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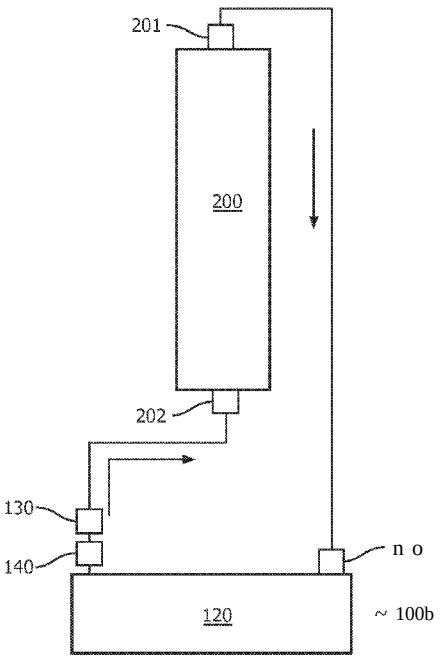

FIG. 2

(57) Abstract: Apparatus comprising an inlet (110), an outlet (130) and a disinfectant source (120) for providing a disinfectant. When an object (200) that needs to be disinfected is coupled to the apparatus, the disinfectant circulates between the object and the apparatus via said inlet and outlet. A system and method for disinfecting an object with the apparatus are also provided. The apparatus is particularly used for disinfecting activated carbon filters devoted to water or air purification.

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APPARATUS, SYSTEM AND METHOD FOR DISINFECTING OBJECTS

TECHNICAL FIELD

The present invention relates to an apparatus, system and method for disinfecting objects; more particularly, to an apparatus, system and method for disinfecting activated carbon filters.

DESCRIPTION OF RELATED ART

Activated carbon filters are used in domestic water purification systems to remove chlorine which causes disagreeable tastes and odors. In a procedure for purifying water, pollutants such as organic matters are adsorbed inside pores of such an activated carbon filter and become nutrients of bacteria.

In order to inhibit bacteria growth, the activated carbon filter may be coated with silver. However, silver ion may be released into water and cause safety issues; moreover, the silver may be packaged to prevent bio-fouling, but this results in a loss of effectiveness. To guarantee the quality of the water, the filter has to be replaced after running for a certain time, such as half a year, which is not cost effective, especially when the filter is coated with silver.

The above-mentioned problems are also present in air purification systems which use activated carbon filters.

SUMMARY OF THE INVENTION

In some embodiments of the invention, disinfection is performed in an off-line manner. That is, an object that needs to be disinfected is disinfected when it is not working; i.e., the object is not doing what it should do, e.g. purifying water or air. In an embodiment, the object

includes a filter, which can be removed from a purifier and coupled to the apparatus which circulates the disinfectant through the filter. Though many other objects can be disinfected according to embodiments of the invention, reference is primarily made to a filter for water purification hereinafter, without loss of generality.

In an embodiment, an apparatus comprises an inlet, an outlet and a disinfectant source for providing disinfectant. When an object that needs to be disinfected is coupled to the apparatus, the disinfectant circulates between the object and the apparatus via the inlet and the outlet. The disinfection happens when the object is not working. Disinfecting an object when the object is not working is also referred to as off-line disinfection herein. Similarly, disinfecting an object when the object is working is referred to as on-line disinfection.

In this embodiment, the lifetime of a filter can be lengthened so a user does not have to replace it frequently. Instead, the user simply removes the filter from the purifier and adapts the filter to the apparatus. Maintenance cost of the purifier as a whole is therefore reduced. In addition, circulating the disinfectant between the object and the apparatus improves effectiveness of the disinfectant because the disinfectant can be reused. Moreover, because some disinfectants have disagreeable tastes and smell, on-line disinfection may not be suitable in many cases when the filter is connected with, for instance, a dispenser or faucet for drinking. According to this embodiment, the filter can be disinfected when it is not working so the disinfectant is not introduced into the atmosphere or drinking water.

When an activated carbon filter is just taken out from a purifier, e.g. detached from an adaptor, the activated carbon particles in the filter may be wet and therefore adhered to one another to form larger particles. The larger particles that are formed bring the disinfection efficiency down dramatically by decreasing the contacting area between the disinfectant and the filter.

In an embodiment, the apparatus may further comprise a pressurizer configured to pressurize the disinfectant before the disinfectant is provided via the outlet. According to this embodiment, the larger particles that are formed can be broken down by the pressurized disinfectant, gaseous ozone, hot water, water solution of ozone or any suitable disinfecting chemicals.

In a particular embodiment, the pressurizer may include a pressure valve configured to be opened when a pressure of the disinfectant from the disinfectant source is higher than a first pressure threshold. The apparatus may further comprise a sprayer in fluid communication with the outlet and configured to spray the pressurized disinfectant to the filter.

According to this embodiment, the larger particles that are formed in the activated carbon filter can be broken down into smaller ones, and the contacting area between the disinfectant and the carbon particles is increased thereby.

Additionally or alternatively, the apparatus may comprise a pressure valve configured to prevent the disinfectant that disinfects the filter from returning to the apparatus unless a certain condition is met; e.g., the pressure valve is configured to be opened when the pressure of the disinfectant from the disinfectant source is higher than a second pressure threshold. In an embodiment, this pressure valve is between the inlet of the apparatus and the object.

According to this embodiment, after coupling the filter to the apparatus and starting the apparatus, the disinfectant will be released from the outlet and applied to the filter; however, at least at this moment, the pressure valve between the inlet of the apparatus and the filter is still closed, which means the disinfectant is not allowed to leave the filter momentarily (e.g., in 10 seconds) while the disinfectant source is still providing disinfectant. In case a gaseous disinfectant such as ozone, high temperature vapor, or the like is used, the pressure and disinfectant concentration that is disinfecting the filter is increased. The pressurized

disinfectant will quickly diffuse into the larger carbon particles and kill the bacteria therein. When the increasing pressure gets to the second pressure threshold, the pressure valve is opened and the disinfectant returns to the apparatus via the inlet.

In an embodiment of the present invention, the apparatus may further comprise an adaptor configured to receive the object and be coupled to at least one of the inlet and the outlet.

This embodiment is particularly useful for a filter without an inlet port and an outlet port, such as a filter of an air purifier. Without this adaptor, such a filter cannot form a leakproof path from the outlet to the inlet for the disinfectant, or at least cannot form a leakproof connection with at least one of the inlet or the outlet.

According to this embodiment, the disinfectant, e.g. ozone, from the disinfectant source can be prevented from leaking outside during the disinfection. This also prevents ambient air from getting into the system to add any pollutant or decrease the concentration of the disinfectant.

In an embodiment, the apparatus may further comprise a sensor configured to measure a concentration of the disinfectant. The disinfectant source may be configured to stop providing the disinfectant when the measured concentration is higher than a concentration threshold.

A disinfectant at or above the concentration threshold can disinfect an object efficiently. Therefore, according to this embodiment, the disinfectant source stops providing the disinfectant when the concentration is enough so as to avoid a waste of disinfectant and/or electrical power for driving the disinfectant source.

In an embodiment, the apparatus may further comprise a collector in fluid communication with the outlet and configured to collect the disinfectant when the disinfection is finished, and a degradation means in fluid communication with the collector and configured

to degrade the collected disinfectant.

Some disinfectants, such as ozone or ammonia water, may have disagreeable smell and therefore should not be released into the atmosphere/drinking water during or after the disinfection. According to this embodiment, after or just before the end of the disinfection, the disinfectant, e.g. ozone, is collected and degraded. It may be advantageous for the collector to collect the remaining disinfectant in the filter after the disinfectant source stops working.

In some embodiments of the present invention, the disinfectant may be any of the following: ozone, water solution of ozone, ammonia water, hot water, any other suitable disinfectant, or any possible combination thereof. When the disinfectant is a solution of disinfecting gas (such as ozone), the disinfectant source may comprise a source configured to provide the disinfecting gas, and a gas-liquid mixer configured to mix the disinfecting gas with liquid solvent so as to prepare the solution.

In this embodiment, the apparatus may comprise a sensor for measuring the concentration of disinfecting gas dissolved in the solution, and the source is configured to stop providing disinfecting gas when the measured concentration is higher than a concentration threshold.

In an embodiment of the present invention, the object may include an activated carbon filter of a water purifier or an air purifier.

According to this embodiment of the present invention, the activated carbon filter can be disinfected by the apparatus instead of being replaced frequently. The maintenance cost of the purifier is therefore reduced. In addition, though larger particles may be formed before the disinfection, the circulation of disinfectant, especially pressurized fluid, can break down the larger particles so as to improve the disinfection.

In an embodiment, the disinfectant includes liquid, and the apparatus may further

comprise an air flow generator configured to generate an air flow after the disinfection so as to dehumidify the object.

Further, the apparatus may further comprise a pressurizer in fluid communication with the air flow generator and configured to pressurize the generated air flow before it is provided to dehumidify the object.

In an embodiment of the present invention, a purification system is provided which comprises a filter for the purifying, an adapter for accommodating the filter when the filter is working, and an apparatus for disinfecting the filter when the filter is not working.

In an embodiment of the present invention, there is provided a method for disinfecting an object with an apparatus comprising an inlet, an outlet, and a disinfectant source for providing disinfectant. The method comprises coupling the object with the apparatus, starting the disinfectant source to provide the disinfectant, and circulating the disinfectant between the object and the apparatus via the inlet and the outlet.

These and other aspects, features and advantages of the present invention will be apparent from and elucidated with reference to the embodiment(s) described hereinafter.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the present invention will be described, by way of example only, with reference to the drawings, in which

Fig. 1 is a schematic diagram illustrating an apparatus 100a according to an embodiment of the present invention;

Fig. 2 illustrates an apparatus 100b according to an embodiment of the present invention and a filter coupled with the apparatus;

Fig. 3 illustrates an apparatus 100c according to an embodiment of the present invention

and a filter coupled with the apparatus;

Fig. 4 illustrates an apparatus lOOd according to an embodiment of the present invention and a filter received by the apparatus;

Fig. 5 illustrates an apparatus lOOe according to an embodiment of the present invention and a filter coupled with the apparatus;

Fig. 6 illustrates an apparatus lOOf according to an embodiment of the present invention and a filter coupled with the apparatus;

Fig. 7 is a schematic diagram illustrating a detailed design of a disinfectant source 120a according to an embodiment of the present invention;

Fig. 8 is a schematic diagram illustrating another detailed design of the disinfectant source 120b according to an embodiment of the present invention;

Fig. 9 is a schematic diagram illustrating another detailed design of the disinfectant source 120c according to an embodiment of the present invention;

Fig. 10 is a schematic block diagram illustrating a purification system 1000 according to an embodiment of the present invention; and

Fig. 11 is a flow chart illustrating a method HOOfor disinfecting an object with an apparatus according to an embodiment of the present invention.

DETAILED DESCRIPTION OF THE EMBODIMENTS

The present invention will now be described more fully hereinafter with reference to the accompanying drawings, in which exemplary embodiments of the present invention are shown.

Fig. 1 is a schematic diagram illustrating an apparatus 100a according to an embodiment of the present invention. Fig. 2 illustrates an apparatus 100b according to an embodiment of

the present invention and a filter 200 coupled with the apparatus 100b.

Referring to Fig. 1, the apparatus 100a comprises an inlet 110, an outlet 130, and a disinfectant source 120 for providing disinfectant.

Referring to Fig. 2, when an object that needs to be disinfected, such as a filter 200 which is an activated carbon filter of a water purifier or an air purifier (neither the water purifier nor the air purifier is shown in these figures), is coupled to the apparatus 100b, the disinfectant provided by the disinfectant source 120 circulates between the filter 200 and the apparatus 100b via the inlet 110 and the outlet 130. The arrows in Fig. 2 indicate the circulation of the disinfectant. The apparatus 100b is configured to disinfect the filter 200 when the filter 200 is not working.

For example, the filter 200 includes an outlet port 201 and an inlet port 202, as shown in Fig. 2. The disinfectant provided by the disinfectant source 120 enters the filter 200 via the outlet 130 of the apparatus 100b and the inlet port 202 of the filter 200, and goes back to the disinfectant source 120 via the outlet port 201 of the filter 200 and the inlet 110 of the apparatus 100b. In some cases, there may be a means for eliminating waste generated during the disinfection (e.g. dead microform in hot water) before the disinfectant goes back to the disinfectant source 120. Polygonal lines between the outlet 130 and the inlet port 202 and polygonal lines between the outlet port 201 and the inlet 110 indicate connections between the filter 200 and the apparatus 100b. In the embodiment illustrated in Fig. 2, the connections between the filter 200 and the apparatus 100b are leakproof in order to prevent the disinfectant provided by the disinfectant source 120 from leaking outside when the filter 200 is being disinfected by the apparatus 100b. The leakproof connections also prevent ambient air from getting in so it cannot add any pollutant or decrease the concentration of the disinfectant.

The apparatus 100b illustrated in Fig. 2 also comprises a pressurizer 140 configured to pressurize the disinfectant before the disinfectant is provided via the outlet 130. The pressurizer 140 may include a pressure valve configured to be opened when a pressure of the disinfectant from the disinfectant source 120 is higher than a first pressure threshold. The apparatus 100b may further comprise a sprayer (not shown) between the outlet 130 and the inlet port 202 of the filter 200 and configured to spray the pressurized disinfectant to the filter 200.

When an activated carbon filter is just taken out from a purifier, e.g. detached from a base, the activated carbon particles in the filter may form many larger particles. Because the disinfectant disinfects the filter by passing through the filter and contacting the surface of carbon pieces, the bigger pieces that are formed therefore decrease the contacting area between the disinfectant and the filter and hence the disinfection efficiency declines dramatically. According to the apparatus 100b illustrated in Fig. 2, the large pieces can be broken down by the pressurized disinfectant.

Additionally or alternatively, the apparatus 100c may comprise a pressure valve 150 between the inlet 110 of the apparatus 100c and the outlet port 201 of the filter 200, as shown in Fig. 3. The pressure valve 150 is configured to prevent the disinfectant disinfecting the filter 200 from returning to the apparatus 100c unless a certain condition is met, e.g., the pressure valve 150 is configured to be opened when the pressure of the disinfectant disinfecting the filter 200 is higher than a second pressure threshold. In some embodiments, the first and second pressure thresholds can be the same.

According to the apparatus 100c illustrated in Fig. 3, after coupling the filter 200 to the apparatus 100c and starting the apparatus 100c, the disinfectant will be released from the outlet 130 and applied to the filter 200, however, at least at this moment, the pressure valve

150 between the inlet 110 of the apparatus 100c and the outlet port 201 of the filter 200 is still closed, which means the disinfectant is not allowed to leave the filter 200 momentarily (e.g. in 10 seconds) while the disinfectant source is still providing disinfectant. In case a gaseous disinfectant such as ozone, high temperature vapor, or the like is used, the pressure and the disinfectant concentration that is disinfecting the filter 200 is increased. The pressurized disinfectant will diffuse into the larger carbon particles quickly and kill the bacteria therein. When the increasing pressure in the filter 200 gets to the second pressure threshold, the pressure valve 150 will be open and the disinfectant returns to the apparatus 100c via the inlet 110.

The apparatus 100c illustrated in Fig. 3 also comprises a sensor 160 configured to measure a concentration of the disinfectant. The disinfectant source 120 is configured to stop providing the disinfectant when the measured concentration is higher than a concentration threshold.

According to the apparatus 100c illustrated in Fig. 3, the disinfectant source 120 stops providing ozone when the concentration is enough so as to avoid waste of disinfectant and/or electrical power for driving the disinfectant source, so the disinfectant source 120 will work more effectively. Alternatively, the disinfectant source 120 can be configured to stop providing the disinfectant after a certain period of time (e.g. 10 minutes) without the use of the sensor 160.

Fig. 4 illustrates an apparatus lOOd according to an embodiment of the present invention and a filter 200a received by the apparatus lOOd.

Referring to Fig. 4, compared to the apparatus 100a illustrated in Fig. 1, the apparatus lOOd illustrated in Fig. 4 further comprises an adaptor 170 having an inlet port 172 and an outlet port 171.

The inlet port 172 of the adaptor 170 is connected with the outlet 130 and the outlet port 171 of the adaptor 170 is connected with the inlet 110. The disinfectant from the disinfectant source 120 enters the adaptor 170 via the outlet 130 and the inlet port 172, and goes back to the disinfectant source 120 via the outlet port 171 and the inlet 110. Similarly to the embodiment illustrated in Fig. 2, Polygonal lines between the outlet 130 and the inlet port 172 and polygonal lines between the outlet port 171 and the inlet 110 indicate connections between the adaptor 170 and the apparatus 100d. The adaptor 170 and the connections between the adaptor 170 and the apparatus 100d are leakproof.

According to the apparatus 100d illustrated in Fig. 4, the disinfectant, e.g. ozone, from the disinfectant source 120 can be prevented from leaking outside during the disinfection. The leakproof connections also prevent ambient air from getting into the system so it cannot add any pollutant or decrease the concentration of the disinfectant. This embodiment is particularly useful for a filter without an inlet port and an outlet port, such as a filter of an air purifier. Without the adaptor 170, such a filter cannot form a leakproof path from the outlet 130 to the inlet 110 for the disinfectant, or at least cannot form a leakproof connection with at least one of the inlet 110 or the outlet 130.

Fig. 5 illustrates an apparatus 100e according to an embodiment of the present invention and a filter 200 coupled with the apparatus 100e. In this embodiment, the apparatus 100e further comprises an collector 180 in fluid communication with the outlet 130 and configured to collect disinfectant e.g., ozone, when the disinfection is finished, and a degradation means 190 in fluid communication with the collector 180 and configured to degrade the collected disinfectant. The broken line arrow in Fig. 5 indicates the disinfectant being collected by the collector 180.

Some disinfectants such as ozone, or ammonia water, may have a disagreeable smell and

therefore should not be released into the atmosphere/drinking water during or after the disinfection. According to the apparatus 100e illustrated in Fig. 5, after or just before the end of the disinfection, the disinfectant, e.g. ozone, is collected and degraded. It may be advantageous for the collector 180 to collect the remaining disinfectant in the filter after the disinfectant source 120 stops working. The degradation means 190 may cause the collected disinfectant to be degraded quickly. It should be understood that the collector 180 and the degradation means 190 are not necessary because, for example, the ozone will be degraded by itself after a certain time (for example, in 30 minutes).

Fig. 6 illustrates an apparatus 100f according to an embodiment of the present invention and a filter 200 coupled with the apparatus 100f. In this embodiment, the disinfectant is liquid, and the apparatus 100f further comprises an air flow generator 192 configured to generate an air flow after the disinfection so as to dehumidify the filter 200. Further, the apparatus further comprises a pressurizer 194 in fluid communication with the air flow generator 192 and configured to pressurize the generated air flow before it is provided to dehumidify the filter 200. The broken line arrow in Fig. 6 indicates the generated air flow being provided to dehumidify the filter 200.

Figs. 7 to 9 are schematic diagrams that illustrate the detailed designs of the disinfectant source 120 according to embodiments of the present invention.

Referring to Fig. 7, the disinfectant source 120a comprises an ozone generator 121, a gas pump 122, and a single-way valve 123. The disinfectant is ozone.

Air from ambient environment may be provided to the gas pump 122 via the single-way valve 123. After starting the apparatus, the gas pump 122 will take air from the ambient environment through the single-way valve 123, and transport the air into the ozone generator 121 for generating the ozone. The disinfectant may be a gaseous disinfectant other than ozone,

for example, sterilizing gases with a bactericidal function, and the disinfectant source 120a may comprise corresponding gas generators.

Referring to Fig. 8, the disinfectant source 120b comprises a water pump 124, a heater 125 and a water-adding pore 126. The disinfectant is hot water. In a preferred embodiment, the water pump 124 will start to work after the water temperature arrives at 100 °C.

The disinfectant may be liquid disinfectant other than hot water, for example ozone water solution, which is a kind of solution of disinfecting gas, and the disinfectant source may be modified correspondingly as illustrated in Fig. 8.

Referring to Fig. 9, the disinfectant source 120c comprises an ozone generator 121, which is a source configured to provide disinfecting gas, a gas pump 122, a single-way valve 123, a water pump 124, a water-adding pore 126 and a gas-water mixer 127, which is a gas-liquid mixer configured to mix the disinfecting gas with liquid solvent so as to provide a solution of the disinfecting gas.

Water from the water pump 124 and ozone from the ozone generator 121 are mixed at the gas-water mixer 127 so as to generate the ozone water solution. In this case, the sensor 160 of the apparatus 100c illustrated in Fig. 3 may be configured to measure a concentration of the ozone dissolved in the ozone water solution, and the ozone generator 121 is configured to stop providing ozone when the measured concentration is higher than a concentration threshold.

It will be appreciated that the detailed designs of the disinfectant source 120a to 120c respectively illustrated in Figs. 7 to 9 can be applied to all of the apparatuses 100a to lOOf illustrated in Figs. 1 to 6.

Fig. 10 is a schematic block diagram illustrating a purification system 1000 according to an embodiment of the present invention.

Referring to Fig. 10, the purification system 1000 comprises a filter 200 for purifying, an adapter 300 for accommodating the filter 200 when the filter 200 is working, and an apparatus 100 for disinfecting the filter 200 when the filter 200 is not working.

When the filter 200 is used for purifying water or air, the apparatus 100 is separated from the filter 200. After working for a certain time (e.g. two weeks), the filter 200 can be taken out from the adapter 300 and coupled with or placed in the apparatus 100 so as to be disinfected.

Fig. 11 is a flow diagram illustrating a method 1100 for disinfecting an object with an apparatus according to an embodiment of the present invention. The method 1100 is used for disinfecting the object with an apparatus comprising an inlet, an outlet, and a disinfectant source.

Referring to Fig. 11, at block 1101, the object that needs to be disinfected is coupled with the apparatus. Preferably, connections between object and the apparatus are leakproof, in order to prevent the disinfectant provided by the disinfectant source from leaking outside when the object is disinfected by the apparatus.

At block 1102, the disinfectant source starts to provide the disinfectant, so that the disinfectant can circulate between the object and the apparatus via the inlet and the outlet of the apparatus at block 1103.

While the invention has been illustrated and described in detail in the drawings and foregoing description, such illustration and description are to be considered illustrative or exemplary and not restrictive. The invention is not limited to the disclosed embodiments. The different embodiments described above and in the claims can also be combined. Other variations to the disclosed embodiments can be understood and effected by those skilled in the art in practicing the claimed invention, from the study of the drawings, the disclosure and the appended claims.

In the claims, the word "comprising" does not exclude other elements or steps, and the indefinite article "a" or "an" does not exclude a plurality. The mere fact that measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage. The reference signs in the claims should not be construed as limiting the scope of these claims

CLAIMS:

1. An apparatus comprising:

an inlet;

an outlet; and

a disinfectant source for providing disinfectant,

wherein, when an object to be disinfected is coupled to the apparatus, the disinfectant circulates between the object and the apparatus via the inlet and the outlet, and the apparatus is configured to disinfect the object when the object is not working.

2. The apparatus according to claim 1, further comprising:

a pressurizer configured to pressurize the disinfectant before the disinfectant is provided via the outlet.

3. The apparatus according to claim 2, wherein the pressurizer includes a pressure valve configured to be opened when the pressure of the disinfectant from the disinfectant source is higher than a first pressure threshold.

4. The apparatus according to claim 2, further comprising a sprayer in fluid communication with the outlet and configured to spray the pressurized disinfectant.

5. The apparatus according to claim 1, further comprising:

a pressure valve between the inlet of the apparatus and the object,

wherein the pressure valve is configured to be opened when the pressure of the disinfectant from the disinfectant source is higher than a second pressure threshold.

6. The apparatus according to claim 1, further comprising an adaptor configured to receive the object and to be coupled to at least one of the inlet and the outlet.

7. The apparatus according to claim 6, wherein the adaptor is leak proof.

8. The apparatus according to claim 1, further comprising:

a sensor configured to measure the concentration of the disinfectant disinfecting the object,

wherein the disinfectant source is configured to stop providing the disinfectant when the measured concentration is higher than a concentration threshold.

9. The apparatus according to claim 1, further comprising:

a collector in fluid communication with the outlet and configured to collect the disinfectant after the disinfection is finished; and

a degradation means in fluid communication with the collector and configured to degrade the collected disinfectant.

10. The apparatus according to claim 1, wherein the disinfectant includes a solution of disinfecting gas, the disinfectant source comprises a source configured to provide the disinfecting gas, and a gas-liquid mixer configured to mix the disinfecting gas with liquid solvent so as to provide the solution.

11. The apparatus according to claim 1, wherein the object includes an activated carbon filter of a water purifier or an air purifier.

12. The apparatus according to claim 1, wherein the disinfectant includes liquid,

and the apparatus further comprises an air flow generator configured to generate an air flow after the disinfection so as to dehumidify the object.

13. The apparatus according to claim 12, further comprising a pressurizer in fluid communication with the air flow generator and configured to pressurize the generated air flow before it is provided to dehumidify the object.

14. A purification system comprising:

a filter for purifying;

an adapter for accommodating the filter when the filter is working; and

an apparatus according to any one of claims 1 to 13 for disinfecting the filter when the filter is not working.

15. A method for disinfecting an object with an apparatus according to any one of claims 1 to 13, comprising:

coupling the object with the apparatus,

starting the disinfectant source to provide the disinfectant, and

circulating the disinfectant between the object and the apparatus via the inlet and the outlet.

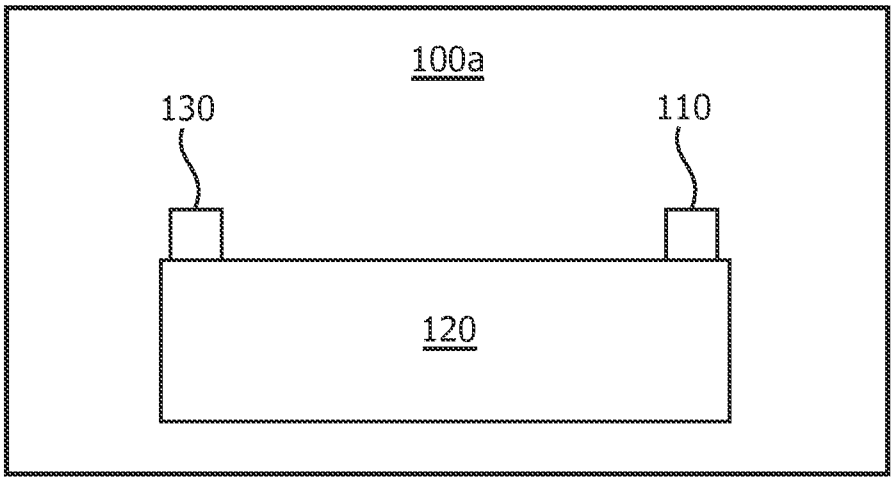

FIG. 1

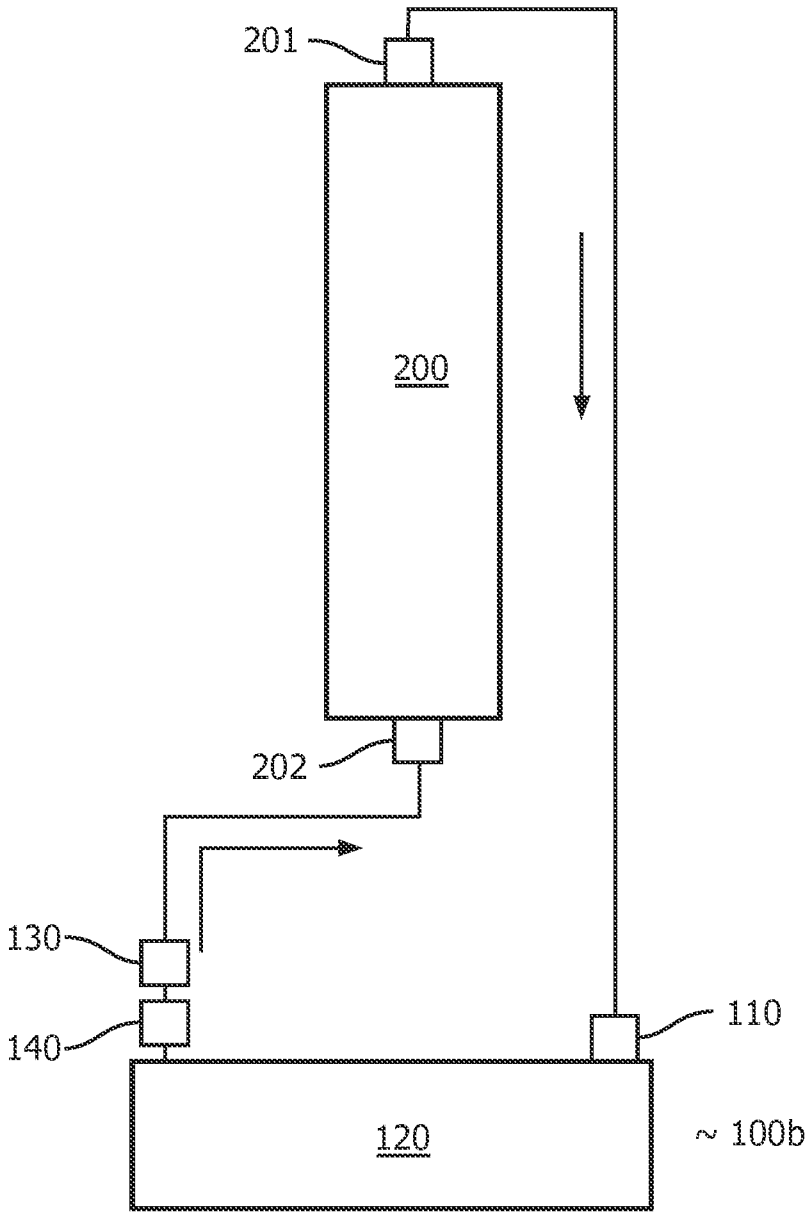

FIG. 2

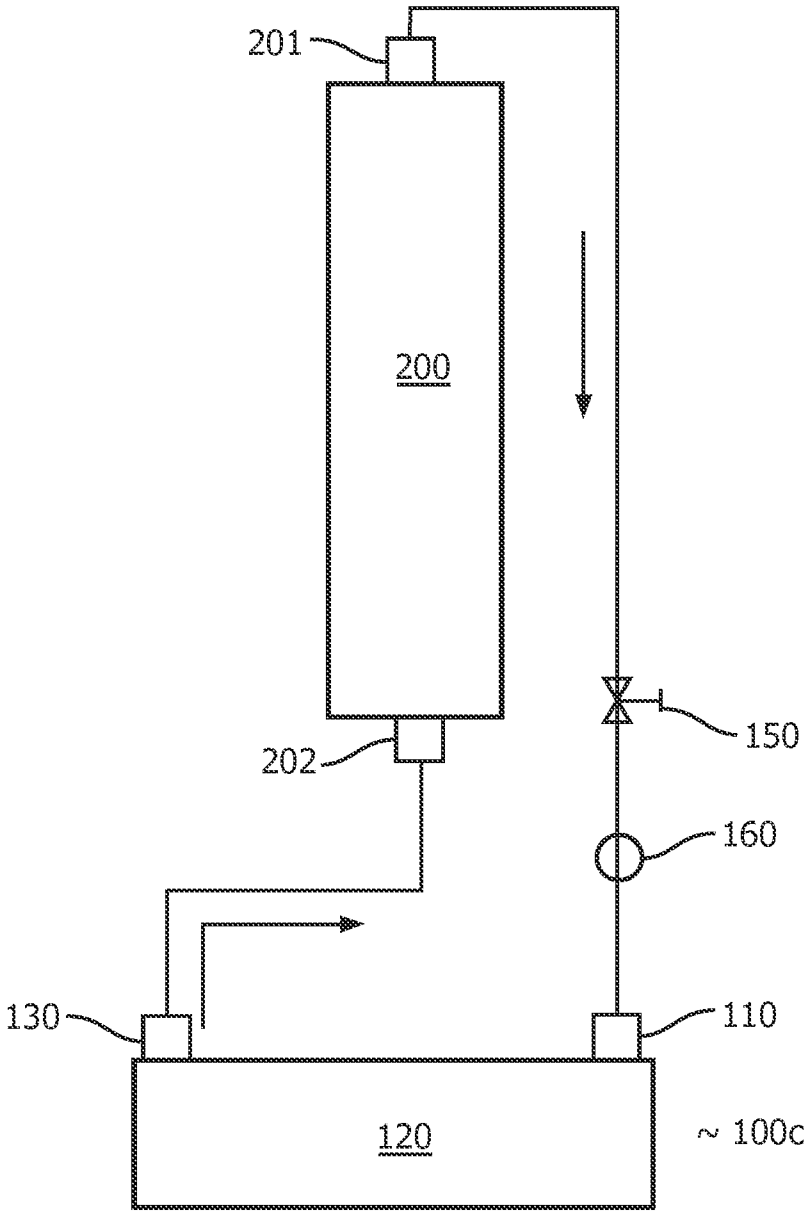

FIG. 3

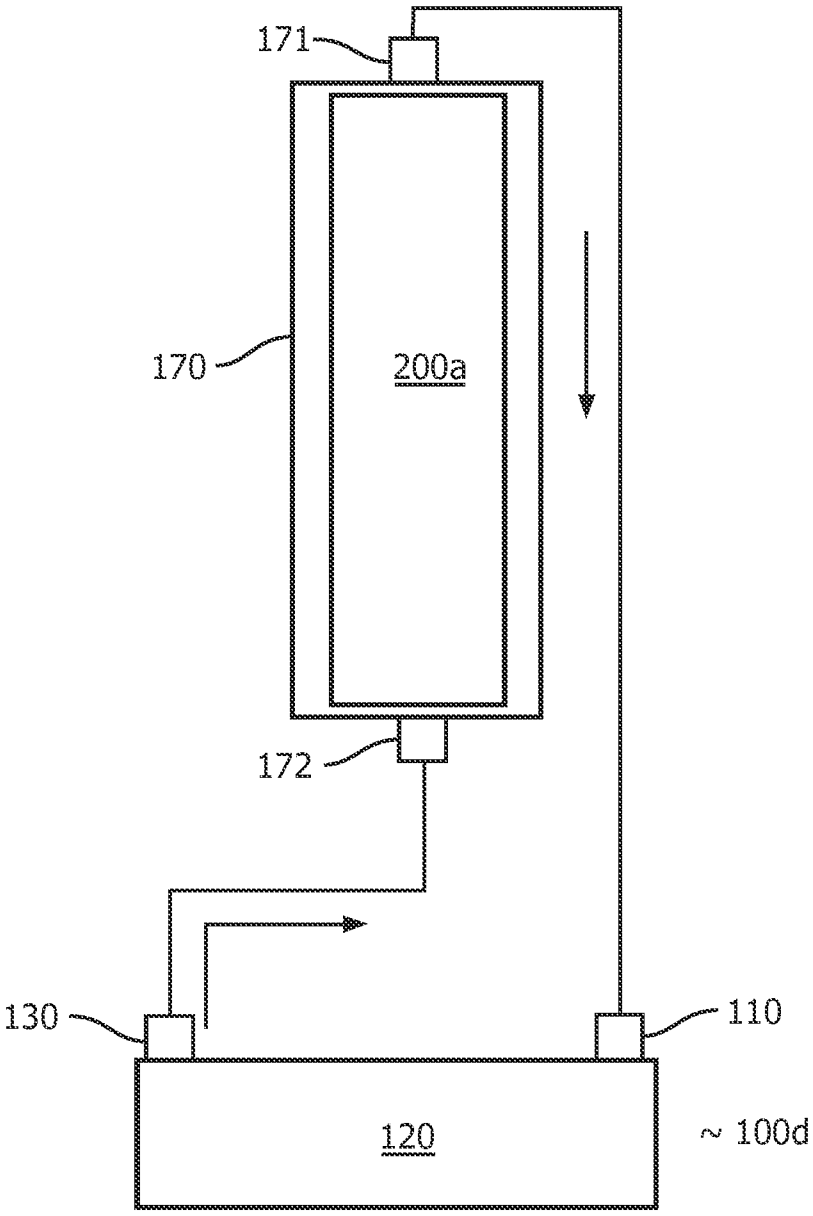

FIG. 4

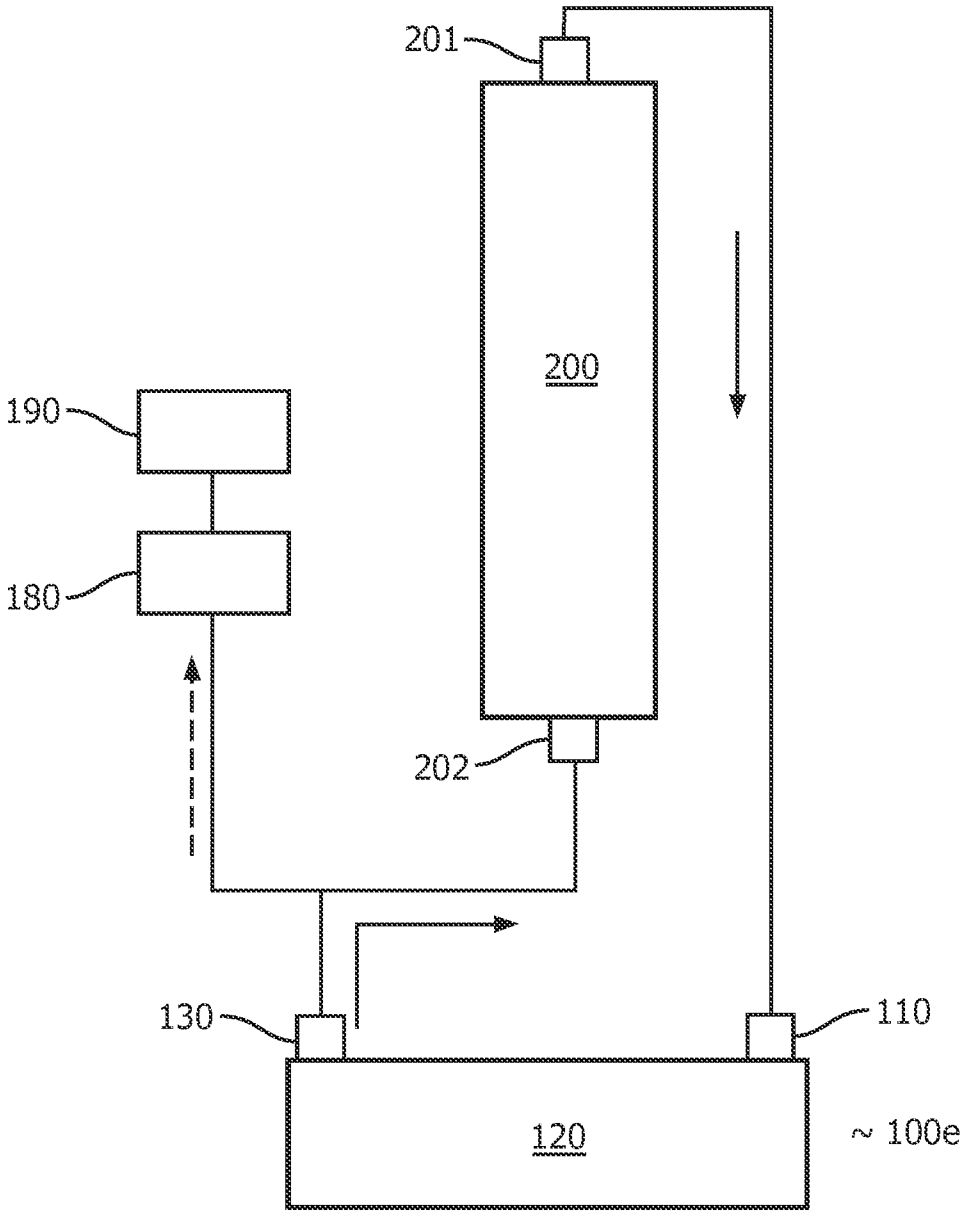

FIG. 5

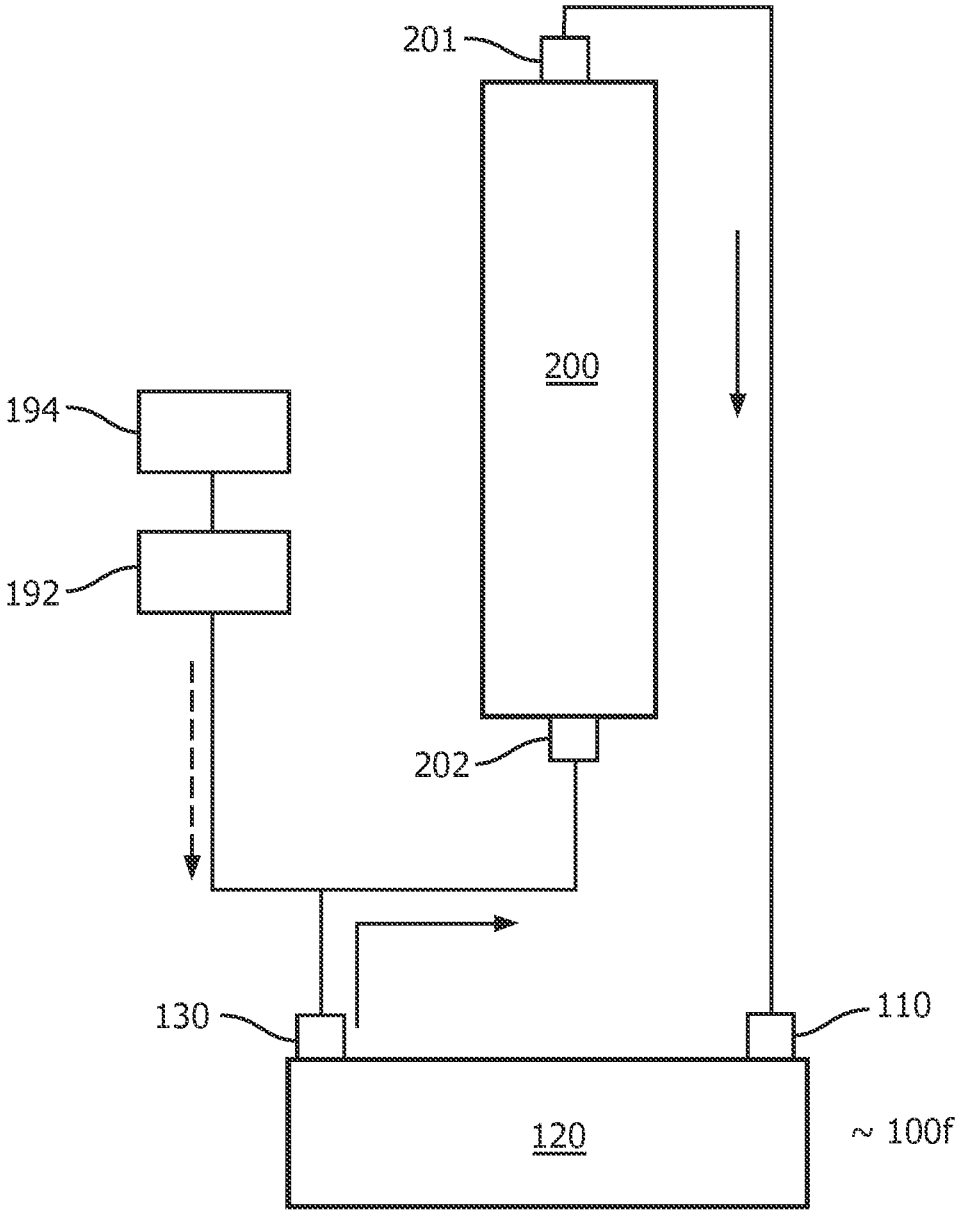

FIG. 6

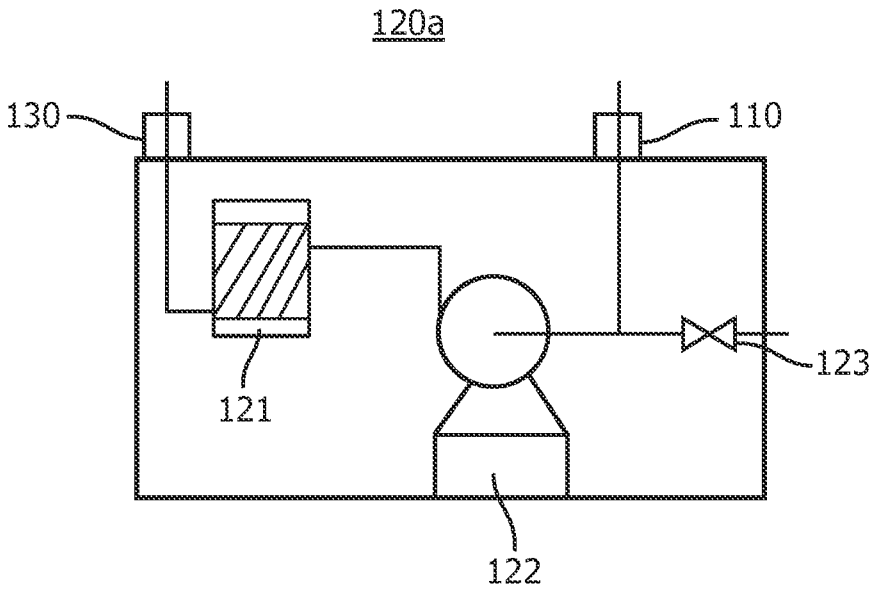

FIG. 7

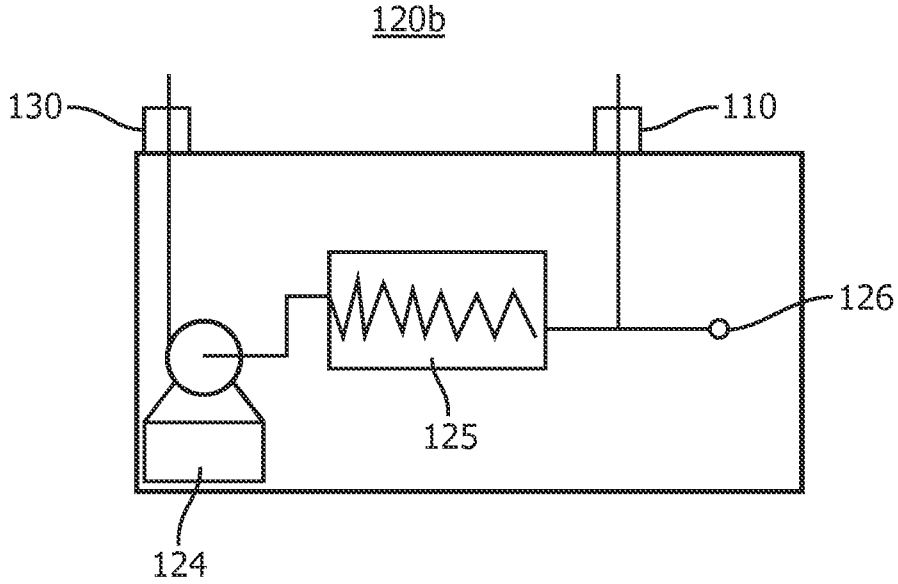

FIG. 8

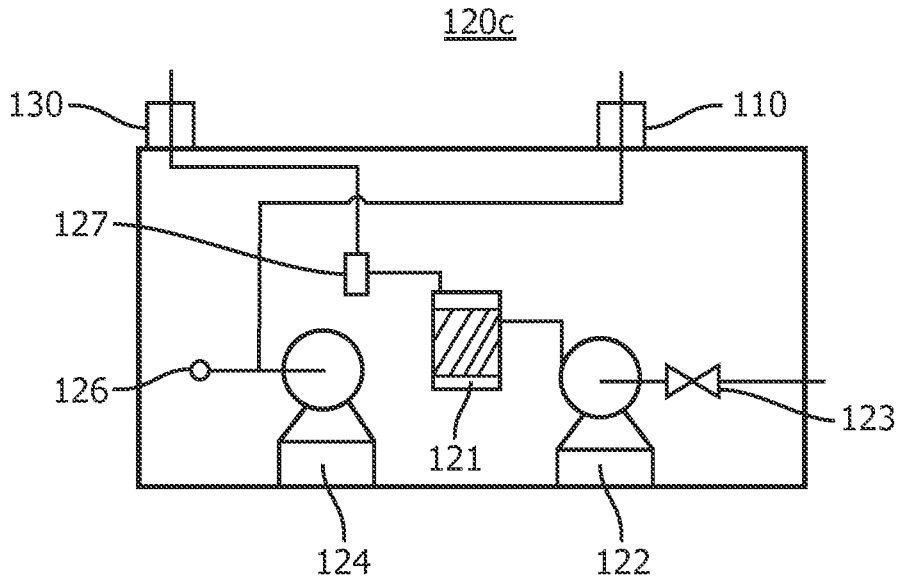

FIG. 9

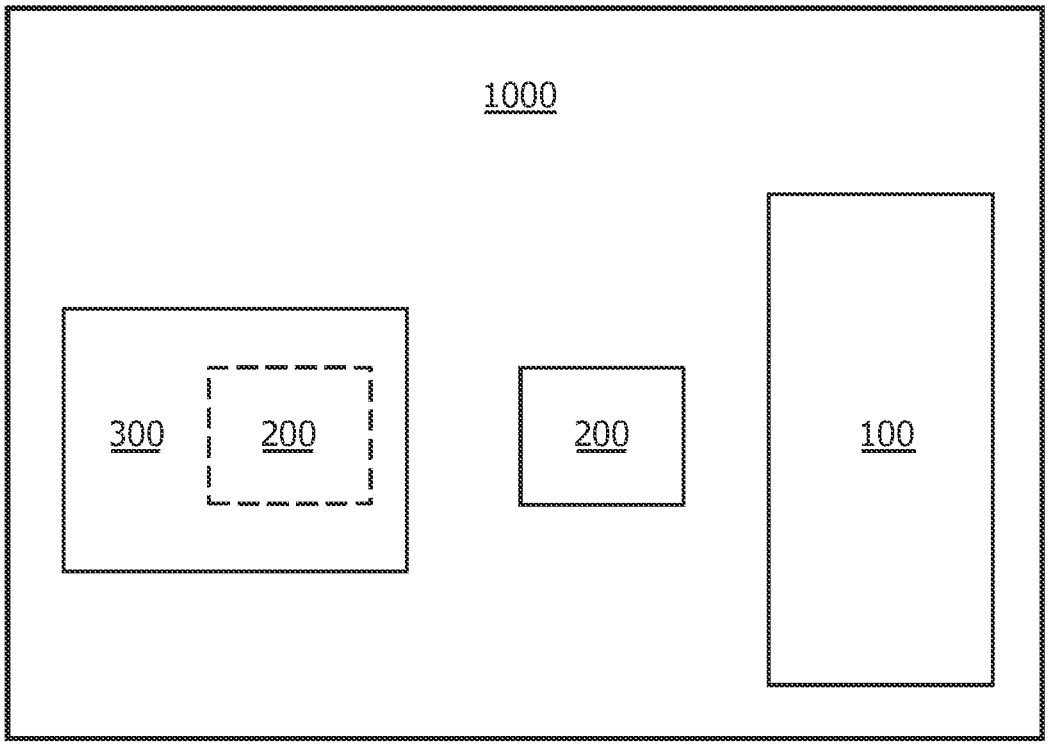

FIG. 10

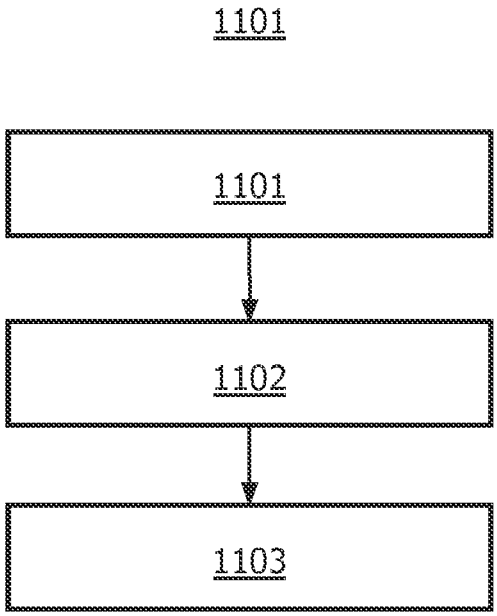

FIG. 11

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2012/057267

A. CLASSIFICATION OF SUBJECT MATTER
INV. A61L2/18 B01D41/02
ADD.

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)
A61L B01D

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EPO-Internal , WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
11 April 2013	24/04/2013

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Maremonti , Michele

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