



(51) International Patent Classification:

B01D 27/04 (2006.01) B01D 35/30 (2006.01)

B01D 27/08 (2006.01) B01D 39/18 (2006.01)

B01D 29/50 (2006.01) B01D 39/16 (2006.01)

(21) International Application Number:

PCT/US2017/041570

(22) International Filing Date:

11 July 2017 (11.07.2017)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

62/361,336 12 July 2016 (12.07.2016) US

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(81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

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

(54) Title: XYLEM BASED WATER FILTRATION SYSTEM

(57) Abstract: A filtration device includes a filter having at least one xylem filter. The filter attaches, removably or permanently, to a water container, for example the commonly used Jerrycan, and a xylem disc that can hold an array of xylem pieces.

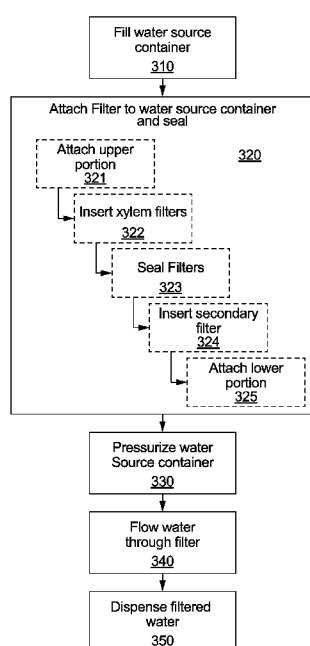


FIG. 8

Declarations under Rule 4.17:

- *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*
- *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

Published:

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

XYLEM BASED WATER FILTRATION SYSTEM

Technical Field

[0001] The present disclosure relates generally to methods and systems for water filtration.

Background

[0002] Every year, millions of people in developing countries die from waterborne diseases that are caused by bacteria and viruses, due to the lack of access to clean water. There is a need to create an effective point-of-use, cheap and easy to use device that can provide clean water and significantly reduce the global burden of waterborne diseases. Previous research done at the Massachusetts Institute of Technology has proven that plant xylem from the pinus strobus is capable of removing 99% of bacteria from water. The plant's xylem provides nanopores and nano scale spacing between channels in the xylem. These function as filters, allowing water to pass but filtering solid materials such as bacterial or dirt from the water.

[0003] However, the xylem is not useful as a filtering material without a filtration device in which it can function. While xylem was shown to filter water, the rate of filtration is too slow to provide sufficient water for a typical human's daily needs. Thus, a need remains for a xylem based water filter system.

Summary of the Invention

[0004] One embodiment relates to a water filter comprising an upper body having a first opening and a lower body having a second opening, the upper body and lower body removably engageable with each other; and a filter body affixed to one of the upper body and the lower body, the filter body having a plurality of passages there through and extending from the first opening to the second opening, each of the plurality of passages having a stop mechanism.

[0005] Another embodiment relates to a water filtration system comprising a water source container and a water filter affixable to the water source container. The water filter has an upper body and a lower body, the upper body and lower body removably engageable with each other; and a filter body affixed to one of the upper body and the lower body, the filter body having a plurality of passages there through.

[0006] Another embodiment relates to a method of filtering water comprising filling a water source container; sealing the water source container with a filter, the filter having a plurality of xylem filters disposed therein; exerting pressure on the water, driving the water through the xylem filters, wherein the flow of water through the filter is at least 1.5L per day.

Brief Description of Drawings

[0007] The foregoing and other features of the present disclosure will become more fully apparent from the following description and appended claims, taken in conjunction with the accompanying drawings. Understanding that these drawings depict only several implementations in accordance with the disclosure and are therefore, not to be considered limiting of its scope, the disclosure will be described with additional specificity and detail through use of the accompanying drawings.

[0008] Figure 1 shows an embodiment of a water filtration device.

[0009] Figure 2 shows an exploded view of one embodiment of a water filter.

[0010] Figure 3A shows an exploded view of one embodiment of a water filtration device with a unitary filter.

[0011] Figure 3B shows an exploded view of one embodiment of a water filtration device with a multi-part filter having an upper portion and a lower portion.

[0012] Figure 4A shows a perspective view of one embodiment of a unitary water filter; Figure 4B shows a cross-sectional perspective view of the embodiment of Figure 4A.

[0013] Figure 5A shows a plane view of one embodiment of an upper portion of a water filter; Figure 5B shows a cross-sectional perspective view of the embodiment of Figure 5A; Figure 5C shows a perspective view of the embodiment of Figure 5A; Figure 5D shows an embodiment of a filter with an upper portion and lower portion assembled.

[0014] Figure 6A is a plane view of an embodiment of a lower portion of a water filter having one filter passage; Figure 6B is a cross-sectional view of the embodiment of Figure 6A.

[0015] Figure 7A is a perspective view of an embodiment of a lower portion of a water filter having a plurality of filter passages; Figure 7B is a cross-sectional view of the embodiment of Figure 7A; Figure 7C illustrates a lower portion having a filter body with a plurality of passages, each passage having a xylem filter and a sealant applied.

[0016] Figure 8 is a flowchart depicting one embodiment of a method of filtering water.

[0017] Reference is made to the accompanying drawings throughout the following detailed description. In the drawings, similar symbols typically identify similar components, unless context dictates otherwise. The illustrative implementations described in the detailed description, drawings, and claims are not meant to be limiting. Other implementations may be utilized, and other changes may be made, without departing from the spirit or scope of the subject matter presented here. It will be readily understood that the aspects of the present disclosure, as generally described herein, and illustrated in the figures, can be arranged, substituted, combined, and designed in a wide variety of different configurations, all of which are explicitly contemplated and made part of this disclosure.

Detailed Description of Various Embodiments

[0018] Here we show one embodiment of a design and implementation process of a device and system that uses the filtration properties of plant xylem to create a cheap and simple-to-use water filter. The filtration device 100 includes is a filter that attaches, removably or permanently, to a water container, for example the commonly used Jerrycan, and a filter base that can hold at least one xylem filter. The water filtration device, in one embodiment, includes a water source container 110 (dirty water), a water filter 150 connected to the water source container 110, and a water collector 180 (filtered water).

[0019] The water source container 110 may comprise any number of water sources, including a source or stream directly from a natural or artificial body of water. The water source container 110 may be a bucket, bowl, or, as in the illustrated embodiments, a Jerrycan. The water in the water source container 110 provides the hydrostatic force that drives water through the filter. Thus, a method of using the filtration device 100

[0020] The water source container 110 is connected to a filter 150. The filter 150 is, in one embodiment, connectable with both the water source container 110 and the water collector 180. In some embodiments, one or both of the connections to the water source container 110 and collector 180 may be permanent or may be removable. The filter 150 comprises a filter upper housing 152. The filter upper housing 152 has an lower housing 153 with one or more passages 160 extending from the upper housing to the lower housing. The filter upper housing 152 and filter lower housing 153 may be a unitary component or may be separate components that fit together, such as by threading, friction, snapfit, or adhesive. In one embodiment, such as illustrated in the figures, the filter upper housing 152 is fabricated using 3D rapid prototyping printer. The filter 150 has a first opening 155 that is associated with the water source container 110 (and unfiltered water) and at an opposite end a second opening 156 associated with the water collector 180 (and filtered water). In one embodiment, the first opening is positioned on the upper portion 152 and the second opening is positioned on the lower

portion 153. Filter passages 160 extend from the first opening 155 to the second opening 156. The filter passages 160 extend through a filter body 158. The filter body 158 may be a separate component that is retained in place by the upper portion 152 and the lower portion 153 or may be integral with or attached to the upper portion 152 or the lower portion 153. Thus, water is able to flow from the water source container 110 through the filter 150, specifically through the filter passages 160, into the water collector 180.

[0021] The filter passages 160 are configured to accept a xylem filter 162 disposed therein. Water flow through xylem has been shown to be associated with low flow rate, thus, in one embodiment, the device 100 includes multiple water flow paths within the filter 150 each filtered by a xylem filter 162 to provide for an larger overall filtration throughput than a single flow path with a same-sized xylem filter 162. Further, the filter upper housing lower housing 153 may be compressible and elastic such that the size of the passages 160 are flexible and adjust to xylem filters of different diameters. The passages 160, in one embodiment, have a circular cross-section and a cylindrical shape to accommodate the most common shape of branches. In one embodiment, a filler or sealant is utilized to provide a water-tight seal between the xylem filter 162 and the sides of the passage 160. For example, in one embodiment, a sealant 170 is used to seal the filter such that water must flow through the xylem filter 162 to exit. The sealant may comprise, in various embodiments, candle wax, bee's wax, plastic (melted consumer plastics), silicon, organic plastics or rubber. For example, candle wax is used to seal the gaps between the xylem filter 162 and lower housing 153, which can be easily removed for exchanging xylem filters 162 with fresh pieces when needed.

[0022] In one embodiment, the water source container 110 and the filter upper housing 152 are permanently sealed while the filter lower housing 153 is removable therefrom. For example, epoxy glue is used create a permanent seal between the water source container 110, such as the cap/mount of a Jerrycan, and the first opening 155 of the filter 150 located in the filter upper housing 152. In the illustrated embodiment, the threads of one side of the filter upper housing 152 were designed to

match those of the water source container 110 and the other thread, interior threads, were designed to match those of the filter lower housing.. In one embodiment, a gasket 151 or the like, such as a butyl rubber gasket, is used to prevent leakage between the two pieces. In a further embodiment, the lower housing 153 is designed with an additional smooth ring wall 159 that presses against the gasket 151 as the two pieces are screwed into each other. The pressure exerted by the smooth wall 159 creates a watertight seal.

[0023] The xylem filter 162 may be comprised of organic vascular plant materials, including wood. The xylem filter may comprise portions of trees or woody plants, such as roots, stems, branches, trunks, etc. The xylem filter may be cut to size and include or exclude bark or outer portions of the plant. The xylem filter 162 is “wet”, that is it is exposed to water when filtering and, in one embodiment, will be inundated with water. The water is filtered by action of the water traveling through the xylem, where spacing is typically less than 100nm and may be less than 70nm, filter out larger particles and bacteria that cannot pass through the tracheids or vessels. Example woods that can be used include local native trees, such as gymnosperms or Yellowwood trees in East and Southern Africa.

[0024] In one embodiment, the passage 160 includes a reduced portion or stop 165 located near 165 the second opening. The stop 165 provides a physical resistance for the xylem filter 163 in each hole for holding the xylem in place during hydrostatic pressure application.

[0025] Further, in one embodiment, the water source container 110 may have a pump associated therewith. The pump may be manual or driven by a motor and provides further pressure, such as by pumping air or water into the container 110. In one embodiment, at least 5 PSI is exerted on water at the xylem filter 163.

[0026] In one embodiment, the xylem filter 163 filters particles greater than 150nm, greater than 100nm, or greater than 70nm.

[0027] In one embodiment, the filter 150 may be configured to receive an additional secondary filter or purifying agent, for example chemical tablets (such as chlorine) or activated charcoal. For example, the filter may include a space between the lower housing 153 and the filter upper housing 152 where a charcoal filter, such as activated charcoal, can be deposited. The charcoal filter may be charcoal disposed in a bag, such as a cheese-cloth bag. In one embodiment, the filter includes a screen or mesh at the first opening 155 and the charcoal is captured between the mesh and the lower housing 153 when the filter 150 is assembled. Further, the screen or mesh may be used in embodiments as its own secondary filter, serving to prevent larger debris such as leaves from clogging the xylem filter 163.

[0028] The water collection 180 may be used to store or collect water. Alternatively, the output from the filter 150 may be directly to an end user.

[0029] In one embodiment, the filter 150 may include a valve to seal the first opening 155. The valve both prevents water from continuing to “run” as well as preventing water retained in the water supply container 110 from sedimenting and ruining or damaging the filter 150. The device 100 can be agitated to re-suspend sediment before opening the valve to continue filtering.

[0030] In one embodiment, with reference to Figure 7, a method of filter water comprises filling the water source container at step 310. The water source container is then sealed at step 320 with the filter 150, for example by attaching (step 321) on the upper portion 152 and then attaching (step 325) the lower portion 153. Optionally (step 322), the xylem filters 163 are inserted into the filter body 158. Optionally (step 323), the xylem filters 163 are sealed. Optionally (step 324), a secondary filter is utilized, such as placing charcoal in the filter 150 prior to securing the lower portion 153.

[0031] The device is then pressurized at step 330, such as by turning it upside down. The water is then driven through the filter, specifically through the xylem filters 162 and out of the filter 150. The water is filtered at step 340 and dispensed from the filter at step 350.

[0032] In one embodiment, the device is capable of filtering 12 liters of water per day. In one embodiment, the flow rate of the device is 100-12000 ml per day. In another embodiment, the flow rate is at least 120ml per day, 240ml per day, 360ml per day, 480ml per day, 600ml per day, 720ml per day, 840ml per day, 960ml per day, 1080ml per day,

[0033] While embodiments herein have been described with regard to water, it should be appreciated that various liquids may be utilized with the described filtration device 100.

[0034] As used herein, the singular forms “a”, “an” and “the” include plural referents unless the context clearly dictates otherwise. Thus, for example, the term “a member” is intended to mean a single member or a combination of members, “a material” is intended to mean one or more materials, or a combination thereof.

[0035] As used herein, the terms “about” and “approximately” generally mean plus or minus 10% of the stated value. For example, about 0.5 would include 0.45 and 0.55, about 10 would include 9 to 11, about 1000 would include 900 to 1100.

[0036] It should be noted that the term “exemplary” as used herein to describe various embodiments is intended to indicate that such embodiments are possible examples, representations, and/or illustrations of possible embodiments (and such term is not intended to connote that such embodiments are necessarily extraordinary or superlative examples).

[0037] The terms “coupled,” “connected,” and the like as used herein mean the joining of two members directly or indirectly to one another. Such joining may be stationary (e.g., permanent) or moveable (e.g., removable or releasable). Such joining may be achieved with the two members or the two members and any additional intermediate members being integrally formed as a single unitary body with one another or with the two members or the two members and any additional intermediate members being attached to one another.

[0038] It is important to note that the construction and arrangement of the various exemplary embodiments are illustrative only. Although only a few embodiments have been described in detail in this disclosure, those skilled in the art who review this disclosure will readily appreciate that many modifications are possible (e.g., variations in sizes, dimensions, structures, shapes and proportions of the various elements, values of parameters, mounting arrangements, use of materials, colors, orientations, etc.) without materially departing from the novel teachings and advantages of the subject matter described herein. Other substitutions, modifications, changes and omissions may also be made in the design, operating conditions and arrangement of the various exemplary embodiments without departing from the scope of the present invention.

[0039] While this specification contains many specific implementation details, these should not be construed as limitations on the scope of any inventions or of what may be claimed, but rather as descriptions of features specific to particular implementations of particular inventions. Certain features described in this specification in the context of separate implementations can also be implemented in combination in a single implementation. Conversely, various features described in the context of a single implementation can also be implemented in multiple implementations separately or in any suitable subcombination. Moreover, although features may be described above as acting in certain combinations and even initially claimed as such, one or more features from a claimed combination can in some cases be excised from the combination, and the claimed combination may be directed to a subcombination or variation of a subcombination.

WHAT IS CLAIMED IS:

1. A water filter comprising:
an upper body having a first opening and a lower body having a second opening, the upper body and lower body removably engageable with each other; and
a filter body affixed to one of the upper body and the lower body, the filter body having a plurality of passages there through and extending from the first opening to the second opening, each of the plurality of passages having a stop mechanism.
2. The water filter of claim 1, further comprising a xylem filter disposed in the filter body.
3. The water filter of claim 2, further comprising a plurality of xylem filters.
4. The water filter of claim 1, further comprising a secondary filter.
5. The water filter of claim 1, wherein the secondary filter comprises a mesh associated with the first opening.
6. The water filter of claim 1, wherein the upper body has threading about the first opening configured for engaging a water source container and the upper body and lower body are threadably removably engageable.
7. The water filter of claim 1, wherein the stop mechanism comprises a reduced diameter portion of the plurality of passages.
8. A water filtration system comprising
a water source container;
a water filter affixable to the water source container, the water filter having:
an upper body and a lower body, the upper body and lower body removably engageable with each other; and

a filter body affixed to one of the upper body and the lower body, the filter body having a plurality of passages there through.

9. The water filtration system of claim 8, further comprising a xylem filter disposed in the filter body.

10. The water filtration system of claim 9, further comprising a plurality of xylem filters.

11. The water filtration system of claim 8, further comprising a secondary filter.

12. The water filtration system of claim 8, wherein the secondary filter comprises a mesh associated with the first opening.

13. The water filtration system of claim 8, wherein the upper body has threading about the first opening configured for engaging a water source container and the upper body and lower body are threadably removably engageable.

14. The water filtration system of claim 8, wherein each of the plurality of passages has a stop mechanism.

15. The water filtration system of claim 14, wherein the stop mechanism comprises a reduced diameter portion of the plurality of passages.

16. A method of filtering water comprising:

filling a water source container;

sealing the water source container with a filter, the filter having a plurality of xylem filters disposed therein;

exerting pressure on the water, driving the water through the xylem filters,

wherein the flow of water through the filter is at least 1.5L per day.

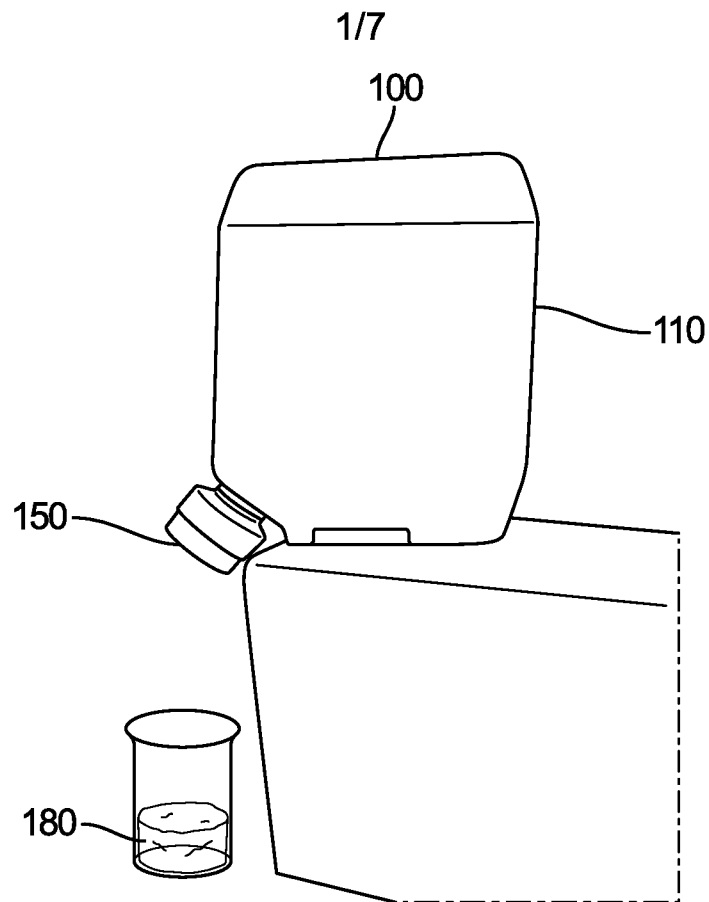


FIG. 1

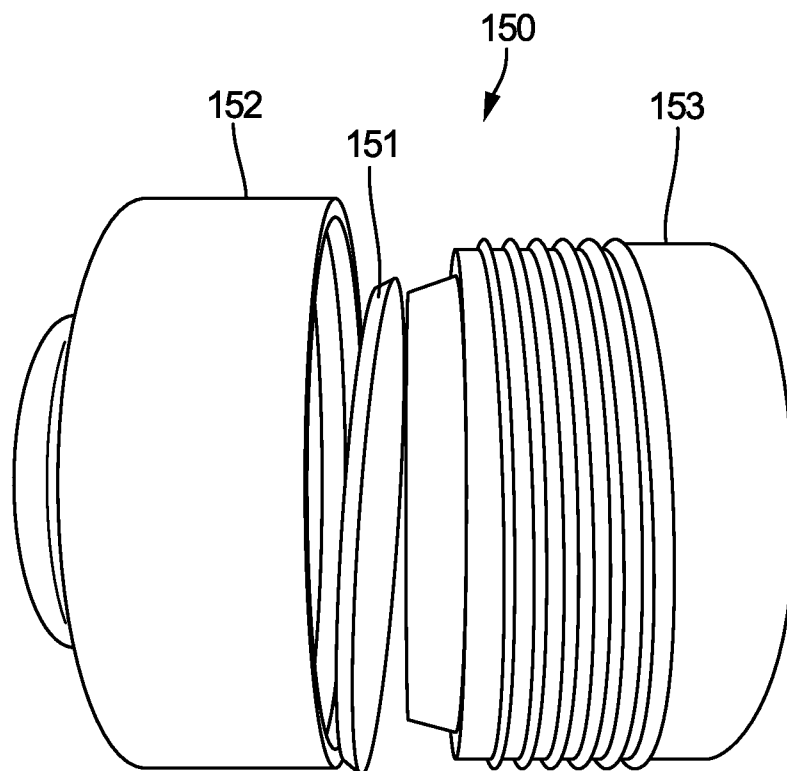


FIG. 2

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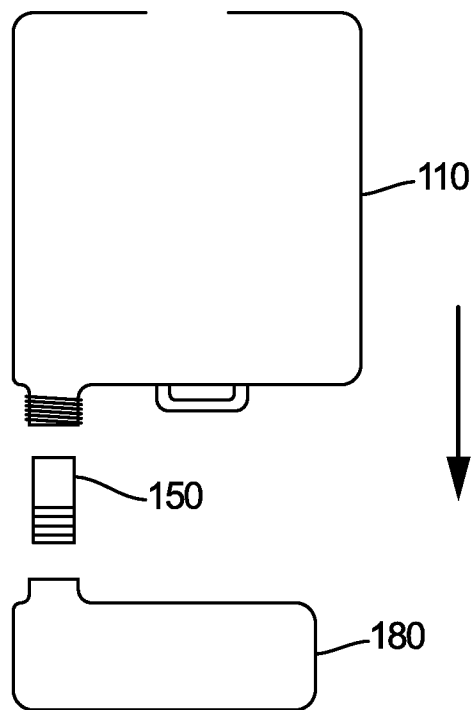


FIG. 3A

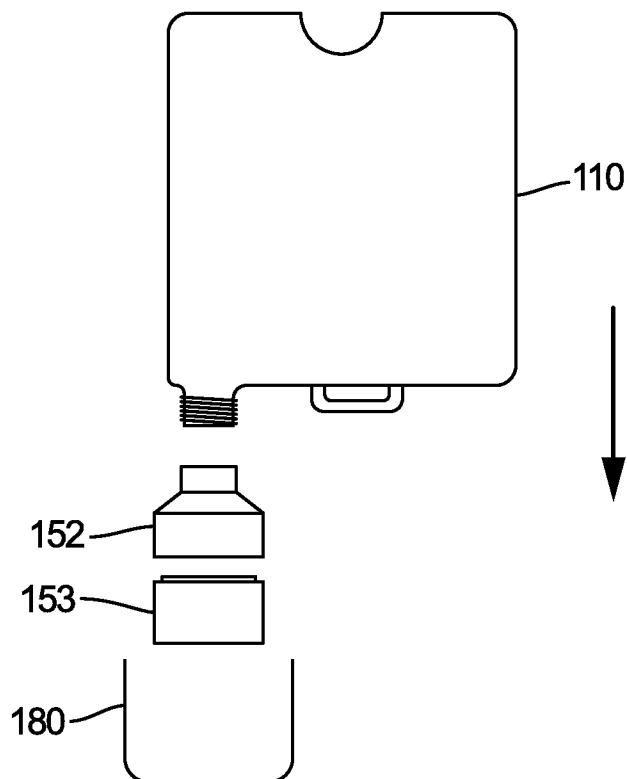


FIG. 3B

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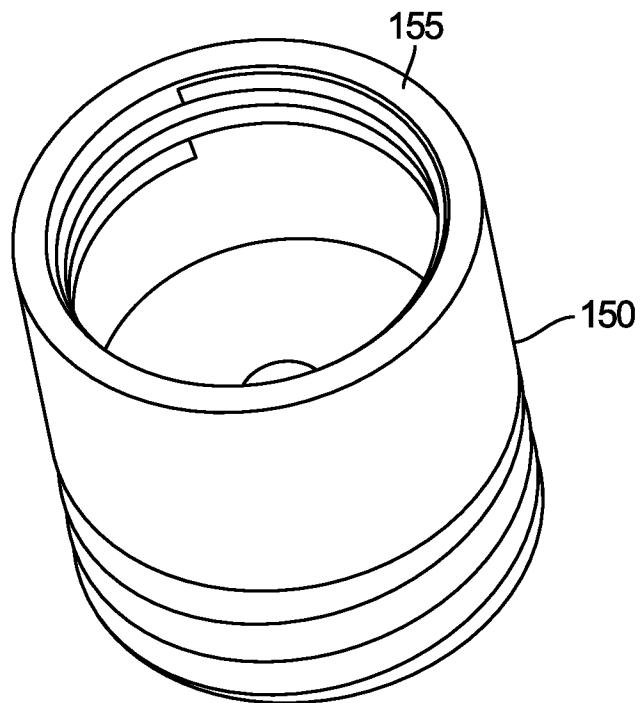


FIG. 4A

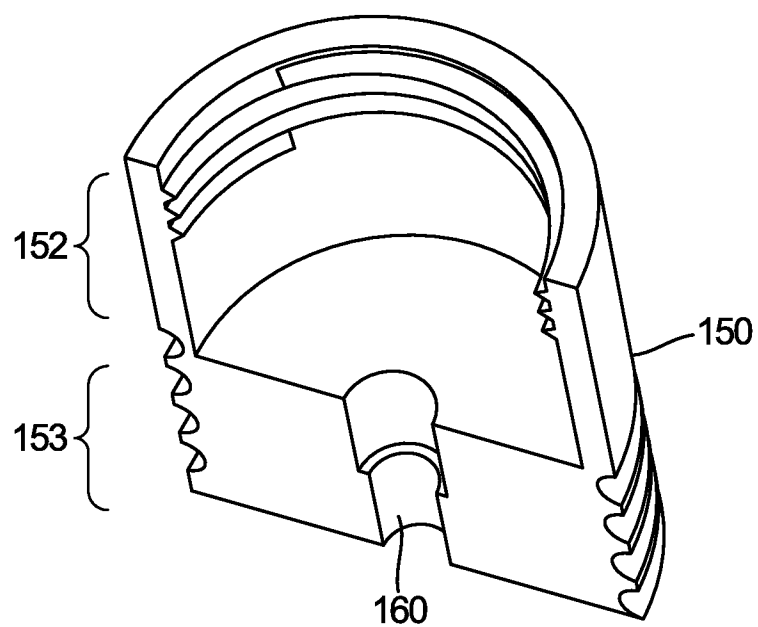


FIG. 4B

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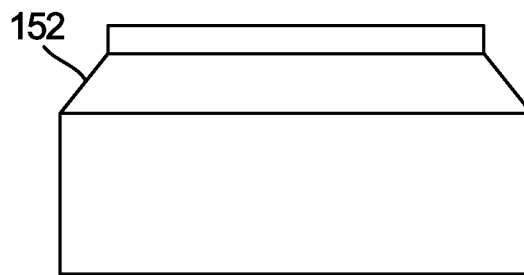


FIG. 5A

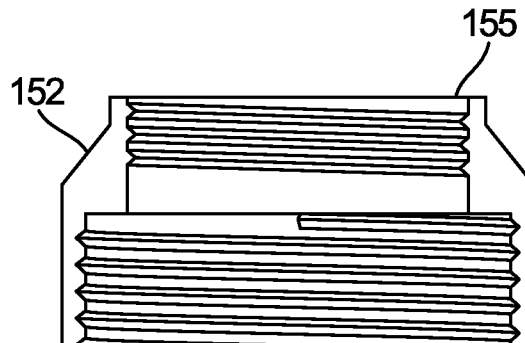


FIG. 5B

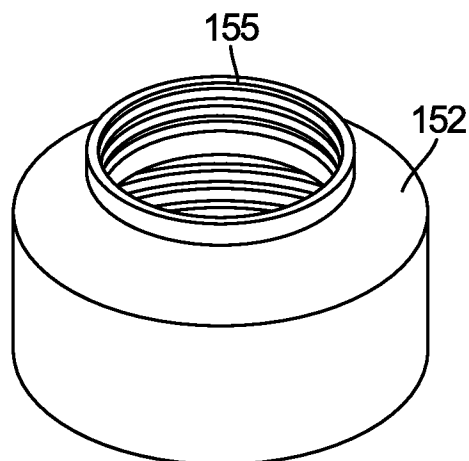


FIG. 5C

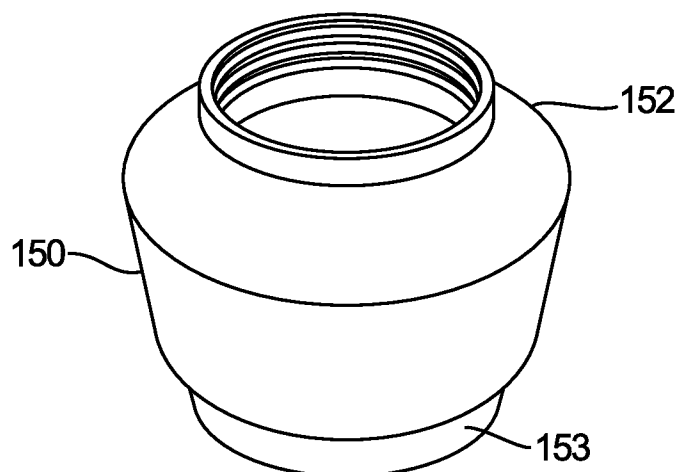


FIG. 5D

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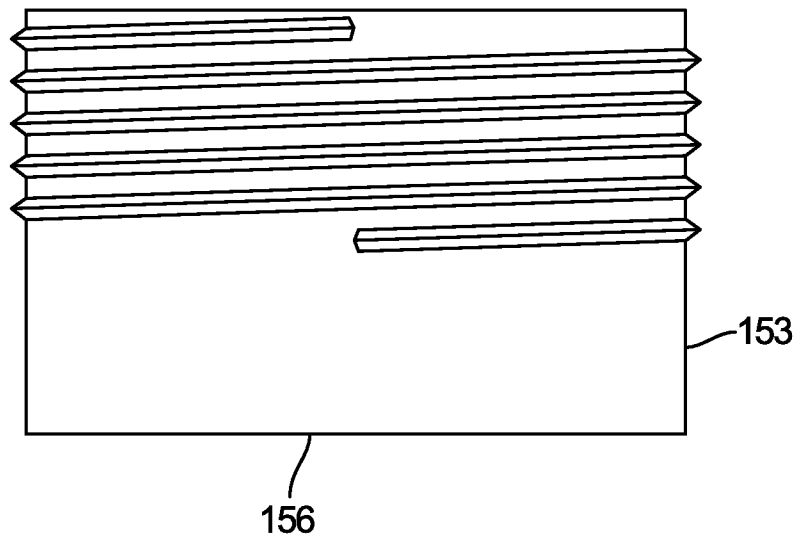


FIG. 6A

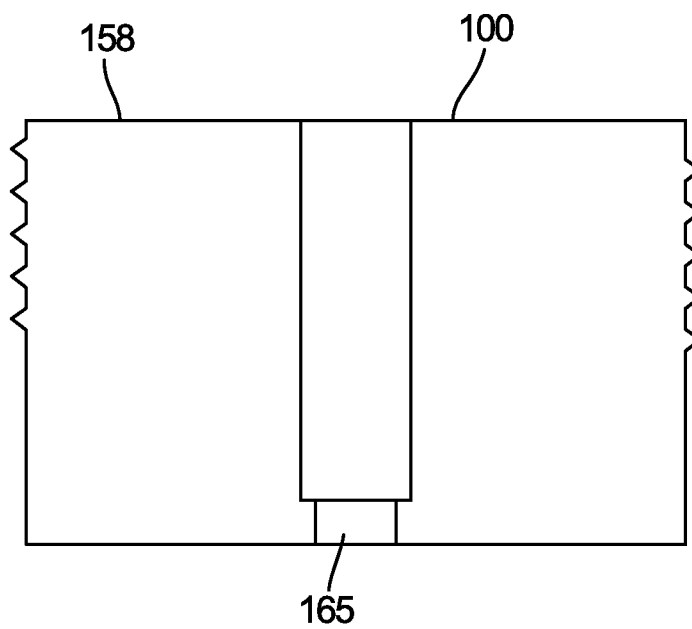


FIG. 6B

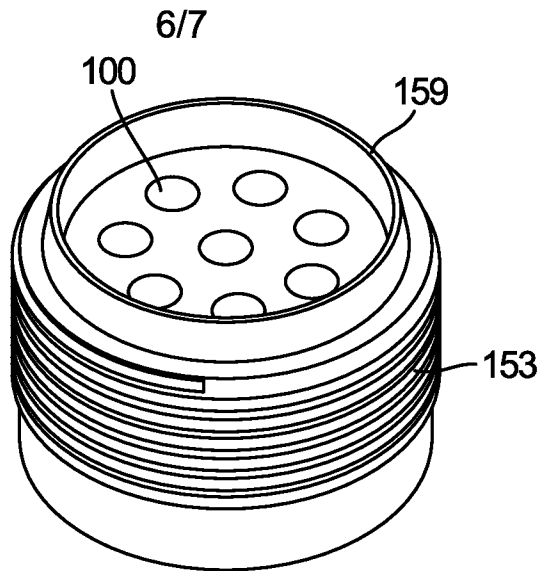


FIG. 7A

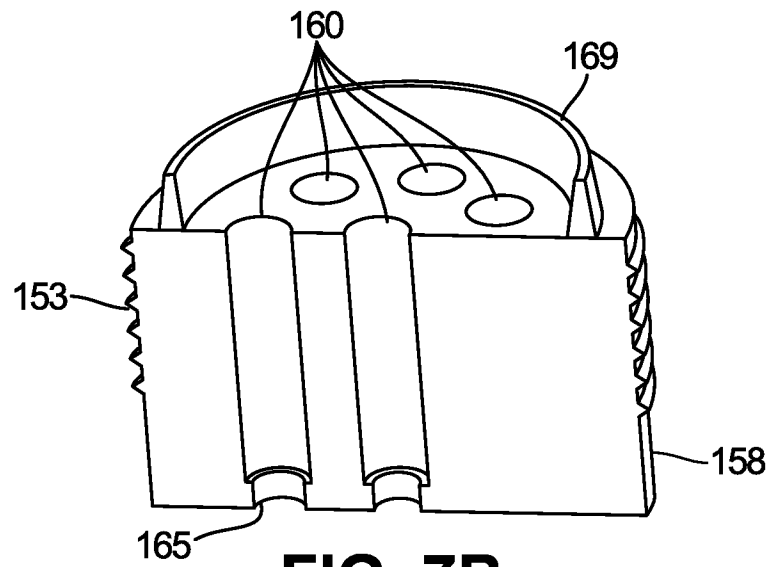


FIG. 7B

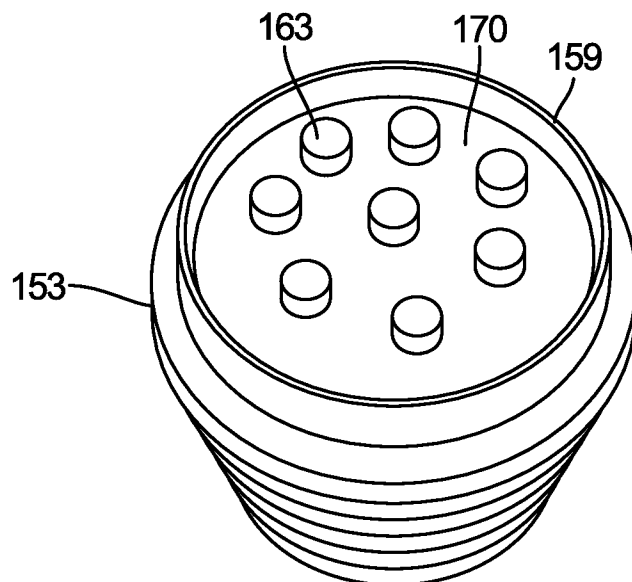
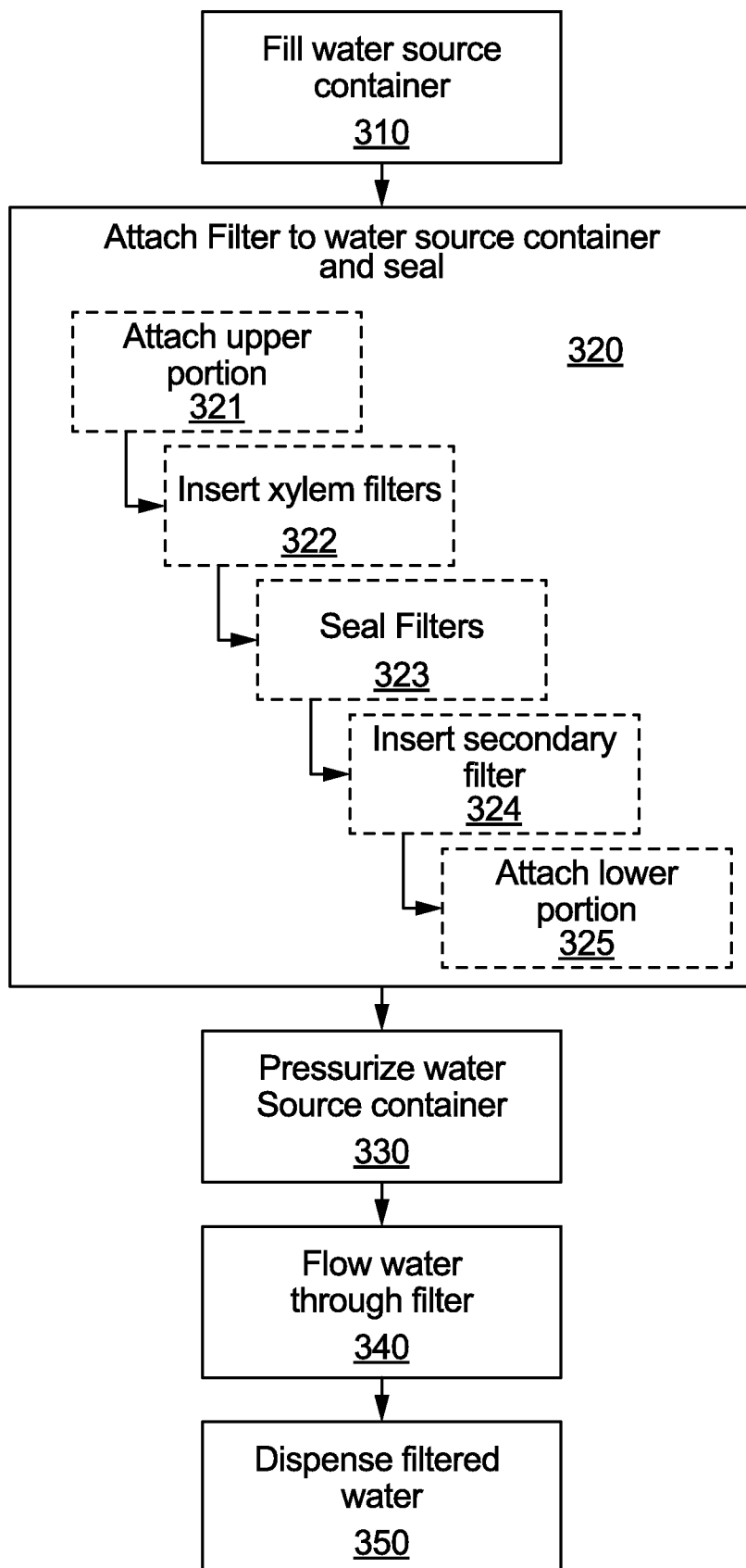


FIG. 7C

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**FIG. 8**

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 17/41570

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - B01D 27/04, 27/08, 29/50, 35/30, 39/16, 39/18 (2017.01)

CPC - B01D 27/08, 35/301, 27/00, 27/04, 27/14, 27/142, 29/00, 29/085, 29/50, 29/52, 35/00, 35/02, 35/04, 35/046, 35/30, 35/306, 39/00, 39/16, 39/1607, 39/1615, 39/18; B67D 2210/0001; C02F 1/00, 1/001, 1/002, 1/003, 2201/006, 2201/007, 2307/02, 2307/04, 2307/06, 2307/10

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)

See Search History Document

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

See Search History Document

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

See Search History Document

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 3,780,869 A (Krongos) 25 December 1973 (25.12.1973), Figs. 1-3, col. 4, ln. 5-62	1, 4, 6-8, 11 and 13-15 --- 2-3, 5, 9-10, 12 and 16
Y	US 2014/0239014 A1 (Back Road Ventures, Inc., dba Zip 2 Water) 28 August 2014 (28.08.2014), para [0050]	2-3, 9-10, and 16
Y	US 2009/0008318 A1 (Anes et al.) 08 January 2009 (08.01.2009), Fig. 1, para [0048]	5 and 12
A	US 2009/0321339 A1 (Suzuki et al.) 31 December 2009 (31.12.2009), Figs. 1a-1c, 2a-2b, para [0052]-[0053]	1-16
A	US 2016/0031719 A1 (Yang) 04 February 2016 (04.02.2016), Figs. 1-2, para [0027]-[0032]	1-16

☐

Further documents are listed in the continuation of Box C.

☐

See patent family annex.

* Special categories of cited documents:

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Date of the actual completion of the international search

10 September 2017

Date of mailing of the international search report

12 OCT 2017

Name and mailing address of the ISA/US

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