

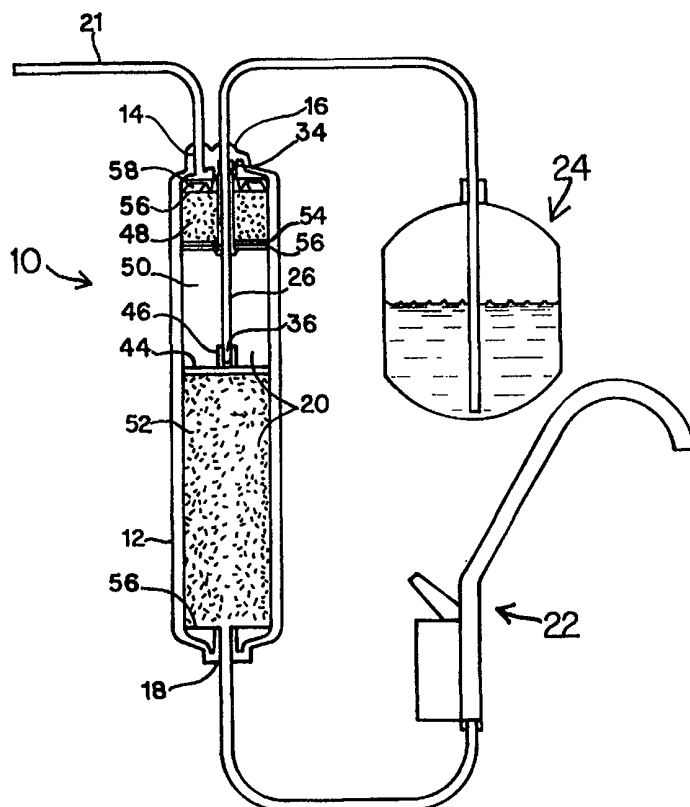


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(54) Title: WATER FILTRATION APPARATUS**(57) Abstract**

Embodiments of a method and filter apparatus (10) for filtering and/or treating water are shown and described, each embodiment being for multiple-stage processing of water or other liquid, with storage intermediate between the stages. Preferably, water is passed through a first zone (28) of a filter housing cavity and conducted through an intermediate port (16) to storage (24). When water is demanded by a usage device (22), water flows in reverse from storage back into the filter (10), to flow through the second zone (42) for a second stage of filtering/treatment, and then preferably out an outlet port (18) to the usage device. Water may also flow from the water source directly through the first and second zones (28, 42) and to the usage device (22), without intermediate storage. Preferably, both first and second zones are contained and axially arranged within a single filter housing (12). Preferably, water flows bi-directionally through a central return tube (26, 26''), or other axial passage (26') through the first zone media that connects to a combined outlet-inlet intermediate port (16) in or near the housing top wall, so that this tube or axial passage may be used as the collector for the first zone effluent and also the distributor for the second zone feed. Alternatively, a side-wall combined outlet-inlet intermediate port (16') may be used to conduct the inter-zone liquid to and from storage.



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WATER FILTRATION APPARATUS

DESCRIPTION

BACKGROUND OF THE INVENTIONField of the Invention

This invention relates generally to water filter or treatment systems, and, more specifically, to systems including intermediate storage for filtered or treated water.

Related Art

Conventional filter systems permit water to flow in a single pass through filter or treatment media to a storage tank, water tap, or other usage device. When additional filtering of stored water is desired to remove contamination or biocides immediately before use, conventional systems typically require multiple filter canisters and complicated valving and piping.

Reid (U.S. Patent 5,248,417) discloses a double-flow-through system using a single filter housing. In this system, water flows through a single bed of filter media and then through a combination outlet-inlet port to a storage tank. When a tap or faucet is opened, the stored water flows back through the combination port into the filter housing to flow again through the filter media bed and then out to the tap. Thus, the Reid '417 system provides two passes through a single bed of filter media, with intermediate storage between the two passes.

The Reid '417 apparatus includes a pair of check valves to control flow to and from the combination port, and, thus, to and from storage. When the water tap is closed, unfiltered water enters the upper portion of the filter housing through the inlet port and is prevented by a cup-type check valve from flowing directly to the combination outlet-inlet port. The water passes a first time through the media and flows up through a filter tube to the combination port. A slit-type check valve disposed at the top of the filter tube prevents water from flowing from the combination port back into the filter tube. Once the water tap is opened, the cup-style check valve allows water to flow from storage through the combination port, through the cup check valve into the top portion of the filter housing, through the media a second time, and then to the tap.

Reid (U.S. Patent 5,232,590) discloses a water filtration apparatus with an internal by-pass for conducting water from a water source to a storage tank without passing through the filter media. When the tap or faucet is opened, water then flows back from the storage tank into the filter housing, through the filter media, out the outlet port, and out of the faucet.

Grayson, et al. (U.S. Patent 5,082,557) discloses a filter control head for directing water to various locations. The control head can direct water to a first filter canister, to a drain, and to a storage tank. When a downstream usage device demands water, purified water may then flow from the storage tank, back to the control head, and then to a separate, second filter canister and a downstream usage device.

SUMMARY OF THE INVENTION

An object of the present invention is to provide an economical system with at least two stages of filtration or treatment and with intermediate storage. The invention features a "split-flow" scheme in which inter-stage liquid is split off to intermediate storage and then subsequently returned to a later stage of processing, preferably in the same filter housing, combined with liquid flowing through the first stage of processing. Another object of the invention is to provide an apparatus wherein the first and second filtration/treatment zones are both contained in a single filter housing. Another object of the invention is to provide a system having two or more filtration zones that each may be operated at differing flowrates.

The present invention comprises a filter housing comprising first and second filtering zones in series, and removal means and return means for conducting liquid to and from

storage in between the zones. Separate, intermediate outlet and inlet ports may extend through the housing wall, or, preferably, a single, intermediate combined outlet-inlet port may accommodate flow in both the outward (to storage) and the inward (from storage) directions.

5 In a preferred embodiment, the intermediate outlet and inlet ports is combined into a single port, which is in fluid communication with an elongated filter tube extending through the first zone. The bottom of the filter tube is located near the bottom of the first zone and near the top of the second zone. Therefore, the filter tube collects water after passage through the first zone and allows it to flow out of the intermediate port to storage. Upon opening of a
10 tap, which is in fluid communication with the outlet of the second zone, the stored water flows back into the intermediate port and into the filter tube, out of the bottom of the filter tube, through the second zone, and through an outlet port to the water tap.

Each of the multiple zones of the present invention may include one or more beds or layers comprising filter media, treatment media, or void space. In a preferred embodiment,
15 the first zone comprises both anti-bacterial treatment with an iodinated resin and extended contact between bacteria and the iodide/iodine species in a void chamber. In this preferred embodiment, the intermediate storage provides additional contact time between biocide and bacteria, and the second zone filters the water and removes the biocide from the water immediately before use. The structural configurations of the zones may be designed for either
20 axial flow, radial flow, or both types of flow distribution.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a cross-sectional side view of one embodiment of the invention having axial-
25 flow first and second filtration zones.

Fig. 2A is a schematic cross-sectional side view of the embodiment of Fig. 1, showing liquid flow when the tap is closed and the storage tank is filling.

Fig. 2B is a schematic cross-sectional side view of the embodiment of Fig. 2A, showing liquid flow when the tap is open and the storage tank contains liquid.

30 Fig. 2C is a schematic cross-sectional side view of the embodiment of Fig. 2A, showing liquid flow when the tap is open and the storage tank is empty.

Fig. 3A is a schematic cross-sectional side view of an alternative embodiment of the invention having radial-flow first and second filtration zones, showing liquid flow when the tap is closed and the storage tank is filling.

Fig. 3B is a schematic cross-sectional side view of the embodiment of Fig. 3A, showing liquid flow when the tap is open and the storage tank contains liquid.

Fig. 3C is schematic cross-sectional side view of an alternative radial-flow embodiment of the invention, wherein a liquid-permeable elongated return tube is included in the first zone to create a media axial passage. Fig. 3C shows liquid flow when the tap is open and the storage tank contains liquid.

Fig. 4 is a schematic cross-sectional side view of an alternative embodiment of the invention, having a combined outlet-inlet intermediate port located part of the way down the filter housing sidewall, and showing liquid flow when the tap is open and the storage tank contains liquid.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring to the Figures, there are shown several, but not the only, embodiments of the invented split-flow water filtration apparatus, which is herein called a "filter" but which may include adaptations for filtration, treatment, and other forms of component removal and addition from/to liquid. In Figure 1, there is shown the preferred embodiment, including a central return tube that both collects water after the first stage of filtration and distributes water to the second stage of filtration.

Filter 10 comprises a filter housing 12 with inlet port 14, intermediate port 16, and outlet port 18. The housing 12 is a generally cylindrical shape with an interior cavity 20 for holding filter or treatment media. The inlet port 14 and intermediate port 16 extend through a first wall, preferably the top wall 15 of the housing 12, and the outlet port 18 extends through a second wall, preferably the bottom wall 19 of the housing 12. The inlet port 14 is in fluid communication with a water source 21 and the outlet port 18 is in fluid communication with a water usage device, such as a tap 22.

The intermediate port 16 is connected to and in fluid communication with storage tank 24. Associated with storage tank 24 is a pressurizing means, for pressurizing or

pumping liquid back to the filter 10 when the tap 22 is opened. The pressurizing means may be apparatus to pressurize the tank, pressurize a bladder, or to pump liquid.

The central return tube 26, which in Figure 1 has a non-perforated side wall, extends down through the first zone 28 of the filter 10 and is in fluid communication with the intermediate port 16. The top end 30 of the return tube 26 may be sealed in the filter head by one or more o-rings 34. The bottom end 36 of the return tube 26 extends to the bottom 38 of the first zone 28 and to near the top 40 of the second zone 42. The tube bottom end 36 is held in the center of the cavity 20 by a retaining means, which is preferably a radially-disposed support disk 44 having a tube retainer 46 at the center of the disk 44 for connection to the tube bottom end 36.

The first zone 28 comprises a first bed 48 of resin followed by a dwell chamber 50, which is a void space not containing any filter or treatment media. The second zone 42 is a filter bed 52, containing a filter media such as activated carbon. Resin bed 48, dwell chamber 50, and filter bed 52 are separated/supported by support disks 54 and felt 56. The resin bed 48 is held in compaction by a spring disk 58, and the filter bed 52 is supported by felt 56 on top of the bottom interior surface of the housing 12. Disks 54, felt 56, and spring disk 58 support and/or separate the media beds while letting fluid pass from one bed or zone to the next, as is well-known in the art of filters.

The preferred embodiment of Fig. 1 is designed for anti-bacterial treatment with an iodinated resin, followed by residence time in the dwell chamber 50 for extended contact between bacteria and the iodide/iodine species in the water for a high percentage of bacteria destruction. The dwell chamber 50, which is preferably empty except for the water being treated, maximizes residence time for a given volume of filter housing, as is disclosed in Hughes (U.S Patent 5,407,573). The storage tank 24 provides additional contact time, and the second zone 42 filters and removes biocide from the water immediately before use.

In use, when the tap 22 is closed, water or other fluid from the source enters the filter 10 through inlet port 14 and flows axially down through the first bed 48 and into the dwell chamber 50. From the dwell chamber 50, the water flows up through the central return tube 26 to the intermediate port 16 and to the storage tank 24. This first stage filtration flow scheme, shown schematically in Figure 2A, continues until the storage tank 24 is full or until the tap 22 is opened to demand water for use. When the storage tank 24 is full and the tap is

closed, water flow stops unless the system is fitted with an optional drain for maintaining a small flow through one or more of the filter zones.

When the tap 22 is opened, as shown in Figure 2B, water flows in the reverse direction from the storage tank 24, enters the tube top opening 25, flows axially down through the tube 26 and out the tube bottom opening 64, through the second zone 42, and out the outlet port 18. In most designs, when the tap is open, some water also flows from the inlet port 14, down through both the first zone 28 and second zone 42, and out the outlet port 18. When the tap 22 is open but the storage tank 24 is empty, as shown in Figure 2C, water continues to flow from the inlet port 14 through both zones 28, 42 and out the outlet port 18.

The split-flow filter 10 system allows the flowrates through the first zone 28 and second zone 42 to be different. The flowrates through the first and second zones are determined by the pressures of the water source and storage tank, the various pressure drops through the system, etc., as is known in filter design and fluid mechanics. Thus, when the tap 22 is open and the water flowing to the tap is a combination of water from storage 24 and water that has come from the inlet port 14 directly through the two zones, the relative proportions of these two water types is also a function of tank pressure, source pressure, pressure drop, etc. In the preferred system, the flow of water from storage 24 through the second zone 42 to the tap 22 is relatively fast compared to the flow of water either through the first zone 28 to storage 24 or through the first zone 28, second zone 42, and tap 22.

In Figures 1 and 2A-C, the first zone 28 is portrayed as having a central return tube 26 with a non-liquid-permeable side wall. This non-permeable return tube is one example of a support structure defining an axial passage through the first zone 28.

Alternative embodiments may have other means for creating an internal axial passage through the first zone media. For example, a solid media may have an internal media cavity defined by the media inside diameter and running axially through the media. Such an embodiment is depicted in the radial-flow filter 100 of Figs. 3A and 3B. In such a solid media embodiment, a separate support structure at the media's inside diameter is normally unnecessary. Alternatively, another structure for creating an axial passage through media is a perforated, slotted, or otherwise liquid permeable central return tube (such as shown in the filter 110 of Figure 3C) that holds the media in place but allows radial-flow of liquid through

the media and through the wall of the return tube. Such a return tube may be used for granular media in the first and/or second.

In the radial-flow filter embodiment 100 of Fig. 3A, unfiltered water enters the inlet port 14, flows radially through the first zone 28', flows out from the inside diameter 62 of the media into the media cavity 26', and flows up to the intermediate port 16 and to storage 24. When the tap 22 is opened, as in Fig. 3B, the stored water flows back into the intermediate port 16, down through the media cavity 26', out the bottom 64' of the cavity 26', and to the second zone 42'. In the second zone 42', the water flows radially into the second zone media cavity 60 formed by the inside diameter of the radial flow media, to the outlet port 18, and to the tap 22.

Included in the filter embodiment 100 portrayed in Fig. 3A and B is a sealing means resting on top of the media, for sealing the media to the tube 69 that extends through the intermediate port 16. The sealing member 70 has a plate covering the top end surface of the media and one or more o-rings for creating a seal between the member 70 and the tube 69. Alternatively, a sealing member may be designed to seal the media to the head of the filter at the intermediate port 16. Such an alternative embodiment includes a plate for covering the media, and a cylindrical extension upending to contact and seal with the intermediate port by the use of o-rings encircling the upper end of the cylindrical extension.

A sealing means is preferably located on the top end surface of the second zone media. The sealing means may be an end plate 72 that prevents water from entering media cavity 60 from the top. Both end plate 72 and the first zone sealing member 70 may be attached to media by, for example, hot gluing.

Therefore, in both axial-flow and radial flow embodiments, the first and second zones are in series-flow liquid communication, wherein the effluent of the first zone flows directly, or by way of storage, to the inlet of the second zone. The first zone inlet may be either the top end 63 of a axial-flow bed or the outer annular surface 65 of a radial-flow bed. The first zone outlet may be either the bottom end 38 of an axial-flow bed or the inner annular surface 66 of a radial-flow bed. The inlet and outlet of an axial-flow second zone are at the top end 40 and bottom end 67 of the zone, respectively. The inlet and outlet of a radial-flow second zone are the outer annular and inner annular surfaces, respectively. Therefore, by saying the central return tube bottom opening 64 or the bottom 64' of the media cavity is "near the

second zone inlet", it is meant that the bottom opening 64 or cavity bottom 64' may either be near the top end of an axial-flow bed (so that the first zone effluent flows axially down into the second zone) or near the top end of a radial-flow bed (so that the first zone effluent flows down to the annular feed 68 space and then radially into the second zone). Thus, the return tube bottom 64 or cavity bottom 64' is in fluid communication with the second zone inlet, whether the second zone is axial or radial.

Optionally, the present invention may include an adjustment means for shortening the length of the central return tube 26, 26", in order to adjust the location of the first and second zones in the filter cavity and change the portions of cavity used as first and second zones. In an axial-flow filter, for example, shortening or lengthening the return tube 26 changes the location of the first zone outlet and second zone inlet, and allows the filter cavity to be loaded with different volumes of first and second zone media.

Figure 4 illustrates another alternate filter embodiment 200, in which the combined outlet-inlet intermediate port 16' is located in a third wall of the housing 12', that is, the sidewall of the preferably cylindrical housing 12'. In this embodiment, water flows through the first zone 28'' and to storage through the intermediate port 16', which is located near the bottom of the first zone 28''. When the tap 22 demands water, the stored water returns to the filter through the intermediate port 16', and flows through the second zone 42'' to the tap 22. As in the other embodiments, the pressure balance at the various locations through the system would control the flows through the first zone 28'', intermediate port 16', and second zone 42'' of this filter and would control the ratio of storage water/ first-zone-water flowing to the second zone and out to the tap.

The invention preferably has only two zones with adaptation for flow out and in between the two zones, preferably via a single combined outlet-inlet port. Alternatively, the invention may include more than two stages, with removal and return of the liquid intermediate between all or some of the stages. Each removal and return of liquid between stages preferably is done via a combined (single) intermediate port located in each inter-zone area, rather than via separate outlet port and inlet port structures in each of the inter-zone areas. Thus, preferably, the stages of filtration/treatment are accomplished in zones with combined outlet-inlet intermediate ports that are all contained in a single filter housing, and, preferably, only a single pipe extends out from each combined outlet-inlet intermediate port.

The preferred embodiments, with their minimized vessel, piping and valving requirements, are therefore economical and efficient in structure, use, and installation.

The plurality of zones in the filter housing may all be axial-flow, as illustrated in Figure 1, may all be radial flow, as illustrated in Figure 3 A, B and C, or some may be axial-flow and some may be radial. Conventional aspects of filter design, such as retainer disks, felt, o-rings, port connections, housing shape, etc., may be varied according to known filter art and still be within the scope of this invention.

The configuration of the filtering/treatment zones may be changed to accommodate various types of filter or treatment media. For example, desirable first zone media may include biocide resins, ion exchange resins for softening, demineralizing, desilicizing, or disinfecting, and resins for removal of tannin/organic, nitrate, and alkalinity, etc. Desirable second zone media may include felt wrap, pleated material, folded material, carbon, block activated carbon, granular carbon, etc. Many combinations and arrangements of media may be used, including a plurality of beds within a single zone.

In this Description and the Claims, the words "filtering", "filtration", "treatment", or "filtration media" are not intended to limit the invention to media which performs a particular filtration function, but, rather, include media that removes material from a liquid, adds material to a liquid, otherwise treats or transforms a liquid, or is inert to the liquid under different circumstances. The zones may also be empty or have spaces that are empty of media, as in the dwell chamber in Figure 1. Also in the Description and Claims, the terms "up" or "down" are not intended to limit the invention to particular orientations relative to the ground or gravity, but are used to clarify directions of liquid flow relative to the apparatus.

Although this invention has been described above with reference to particular means, materials, dimensions, embodiments, and methods of installation, it is to be understood that the invention is not limited to these disclosed particulars, but extends instead to all equivalents within the scope of the following claims.

CLAIMS

I claim:

1 1. A filter apparatus for filtering liquid from a source and delivering the liquid to a
2 storage tank and to a tap, the filter apparatus comprising:
3 a housing defining an interior cavity having a plurality of zones, said zones
4 comprising a first zone and a second zone in series-flow liquid communication,
5 wherein the first zone and second zone each have a zone inlet and zone outlet,
6 said housing including an inlet port in fluid communication with the source
7 and an outlet port in fluid communication with the tap,
8 media received within at least part of the said first zone and at least part of the
9 said second zone,
10 wherein the housing further comprises a single combined outlet-inlet
11 intermediate port in fluid communication with the first zone outlet and with the
12 second zone inlet, the combined outlet-inlet intermediate port being adapted both to
13 remove liquid from between the first zone and the second zone to remove said liquid
14 from the housing for storage in a storage tank, and to return liquid from the storage
15 tank to the housing in between the first zone and the second zone.

1 2. A filtration apparatus as in Claim 1, wherein the housing comprises only two zones
2 and comprises only three liquid ports, which are a single inlet port communicating with the
3 liquid source, a single outlet port communicating with the tap, and said single combined
4 outlet-inlet intermediate port communicating with the first zone outlet and second zone inlet.

1 3. A filtration apparatus as in Claim 1, wherein the media comprises an anti-bacterial
2 media received in at least a part of the first zone.

1 4. A filtration system as in Claim 3, wherein the media comprises a biocide-removal
2 media received in at least a part of the second zone.

1 5. A filtration apparatus as set forth in Claim 1, wherein:
2 the housing has a top wall, a bottom wall, and a side wall, and
3 wherein said inlet port is located near the top wall, said outlet port is located near the
4 bottom wall, and said intermediate port is located in the top wall.

1 6. A filtration apparatus as set forth in Claim 1, wherein:
2 the housing has a top wall, a bottom wall, and a side wall, and
3 said inlet port is located in the top wall, said outlet port is located in the bottom wall,
4 and said intermediate port is located in the side wall between the first and second zones.

1 7. A filtration apparatus as in Claim 5, wherein the housing has a longitudinal axis
2 extending between the top wall and bottom wall, and wherein the filter apparatus further
3 comprises an elongated return tube extending axially through said first zone, the return tube
4 having a top opening in fluid communication with said intermediate port and a bottom
5 opening near and in fluid communication with the second zone inlet, the return tube being
6 adapted to conduct liquid, after it has passed through the first zone, to the intermediate port
7 for passage to the storage tank, and the return tube being adapted to conduct liquid, returning
8 from the storage tank through the intermediate port, to the second zone inlet.

1 8. A filtration system as in Claim 7, wherein the media comprises an anti-bacterial
2 media received in at least a part of the first zone.

1 9. A filtration system as in Claim 8, wherein the media comprises a biocide-removal
2 media received in at least a part of the second zone.

1 10. A filtration apparatus as set forth in Claim 7, wherein the said first zone comprises an
2 axial-flow zone.

1 11. A filtration apparatus as set forth in Claim 7, wherein the said first zone comprises a
2 radial-flow zone and the elongated return tube is liquid permeable.

1 12. A filtration apparatus as set forth in Claim 7, wherein the said second zone comprises
2 an axial-flow zone.

1 13. A filtration apparatus as set forth in Claim 7, wherein the said second zone comprises
2 a radial-flow zone.

1 14. A filtration apparatus as set forth in Claim 7, wherein said first and second zones are
2 axial-flow zones and the filtration apparatus further comprises an adjustment means for
3 changing the length of said axially-extending elongated return tube to change the distance of
4 the return tube bottom opening from the top wall to change the location of the second zone
5 inlet relative to the top wall.

1 15. A filtration apparatus as in Claim 5, wherein the housing has a longitudinal axis
2 extending between the top wall and the bottom wall, and the filter apparatus comprises:
3 a solid media block received within at least a part of the first zone, and a
4 media received in at least a part of the second zone,
5 wherein said solid media block has a media cavity extending axially through
6 said solid media block, the media cavity having a top opening in fluid communication
7 with said intermediate port and a cavity bottom near and in fluid communication with
8 the second zone inlet, the media cavity being adapted to conduct liquid, after it has
9 passed through the first zone, to said intermediate port for passage to the storage tank
10 and the media cavity further being adapted to receive liquid from the storage tank
11 through the intermediate port and to conduct the liquid to the second zone inlet.

1 16. A filtration apparatus as set forth in Claim 15, wherein the said first zone comprises a
2 radial-flow zone.

1 17. A filtration system as in Claim 15, wherein the solid media block comprises an anti-
2 bacterial media.

1 18. A filtration system as in Claim 17 comprising a biocide-removal media received in at
2 least a part of the second zone.

1 19. A method of filtering liquid through a filter, the method comprising:
2 forcing unfiltered liquid through a first zone of a filter cavity at least partly filled with
3 media;
4 collecting the first-zone-treated liquid at a fluid outlet of the first zone and removing it
5 from the filter;
6 conducting the collected liquid to a storage tank;
7 returning the liquid from said storage tank to the filter by forcing the liquid in a
8 reverse direction to the fluid outlet of the first zone and then to an inlet of a second zone of
9 the filter cavity, the second zone inlet being in fluid communication with the first zone outlet
10 and the second zone being at least partly filled with media;
11 forcing the liquid through said second zone; and
12 removing the second-zone-treated liquid from the filter.

1 20. A method as in Claim 19, wherein the first zone outlet comprises a central return tube
2 extending down through the first zone and having an open bottom end.

1 21. A method as in Claim 19, wherein the first zone outlet comprises a media cavity and
2 the first-zone-treated liquid is collected in the media cavity and conducted to the storage tank,
3 and then returned to the media cavity and forced to the inlet of the second zone.

1 22. A method as in Claim 19 wherein an anti-bacterial media is received in at least a part
2 of the first zone.

1 23. A method as in Claim 19 wherein a biocide-removal media is received in at least a
2 part of the second zone.

1 24. A method as in Claim 19, wherein the collected liquid is conducted to the storage tank
2 and returned from the storage tank through a combined outlet-inlet intermediate port.

AMENDED CLAIMS

[received by the International Bureau on 25 October 1999 (25.10.99);
original claims 3, 8, 17 and 22 cancelled;
original claims 1, 4, 9, 18 and 19 amended;
remaining claims unchanged (5 pages)]

1. A filter apparatus for filtering liquid from a source and delivering the liquid to a storage tank and to a tap, the filter apparatus comprising:
 - a housing defining an interior cavity having a plurality of zones, said zones comprising a first zone and a second zone in series-flow liquid communication, wherein the first zone and second zone each have a zone inlet and zone outlet,
 - said housing including an inlet port in fluid communication with the source and an outlet port in fluid communication with the tap,
 - anti-bacterial media received within at least part of said first zone and a media received in at least part of said second zone,
 - wherein the housing further comprises a single combined outlet-inlet intermediate port in fluid communication with the first zone outlet and with the second zone inlet, the combined outlet-inlet intermediate port being adapted both to remove liquid from between the first zone and the second zone to remove said liquid from the housing for storage in a storage tank, and to return liquid from the storage tank to the housing in between the first zone and the second zone.
2. A filtration apparatus as in Claim 1, wherein the housing comprises only two zones and comprises only three liquid ports, which are a single inlet port communicating with the liquid source, a single outlet port communicating with the tap, and said single combined outlet-inlet intermediate port communicating with the first zone outlet and second zone inlet.

4. A filtration system as in Claim 1, wherein the media in the second zone comprises a biocide-removal media.
5. A filtration apparatus as set forth in Claim 1, wherein:
the housing has a top wall, a bottom wall, and a side wall, and
wherein said inlet port is located near the top wall, said outlet port is located near the bottom wall, and said intermediate port is located in the top wall.
6. A filtration apparatus as set forth in Claim 1, wherein:
the housing has a top wall, a bottom wall, and a side wall, and
said inlet port is located in the top wall, said outlet port is located in the bottom wall,
and said intermediate port is located in the side wall between the first and second zones.

7. A filtration apparatus as in Claim 5, wherein the housing has a longitudinal axis extending between the top wall and bottom wall, and wherein the filter apparatus further comprises an elongated return tube extending axially through said first zone, the return tube having a top opening in fluid communication with said intermediate port and a bottom opening near and in fluid communication with the second zone inlet, the return tube being adapted to conduct liquid, after it has passed through the first zone, to the intermediate port for passage to the storage tank, and the return tube being adapted to conduct liquid, returning from the storage tank through the intermediate port, to the second zone inlet.

9. A filtration system as in Claim 7, wherein the media in the second zone comprises a biocide-removal media.

10. A filtration apparatus as set forth in Claim 7, wherein the said first zone comprises an axial-flow zone.

11. A filtration apparatus as set forth in Claim 7, wherein the said first zone comprises a radial-flow zone and the elongated return tube is liquid permeable.

16. A filtration apparatus as set forth in Claim 15, wherein the said first zone comprises a radial-flow zone.

18. A filtration system as in Claim 15, wherein the media in the second zone comprises a biocide-removal media.

19. A method of filtering liquid through a filter, the method comprising:

forcing unfiltered liquid through a first zone of a filter cavity at least partly filled with an anti-bacterial media to impart a biocide to the liquid;

collecting the first-zone-treated liquid at a fluid outlet of the first zone and removing it from the filter;

conducting the collected liquid to a storage tank;

retaining the liquid in the storage tank to allow the biocide to kill bacteria in the liquid;

returning the liquid from said storage tank to the filter by forcing the liquid in a reverse direction to the fluid outlet of the first zone and then to an inlet of a second zone of the filter cavity, the second zone inlet being in fluid communication with the first zone outlet and the second zone being at least partly filled the media;

forcing the liquid through said second zone; and

removing the second-zone-treated liquid from the filter.

20. A method as in Claim 19, wherein the first zone outlet comprises a central return tube extending down through the first zone and having an open bottom end.

21. A method as in Claim 19, wherein the first zone outlet comprises a media cavity and the first-zone-treated liquid is collected in the media cavity and conducted to the storage tank, and then returned to the media cavity and forced to the inlet of the second zone.

23. A method as in Claim 19 wherein a biocide-removal media is received in at least a part of the second zone.

24. A method as in Claim 19, wherein the collected liquid is conducted to the storage tank and returned from the storage tank through a combined outlet-inlet intermediate port.

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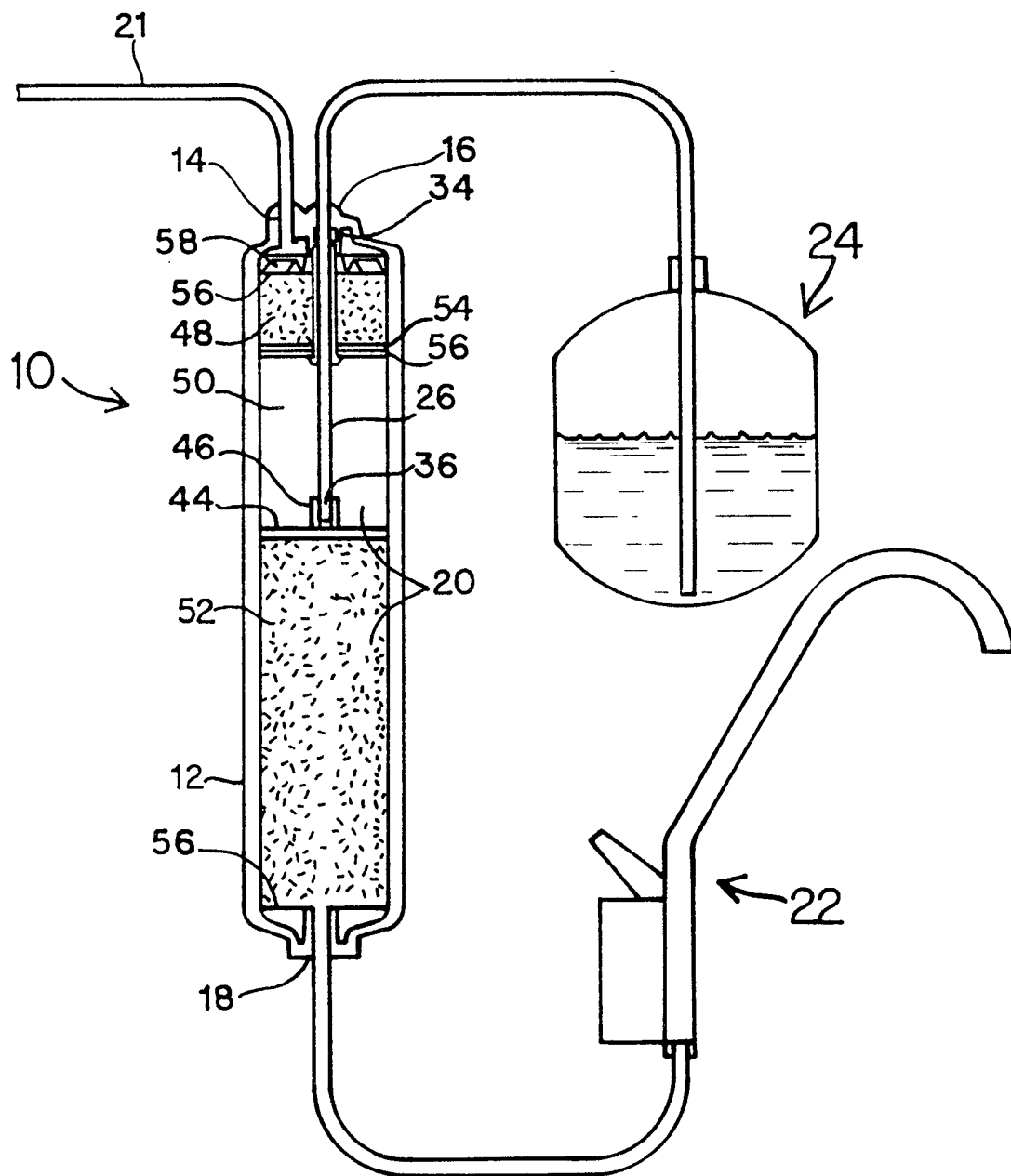


FIG. 1

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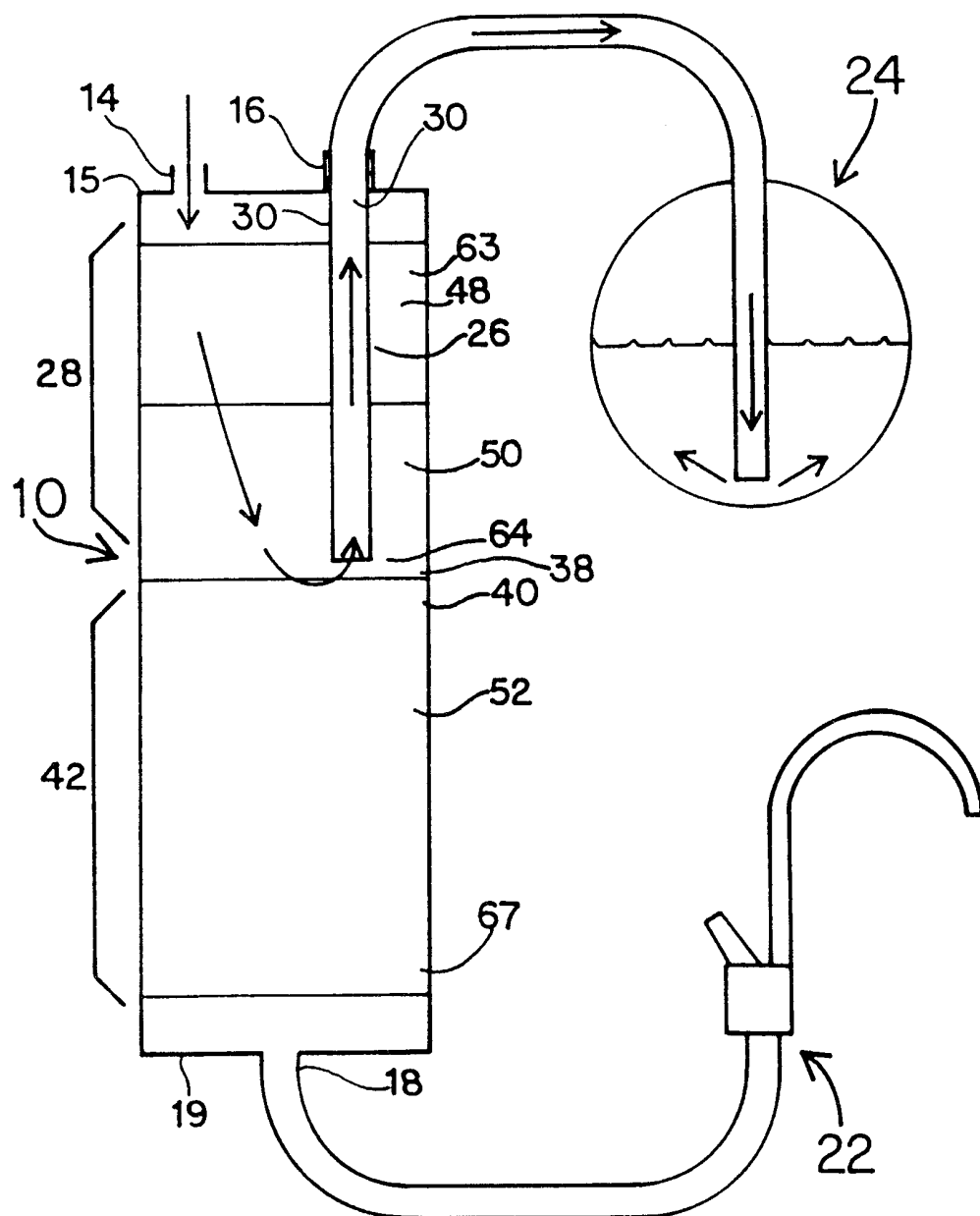


FIG. 2A

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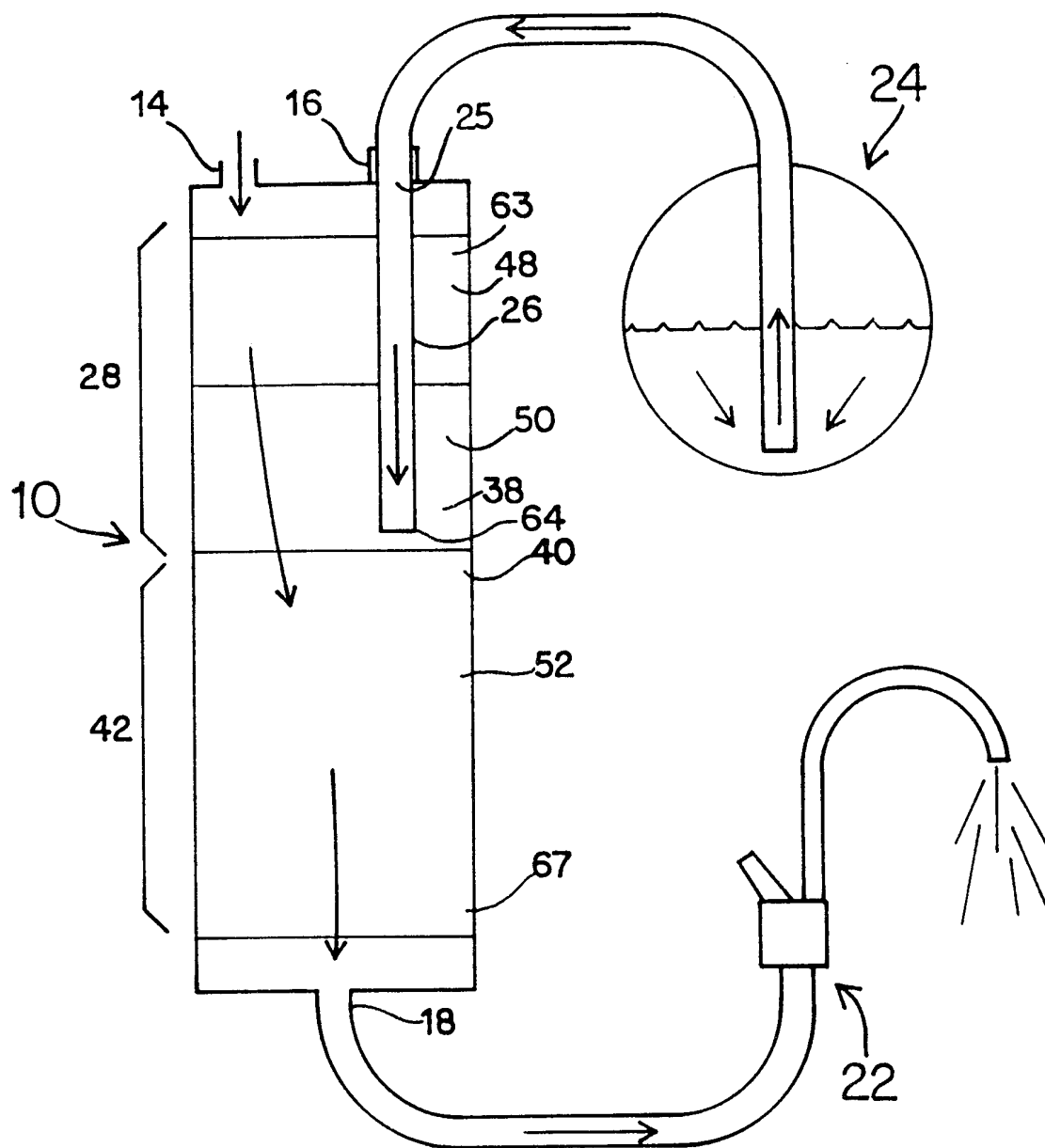


FIG. 2B

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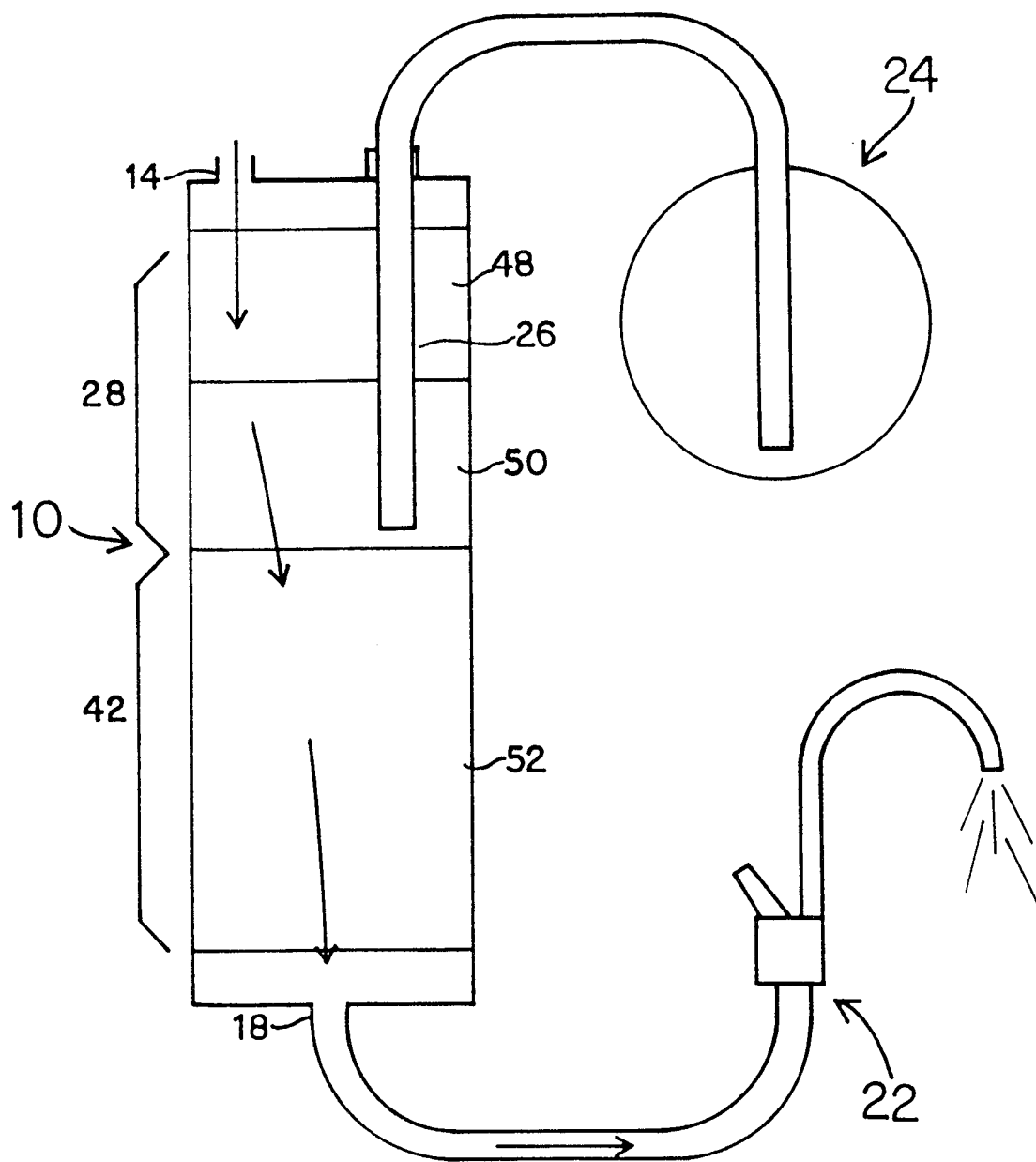


FIG. 2C

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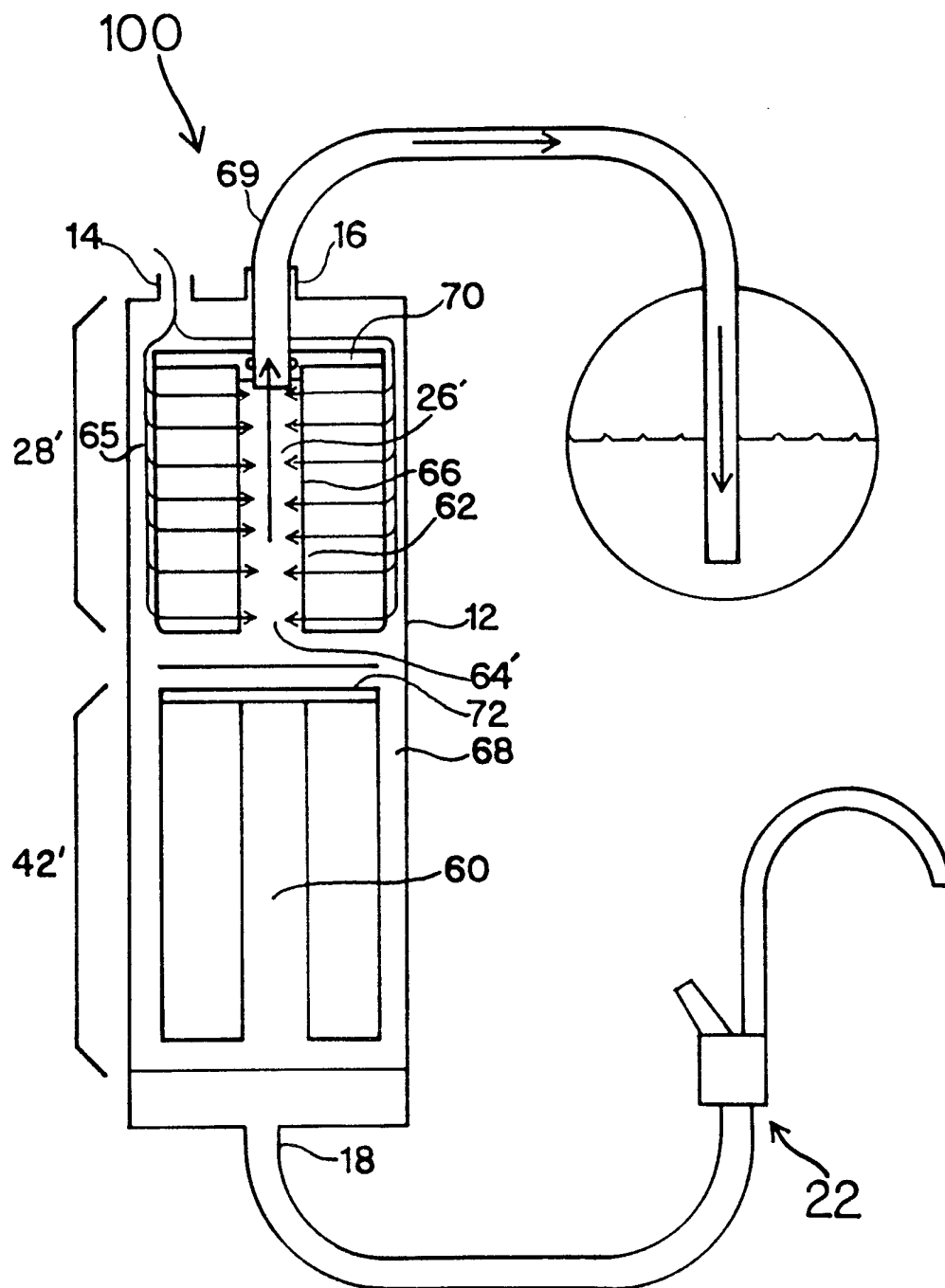


FIG. 3A

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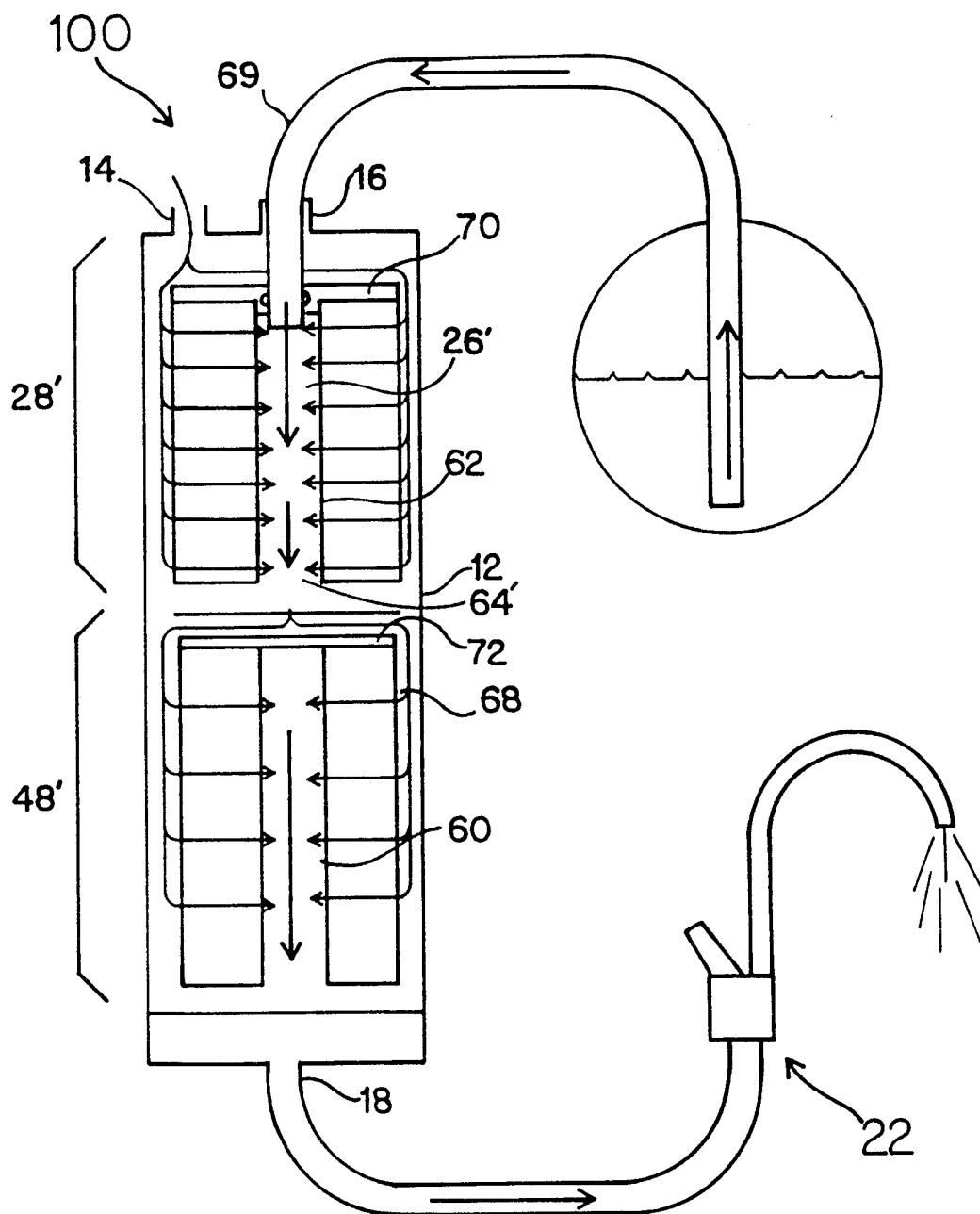


FIG. 3B

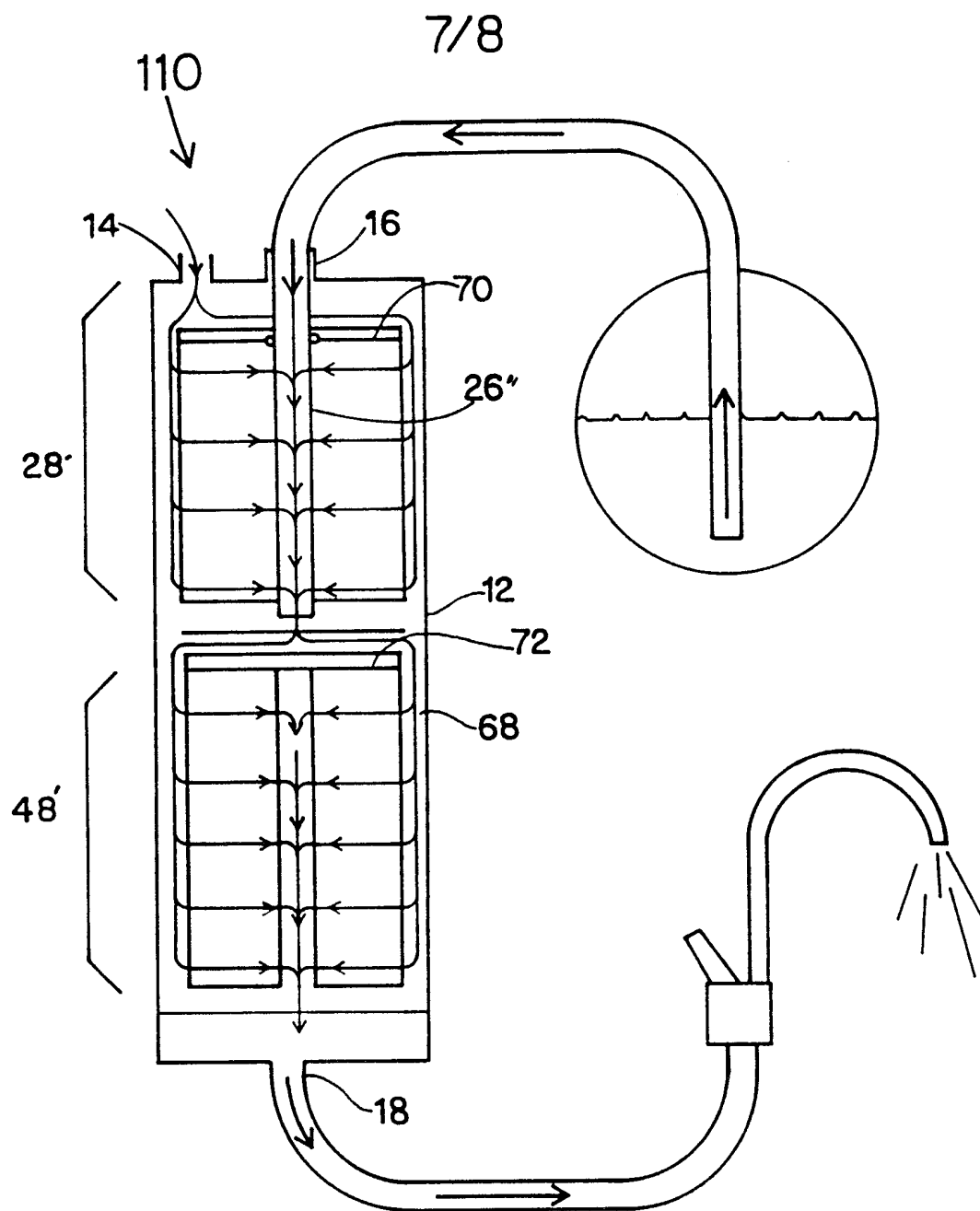


FIG. 3C

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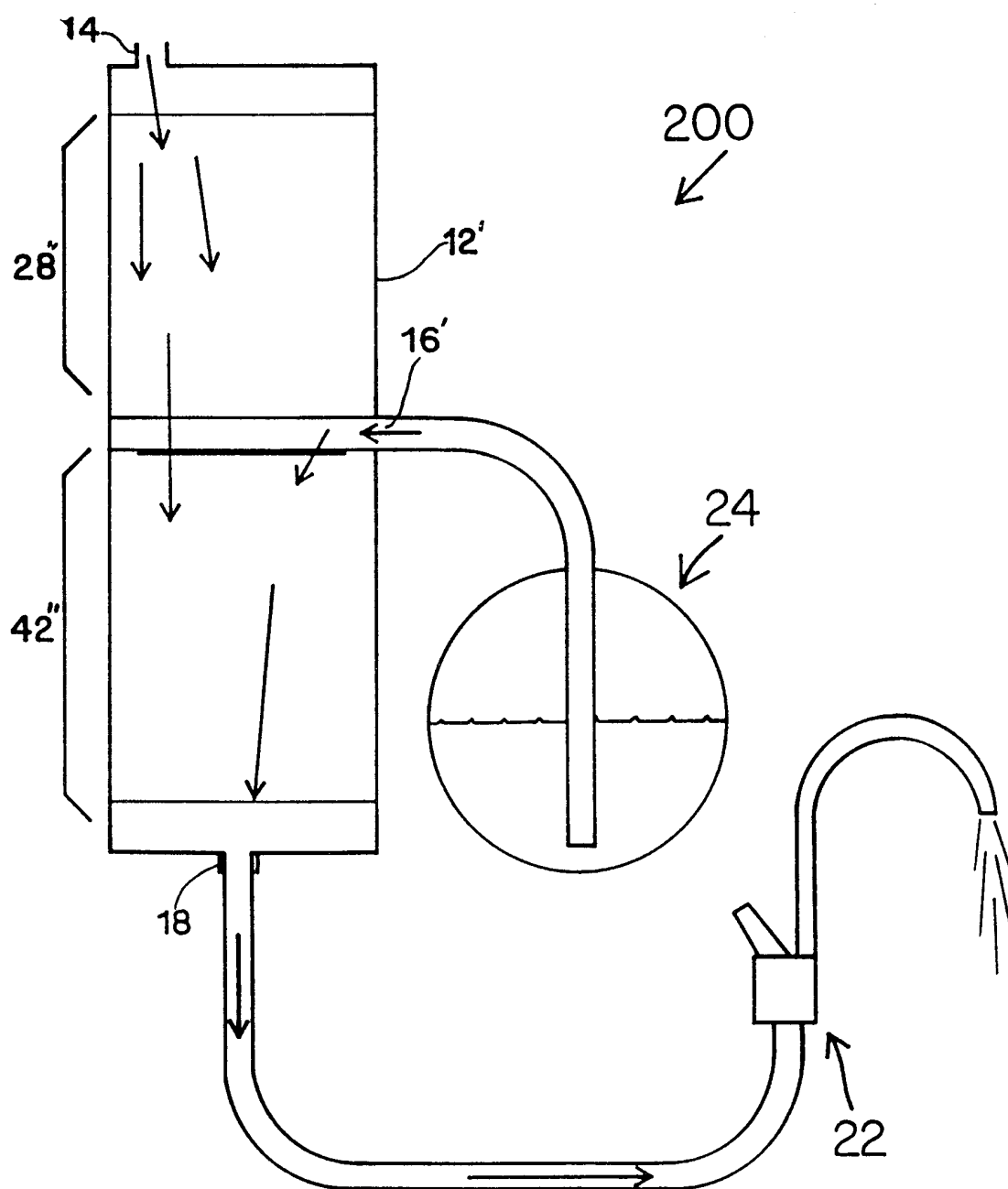


FIG. 4

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 98/13273

A. CLASSIFICATION OF SUBJECT MATTER

IPC 6 B01D35/30 B01D24/18 C02F9/00

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 6 B01D C02F

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 4 595 497 A (BURROWS BRUCE D) 17 June 1986 see the whole document ---	1-10, 15, 19-21, 24
Y	US 5 082 557 A (GRAYSON JOHN R ET AL) 21 January 1992 see column 7, line 27 - column 10, line 17; figure 1 ---	1-10, 15, 19-21, 24
A	US 5 681 459 A (BOWMAN DENNIS E) 28 October 1997 see column 6, line 14-46; figure 2 ---	1-24
A	US 5 714 066 A (JANG JAE YOUNG) 3 February 1998 see column 1, line 41-64 see column 2, line 60 - column 3, line 51; figures 1, 2 --- -/--	1-24

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

26 February 1999

Date of mailing of the international search report

09/03/1999

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INTERNATIONAL SEARCH REPORT

International Application No
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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A	US 5 232 590 A (REID ROGER P) 3 August 1993 see the whole document ---	1-24
A	US 4 882 061 A (PETRUCCI RAYMOND M ET AL) 21 November 1989 see figure 1 -----	1-24

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

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