

the pressure vessel comprising

a cover having a top wall, a side wall extending downwardly from the top wall, the side wall of the cover having a lower end portion, and a cover rim formed on the lower end portion of the side wall of the cover,

a bowl having a bottom wall, a side wall extending upwardly from the bottom wall, the side wall of the bowl having an upper end portion, and a bowl rim formed on the upper end portion of the side wall of the bowl,

the cover rim and the bowl rim being joined together to form a sealed seam portion of the pressure vessel, and

a reinforcement member secured around the pressure vessel for reinforcing the pressure vessel.

46. The apparatus of claim 45,

the reinforcement member comprising a metal ring or a metal clamp or carbon, fiberglass, aramid or other suitable fibers or materials wrapping around the pressure vessel.

47. The apparatus of claim 35,

the pressure vessel including a compressible column mounted therein and substantially surrounded by the means for filtering and/or conditioning and/or purifying a fluid for accommodating possible expansion of the fluid ,

the compressible column protecting against damage to the pressure vessel and/or means for filtering and/or conditioning and/or purifying a fluid caused by freezing if the fluid freezes and expands in the pressure vessel by providing space, for fluid to expand , the fluid expanding into and comprising the compressible column as the fluid freezes.

48. The apparatus of claim 47,

the outlet port of the pressure vessel including a tube having a first end portion, a second end portion, and a passageway extending through the tube from a first end of the tube to a second end of the tube through which fluid that has been filtered and/or conditioned and/or purified in the pressure vessel moves to exit the pressure vessel,

the tube having an interior surface portion and an exterior surface portion,

the tube having a plurality of fins formed on the interior surface portion of the tube at the first end portion of the tube, the fins extending inwardly into the passageway of the tube and being oriented to extend parallel to a center axis of the tube for blocking the compressible column from entering the tube and plugging the passageway extending there through if the

compressible column inadvertently breaks loose from where it is mounted in the pressure vessel, and

the tube at its first end portion having a plurality of cutouts made therein to permit flow of fluid that has been filtered and/or conditioned and/or purified in the pressure vessel to continue to enter the tube if the compressible column breaks loose from where it is mounted in the pressure vessel and abuts against the first end of the tube.

49. The apparatus of claim 35,

the outlet port of the pressure vessel including a tube having a passageway extending through the tube through which fluid that has been filtered and/or conditioned and/or purified moves to exit the pressure vessel,

the tube having an exterior surface portion, and

the exterior surface portion having an annular groove formed therein,

the pressure vessel further including

a flapper valve for reducing/preventing backflow of fluid from the inlet port of the pressure vessel,

the flapper valve comprising a flexible disc mounted on the tube in the annular groove formed on the tube, the flexible disc having a central opening formed therein through which the tube extends,

the flexible disc extending across the first passageway of the pressure vessel,

the flexible disc flexing in a first direction to open the first passageway of the pressure vessel when pushed by inbound fluid entering the pressure vessel to permit inbound flow of fluid to pass it as inbound fluid flows through the first passageway of the pressure vessel, and

the flexible disc flexing in a second direction to abut against a portion of an interior wall of the pressure vessel along the first passageway of the pressure vessel to close the first passageway of the pressure vessel when pushed by a back flow of fluid from the pressure vessel along the first passageway of the pressure vessel.

50. The apparatus of claim 35,

the pressure vessel having a bottom wall having a passageway extending through it for venting purposes, the passageway being defined by a wall,

an automatic venting device positioned in the passageway for automatically venting air and for breaking any unwanted vacuum,

the automatic venting device including a vent sleeve positioned in a chamber formed in the passageway, the vent sleeve having a downstream end portion and an upstream end portion, the vent sleeve having a cylindrical wall having an annular inwardly extending ledge formed at the downstream end portion of the vent sleeve, the vent sleeve having a plurality of cutouts in its cylindrical wall extending from the upstream end portion of the vent sleeve toward the downstream end portion of the vent sleeve, the ledge having an upstream side and a downstream side,

means positioned downstream of the ledge for creating a valve seat and for sealing between the valve seat and the wall of the passageway, and

a ball having a density slightly greater than the density of the fluid being filtered and/or conditioned and/or purified, the ball being positioned in the vent sleeve,

the venting device remaining in an open position until the ball is pushed by the fluid into engagement with the valve seat to close the passageway.

51. The apparatus of claim 35, further including

a color-coded, snap-on ring mounted around an outlet port formed at an outlet portion of the second passageway in the valve head to assist in distinguishing such outlet port from an inlet port formed at an inlet portion of the first passageway in the valve head.

52. An automatic valving device for a pressure vessel that holds means for filtering and/or conditioning and/or purifying a fluid, comprising

a body having a first passageway extending through it and being adapted to be connected to a fluid transmission line,

a first check valve positioned in the first passageway of the body for blocking flow of fluid through the first passageway when the valve is closed,

an outlet port formed at an outlet end portion of the first passageway in the body,

the body having a second passageway extending through it and adapted to be connected to a fluid receiving line at an outlet port of the second passageway of the body,

the body having an inlet port formed at an inlet end portion of the second passageway of the body,

the inlet port formed at the inlet end portion of the second passageway in the body being in fluid communication with the outlet port of the pressure vessel when the pressure vessel is connected to the body,

connecting/disconnecting means formed on the body for connecting the body to the pressure vessel, when desired, to permit flow of fluid from the first passageway in the body to the pressure vessel, and for disconnecting the body from the pressure vessel, when desired, to stop flow of fluid from the first passageway of the body to the pressure vessel,

actuating means for automatically opening the first check valve in the body when the pressure vessel is connected to the body,

a second check valve positioned in the second passageway of the body for blocking backflow of fluid from the second passageway of the body when the pressure vessel is not connected to the body,

the body having a third passageway formed therein and extending from the first passageway at a position upstream of the first check valve to the second passageway downstream of the second check valve, and

a bypass valve positioned in the body that has a portion that when extended into the third passageway blocks flow of fluid through the third passageway and that when withdrawn from a blocking position in the third passageway opens the third passageway to permit fluid to flow therethrough.

53. The device of claim 52,

the bypass valve including

a shaft having a first end portion, a second end portion, and threading on a portion of its length,

a thread engaging member secured on the body for engaging the threading of the shaft,

a handle mounted on the first end portion of the shaft for rotating the shaft in a first direction to move the second end portion of the shaft from the third passageway and for rotating the shaft in a direction opposite to the first direction to move the second end portion of the shaft into the third passageway, and

a sealing member mounted on the second end portion of the shaft.

54. The device of claim 52, the bypass valve including

a shaft having a first end portion and a second end portion,

a sealing member mounted on the first end portion of the shaft for sealing between the shaft and a portion of the third passageway wall to sealingly close the third passageway that the first end of the shaft is positioned in the third passageway,

a biasing member mounted on the shaft for pushing the shaft into a position that closes the third passageway, and

a handle pivotly mounted on the second end portion of the shaft, the handle having a cam formed thereon,

wherein when the handle is positioned in the first position, the biasing member pushes the shaft into a position that closes the third passageway, and when the handle is positioned in a second position by pivoting the handle on its cam, the first end portion is pulled into a position that opens the third passageway by withdrawing the first end portion of the shaft from a blocking position in the third passageway.

55. The device of claim 52,

the body having a fourth passageway extending therethrough for venting purposes, the fourth passageway being defined by a wall,

an automatic venting/vacuum breaking device positioned in the fourth passageway for automatically venting air and for breaking any unwanted vacuum,

the automatic venting/vacuum breaking device including a vent sleeve positioned in a chamber formed along the fourth passageway, the vent sleeve having a downstream end portion and an upstream end portion, the vent sleeve having a cylindrical wall having an annular inwardly extending ledge formed at the downstream end portion of the vent sleeve, the vent sleeve having a plurality of cutouts in its cylindrical wall extending from the upstream end

portion of the vent sleeve toward the downstream end portion of the vent sleeve, the ledge having an upstream side and a downstream side,

an o-ring seal positioned downstream of the ledge, and

a ball having a density slightly greater than the density of the fluid being filtered and/or conditioned and/or purified, the ball being positioned in the vent sleeve,

the venting/vacuum breaking device remaining in an open position until the ball is pushed by the fluid into engagement with a portion of the o-ring creating a seal between the ball and the o-ring and the o-ring and a portion of the fourth passageway wall, thereby closing the fourth passageway.

56. An automatic valving device for a pressure vessel that holds means for filtering and/or conditioning and/or purifying a fluid, comprising

a body having a first passageway extending through it and being adapted to be connected to a fluid transmission line,

a first check valve positioned in the first passageway of the body for blocking flow of fluid through the first passageway when the valve is closed,

an outlet port formed at an outlet end portion of the first passageway in the body,

the body having a second passageway extending through it and adapted to be connected to a fluid receiving line at an outlet port of the second passageway of the body,

the body having an inlet port formed at an inlet end portion of the second passageway of the body,

the inlet port formed at the inlet end portion of the second passageway in the body being in fluid communication with the outlet port of the pressure vessel when the pressure vessel is connected to the body,

connecting/disconnecting means formed on the body for connecting the body to the pressure vessel, when desired, to permit flow of fluid from the first passageway in the body to the pressure vessel, and for disconnecting the body from the pressure vessel, when desired, to stop flow of fluid from the first passageway of the body to the pressure vessel,

actuating means for automatically opening the first check valve in the body when the pressure vessel is connected to the body,

a second check valve positioned in the second passageway of the body for blocking backflow of fluid from the second passageway of the body when the pressure vessel is not connected to the body,

the body having a fourth passageway extending therethrough for venting purposes, the fourth passageway being defined by a wall,

an automatic venting/vacuum breaking device positioned in the fourth passageway for automatically venting air and for breaking any unwanted vacuum,

the automatic venting/vacuum breaking device including a vent sleeve positioned in a chamber formed along the fourth passageway, the vent sleeve having a downstream end portion and an upstream end portion, the vent sleeve having a cylindrical wall having an annular inwardly extending ledge formed at the downstream end portion of the vent sleeve, the vent sleeve having a plurality of cutouts in its cylindrical wall extending from the upstream end portion of the vent sleeve toward the downstream end portion of the vent sleeve, the ledge having an upstream side and a downstream side,

an o-ring seal positioned downstream of the ledge, and

a ball having a density slightly greater than the density of the fluid being filtered and/or conditioned and/or purified, the ball being positioned in the vent sleeve,

the venting device/vacuum breaking remaining in an open position until the ball is pushed by the fluid into engagement with a portion of the o-ring creating a seal between the ball and the o-ring and the o-ring and a portion of the fourth passageway wall, thereby closing the fourth passageway.

57. A pressure vessel for filtering and/or conditioning and/or purifying a fluid, comprising

a cover having a top wall, a side wall extending downwardly from the top wall, the side wall of the cover having a lower end portion, and a cover rim formed on the lower end portion of the side wall of the cover,

a bowl having a bottom wall, a side wall extending upwardly from the bottom wall, the side wall of the bowl having an upper end portion, and a bowl rim formed on the upper end portion of the side wall of the bowl,

the cover rim and the bowl rim being joined together to form a sealed seam portion of the pressure vessel,

means positioned in the pressure vessel for filtering and/or conditioning and/or filtering the fluid, and

a compressible column mounted in the pressure vessel,

the compressible column protecting against damage to the pressure vessel and/or means for filtering and/or conditioning and/or purifying a fluid caused by freezing if the fluid freezes and expands in the pressure vessel and for mitigating possible millisecond and /or microsecond pressure spikes by providing space, for fluid to expand into.

58. The pressure vessel of claim 57, further including

a reinforcement member secured around the pressure vessel for reinforcing the pressure vessel.

59. The pressure vessel of claim 57,

the outlet port of the pressure vessel including a tube having a passageway extending through the tube through which fluid that has been filtered and/or conditioned and/or purified moves to exit the pressure vessel,

the tube having an exterior surface portion, and

the exterior surface portion having an annular groove formed therein,

the pressure vessel further including

a flapper valve for reducing possible backflow of fluid from the inlet port of the pressure vessel,

the flapper valve comprising a flexible disc mounted on the tube in the annular groove formed on the tube, the flexible disc having a central opening formed therein through which the tube extends,

the flexible disc extending across the first passageway of the pressure vessel,

the flexible disc flexing in a first direction to open the first passageway of the pressure vessel when pushed by inbound fluid entering the pressure vessel to permit inbound flow of fluid to pass it as inbound fluid flows through the first passageway of the pressure vessel, and

the flexible disc flexing in a second direction to abut against a portion of an interior wall of the pressure vessel along the first passageway of the pressure vessel to close the first passageway of the pressure vessel when pushed by a back flow of fluid from the pressure vessel along the first passageway of the pressure vessel.

60. The pressure vessel of claim 57,

the bottom wall of the bowl having a passageway extending therethrough for venting purposes, the passageway being defined by a wall,

an automatic venting/vacuum breaking device positioned in the passageway for automatically venting air and for breaking any unwanted vacuum,

the automatic venting/vacuum breaking device including a vent sleeve positioned in a chamber formed in the passageway, the vent sleeve having a downstream end portion and an upstream end portion, the vent sleeve having a cylindrical wall having an annular inwardly extending ledge formed at the downstream end portion of the vent sleeve, the vent sleeve having a plurality of cutouts in its cylindrical wall extending from the upstream end portion of the vent sleeve toward the downstream end portion of the vent sleeve, the ledge having an upstream side and a downstream side,

means positioned downstream of the ledge for creating a valve seat and for sealing between the valve seat and the wall of the passageway, and

a ball having a density slightly greater than the density of the fluid being filtered and/or conditioned and/or purified, the ball being positioned in the vent sleeve,

the venting/vacuum breaking device remaining in an open position until the ball is pushed by the fluid into engagement with the valve seat to close the passageway.

61. A pressure vessel for filtering and/or conditioning and/or purifying a fluid, comprising

a cover having a top wall, a side wall extending downwardly from the top wall, the side wall of the cover having a lower end portion, and a cover rim formed on the lower end portion of the side wall of the cover,

a bowl having a bottom wall, a side wall extending upwardly from the bottom wall, the side wall of the bowl having an upper end portion, and a bowl rim formed on the upper end portion of the side wall of the bowl,

the cover rim and the bowl rim being joined together to form a sealed seam portion of the pressure vessel,

means positioned in the pressure vessel for filtering and/or conditioning and/or filtering the fluid, and

the bottom wall of the bowl having a passageway extending therethrough for venting purposes, the passageway being defined by a wall,

an automatic venting/vacuum breaking device positioned in the passageway for automatically venting air and for breaking any unwanted vacuum,

the automatic venting/vacuum breaking device including a vent sleeve positioned in a chamber formed in the passageway, the vent sleeve having a downstream end portion and an upstream end portion, the vent sleeve having a cylindrical wall having an annular inwardly extending ledge formed at the downstream end portion of the vent sleeve, the vent sleeve having a plurality of cutouts in its cylindrical wall extending from the upstream end portion of the vent sleeve toward the downstream end portion of the vent sleeve, the ledge having an upstream side and a downstream side,

means positioned downstream of the ledge for creating a valve seat and for sealing between the valve seat and the wall of the passageway, and

a ball having a density slightly greater than the density of the fluid being filtered and/or conditioned and/or purified, the ball being positioned in the vent sleeve,

the venting device/vacuum breaking remaining in an open position until the ball is pushed by the fluid into engagement with the valve seat to close the passageway.

62. An automatic air vent valving apparatus that opens to permit air to vent from a device and that closes after the air has been vented from the device, comprising

a ball

a vent sleeve for receiving the ball, the vent sleeve having a downstream end portion and an upstream end portion,

means when positioned downstream of the vent sleeve for forming a valve seat that receives a portion of the ball to close the air vent valving apparatus, and

air directing means formed in the vent sleeve for directing air being vented past the ball and then back toward the ball to prevent the ball from prematurely abutting against the valve seat until most, if not all, of the air has been vented.

63. The automatic air vent valving apparatus of claim 62,

the air directing means including

a plurality of cutouts formed in the vent sleeve and extending from the upstream end portion of the vent sleeve toward the downstream end portion of the vent sleeve which direct air to move along past the ball, and

an annular inwardly extending flange formed on the downstream end portion of the vent sleeve which directs air that has moved past the ball to rebound off back toward the ball.

64. A method for providing filtered and/or conditioned and/or purified water from a potable water distribution system, comprising the steps of

providing a valve head, the valve head having a first passageway extending through it and being adapted to be connected to a water transmission line, a first check valve positioned in the first passageway of the valve head for blocking flow of water through the first passageway when the valve is closed, an outlet port formed at an outlet end portion of the first passageway in the valve head the connects to an inlet port of a pressure vessel, a second passageway extending through the valve head and adapted to be connected to a water receiving line at an outlet port of

the second passageway of the valve head, an inlet port formed at an inlet end portion of the second passageway of the valve head that connects to an outlet port of a pressure vessel, actuating means for automatically opening the first check valve in the valve head when a pressure vessel is connected to the valve head, a second check valve positioned in the second passageway of the valve head for blocking backflow of water from the second passageway of the valve head when the pressure vessel is not connected to the valve head, a third passageway extending from the first passageway upstream from the first check valve to the second passageway downstream from the second check valve, and the valve head having a bypass valve positioned in the third passageway,

connecting a pressure vessel to the valve head when it is desired to filter and/or condition and/or purify water by causing the water to flow through the pressure vessel, the pressure vessel having means positioned therein for filtering and/or conditioning and/or purifying water,

automatically triggering the actuating means of the valve head to automatically open the first check valve in the valve head when the pressure vessel is connected to the valve head to permit water to flow from the first passageway of the valve head to the pressure vessel, then through the pressure vessel, then from the pressure vessel to and through the second passageway of the valve head, and then from the outlet port of the second passageway of the valve head to the water receiving line, and

when it is desired to sanitize the potable water distribution system,

opening the bypass valve, and

flowing sanitizing fluid through the potable water distribution system and the valve head to sanitize the system.

65. The method of claim 64, further including the step of

directing the water that has been filtered and/or conditioned and/or purified in the pressure vessel from the outlet port of the second passageway of the valve head directly to an appliance that uses the water to reduce possible exposure to contaminants that may be encountered if the water were to be indirectly brought to the appliance instead.

66. A method for providing filtered and/or conditioned and/or purified water from a potable water distribution system of an aircraft, comprising the steps of

mounting valve heads at various cabin crew readily accessible service locations within galleys and lavatories of the aircraft at or near where water that is to be filtered and/or conditioned and/or purified is to be discharged from the potable water distribution system, each valve head having a first check valve positioned therein, and

connecting the potable water distribution system of the aircraft to the valve heads,

the valve heads being capable of having filtration/purification canisters connected thereto using an easy twist-on motion,

the valve heads being capable of having filtration/purification canisters removed therefrom using an easy twist-on motion,

the filtration/purification canisters automatically opening the first check valves in the valve heads when the filtration/purification canisters and from the filtration/purification canisters back to and through the valve heads to outlet ports from the valve heads, and

the first check valves in the valve heads automatically closing when the filtration/purification canisters are disconnected from the valve heads to stop water from flowing past the first check valves.

67. The method of claim 66, further including the step of

connecting one an outlet port of at least one of the valve heads directly to an appliance that uses the water to reduce possible exposure to contaminants that may be encountered if water were to be indirectly brought from the outlet port of the valve head to the appliance instead.

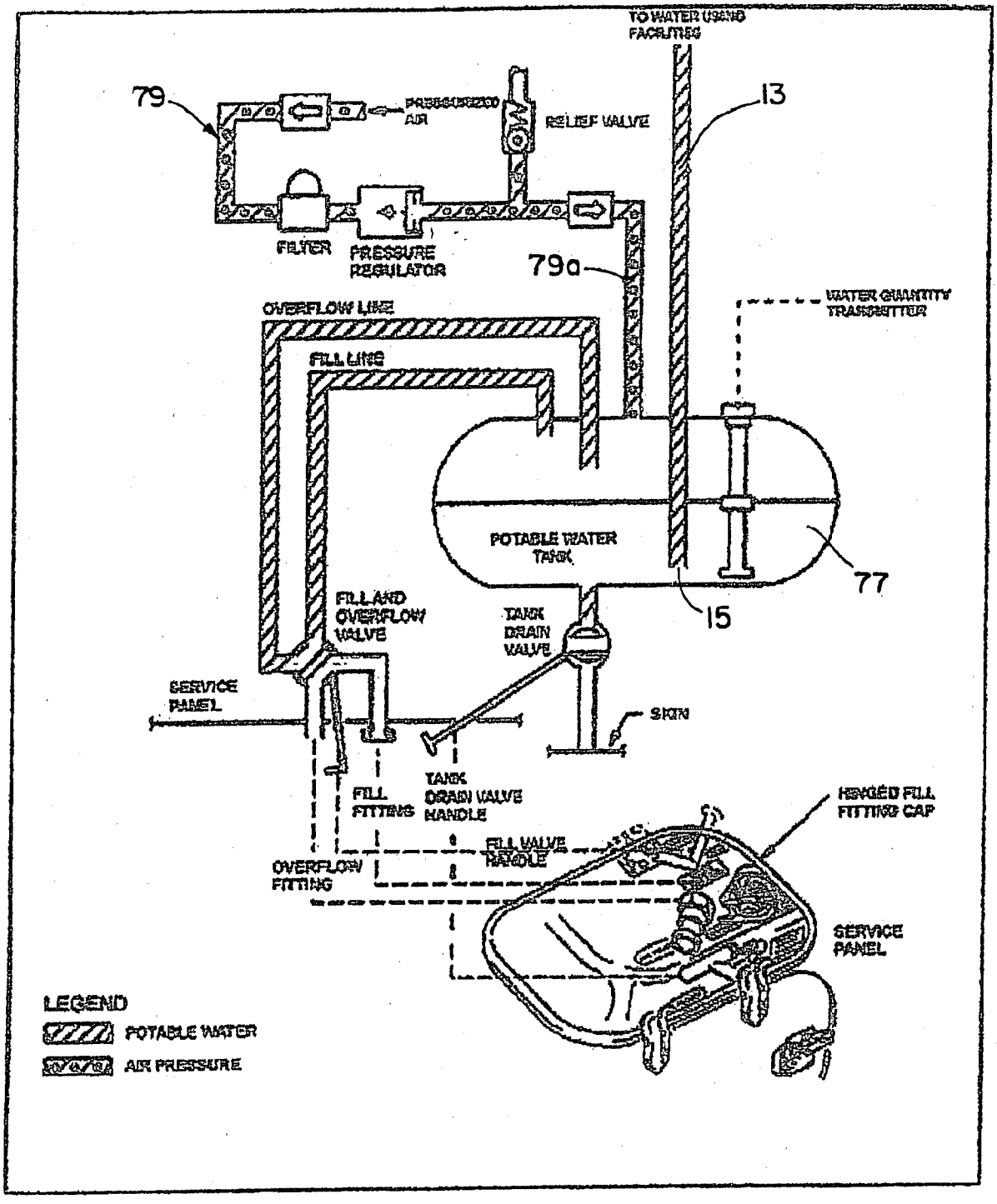


Exhibit 2.1 Aircraft Onboard Water System

FIG. 1

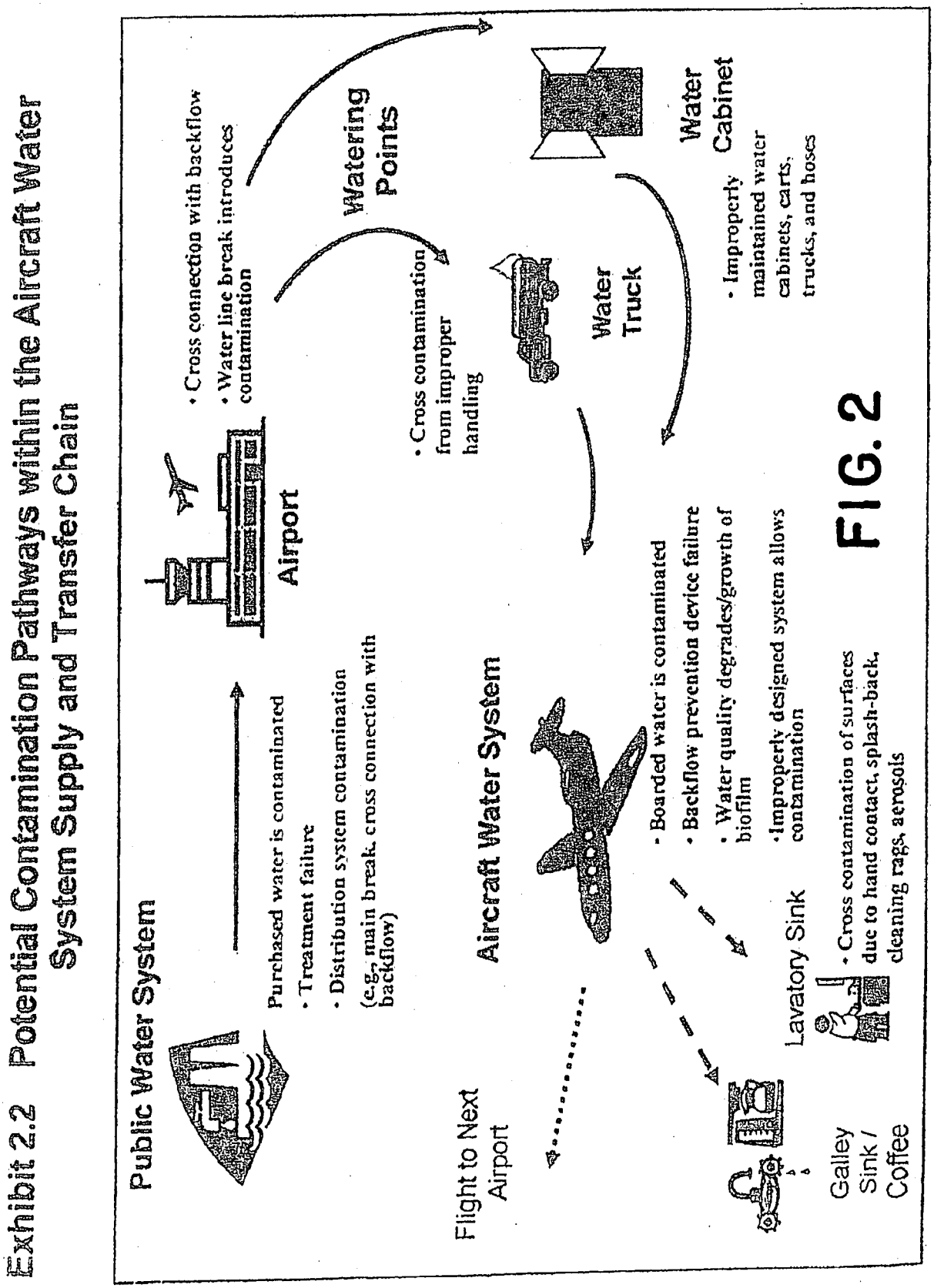


Exhibit 2.2 Potential Contamination Pathways within the Aircraft Water System Supply and Transfer Chain
Public Water System
Purchased water is contaminated
• Treatment failure
• Distribution system contamination (e.g., main break, cross connection with backflow)
Airport
• Cross connection with backflow
• Water line break introduces contamination
Watering Points
• Cross contamination from improper handling
Water Truck
Water Cabinet
• Improperly maintained water cabinets, carts, trucks, and hoses
Aircraft Water System
• Boarded water is contaminated
• Backflow prevention device failure
• Water quality degrades/growth of biofilm
• Improperly designed system allows contamination
Flight to Next Airport
Galley
Sink / Coffee
Lavatory Sink
• Cross contamination of surfaces due to hand contact, splash-back, cleaning rags, aerosols

FIG. 2

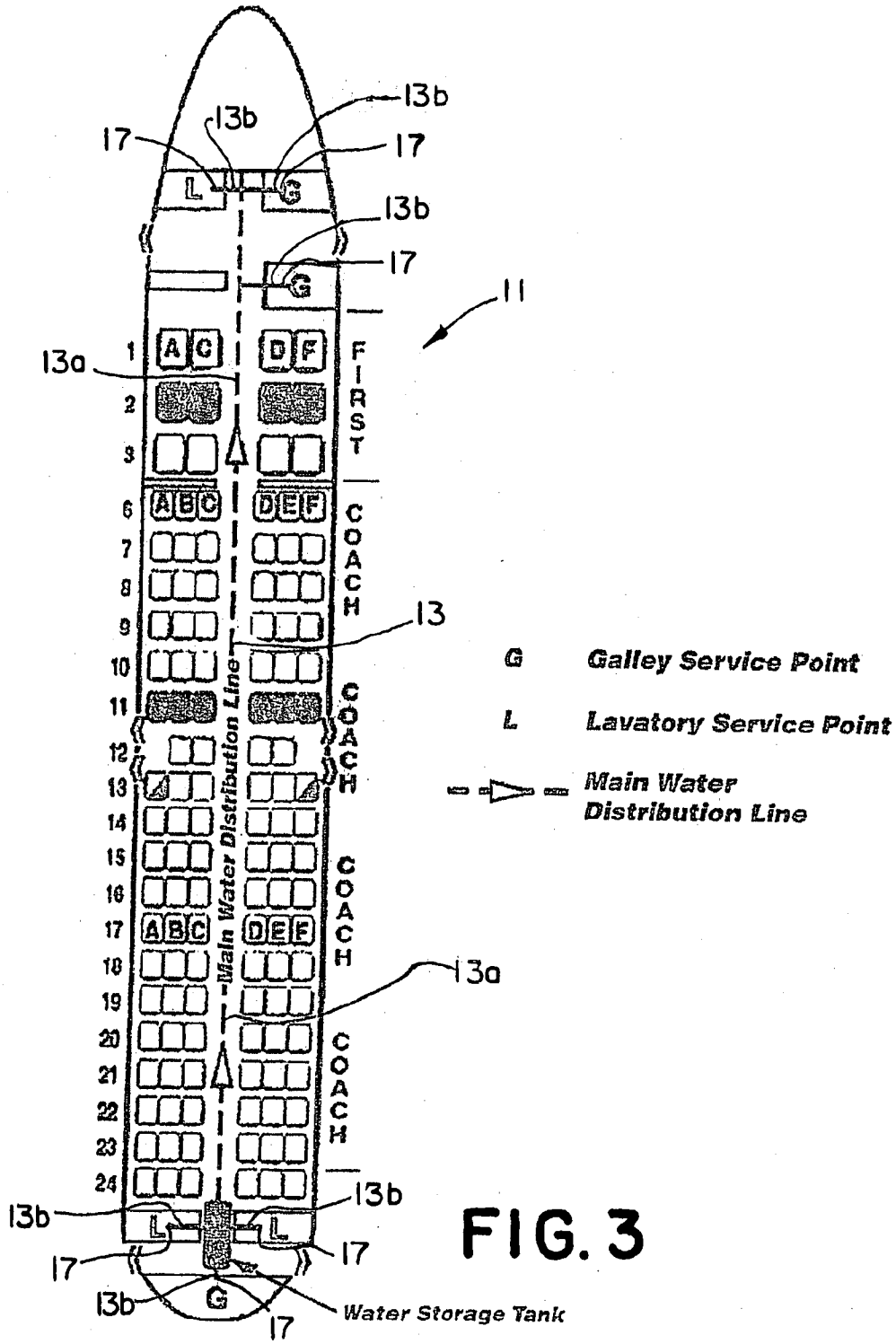


FIG. 3

Typical Layout
Potable Water Distribution System

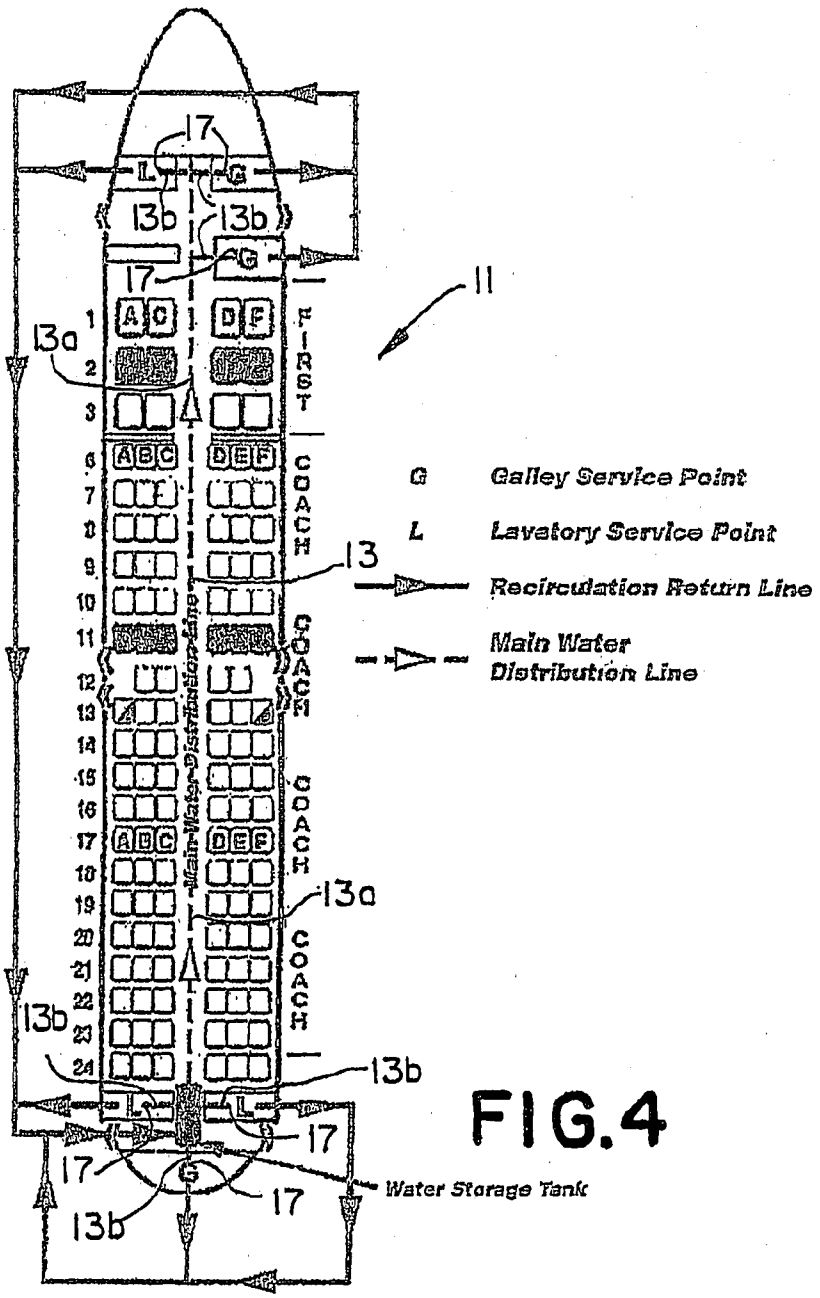


FIG.4

Simplified Schematic of Aircraft with Potable Water Recirculation System—somtimes used on customized aircraft such as "Head of State" and other VIP types

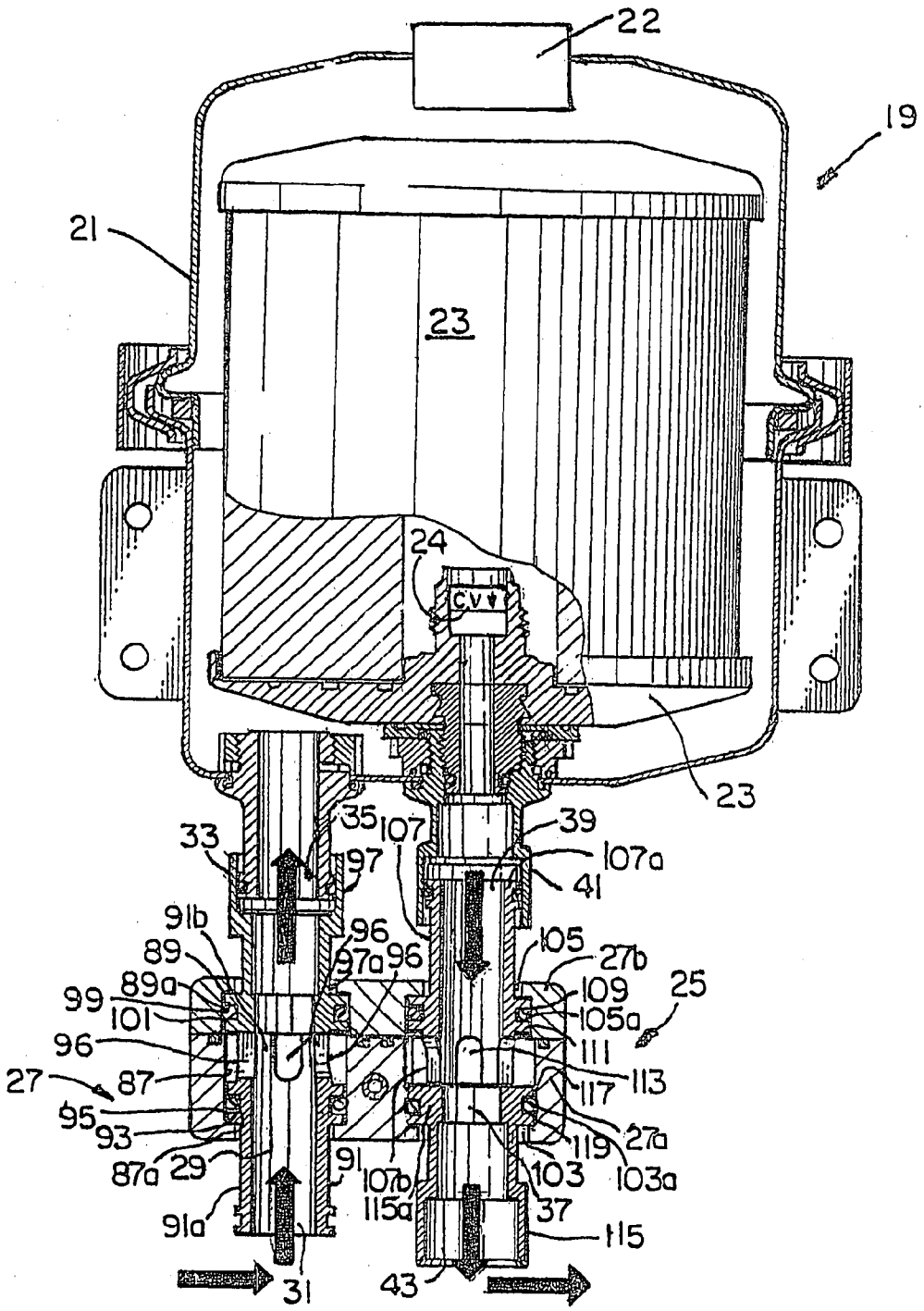

22
19
21
23
24
CV
23
35
107
39
33
97
107a
41
91b
96
105
89
97a
96
27b
89a
109
25
99
101
105a
96
111
27
87
113
117
95
93
119
27a
87a
29
91
107b
103
103a
91a
115a
37
115
31
43

FIG. 5

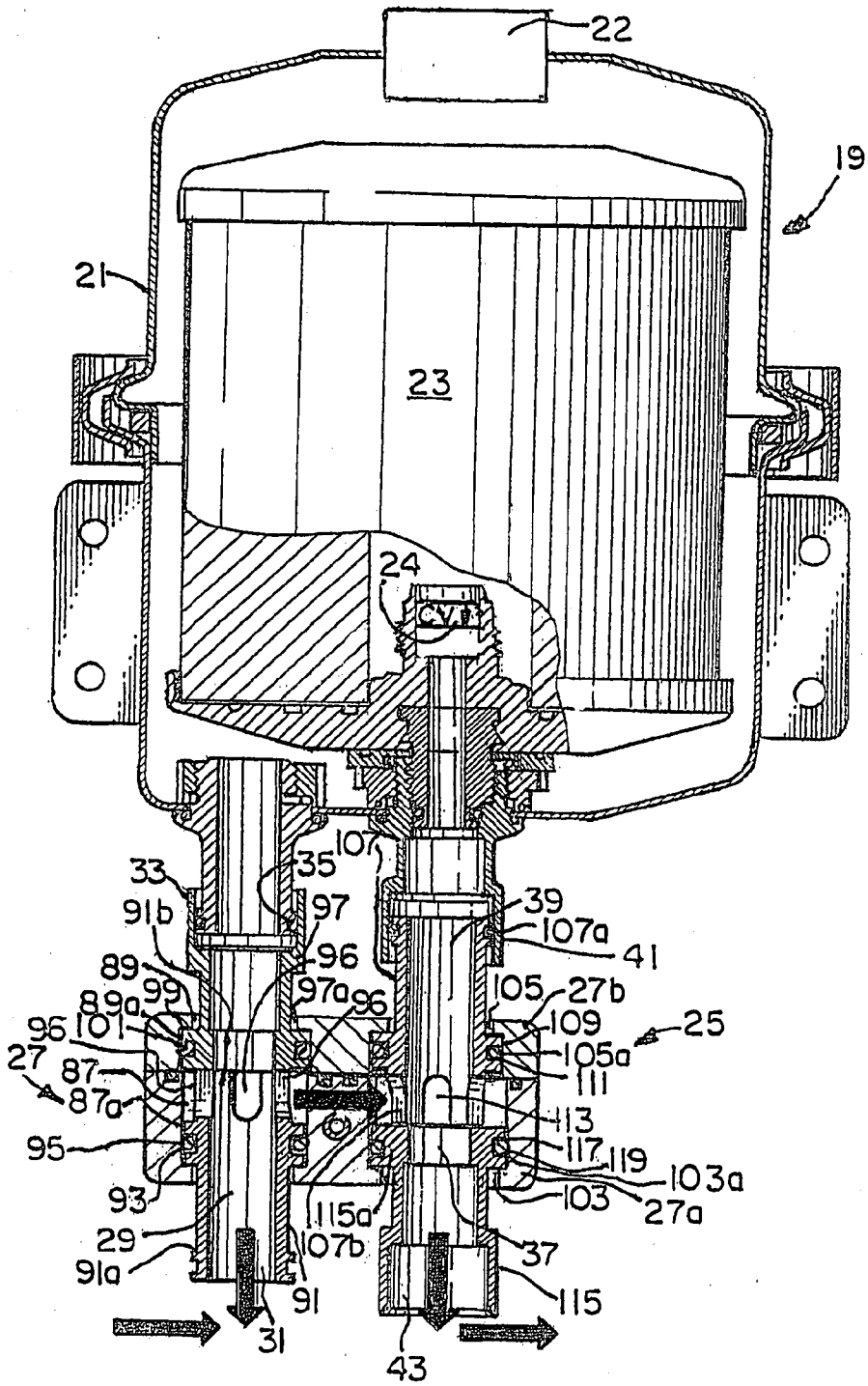

22
19
21
23
24
C.V.T.
107
33
35
39
91b
97
107a
41
89
96
105
27b
89a
99
97a
96
109
25
96
101
105a
27
87
111
87a
113
95
117
119
103a
93
103
27a
115a
29
107b
37
91a
91
115
31
43

FIG. 6

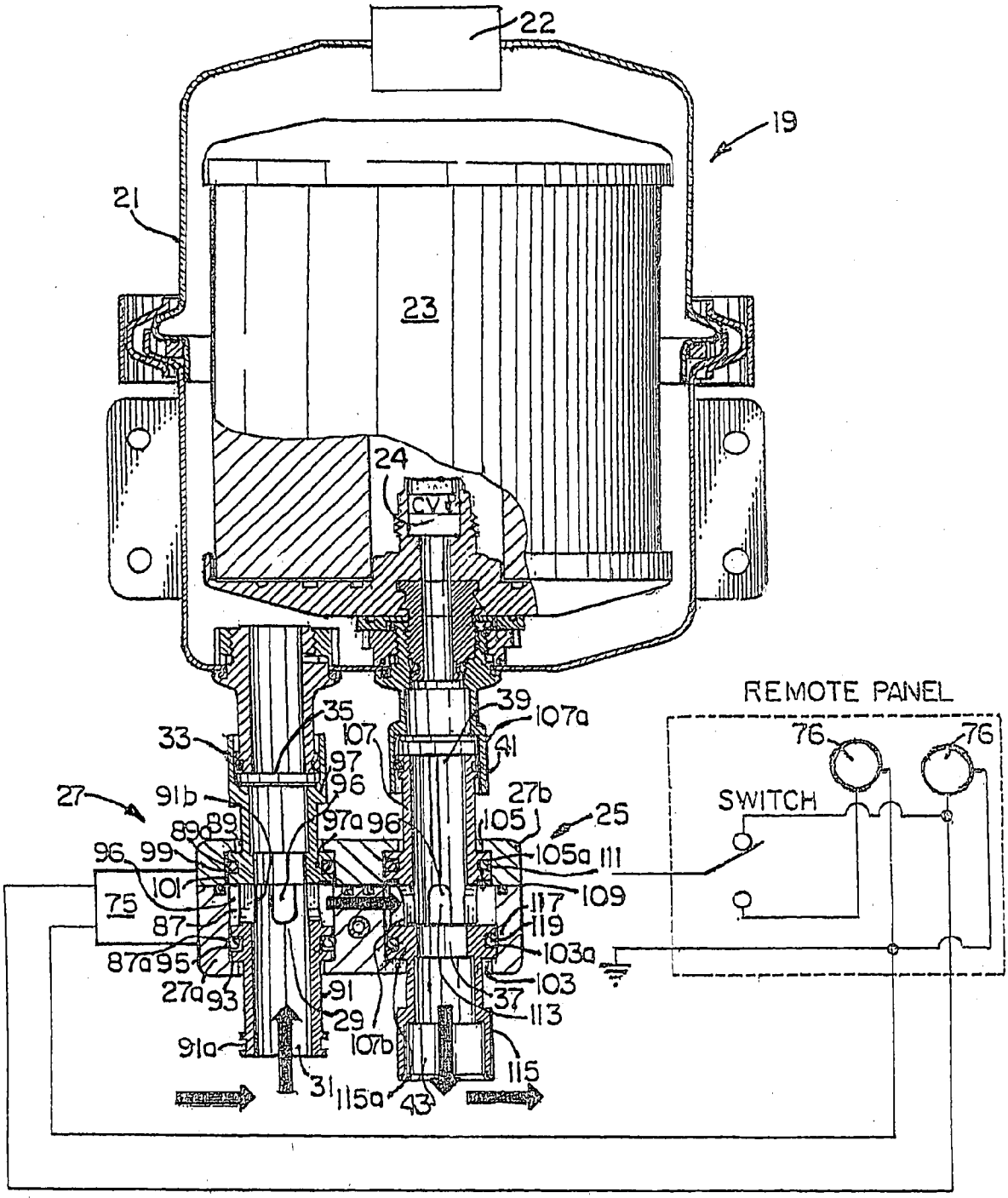

22
19
21
23
24
CV
REMOTE PANEL
76
76
SWITCH
39
107a
41
35
107
33
97
96
27
91b
27b
105
25
89
89a
97a
96
105a
111
96
99
101
109
75
117
87
119
87a
95
103a
27a
93
91
103
37
29
113
91a
107b
115
31
115a
43

FIG. 7

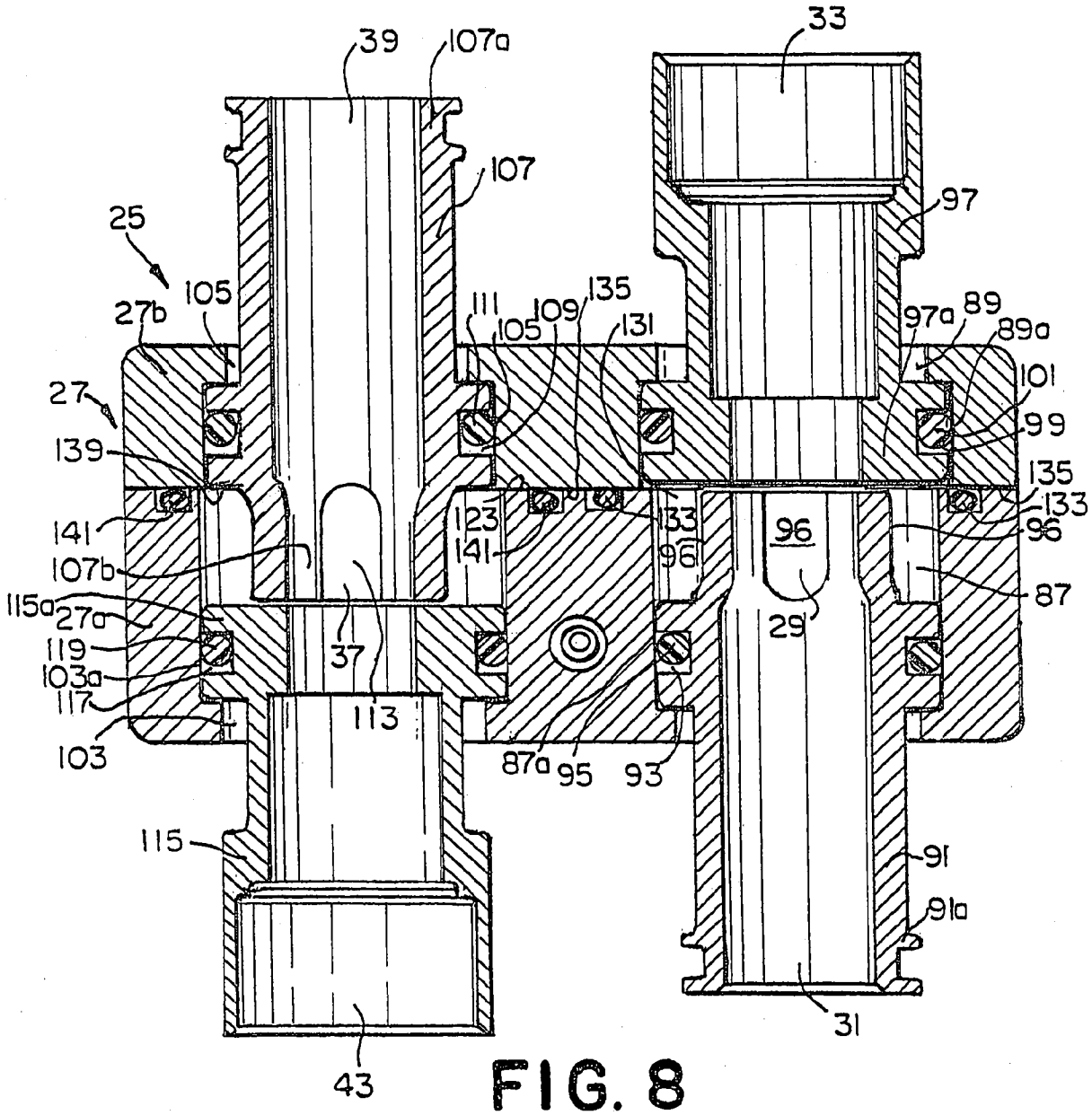

39
107a
33
107
97
25
105
27b
111
105
109
135
131
97a
89
89a
101
27
99
139
135
133
141
123
141
133
96
96
96
107b
87
115a
27a
29
119
37
103a
117
113
103
87a
95
93
115
91
91a
31
43

FIG. 8

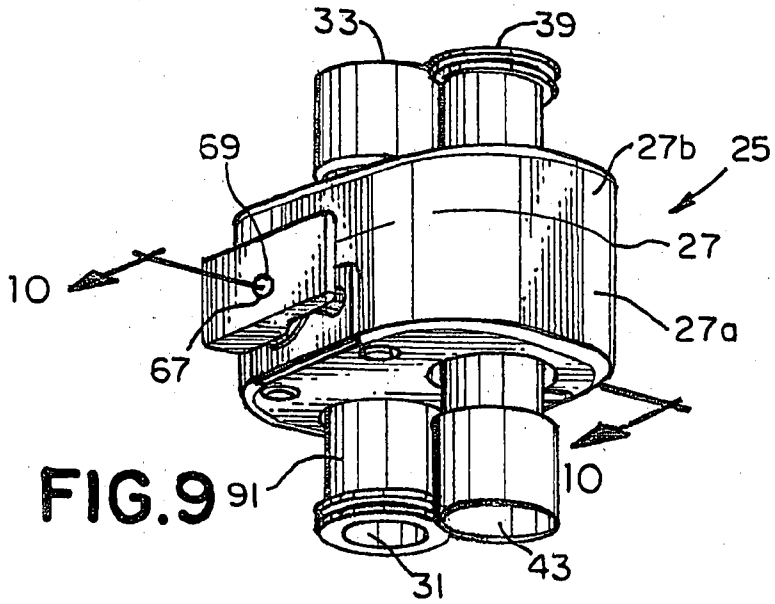

33
39
69
27b
25
27
10
27a
67
10
91
43
31

FIG.9

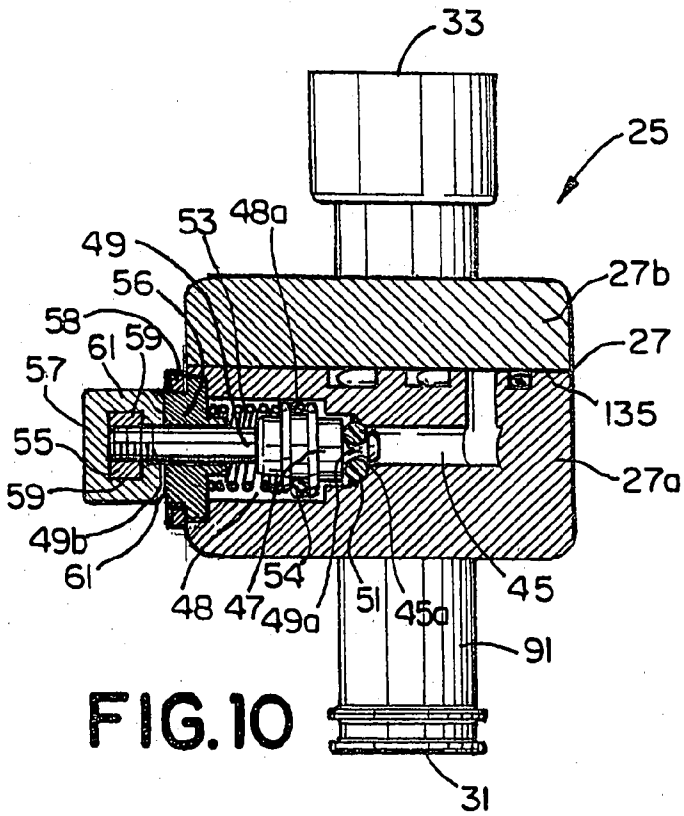

33
25
53
48a
49
27b
56
58
61
59
27
57
135
55
27a
59
49b
61
54
45
48
47
49a
51
45a
91
31

FIG.10

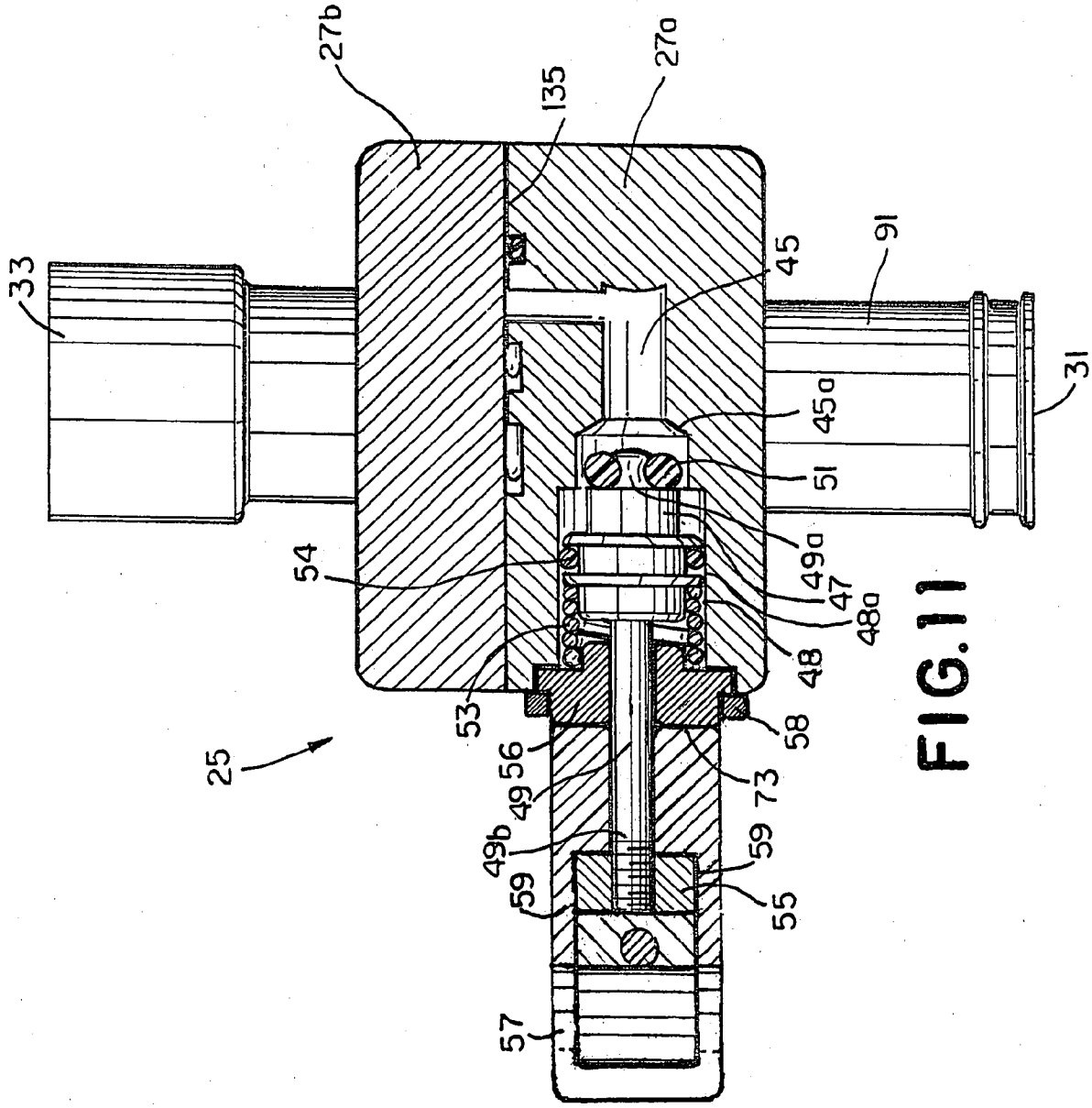

27b
135
27a
33
45
91
31
45a
51
49a
54
47
48a
48
53
58
25
56
49
73
49b
59
59
55
57

FIG.11

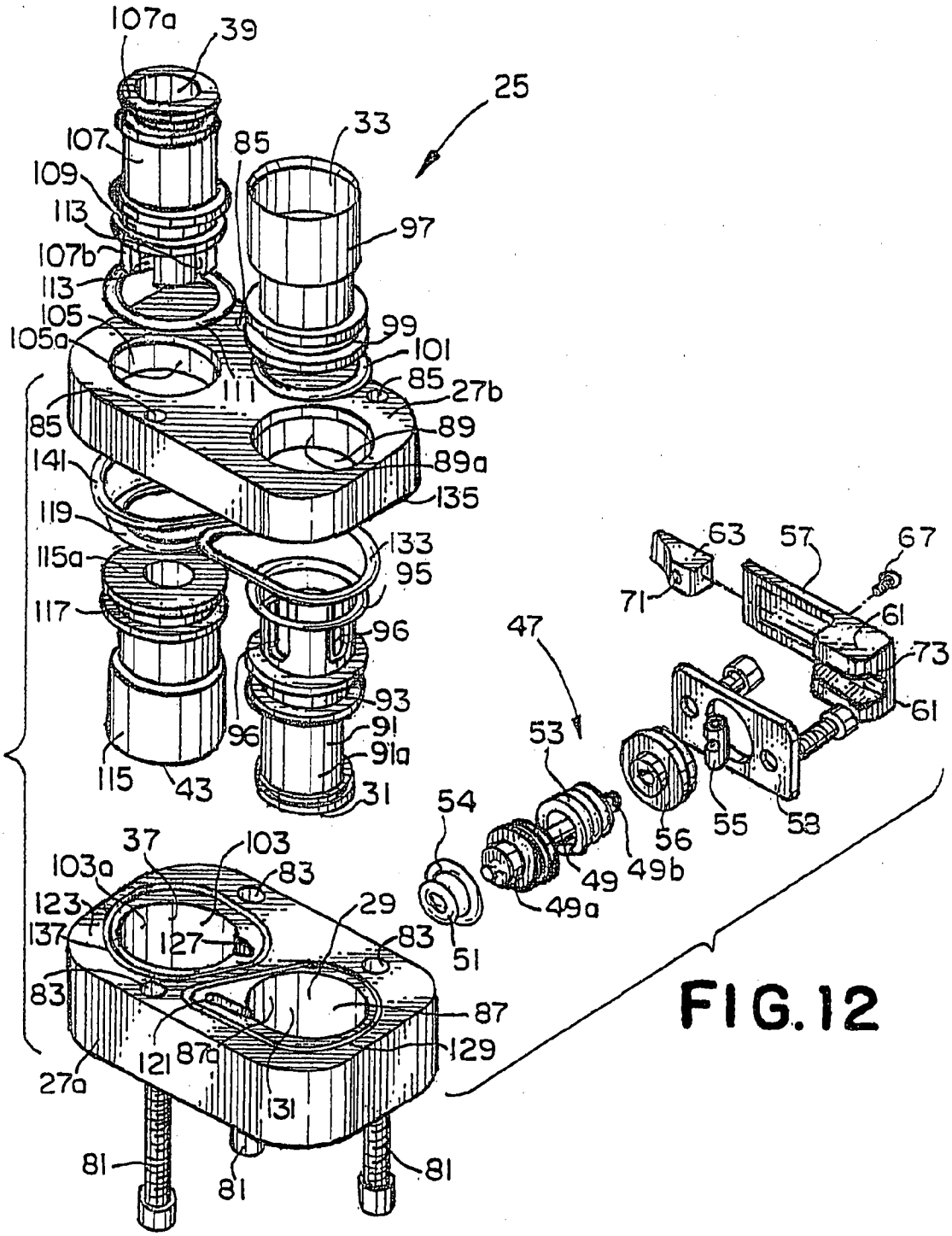
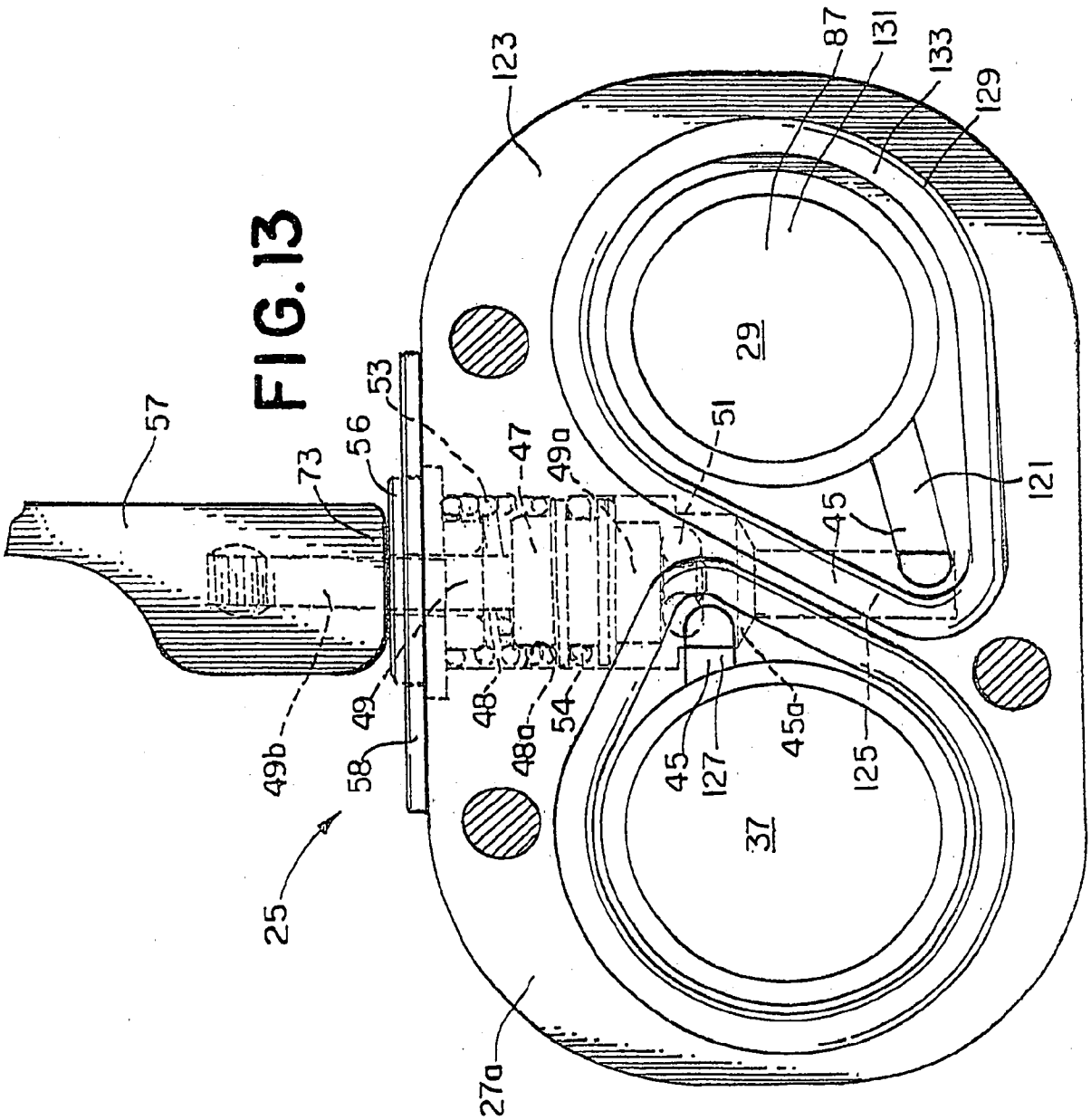

107a
39
25
33
107
85
109
113
97
107b
113
105
105a
99
101
111
85
27b
85
89
141
89a
135
119
133
115a
95
117
96
93
91
96
91a
115
43
31
37
103
103a
83
123
29
137
127
83
83
87
121
87a
129
27a
131
81
81
81
47
63
57
67
71
61
73
61
53
54
56
55
58
49
49b
49a
51

FIG. 12

FIG.13


123
87
131
133
129
29
51
121
45
57
53
56
73
47
49a
49
49b
58
48
48a
54
45
127
45a
125
37
25
27a

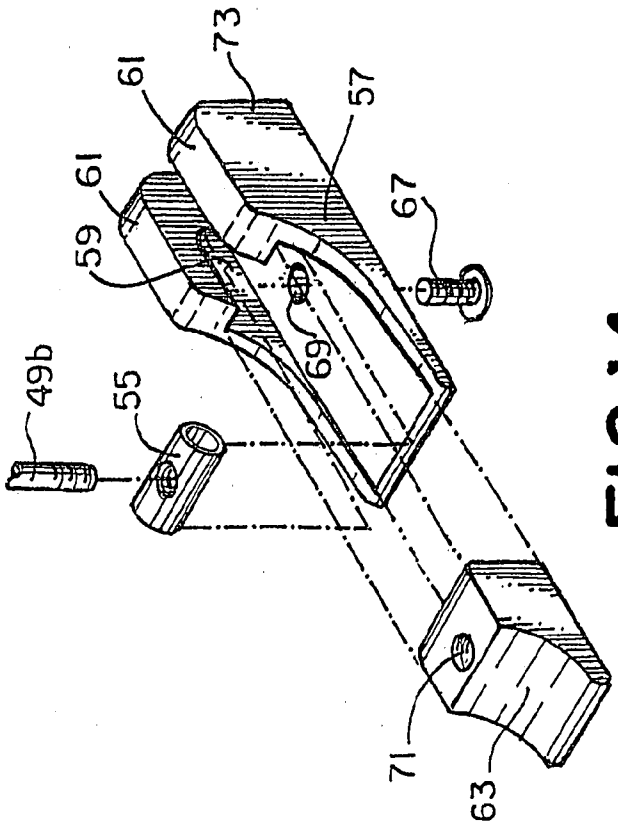


FIG.14

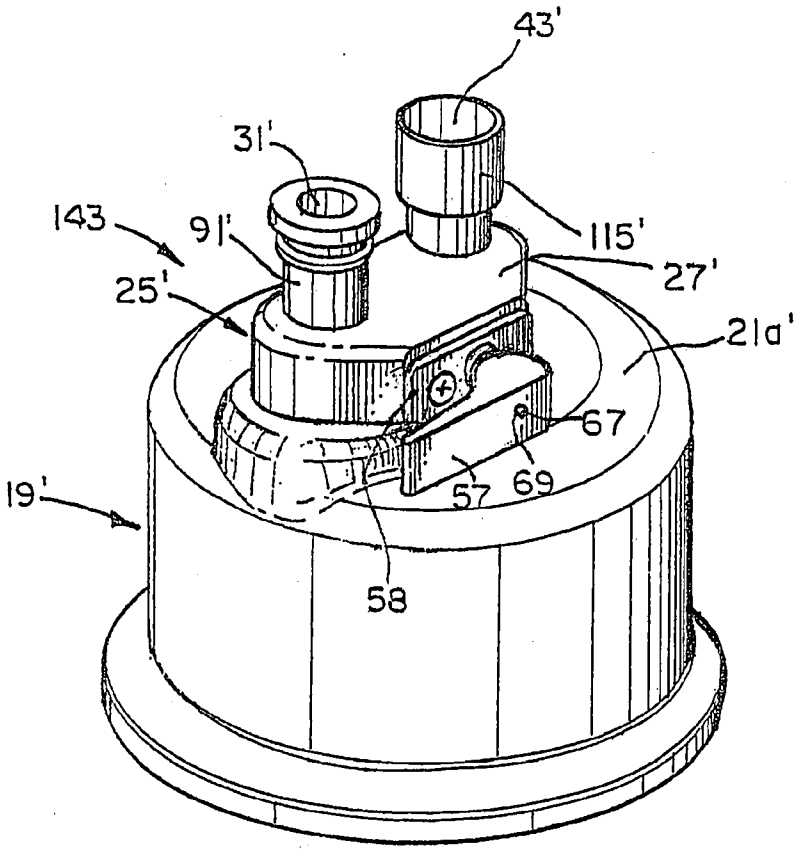


FIG. 15

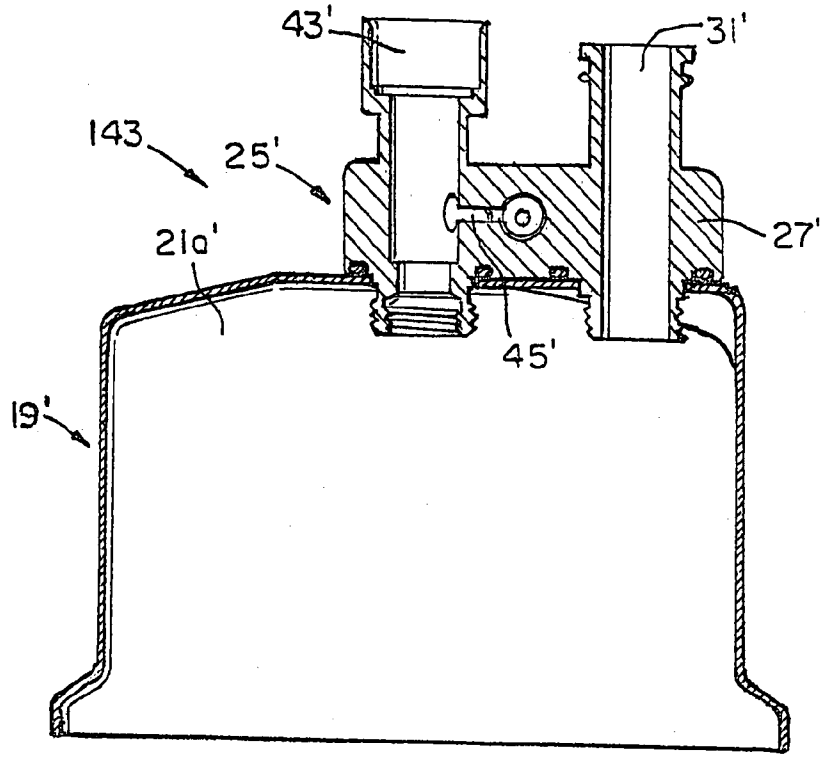

43'
31'
143
25'
27'
21a'
45'
19'

FIG. 17

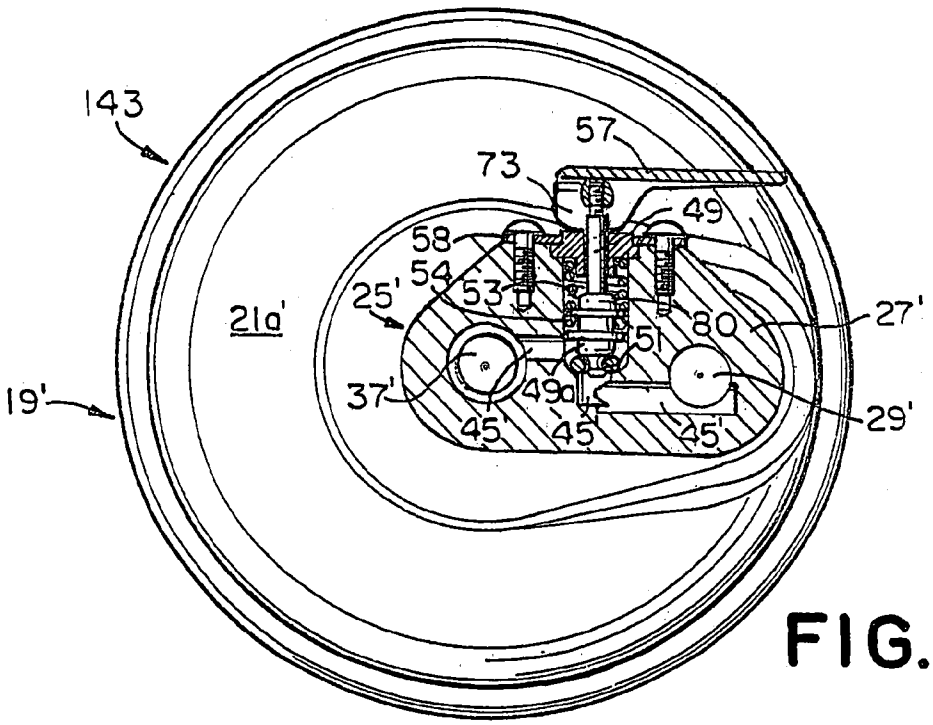

143
57
73
49
58
54
53
25'
21a'
80
27'
51
37'
49a
29'
45'
45'
45'
19'

FIG. 16

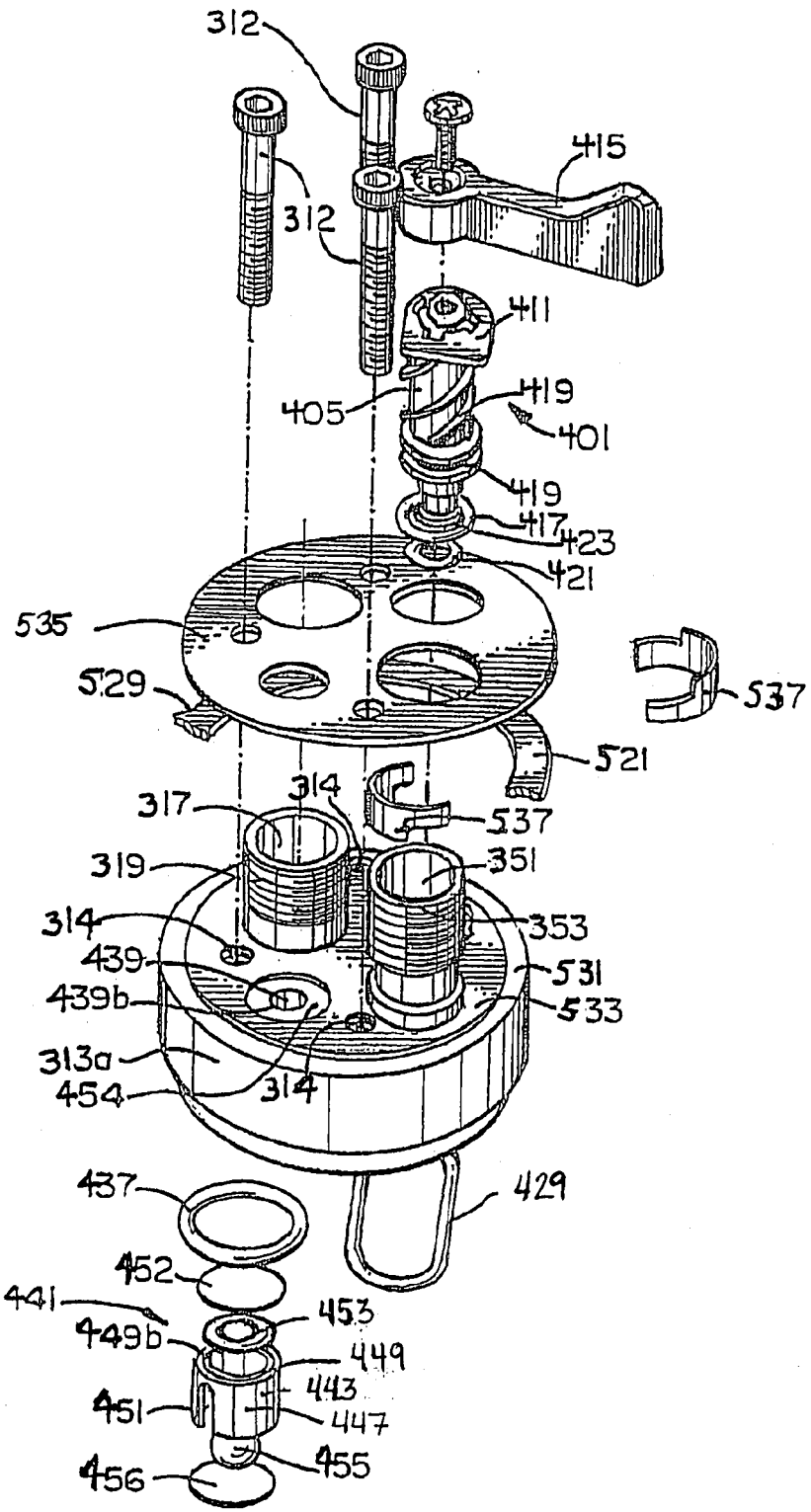

312
415
312
411
405
419
401
419
417
423
421
535
529
537
521
317
314
537
319
351
314
353
439
531
439b
533
313a
454
314
437
429
452
441
453
449b
449
443
451
447
456
455

FIG. 18

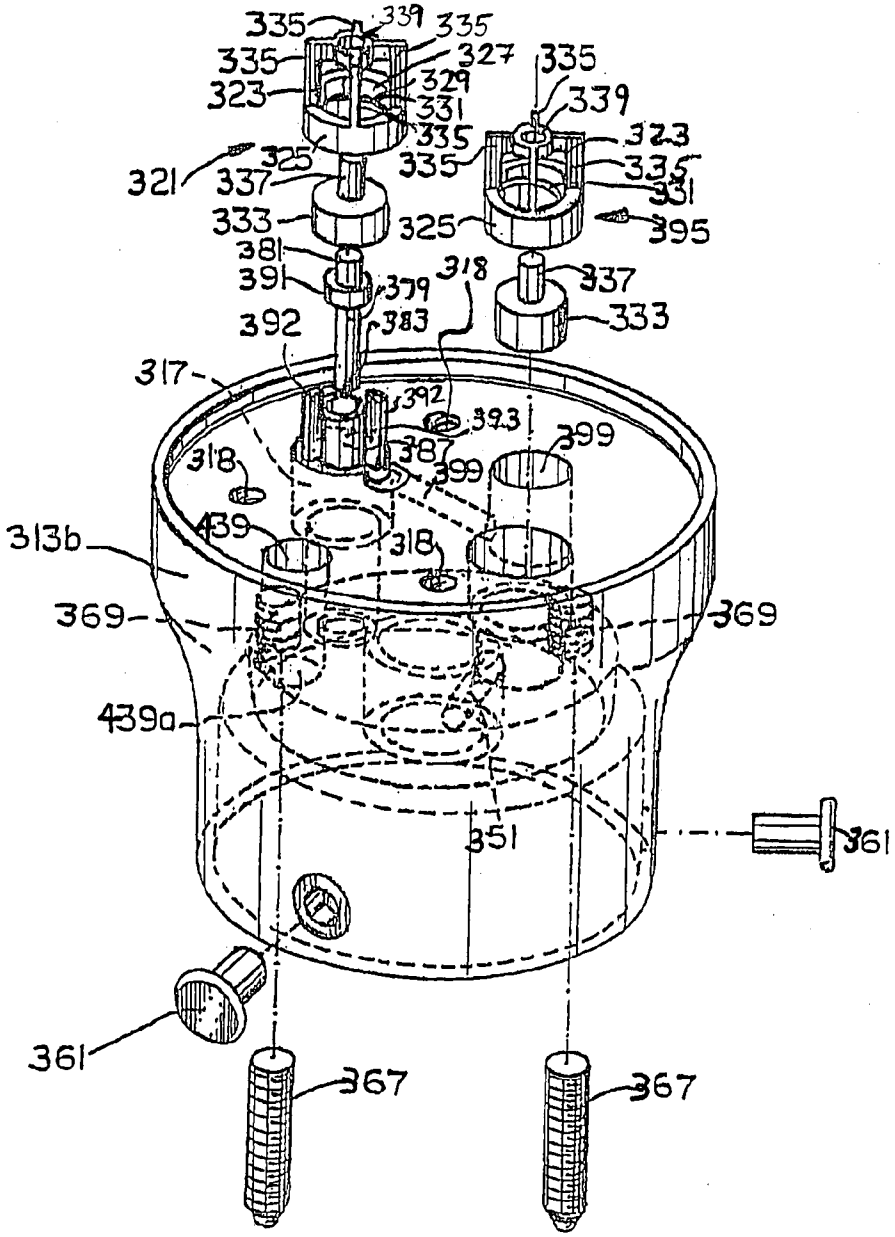

335
339
335
335
327
335
323
329
339
331
335
323
325
335
335
321
337
331
333
325
395
381
391
379
318
337
392
383
333
317
392
393
399
318
388
399
439
318
313b
369
369
439a
351
361
361
367
367

FIG. 19

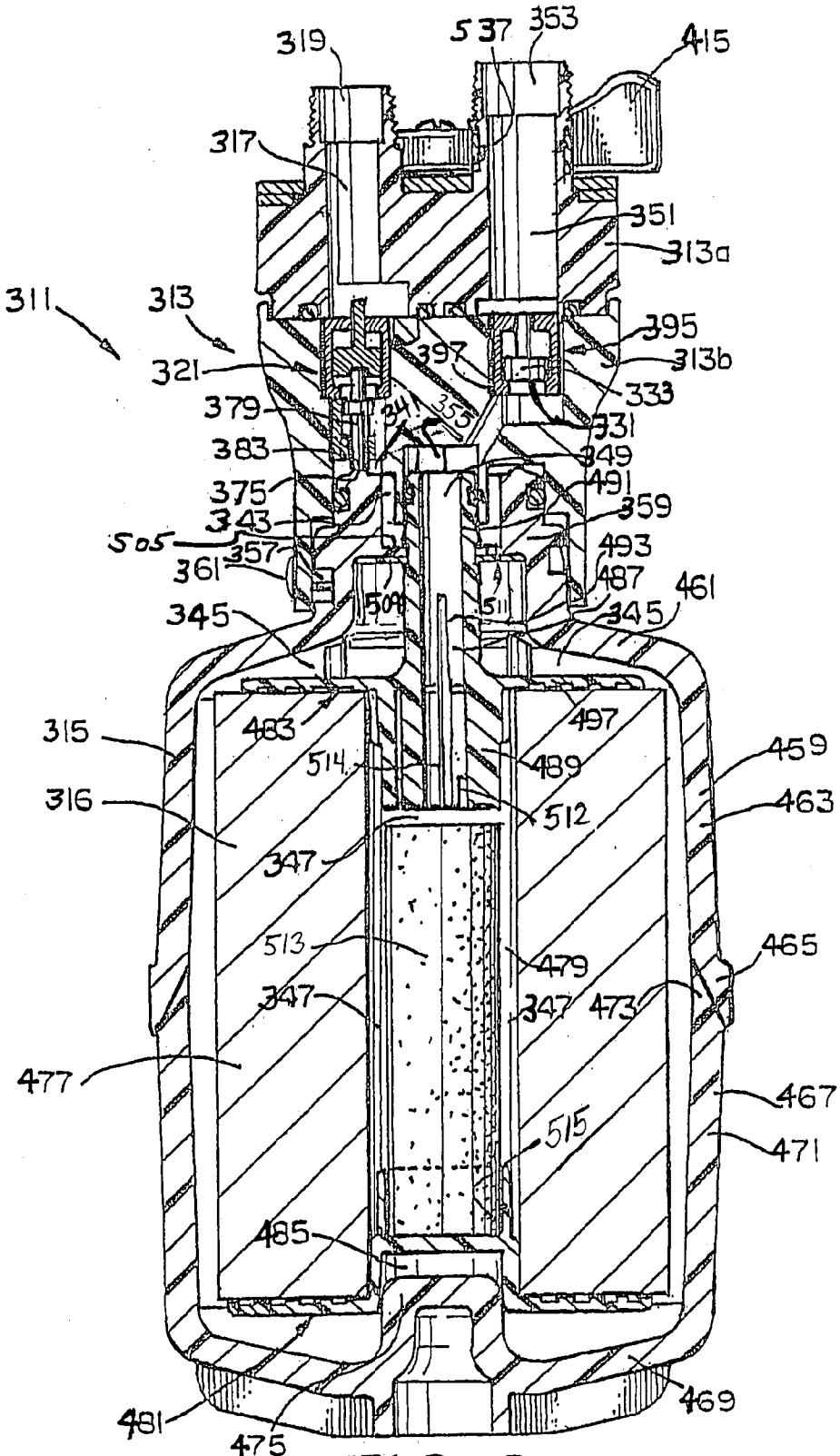

319
537
353
415
317
351
313a
311
313
395
397
313b
321
333
379
331
383
349
491
375
359
343
505
493
357
361
487
461
509
511
345
345
497
315
483
459
514
489
316
512
463
347
513
465
479
347
347
473
477
467
515
471
485
469
481
475

FIG. 21

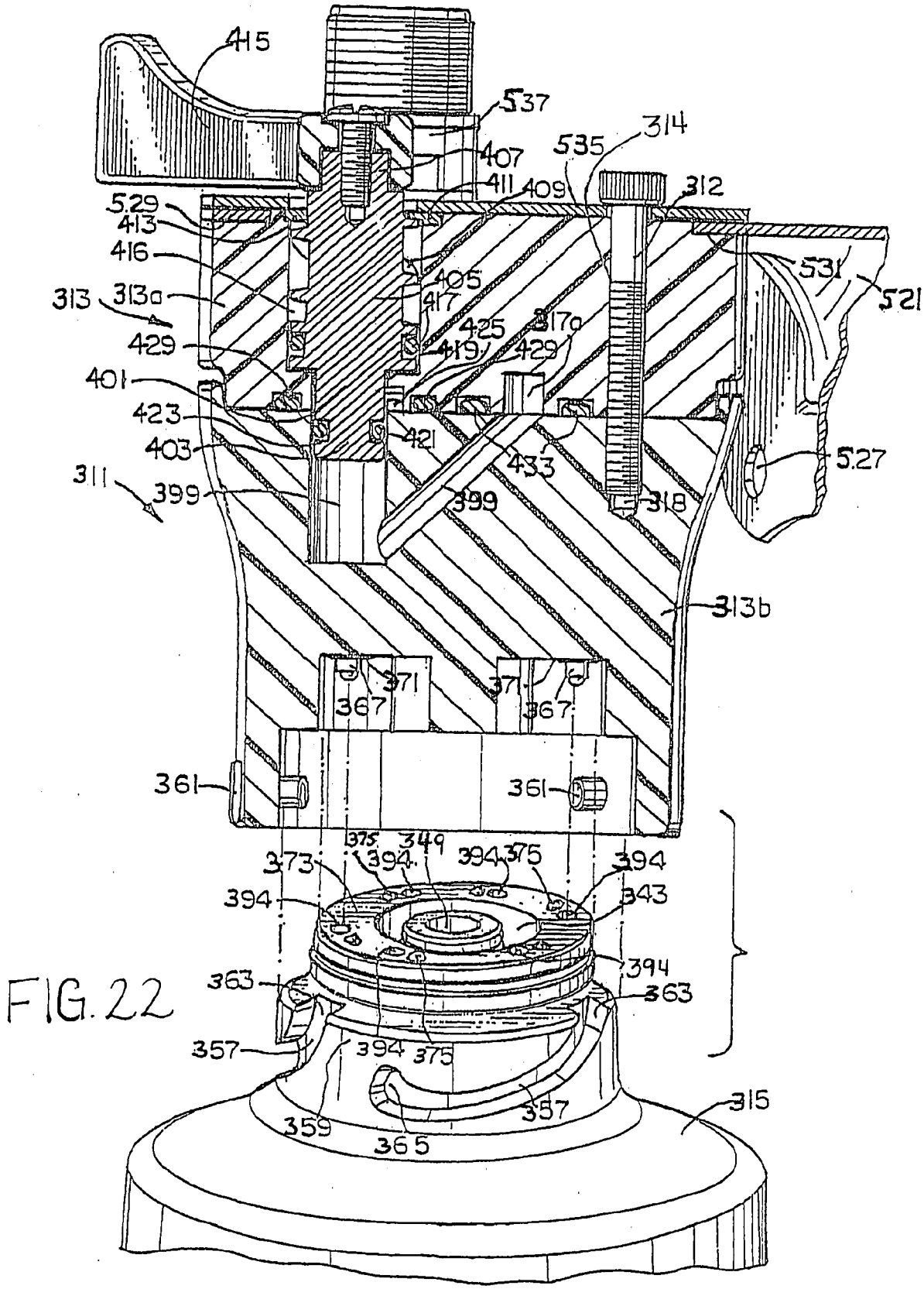

415
537
314
535
407
411
409
312
529
413
416
405
313
313a
417
425
317a
429
419
429
401
423
421
433
403
527
311
399
399
318
313b
371
371
367
367
361
361
375
349
394
394
375
373
394
394
343
394
363
363
357
394
375
357
315
359
365

FIG. 22

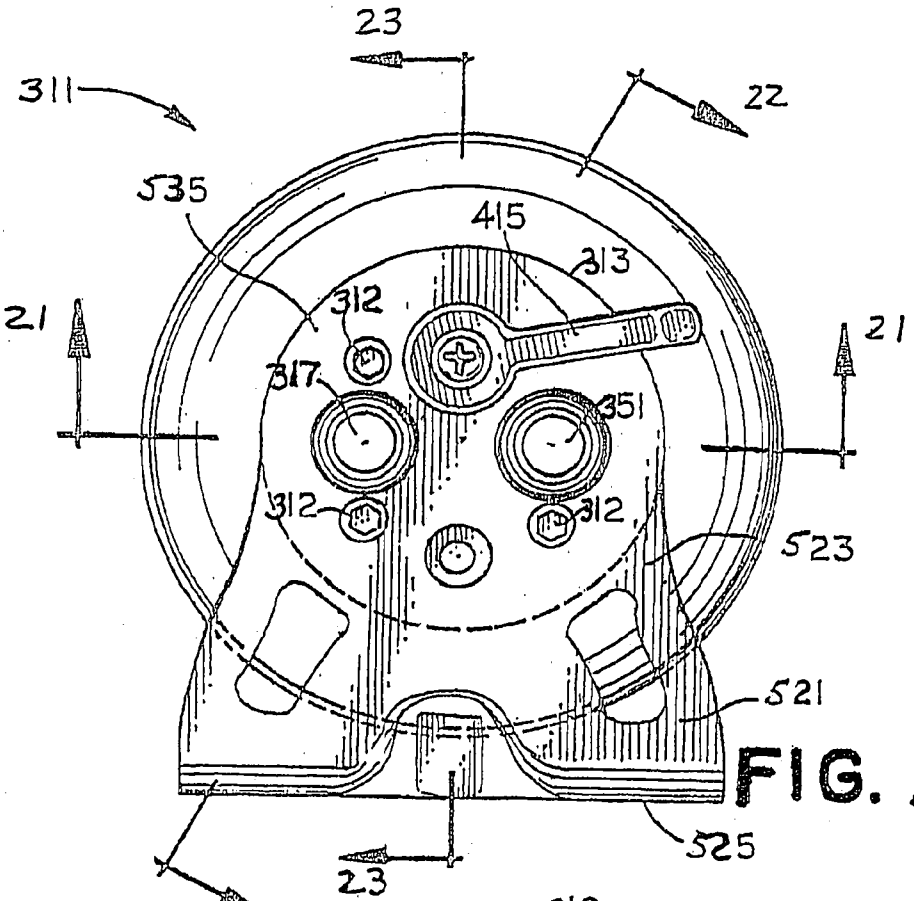

23
311
22
535
415
313
312
21
21
317
351
312
312
523
521
525
23
22

FIG. 20

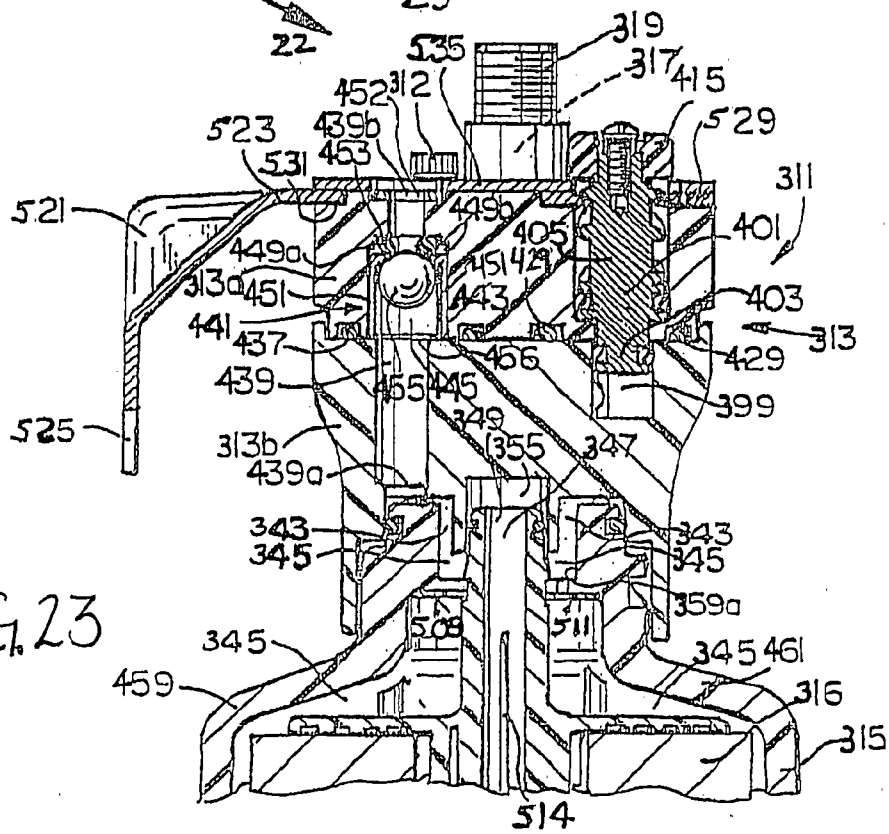

319
535
317
415
312
452
439b
453
523
529
531
311
521
449b
405
401
449a
451
429
313a
451
443
403
441
437
313
456
429
439
455
445
399
525
349
313b
355
347
439a
343
345
343
345
359a
509
511
345
345
461
459
316
315
514

FIG. 23

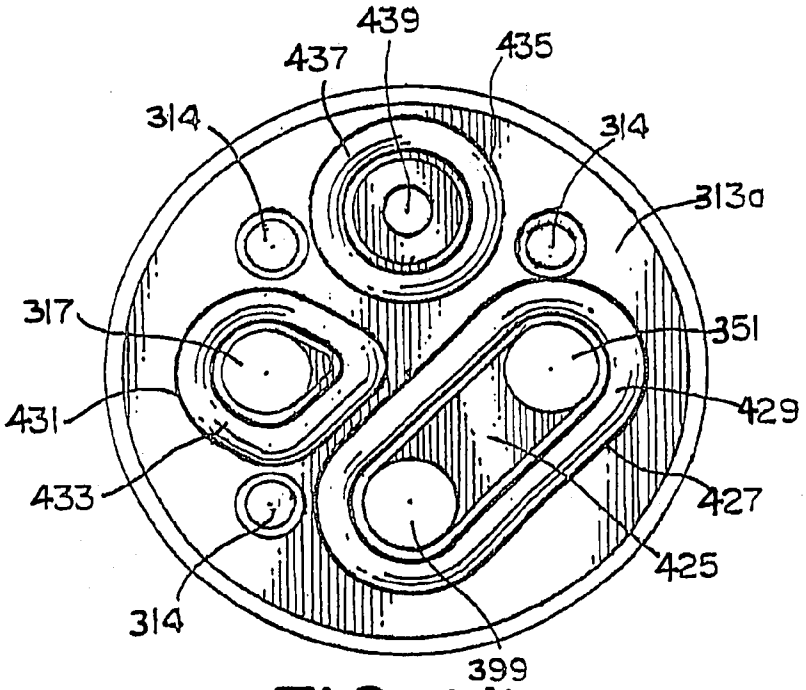

439
437
435
314
314
313a
317
351
431
429
433
427
425
314
399

FIG. 24

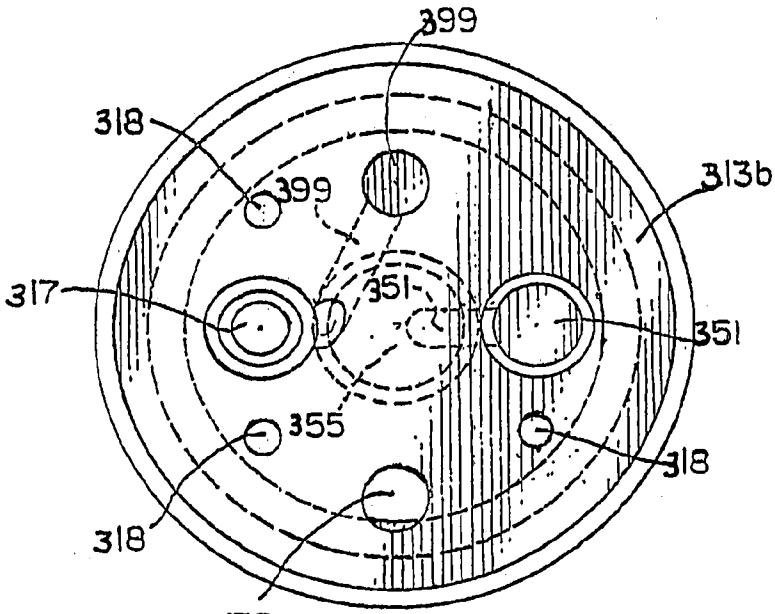
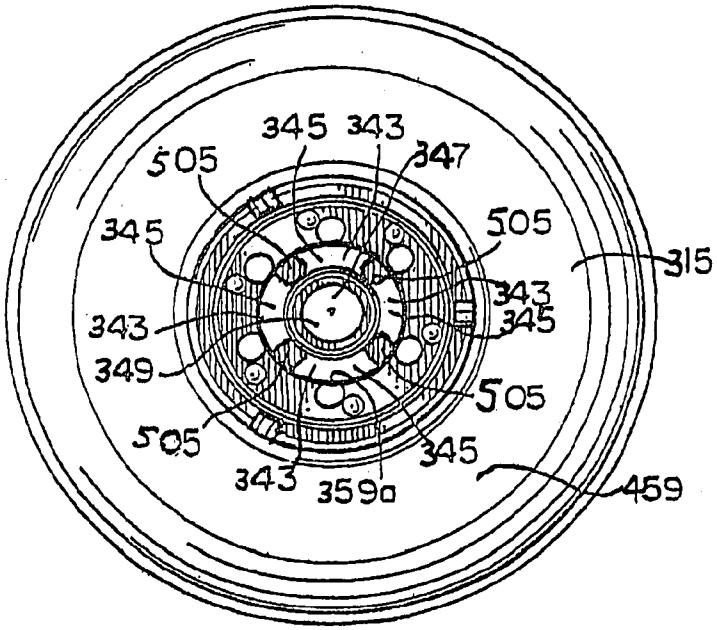

399
318
399
313b
317
351
351
355
318
318
439

FIG. 25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345
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315
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349
505
505
345
343
359a
459

FIG. 26

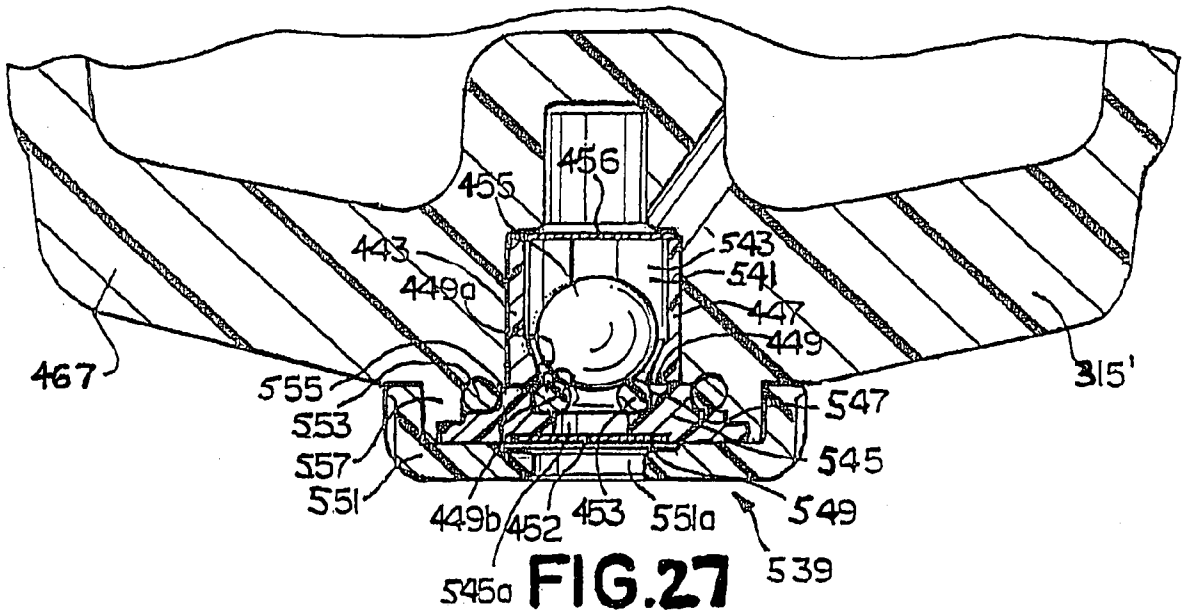

456
455
443
449a
543
541
447
449
467
555
553
557
551
547
545
549
539
315'
449b
452
453
551a
545a

FIG. 27

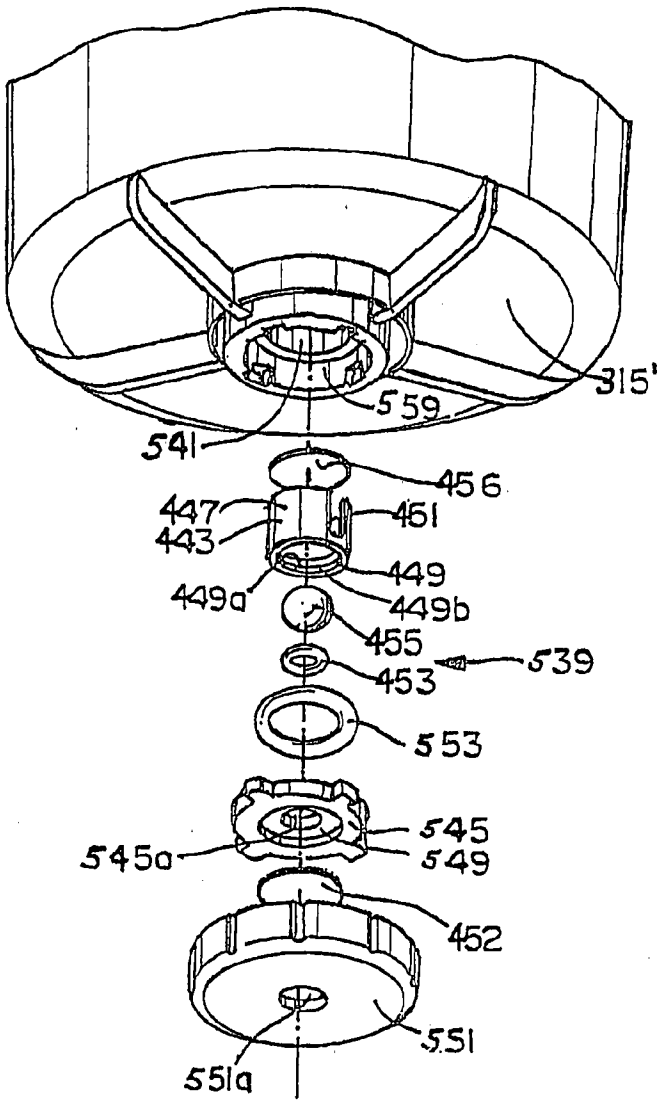
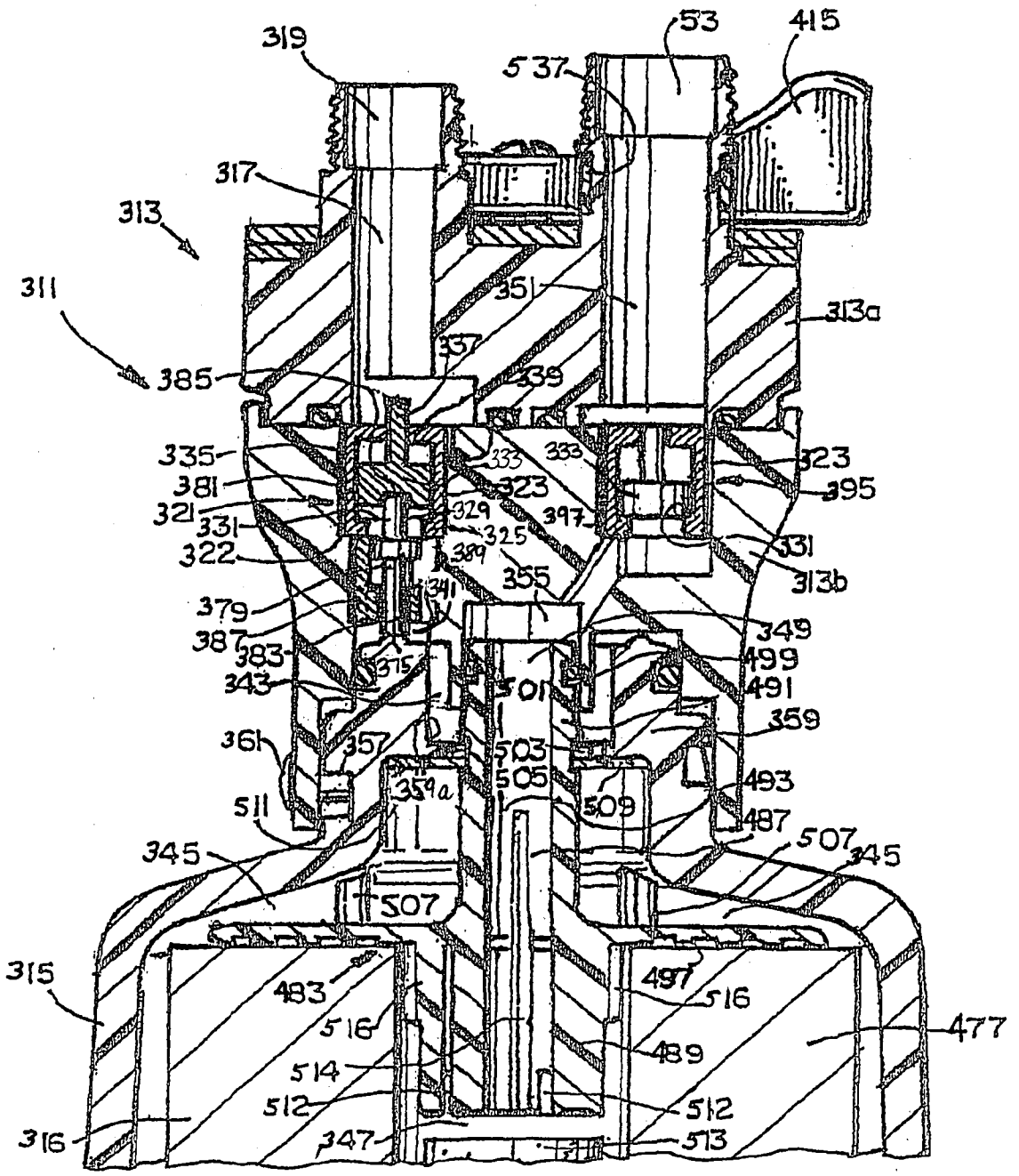

315'
559
541
456
447
443
451
449
449a
449b
455
539
453
553
545
545a
549
452
551
551a

FIG. 28

FIG. 29


319
53
415
537
317
313
311
351
313a
385
337
339
335
333
333
323
381
323
395
321
329
397
331
325
331
322
389
355
313b
379
341
349
387
383
375
499
343
501
491
359
361
357
503
505
493
359a
509
487
511
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345
345
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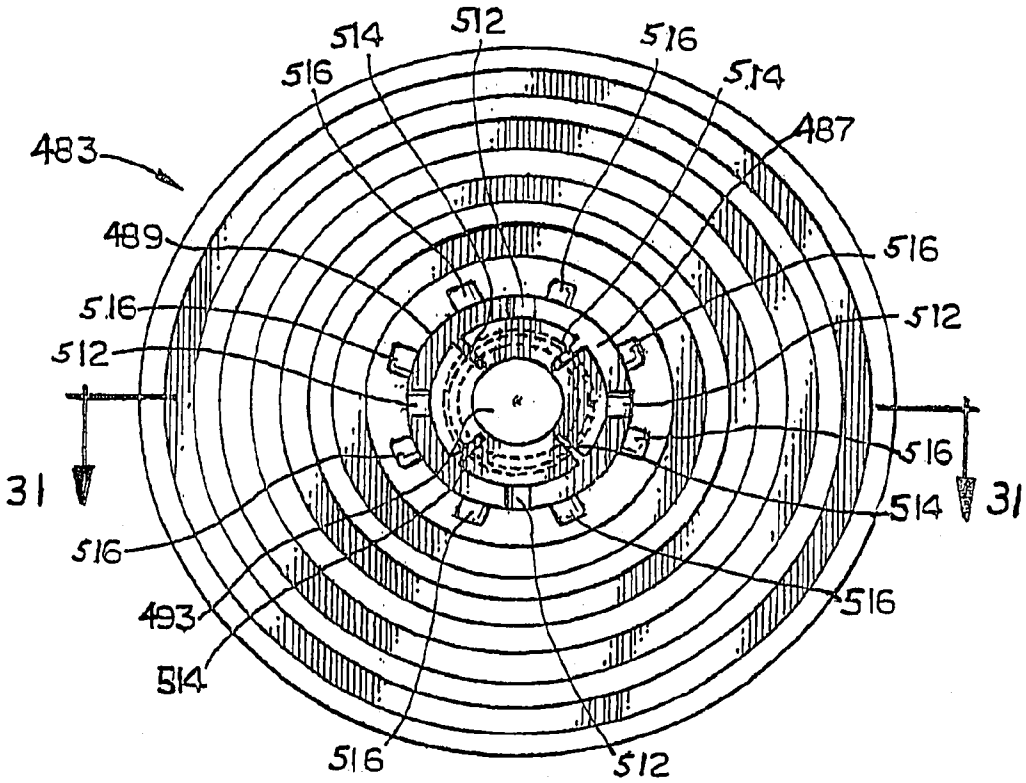
315
483
497
516
516
477
514
489
512
512
316
347
513


514
512
516
516
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487
483
489
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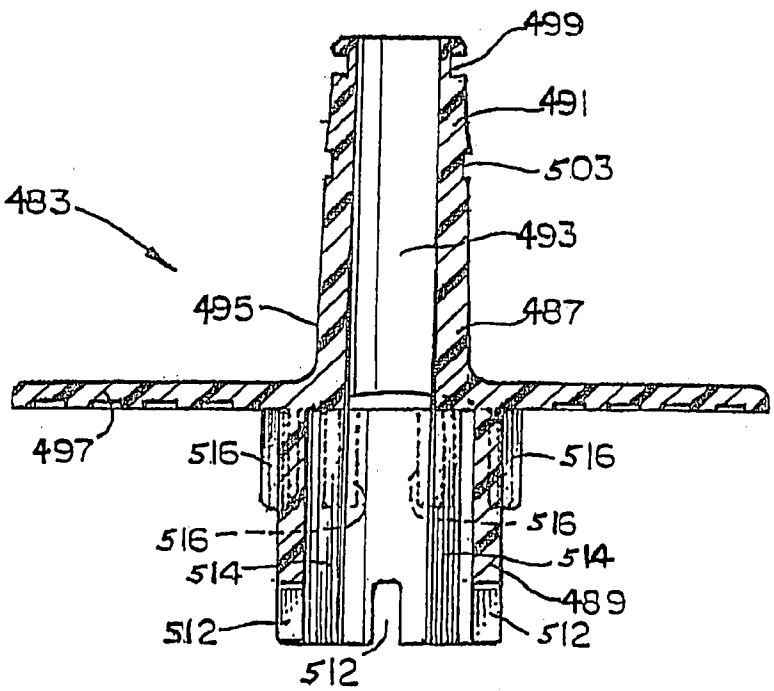
493
514
516
512

FIG. 30


499
491
503
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493
495
487
497
516
516
516
516
514
514
489
512
512
512

FIG. 31

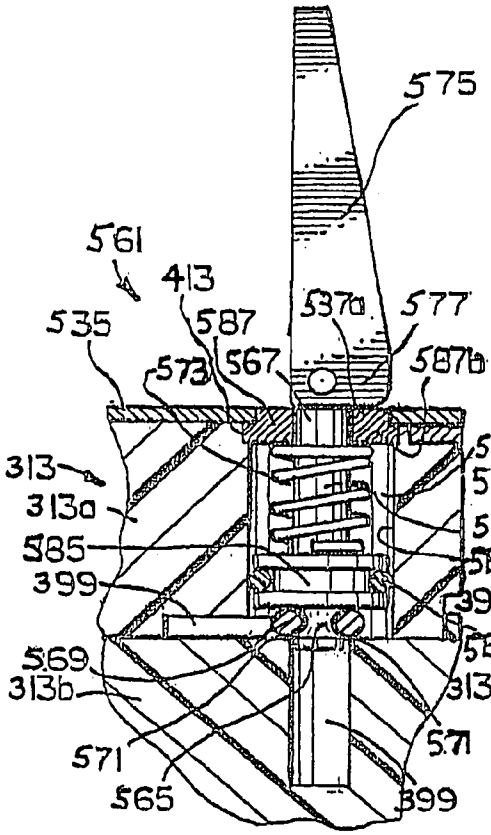
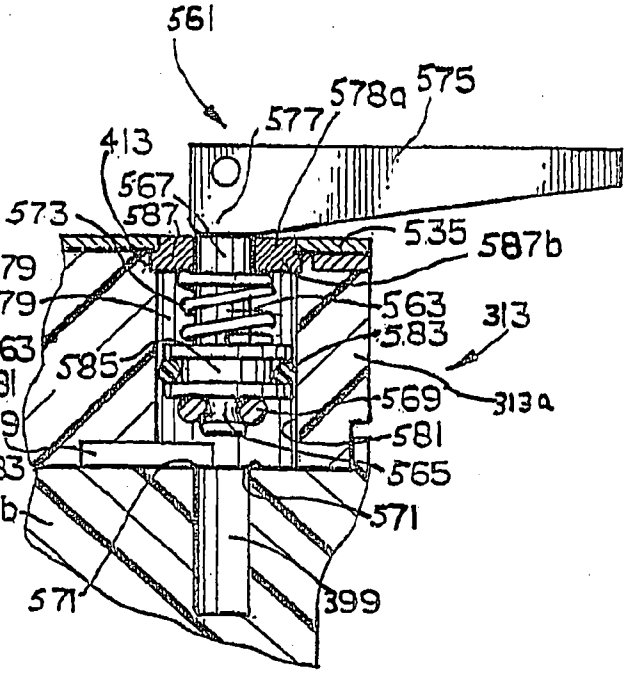

575
561
413
587
535
573
567
537a
577
587b
579
313
313a
585
563
581
399
569
313b
571
565
583

FIG. 32


561
578a
575
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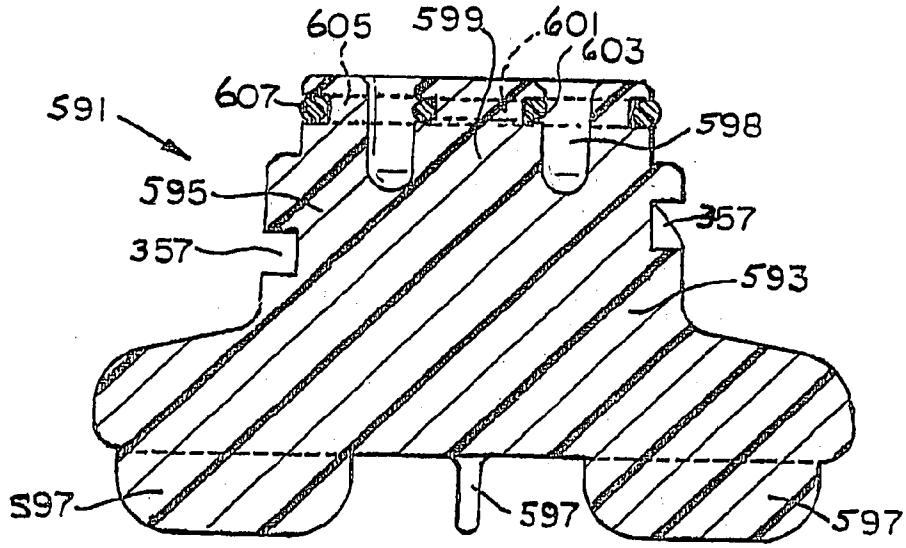
413
567
587
573
535
587b
563
583
313
585
569
313a
581
565
571
399

FIG. 33


605
599
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591
598
595
357
357
593
597
597
597

FIG. 34

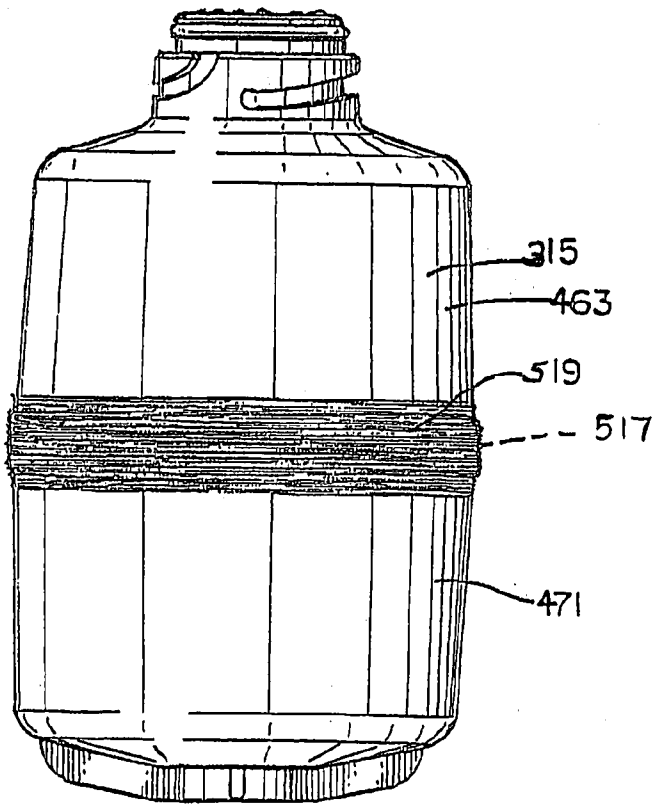
315
463
519
517
471

FIG. 35

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 10/00006

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - C02F 1/78 (2010.01)
USPC - 210/760
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC(8): C02F 1/78 (2010.01)
USPC: 210/760

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
USPC: 210/117, 650; 422/33; 510/161; 701/3
IPC(8): C02F 1/78 (2010.01)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
Electronic Databases Searched: Google Scholar; Google Patent; PubWest (US Patents full-text, US PGPubs full-text, EPO Abstracts, and JPO Abstracts) Search Terms Used: purify, condition, sanitize, solution, chlorine, potable, drinkable, liquid, fluid, remote, inlet, pump, flow, system, device, housing, body, vented, cut-out, o-ring, bypass, by

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 2001/0040121 A1 (GIORDANO et al.) 15 November 2001 (15.11.2001) entire document especially Fig. 1, Fig. 7, Fig. 9; para [0037], para [0038], para [0039], para [0040], para [0047], para [0048], para [0050], para [0051]	11-13, 16 --- 1-10, 14-15, 23-29, 33-56, 64-65
X --- Y	US 2005/0103725 A1 (PALM et al.) 19 May 2005 (19.05.2005) entire document especially Fig. 1; para [0046], para [0060], para [0062], para [0063], para [0064]	17-20, 30-32 --- 1-10, 21-29, 33-34, 64-65
Y	US 2004/0104157 A1 (BEEMAN et al.) 03 June 2004 (03.06.2004) Fig. 1; para [0052]	9, 14-15, 21-22, 26, 29
Y	US 4,268,383 A (TROBAUGH) 19 May 1981 (19.05.1981) Fig. 1; col 3, ln 43-65	35-56, 64-65
Y	US 4,241,770 A (ROBERTSON) 30 December 1980 (30.12.1980) Fig. 3; col 3, ln 41 to col 4, ln 63	40, 50, 55-56
Y	US 6,193,884 B1 (MAGNUSSON et al.) 27 February 2001 (27.02.2001) Fig. 1; col 3, ln 20-64	42, 44
Y	US 2005/0167352 A1 (BURROWS et al.) 04 August 2005 (04.08.2005) Fig. 1, Fig. 6; para [0033], para [0034], para [0048]	43, 48
Y	US 7,410,581 B2 (ARNOLD et al.) 12 August 2008 (12.08.2008) Fig.14; para [0040]	45-46
Y	US 4,585,400 A (MILLER) 29 April 1986 (29.04.1986) Fig. 2; col 5, ln 30-59	47-48

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
14 May 2010 (14.05.2010)	24 MAY 2010
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 10/00006

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 7,238,278 B2 (COFFEY et al.) 03 July 2007 (03.07.2007) Fig. 2; col 5, ln 30-59	49
Y	US 5,439,174 A (SWEET) 08 August 1995 (08.08.1995) Fig. 1; col 4, ln 2-8	51
Y	US 2001/0045380 A1 (KHAN) 29 November 2001 (29.11.2001) Fig. 6; para [0037], para [0039]	44

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 10/00006

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

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

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

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

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

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

This International Searching Authority found multiple inventions in this international application, as follows:
This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees must be paid.

Group I: claims 1-56 and 64-65 directed to a system including a bypass apparatus in line with a filter apparatus as well as the associated method of operating the bypass to flush and sanitize the line (Claims 1-34); and a valve head (similar to the bypass apparatus above) in conjunction with a pressure vessel (similar to the filter apparatus above) as well as the associated method of operation (Claims 35-56 and 64-65).

Group II: claims 57-61 directed to a pressure vessel for filtering and/or conditioning and/or purifying a fluid.

Group III: claims 62-63 directed to an automatic air vent valving apparatus.

Group IV: claims 66-67 directed to method for providing filtered and/or conditioned and/or purified water in an aircraft. . --continued

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.

2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.

3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☒ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:
1-56 and 64-65

Remark on Protest

☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

☒ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 10/00006

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

The inventions listed as Groups I - IVdo not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons:

The invention of Group I does not recite the pressure vessel as required by Group II; the automatic air vent valving apparatus as required by Group III or the purified water in an aircraft as required by Group IV. The invention of Group II does not recite the bypass apparatus in line with a filter apparatus as well as the associated method of operating the bypass to flush and sanitize the line as required by Group I; the automatic air vent valving apparatus as required by Group III or the purified water in an aircraft as required by Group IV. . The invention of Group III does not recite the bypass apparatus in line with a filter apparatus as well as the associated method of operating the bypass to flush and sanitize the line as required by Group I; the pressure vessel as required by Group II; or the purified water in an aircraft as required by Group IV. The invention of Group IV does not recite the bypass apparatus in line with a filter apparatus as well as the associated method of operating the bypass to flush and sanitize the line as required by Group I; the pressure vessel as required by Group II or the the automatic air vent valving apparatus as required by Group III.

Groups I-IV share the technical feature of filtering and/or conditioning and/or purifying a fluid using one or more valves However, this shared technical feature does not represent a contribution over the prior art of US 4,784,763 A to Hambleton et al. (15 November 1988), which teaches filtering and/or conditioning and/or purifying a fluid (abstract and col 1, ln 42-55) using a pressure vessel (col 4, ln 8-18) and check valves (col 2, ln 31-42). As the above filtering and/or conditioning and/or purifying a fluid was known at the time, as evidenced by the teaching of Hambleton, this cannot be considered a special technical feature that would otherwise unify the groups.

Groups I-IV therefore lack unity under PCT Rule 13 because they do not share a same or corresponding special technical feature.