(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
04 May 2023 (04.05.2023)

WIPO | PCT

(10) International Publication Number
WO 2023/076312 A1

(51) International Patent Classification:
A01G 9/02 (2018.01) *A01G 31/06* (2006.01)
A01G 9/24 (2006.01) *A01G 27/02* (2006.01)

(21) International Application Number:
PCT/US2022/047776

(22) International Filing Date:
25 October 2022 (25.10.2022)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
63/262,987 25 October 2021 (25.10.2021) US

(71) Applicant: **LIFEPONIC SOLUTIONS, LLC** [US/US]; 2555 CARDIGAN DRIVE, COLORADO SPRINGS, Colorado 80920 (US).

(72) Inventors: **ENOS, Michael L.**; 2555 Cardigan Drive, Colorado Springs, Colorado 80920 (US). **GOATES, Eldon L.**; 7115 Montarbor Dr., Colorado Springs, Colorado 80918 (US). **JAMES, Marshall Lee**; 19830 W. Top O The Moor, Monument, Colorado 80132 (US).

(74) Agent: **DOCKERY, David F.**; The Navitas Intellectual Property Group LLC, 4600 South Syracuse Street, Suite 900, Denver, Colorado 80237 (US).

(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, CV, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IQ, IR, IS, IT, JM, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, 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, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, CV, 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, ME, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI,

(54) Title: VERTICALLY ORIENTED PLANT GROWING SYSTEMS

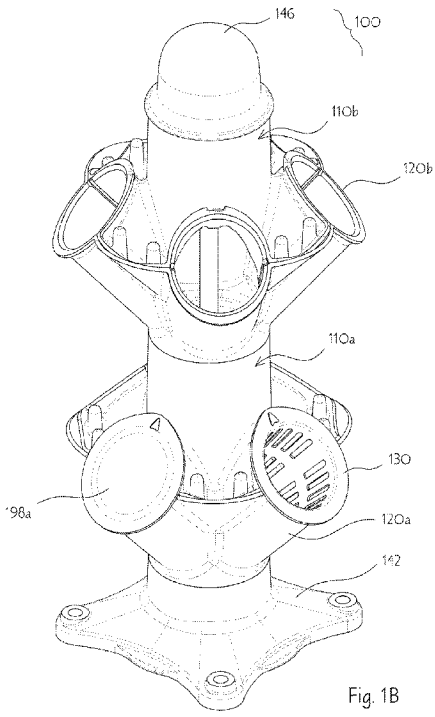

Fig. 1B

(57) Abstract: Plant growth structures and components of plant growth structures. The plant growth structure components provide the ability to customize the plant growth structure to suit the needs of different types of plants. The plant growth structures also provide improved water flow to the plants and a high density of plants in a relatively small growing area.

WO 2023/076312 A1

[Continued on next page]

SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

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

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

VERTICALLY ORIENTED PLANT GROWING SYSTEMS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the priority benefit of US Provisional Patent Application No. 63/262,987 by Enos and filed on October 25, 2021, which is incorporated herein by reference in its entirety.

FIELD

[0002] This disclosure relates to the field of plant growing systems, particularly to vertical plant growing towers that utilize a reduced amount of water for plant growth as compared to conventional growing methods.

BACKGROUND

[0003] Hydroponics is a type of horticulture and a subset of hydroculture which involves growing plants (usually crops) by using mineral nutrient solutions in an aqueous solvent. Terrestrial plants may grow with their roots exposed to the nutritious liquid, or, in addition, the roots may be physically supported by an inert medium such as peat, perlite, gravel, or other substrates.

[0004] Hydroponics offers many advantages as compared to traditional farming methods. Hydroponics enable plants to be grown indoors and using a smaller footprint for the same quantity of plants. Further, there is a significant decrease in water usage. For example, to grow 1 kilogram (2.2 lb) of tomatoes using common farming methods typically requires about 400 liters (88 imp gal; 110 U.S. gal) of water; using hydroponics, 1 kilogram (2.2 lb) of tomatoes typically requires about 70 liters (15 imp gal; 18 U.S. gal. Since hydroponics requires much less water to grow produce , it is possible for people in harsh environments with little accessible water to grow their own food.

SUMMARY

[0005] In one embodiment, a plant growth structure that includes a plurality of planter modules is disclosed. The planter modules include a central section having a top end, a

bottom end and an outer wall defining an interior fluid conduit therethrough for the passage of a liquid. At least three growth basket receptacles are disposed in a substantially horizontal plane around a periphery of the central section, the growth basket receptacles having an outer diameter and being configured so that when a growth basket is placed in a growth basket receptacle, at least a lower portion of the growth basket is in fluid communication with the fluid conduit. The peripheral density of the growth basket receptacles disposed around the central section is at least about 0.6. As a result, the density of plants that may be grown within the area of the plant growth structure is increased as compared to known plant growth structures.

[0006] The foregoing embodiment is subject to a number of characterizations and refinements that may be implemented alone or in any combination. Such characterizations and refinements are set forth in the following description and in the claims filed with the application.

[0007] In another embodiment, a kit for the construction of a plant growth system is disclosed. The kit includes at least a first planter module, the first planter module including a central section having a top end, a bottom end and an outer wall defining an interior fluid conduit therethrough for the passage of a liquid. A plurality of growth basket receptacles are disposed around a periphery of the central section, where the growth basket receptacles are in fluid communication with the interior fluid conduit.

[0008] In one characterization, at least a first riser tube module is provided in the kit. The first riser tube module includes a top end, a bottom end and an outer wall defining an interior fluid conduit for the passage of a liquid. The outer wall has a periphery that is substantially the same cross-section as the outer periphery of the central section of the planter module. The riser tube module is configured to operatively and securely attach to the bottom end of the planter module. The riser tube module outer wall is free from growth basket receptacles.

[0009] In another characterization, at least a first plant support module is provided in the kit. The first plant support module includes a central section having a top end, a bottom end and an outer wall defining an interior fluid conduit for the passage of a liquid therethrough. A plant support tray is operatively disposed around a periphery of the

central section, the plant support tray including a top surface that extends outwardly from the central section and is configured to support portions of a plant thereupon. The central section is configured to operatively and securely attach to the bottom end of the at least first planter module.

[0010] The foregoing embodiment of a kit for the construction of a plant growth structure is subject to a number of additional characterizations and refinements that may be implemented alone or in any combination. Such characterizations and refinements are set forth in the following description and in the claims filed with the application.

[0011] In another embodiment, a plant growth structure is disclosed that includes a plurality of planter modules. The planter modules include a central section having a top end, a bottom end, and a sidewall defining an interior fluid conduit therethrough for the passage of a liquid. At least a first growth basket receptacle is disposed on a periphery of the central section, the first growth basket receptacle having an outer diameter and being in fluid communication with the fluid conduit. At least a first flow guide is disposed on the interior fluid conduit, the first flow guide including a projection extending outwardly from the fluid conduit to direct liquid into a growth basket placed in the growth basket receptacle.

[0012] The foregoing embodiment of a plant growth structure is subject to a number of additional characterizations and refinements that may be implemented alone or in any combination. Such characterizations and refinements are set forth in the following description and in the claims filed with the application.

[0013] In another embodiment, a plant growth basket is disclosed. The plant growth basket is configured to be placed within a growth basket receptacle, e.g., in a vertically-oriented plant growing system. The growth basket includes a sidewall, a bottom wall, a top rim and a top orifice for receiving plant growing matter within the interior of the growth basket. A plurality of fluid apertures are disposed in the sidewall and a plurality of fluid apertures are disposed in the bottom wall. The growth basket includes at least first and second flanges disposed along an exterior surface of the growth basket sidewall.

[0014] The foregoing embodiment of a plant growth basket is subject to a number of additional characterizations and refinements that may be implemented alone or in any

combination. Such characterizations and refinements are set forth in the following description and in the claims filed with the application.

DESCRIPTION OF THE DRAWINGS

[0015] **FIGS. 1A – 1C** illustrate an embodiment of a plant growth structure according to an embodiment of the present disclosure.

[0016] **FIGS. 2A – 2D** illustrate an embodiment of a planter module according to an embodiment of the present disclosure.

[0017] **FIGS. 3A – 3D** illustrate an embodiment of a planter module that is fabricated from two sections according to an embodiment of the present disclosure.

[0018] **FIGS. 4A – 4D** illustrate an embodiment of a plant growth basket according to an embodiment of the present disclosure.

[0019] **FIGS. 5A – 5D** illustrate an embodiment of a plant growth basket according to an embodiment of the present disclosure.

[0020] **FIGS. 6A – 6B** illustrate an embodiment of a base module according to an embodiment of the present disclosure.

[0021] **FIG. 7** illustrates an exploded view of a plant growth structure according to an embodiment of the present disclosure.

[0022] **FIGS. 8A – 8B** illustrate an embodiment of a plant growth structure according to an embodiment of the present disclosure.

[0023] **FIG. 9** illustrates a cross-sectional view of a central section of a plant growth structure module according to an embodiment of the present disclosure.

[0024] **FIG. 10** illustrates a partial cross-section of a planter module and a growth basket spacer according to an embodiment of the present disclosure.

[0025] **FIG. 11** illustrates a perspective view of a riser module according to an embodiment of the present disclosure.

[0026] **FIGS. 12A – 12B** illustrate an embodiment of a plant support module according to an embodiment of the present disclosure.

[0027] **FIG. 13** illustrates a perspective view of a portion of a plant growth structure incorporating a riser module and two plant support modules according to an embodiment of the present disclosure.

DESCRIPTION

[0028] Disclosed herein are vertically oriented plant growth structures, e.g., for the hydroponic growth of plants. The plant growth structures include a plurality of growth basket receptacles, e.g., receptacles that are configured to secure a growth basket containing a growing medium such as perlite, peat, clay aggregate, etc. holding seeds or a live plant. Also disclosed are structural elements and components, e.g., modules, that are configured to supply an aqueous liquid, e.g., nutrient-enhanced water, to the seed and/or live plants contained in the growth baskets in an efficient manner.

[0029] The plant growth structures disclosed herein may be fabricated as a unitary structure or may be fabricated from several components that are interconnected together, e.g., as a modular system. In certain embodiments, the plant growth structure is constructed in a modular fashion, e.g., by interconnecting several modules to construct the vertically oriented plant growth structure.

[0030] **FIGS. 1A – 1C** illustrate a plant growth structure according to an embodiment of the present disclosure. Specifically, **FIG. 1A** illustrates a front view, **FIG. 1B** illustrates a perspective view and **FIG. 1C** illustrates a cross-sectional view of the plant growth structure **100**. The plant growth structure **100** illustrated in **FIGS. 1A – 1C** is a vertically oriented plant growth structure, i.e., the structure **100** has a major axis in the vertical direction when the structure **100** is operatively oriented for the growth of plants. The plant growth structure **100** includes two vertically spaced planter modules **110a/110b** that each include a plurality of growth basket receptacles, such as growth basket receptacles **120a/120b**. The growth basket receptacles are disposed around a central support section **112a/112b** of each planter module **110a/110b**, e.g., are disposed around a periphery of

the central sections. As illustrated in the figures, the central support section of the planter module is substantially round, i.e., has a substantially round cross-section. However, the present disclosure is not limited to a particular shape for the central sections, which may have an oval cross-section or a polygonal cross-section such as a square cross-section. In any event, the growth basket receptacles illustrated in the figures extend outwardly and upwardly from the central sections **112a/112b**, e.g., at an upward angle of from about 35° to about 55° such as at an angle of about 45°. The growth basket receptacles are configured, e.g., sized an shaped, to operatively secure a growth basket, e.g., growth basket **130**, within the receptacles. As is illustrated in **FIG. 1C**, the growth basket **130** comprises an attachment element **138**, e.g., a notch, disposed on a top rim **140** of the growth basket. The attachment element **138** may be mated to a corresponding notch disposed on an upper edge of the plant growth basket receptacle **120a** to secure the basket to the receptacle.

[0031] A base module **142** provides support for the plant growth structure **100** and includes a fluid inlet **143** that is configured to receive a liquid feed, e.g., nutrient-enhanced water, that is pumped through the fluid inlet **143**. As illustrated in **FIG. 1C**, the fluid inlet **143** is in fluid communication with a liquid feed tube **144** that extends upwardly through the central sections **110a/110b** and that terminates below a cap **146** that is operatively affixed to the top of the plant growth structure **100**, e.g., is affixed to a top end **113b** of the planter module **110b**. As a result, when a liquid is pumped into the fluid inlet **143** and moves upwardly through the liquid feed tube **144**, the liquid will exit the feed tube **144** through tube aperture **145** and will flow into a fluid conduit **116b** within the planter module **110b**. As used herein, a fluid conduit is a pathway that enables a liquid to flow, e.g., under the influence of gravity, from an upper portion of a structure or module to a lower portion of the structure or module. Portions of a fluid conduit may be defined by an inner surface of the central sections, and by fluid apertures that may be disposed within the central sections. In any event, the fluid conduit is configured to deliver water to the seeds or plants disposed in the growth baskets.

[0032] For example, the fluid conduit **113b** within the central section **112b** of the planter module **110b** is in fluid communication with the fluid conduit **113a** within the central section **112a** of the planter module **110a**. As a result, liquid may exit the liquid feed tube

144 and flow downwardly, e.g., under the force of gravity, through the fluid conduit **116b** and into the fluid conduit **116a**. As is described in more detail below, the aqueous liquid flow may be generally directed to the interior of the sidewalls **119a/119b** of the central sections **112a/112b**, e.g., so that the aqueous liquid flows down the interior of the sidewalls **119a/119b**. As is best seen in **FIG. 1C**, as the aqueous liquid passes along the interior of the sidewalls of the central sections, the liquid will contact the lower interior portion **135** of the growth basket **130**. Thus, the aqueous liquid will reach the roots of a plant that is contained in the growth basket **130**. Any aqueous liquid that is not captured by the plants within the growth baskets may continue to flow out of the bottom of the plant growth structure **100**, e.g., through the base **142**, upon which the liquid may be captured for recycle.

[0033] The embodiment of a plant growth structure illustrated in **FIGS. 1A – 1C** is for purposes of illustration and the present disclosure is not limited to the particular configuration illustrated therein. For example, the plant growth structure **100** includes two plant growth modules **110a/110b**, each having four growth basket receptacles disposed around a periphery of the plant growth modules. However, the plant growth modules disclosed herein may include one, two, three or more growth basket receptacles disposed around the central section. Further, the plant growth structure **100** illustrated in **FIGS. 1A – 1C** includes two plant growth modules **110a/110b** that are operatively connected and supported by a base module **142** and sealed at the top with a cap **146**. However, the plant growth structures disclosed herein may include a single plant growth module or may include any number of vertically arranged plant growth modules. See **FIGS. 8A - 8B**, for example.

[0034] Further, the embodiment of a plant growth structure illustrated in **FIGS. 1A – 1C** includes growth basket receptacles disposed about the periphery in a generally horizontal plane. While this is convenient for the present disclosure, the present disclosure is not limited to the particular configuration illustrated therein. For example, for access to light and for a pleasing visual effect, the growth basket receptacles may be disposed about the periphery of the central section in a spiral pattern going both around and up the central section, or in an offsetting pattern with every other receptable vertically displaced up or down.

[0035] In one refinement of a plant growth structure according to the present disclosure, the number of growth basket receptacles disposed around the central sections, e.g., on the periphery of the central sections in substantially the same horizontal plane, is very high. Stated another way, the number of growth basket receptacles that may be placed around a central section containing a fluid conduit may be increased in relation to known plant growth structures. As a result, the number of plants that may be grown simultaneously per unit area is increased.

[0036] As illustrated in **FIGS. 1A – 1C**, four growth basket receptacles are disposed around the central section in a manner to permit liquid flowing through fluid conduit to reach the lower portions of the growth baskets. In this construction, the growth basket receptacles are closely spaced, e.g., the outer side edges of the growth basket receptacles are essentially in contact. One way to characterize the spacing of the growth basket receptacles is using a peripheral density of the growth basket receptacles disposed around the periphery of the central section. As used herein, the peripheral density is defined as the combined outer diameters of the growth basket receptacles times the number of growth basket receptacles, divided by the length around the periphery of the central section, e.g., around the circumference of round central section. For example, if four growth basket receptacles are disposed around the central section and each growth basket has an outer diameter of about 2 inches, the combined growth basket receptacle diameters is about 8 inches. If the central section is round, e.g., having a substantially round cross-section, and has an outer diameter of about 2.5 inches, the periphery, e.g., the circumference, is about 7.85 inches, and the value of the peripheral density is about 1.02. The closer the value is to one, the higher the peripheral density of the growth basket receptacles. In one characterization, the peripheral density is at least about 0.6, such as at least about 0.7, such as at least about 0.8 or even at least about 0.9. In one characterization, the peripheral density is at least about 0.95. In contrast, and merely by way of example, a planter module having a round central section with a diameter of about 4.5 inches will have a circumference of about 24.67 inches. If four growth basket receptacles having an outer diameter of about 2 inches are disposed around the central section, the peripheral density would be about 0.57.

[0037] The plant growth structures disclosed herein may be fabricated as a single, unitary structure. In some embodiments of the present disclosure, the plant growth structure may be assembled from a plurality of independent modules that may be operatively connected to form the plant growth structure. Such a modular approach may facilitate ease of shipping, e.g., to a consumer, and may also enable a consumer to construct the plant growth structure in a variety of configurations. **FIGS. 2A** to **2D** illustrate an embodiment of a planter module that may be utilized is such a modular configuration. Specifically, **FIG. 2A** illustrates a perspective view of a planter module **210**, **FIG. 2B** illustrates a front view of the planter module, **FIG. 2C** illustrates a top view of the planter module and **FIG. 2D** illustrates a bottom view of the planter module.

[0038] The planter module **210** includes a plurality of growth basket receptacles **220a/220b/220c/220d** disposed around a central section **212**, e.g., disposed around a periphery of the section **212**. The growth basket receptacles **220a/220b/220c/220d** extend outwardly and upwardly from the central section **212**, e.g., at an angle of from about 35° to about 55° such as at an angle of about 45°. The growth basket receptacles are configured, e.g., sized an shaped, to operatively secure a growth basket within the receptacles. See **FIG. 1C**.

[0039] As particularly illustrated in **FIGS. 2A** and **2B**, the central section **212** includes a top end **213**, e.g., disposed above the growth basket receptacles, and a bottom end **214**, e.g., disposed generally below the growth basket receptacles. To facilitate the modular assembly of two or more planter modules, the bottom end **214** is configured to operatively attach to a top end of a similarly constructed planter module. As illustrated, the bottom end **214** is configured to slide within a top end, e.g., top end **213**, of a planter module disposed below planter module **210**. For example, the bottom end **214** may have an outer diameter that is close to the inner diameter of the top end **213** so that the bottom end **214** may be tightly fit within a top end of a lower planter module in a plant growth structure. In the configuration illustrated in **FIGS. 2A** and **2B**, the outer periphery of the bottom end **214** includes a plurality of notches such as notches **217a/217b/217c** disposed around the periphery. These notches are configured, e.g., sized and shaped, to operatively mate with one or more splines, e.g., spline **218a**, in an adjacent planter module to secure the planter module **210** to an adjacent planter module. In one

refinement, the notches are equally spaced around the periphery of the bottom end **214**. For example, the notches may be spaced around the periphery separated by about 90°, e.g., four total notches, or by about 60°, e.g., six total notches. In one particular characterization, notches are separated by about 45°, e.g., about 8 total notches around the periphery. As is disclosed below, such a construction may enable growth basket receptacles in vertically spaced planter modules to be offset by about 45°, e.g., to facilitate the capture of light by the plants placed in the growth basket receptacles.

[0040] Although illustrated as including splines **218a** in a top end **213** and notches **217a/217b/217c** in a bottom end **214** of the central section **212**, it will be appreciated that the placement of the mating splines and notches may be reversed, i.e., where the top end includes notches and the bottom end includes mating splines. Other means for securing two adjacent planter modules and for providing an angular offset of adjacent planter modules will occur to those of skill in the art.

[0041] **FIGS. 2C** and **2D** illustrate that the central section **212** includes a fluid conduit **216**, i.e., a fluid pathway, which enables the passage of a liquid through the central section **212** from the top end **213** to the bottom end **214**, e.g., by gravity induced flow. A flow direction plate **260** extends across the inner sidewall of the central section **212**, e.g., extends across the fluid conduit **216**. The flow direction plate **260** includes a plurality of fluid apertures, such as fluid aperture **262d**, disposed along an outer periphery of the flow direction plate **260**. The fluid apertures are disposed in vertical alignment with, e.g., disposed over, a growth basket receptacle. For example, fluid aperture **262d** is aligned with growth basket receptacle **220d**. As a result, liquid flowing through the fluid apertures will impinge upon the lower portion of a growth basket that is disposed within a growth basket receptacle. See **FIG. 1C**. As illustrated in **FIGS. 2C** and **2D**, the fluid apertures have a teardrop shape, i.e., being oblong with one end of the fluid aperture having a narrower width than the opposite end. As illustrated in **FIGS. 2C** and **2D**, the end of the aperture with the narrower width is disposed directly adjacent to the inner wall of the central section **212**. Although illustrated as having a teardrop shape, it will be appreciated that the fluid apertures may be round, oval, square, etc. provided that the apertures provide a fluid pathway through the flow direction plate **260**, e.g., near the outer edges of the flow direction plate.

[0042] The flow direction plate **260** illustrated in **FIGS. 2C – 2D** also includes a central aperture **264** to enable the passage of a liquid feed tube through the flow direction plate. See **FIG. 1C**. As is illustrated more clearly in **FIG. 10** below, the flow direction plate **260** may have a non-planar shape, e.g., convex shape, to direct the flow of a liquid that impinges on the plate to the fluid apertures disposed on the outer edge of the flow direction plate.

[0043] The planter modules disclosed herein may be fabricated as a single body, e.g., as a singles section. In one refinement, the planter modules are fabricated from two sections, e.g., a top section and a bottom section, that are operably attached to form the planter module. **FIGS. 3A – 3D** illustrate several views of the top section and bottom section according to one such construction. Specifically, **FIGS. 3A** and **3B** illustrate a top section **310T** of a planter module and **FIGS. 3C** and **3D** illustrate a bottom section **310B** of the planter module. When operatively attached, the two sections **310A/310B** form a complete planter module, e.g., as illustrated in **FIGS. 2A – 2D**.

[0044] The top section **310T** and the bottom section **310B** may be operatively and securely attached using a variety of means such as fasteners, etc. In one refinement, the top section **310T** and the bottom section **310B** may be irreversibly attached, e.g., by using an adhesive, ultrasonic welding, etc. In another refinement, the two sections **310T/310B** may be reversibly attached, e.g., in a manner such that a consumer may attach and detach the two sections without damaging the planter module. In this manner a consumer may dis-assemble the planter module, e.g., for cleaning, and then re-assemble the planter module by re-attaching the two sections. As illustrated in **FIGS. 3A – 3D**, the two sections **310T/310B** are operatively attached by mating a plurality of pin receptacles, e.g., pin receptacles **351a/351b**, disposed in the top planter module section **310T** with a plurality of pins, e.g., vertically extending pins **371a/371b**, disposed in the bottom planter module section **310B**. For example, an outer diameter of the pins **371a/371b** may be substantially similar to the inner diameter of the pin receptacles **351a/351b** so that pins and pin receptacles may be secured by a tight fit, e.g., a friction fit. It is believed that by mating the vertically-extending pins with the pin receptacles, the two sections **310T/310B** will be securely attached and will provide structural rigidity to a vertically-oriented plant growth structure constructed using the planter module.

[0045] **FIGS. 3A** and **3B** also illustrate a plurality of fluid capture apertures, e.g., fluid capture apertures **352a/352b**, disposed between the top sections of the growth basket receptacles. For example, fluid capture aperture **352b** is disposed between growth basket receptacle top sections **320Ta** and **320Tb**. When the sections **310T** and **310B** are operatively attached to form a planter module, the fluid capture apertures will enable liquid that inadvertently spills or leaks along the exterior of the planter module to be returned to the fluid conduit to reach lower planter modules or to be recycled. See **FIG. 1C**.

[0046] As is discussed above, the planter modules disclosed herein include one or more growth basket receptacles, e.g., disposed around the central section. The growth basket receptacles are configured, e.g., sized and shaped, to secure a growth basket within the growth basket receptacles. As is known to those skilled in the art, plants are grown within the growth basket receptacles such as by placing a growing medium, e.g., soil or peat, within the growth baskets and planting one or more seeds in the growing medium. Often, a consumer will plant one or more seeds in the growing medium and allow the seeds to germinate before placing the growth basket in a growth basket receptacle.

[0047] **FIGS. 4A – 4B** illustrate an embodiment of a growth basket according to the present disclosure. Specifically, **FIG. 4A** illustrates a perspective view of the growth basket **430**, **FIG. 4B** illustrates a top view and **FIGS. 4C** and **4D** illustrate side view of the growth basket. As is disclosed above, the growth basket is configured, e.g., sized and shaped, to be operatively secured within a growth basket receptacle to facilitate the growth of a plant that is placed in the growth basket **430**. The growth basket **430** includes a sidewall **431**, e.g., a substantially round sidewall, and a plurality of sidewall fluid apertures, e.g., fluid aperture **432a**, to enable the passage of a liquid into the interior of the growth basket **430**, e.g., to the roots of a plant that is placed in the basket. Similarly, the bottom wall **433** includes fluid apertures, e.g., fluid aperture **434a**, to enable the passage of an aqueous liquid through the bottom wall **433**. The sidewall fluid apertures are uniformly distributed around the entire sidewall **431** to enable the flow of liquid through the basket sidewall, e.g., through the entire sidewall. As illustrated, the sidewall fluid apertures are generally elongate, e.g., slots having a length the exceeds the width of the

apertures, although it will be appreciated that fluid apertures having a variety of shapes may be utilized in the sidewall as well as in the bottom wall. Further, as illustrated in **FIGS. 4A – 4D**, the sidewall **431** tapers inwardly from the top rim **440** down to the bottom wall **433**.

[0048] The growth basket **430** illustrated in **FIGS. 4A – 4D** also includes an attachment element that is configured to secure the growth basket within a growth basket receptacle. See **FIG. 10**. As illustrated in **FIGS. 4A – 4D**, the attachment element **438** comprises a tab, e.g., a projection or protuberance, that is disposed on the top rim **440** of the growth basket **430**, e.g., the tab extends downwardly from the top rim of the growth basket. As illustrated in **FIG. 1C**, the tab is configured to operatively mate with a notch formed on an upper edge of a growth basket receptacle to secure the growth basket within the growth basket receptacle. That is, the tab is spaced away from the sidewall **431** along an upper rim of the sidewall, creating a gap **441** between the tab and the sidewall. The corresponding notch may be mated with, e.g., placed within, the gap **441** to secure the basket to the receptacle. Providing the attachment element **438** on a top rim of the growth basket in this manner advantageously reduces the likelihood that the growth basket will be partially or wholly separated from the growth basket receptacle, e.g., by the weight of a large and horizontally-extending plant contained in the growth basket.

[0049] **FIGS. 5A – 5D** illustrate another embodiment of a growth basket according to the present disclosure. Specifically, **FIG. 5A** illustrates a perspective view of a growth basket **530**, **FIG. 5B** illustrates a top view, and **FIGS. 5C and 5D** illustrate side views. The growth basket **530** illustrated in **FIGS. 5A – 5D** includes similar features as that growth basket **430** illustrated in **FIGS. 4A – 4D**, including a sidewall **531** having a plurality of sidewall fluid apertures, e.g., aperture **532a**, and a bottom wall **533** having a plurality of bottom wall fluid apertures, e.g., aperture **534a**. An attachment element **539** extends from the top rim **540** as is described with respect to growth basket **430**.

[0050] In the embodiment illustrated in **FIGS. 5A – 5D**, the growth basket **530** includes flanges **536a/536b** that are disposed along an exterior surface of the growth basket sidewall **531**. As illustrated in **FIGS. 5A – 5D**, the flanges are disposed on opposites sides of the growth basket sidewall **531**. Stated another way, where the sidewall has a

substantially circular cross-section, the flanges **536a/536b** are separated by about 180° around the periphery of the sidewall **531**. As is illustrated in **FIG. 7**, the flanges **536a/536b** are particularly configured, e.g., sized and shaped, to be placed within seams that disposed in the growth basket receptacles. Further, the sidewall **531** tapers inwardly from the top rim **540** down to the bottom wall **533**. Therefore, the flanges **536a/536b** increase in width as the flanges extend from the top rim **540** towards the bottom wall **533**.

[0051] The flanges **536a/536b** provide at least two important benefits when the growth baskets are placed within a mating growth basket receptacle, e.g., a growth basket receptacle having mating seams. For example, the flanges **536a/536b** secure the growth basket **530** within the growth basket receptacle, e.g., by preventing rotation and/or angular displacement of the growth basket relative to the growth basket receptacle. Further, because the flanges **536a/536b** extend into the seams extending along the growth basket receptacles, the flanges advantageously redirect aqueous liquid into the growth basket **53**, e.g., guides the aqueous liquid down the sidewall of the growth basket rather than flowing away from the growth basket.

[0052] The growth basket **530** also includes an additional feature that may enhance the use of water by a plant growing structure incorporating the growth baskets. As illustrated in **FIGS. 5A – 5D**, a portion **535** of the growth basket sidewall **531** is substantially devoid of fluid apertures. That is, the sidewall portion **535** is essentially solid so that a liquid cannot pass into or out of that portion of the sidewall. In one characterization, the portion that is substantially devoid of fluid apertures is substantially contiguous and covers at least about 10% of the growth basket sidewall, such as at least about 12.5% of the sidewall, or even at least about 15% of the sidewall. Similarly, the bottom wall **533** includes a portion **539** that is substantially adjacent the sidewall portion **535** and is also devoid of fluid apertures. In one characterization, the bottom wall portion that is substantially devoid of fluid apertures is substantially contiguous and covers at least about 10% of the growth basket bottom wall, such as at least about 12.5% of the bottom wall, or even at least about 15% of the bottom wall. In this manner, the portions **535/539** form a cup in the lower interior of the growth basket **530** that may retain an aqueous liquid, e.g., when the growth basket **530** is placed in a growth basket receptacle with the portions **535/539** being oriented at the bottom of the growth basket interior. Such

a feature is particularly useful for plants that may require more water by trapping the water within that lower portion of the growth basket **530**.

[0053] **FIGS. 6A – 6B** illustrate an embodiment of a base module according to an embodiment of the present disclosure. The base module **642** is configured to support one or more planter modules that are vertically disposed above the base module. In this regard, the base module **642** includes an upwardly extending central section **649** that is configured, e.g., sized and shaped, to operatively attach to a lower central section of a planter module. See FIGS. **1A – 1B**. The base module includes attachment apertures, e.g., apertures **648a/648b**, e.g., to accommodate a fastener such as a bolt therethrough to secure the base module **642**, and a plant growth structure supported by the base module, to an underlying surface. The underlying surface may be, for example, a large tank containing an aqueous liquid for feeding the plants. In this regard, the base module **642** includes a liquid feed inlet **643** that is configured to receive an aqueous fluid, e.g., that is pumped through the inlet. The inlet **643** may be in fluid communication with a liquid feed tube that delivers the aqueous liquid to the fluid conduit for delivery to the plants. See **FIG. 1C**.

[0054] **FIG. 7** illustrates and exploded view of a plant growth structure **700** according to an embodiment of the present disclosure. The components illustrated in **FIG. 7** may be provided to a consumer as a kit for the construction of the plant growth structure, e.g., in a modular fashion. The plant growth structure **700** includes two planter modules **710A** and **710B** that are fabricated from two sections **710AT/710AB** and **710BT/710BB**, respectively. A cap **746** is attached over the planter module **710A** and a base module is attached to the bottom of the planter module **710B**. One or more growth baskets, e.g., growth basket **730**, are provided for placement in a growth basket receptacle. In addition, one or more receptacle lids, e.g., receptacle lid **798**, are provided. The receptacle may advantageously be placed over growth basket receptacles that are not is use, e.g., do not contain a plant, to reduce noise emanating from the fluid movement within the structure and/or to reduce evaporation of an aqueous solution that is moving through the structure.

[0055] **FIGS. 8A** and **8B** illustrate perspective views of a plant growth structure **800** according to an embodiment of the present disclosure. The plant growth structure

includes eight planter modules, e.g., planter module **810**, that are attached to a base module. A cap **846** is attached to a top planter module to seal the central section of the plant growth structure. As illustrated in **FIGS. 8A** and **8B**, the growth basket receptacles of vertically-adjacent planter modules are angularly displaced in the vertical plane, e.g., by about 45°.

[0056] **FIG. 9** illustrates a cross-sectional view of a central section **902** of a module, e.g., a planter module, that facilitates the angular displacement of the vertically-adjacent modules. The central section **902** includes an outer sidewall **904a** and an inner sidewall **904b**, e.g., where the inner sidewall **904b** a component of a first planter module and the outer sidewall **904a** is a component of a second planter module that is attached to the first planter module in vertically-spaced relation. The inner sidewall **904b** includes a plurality of notches, e.g., notch **905b**, that are disposed around the periphery of the sidewall **904b**. The notches are configured to mate with one or more splines, e.g., spline **906a**, disposed on an interior surface of the outer sidewall **904a**. As can be seen in **FIG. 9**, the angular displacement of the two planter modules may be set to pre-determined angles by selecting the notches in the inner sidewall **904b** that engage the splines. In one characterization, the notches are offset on a circular central section by about 45°, e.g., as illustrated in **FIGS. 8A – 8B**.

[0057] **FIG. 10** illustrates a partial cross-sectional view of a planter module **1010** according to an embodiment. The planter module **1010** illustrates several features that may be incorporated into the plant growth systems and planter modules disclosed herein.

[0058] For example, **FIG. 10** illustrates a cross-section of a flow guide **1067**, specifically a projection extending outwardly from the fluid conduit **1016**, e.g., extending outwardly from the interior of the sidewall **1019**. See also **FIG. 2B**. The flow guide **1067** is aligned with, e.g., is disposed over, an inner top edge of the plant growth basket receptacle **1020b** where the receptacle joins the sidewall **1019** of the central section. According to this embodiment of the present disclosure, a majority of the aqueous liquid that is fed to the growth baskets contained in the growth basket receptacles travels downwardly along, e.g., in contact with the interior of the sidewalls, e.g., along a an outer surface of the fluid conduit. The flow guide **1067** may advantageously direct the aqueous

liquid to the growth basket receptacles that are vertically aligned with the flow guide. In one construction, and as illustrated in **FIG. 10**, the flow guide **1067** is aligned with, e.g., disposed under an aperture in a flow direction plate **1060** that is positioned above the flow guide.

[0059] **FIG. 10** also illustrates a growth basket receptacle cap **1098** that is operatively disposed over the growth basket receptacle **1020a**, e.g., when no plant is growing within the receptacle **1098**. The cap **1098** is particularly useful for reducing the amount of noise that is caused by the internal flow of an aqueous liquid through the plant growth structure. Further, the cap is useful for reducing evaporation of an aqueous liquid, e.g., when the plant growth structure is in use but the plant growth receptacle **1020a** is not being utilized for plant growth.

[0060] Further, **FIG. 10** illustrates the use of a growth basket spacer **1080** that is positioned over a top edge of the growth basket receptacle **1020b** and under the rim of the growth basket **1030**. For example, in the embodiment illustrated in **FIG. 10**, the growth basket spacer **1080** may be in the form of a thick washer, e.g., a round body with an aperture therethrough. The growth basket spacer **1080** causes the bottom end of the growth basket **1030** to move towards the inner sidewall of the central section, thereby reducing the amount of liquid that falls upon the growth basket. In this manner, the growth basket spacer **1080** may be used with a plant that requires a reduced amount of aqueous liquid as compared to other plants in the plant growth structure.

[0061] According to one embodiment of the present disclosure, a plant growth structure, e.g., a kit for constructing a plant growth structure, may be provided with one or more components that enhance the ability of the structure to grow healthy plants, including larger plants. Such components may be provided individually or in any combination.

[0062] **FIG. 11** illustrates a riser module according to one embodiment. The riser module **1184** is configured to operatively and securely attach to at least the bottom end of a planter module, e.g., operatively attached to a first planter module above the riser module **1184** and attached to a second planter module below the riser module **1184**. In this regard, the riser module includes a central section **1185** having a top end **1182** and

a top end **1183**. The ends **1182/1183** are configured to operatively attach to vertically-adjacent planter modules, e.g. in a manner similar to that described above for adjacent planter modules. The sidewall **1188** defines an interior fluid conduit **1187** for the passage of a liquid therethrough. Of note, the riser sidewall **1188** is free from growth basket receptacles, e.g., so that plants are not grown directly on the riser module. In this manner, when the riser module **1184** is placed between two planter modules in a plant growth structure, the lower planter module will have additional space above the planter module, e.g., to facilitate larger plants and/or to increase the amount of light that reaches plants in the lower planter module. In addition, the riser module may be placed directly between a base module and a planter module to elevate the plant growth receptacles above the base module for ease of access to plants growing therein.

[0063] **FIGS. 12A – 12B** illustrate a plant support module **1290** according to another embodiment of the present disclosure. The plant support module **1290** includes a central section **1291** having a top end **1292**, a bottom end **1293** and an outer wall defining an interior fluid conduit for the passage of a liquid therethrough. A plant support tray **1296** is operatively disposed around a periphery of the central section **1291**. The plant support tray **1296** includes a top surface **1294** that extends outwardly from the central section **1291** and is configured to support portions of a plant upon the top surface **1294**. As with the riser module, the central section **1291** is configured to operatively and securely attach to the bottom end of a planter module. The top surface **1294** may be flat, and in one characterization the top surface **1294** of the plant support tray **1296** is concave to facilitate the support of a plant and/or its fruit or vegetables thereon.

[0064] **FIG. 13** illustrates a portion of a plant growth structure **1300** that includes several modules in combination. Specifically, the structure **1300** includes a two planter modules **1310a/1310b**, e.g., as described above. A plant support module **1390b** is operatively attached to the bottom end of the planter module **1310b**. The structure also includes a second planter module **1310a** having a second plant support module **1390a** attached to a bottom end of the planter module **1310a**. A riser module is operatively attached to the top end of the planter module **1310b** and the bottom end of the plant support module **1390a** to separate the planter modules and the plant support modules,

e.g., to provide easier access to and increased light to plants that are growing in the planter module **1390b**.

[0065] The embodiments of a plant growth structure, the components of a plant growth structure and the elements of a plant growth structure may provide numerous advantages in relation to existing plant growth structures. For example, embodiments of the plant growth structure that implement a modular construction of the plant growth structure, e.g., by a consumer, may enable the individual modules to be dis-assembled and cleaned if necessary, e.g., in a powered dishwasher. The consumer may then re-assemble the plant growth structure, either in the same configuration or in a different configuration, e.g., for the growth of different types of plants.

[0066] The foregoing embodiments of a plant growth structure, elements of a plant growth structure and components of a plant growth structure may be implemented in any combination. For example, the plant growth structures may implement any one or several of the components disclosed herein, including the planter modules, riser modules, plant support modules, growth baskets, growth basket spacers, and growth basket receptacle lids. These combinations of different components may be supplied as an assembled unit or may be supplied as a kit containing several of the components, e.g., for assembly by a consumer.

[0067] The various growth structure elements, such as the flow direction plate, flow direction plate apertures, the flow guide, the growth basket flanges, the fluid capture apertures and other elements may be implemented individually or in any combination. These elements improve the liquid flow through the liquid conduit and may reduce to overall consumption of the aqueous liquid by the system.

[0068] While various embodiments of a plant growth system have been described in detail, it is apparent that modifications and adaptations of those embodiments will occur to those skilled in the art. However, is to be expressly understood that such modifications and adaptations are within the spirit and scope of the present disclosure.

What is Claimed is:

1. A plant growth structure comprising a plurality of planter modules, the planter modules comprising:

a central section having a top end, a bottom end and an outer wall defining an interior fluid conduit therethrough for the passage of a liquid, and

at least three growth basket receptacles disposed in a substantially horizontal plane around a periphery of the central section, the growth basket receptacles having an outer diameter and being configured so that when a growth basket is placed in a growth basket receptacle, at least a lower portion of the growth basket is in fluid communication with the fluid conduit, wherein the peripheral density of the growth basket receptacles disposed around the central section is at least about 0.6.

2. The plant growth structure recited in Claim 1, wherein the planter modules comprise four growth basket receptacles disposed around the periphery of the central section in the horizontal plane.

3. The plant growth structure recited in any one of Claims 1 or 2, wherein the peripheral density of the growth basket receptacles disposed around the central section is at least about 0.8.

4. The plant growth structure recited in any one of Claims 1 to 3, further comprising a plurality of growth baskets that are configured to be operatively secured in the growth basket receptacles, wherein the growth baskets comprise a plurality of sidewall fluid apertures disposed in a basket sidewall to enable the flow of liquid through the basket sidewall.

5. The plant growth structure recited in Claim 4, wherein the growth baskets comprise an attachment element that is configured to secure the growth basket in the growth basket receptacle.

6. The plant growth structure recited in Claim 5, wherein the attachment element is disposed on a top rim of the growth basket and proximate to the central section when the growth basket is operatively placed in the growth basket receptacle.

7. The plant growth structure recited in Claim 6, wherein the attachment element comprises a tab extending from the top rim of the growth basket and wherein the growth basket receptacle comprises a notch that is configured to receive the tab to secure the growth basket in the growth basket receptacle.

8. The plant growth structure recited in any one of Claims 4 to 7, wherein the sidewall fluid apertures comprise a plurality of vertically disposed slots formed in the sidewalls.

9. The plant growth structure recited in any one of Claims 4 to 8, further comprising a plurality of bottom wall fluid apertures disposed through a bottom wall of the growth basket.

10. The plant growth structure recited in any one of Claims 1 to 9, wherein a lower portion of the growth basket sidewall adjacent the bottom wall is substantially devoid of fluid apertures to retain liquid in the lower interior portion of the growth basket.

11. The plant growth structure recited in Claim 10, wherein a portion of the bottom wall adjacent the lower portion of the sidewall is devoid of bottom wall apertures to retain liquid in the lower interior portion of the growth basket.

12. The plant growth structure recited in any one of Claims 1 to 11, wherein the planter modules are formed from a top planter module section and a bottom planter module section that are operatively attached to form the planter module.

13. The plant growth structure recited in Claim 12, wherein the top planter module section and the bottom planter module section are irreversibly attached.

14. The plant growth structure recited in any one of Claims 12 or 13, wherein the top planter module section and the bottom planter module section are operatively attached by sliding a plurality of pin receptacles disposed in one of the planter module sections over a plurality of vertically extending pins disposed in the other planter module section.

15. The plant growth structure recited in Claim 14, wherein the top planter module section and the bottom planter module section are operatively attached by sliding

a plurality of pin receptacles disposed in the top planter module section over a plurality of pins disposed in the bottom planter module section.

16. The plant growth structure recited in any one of Claims 12 to 15, further comprising two seams disposed along an interior surface of the growth basket receptacles, wherein the two seams are formed along an interface between the top section and the bottom section of the growth basket receptacles.

17. The plant growth structure recited in Claim 16, wherein the structure further comprises a plurality of growth baskets that are operatively secured in the growth basket receptacles, wherein the growth baskets comprise at least a first flange disposed along an exterior of a growth basket sidewall and wherein the first flange is configured to be placed within a first seam of the growth basket receptacles.

18. The plant growth structure recited in Claim 17, wherein the growth baskets comprise at least a second flange disposed along the exterior of the growth basket sidewall and wherein the second flange is configured to be placed within a second seam of the growth basket receptacles.

19. The plant growth structure recited in any one of Claims 1 to 18, further comprising at least a first growth basket spacer disposed over a top surface of the growth basket receptacle and a growth basket placed over the growth basket spacer.

20. The plant growth structure recited in any one of Claims 1 to 19, wherein the central section comprises a flow direction plate extending across the interior fluid conduit.

21. The plant growth structure recited in Claim 20, wherein the flow direction plate comprises a substantially convex upper surface.

22. The plant growth structure recited in any one of Claims 20 or 21, wherein the flow direction plate comprises a plurality of fluid apertures disposed along an outer periphery of the flow direction plate, wherein the fluid apertures are aligned with a growth basket receptacle.

23. The plant growth structure recited in Claim 22, wherein the fluid apertures have a teardrop shape.

24. The plant growth structure recited in any one of Claims 20 to 23, wherein the flow direction plate comprises a central aperture configured to allow a feed pipe to pass therethrough.

25. The plant growth structure recited in any one of Claims 1 to 24, further comprising at least a second planter module disposed above the at least first planter module.

26. The plant growth structure recited in Claim 25, wherein:

the first planter module and the second planter module comprise the same number of growth basket receptacles; and

the growth basket receptacles of the first planter module and the second planter module are substantially aligned in the vertical plane.

27. The plant growth structure recited in Claim 25, wherein:

the first planter module and the second planter module comprise the same number of growth basket receptacles; and

the growth basket receptacles of the first planter module and the second planter module are angularly offset in the vertical plane.

28. The plant growth structure recited in Claim 27, wherein:

the at least first planter module comprises four growth basket receptacles separated by about 90° around the periphery of the first planter module central section; and

the at least second planter module comprises four growth basket receptacles separated by about 90° around the periphery of the second planter module central section,

wherein the growth basket receptacles of the first planter module are offset from the growth basket modules of the second planter module by about 45° in the vertical plane.

29. The plant growth structure recited in Claim 27, wherein:

the at least first planter module comprises three growth basket receptacles separated by about 120° around the periphery of the first planter module central section; and

the at least second planter module comprises three growth basket receptacles separated by about 120° around the periphery of the second planter module central section,

wherein the growth basket receptacles of the first planter module are offset from the growth basket modules of the second planter module by about 60° in the vertical plane.

30. A kit for the construction of a plant growth structure, comprising:

at least a first planter module, the first planter module comprising;

a central section having a top end, a bottom end and an outer wall defining an interior fluid conduit therethrough for the passage of a liquid, and

a plurality of growth basket receptacles disposed around a periphery of the central section, the growth basket receptacles being in fluid communication with the interior fluid conduit,

at least a first riser tube module, the first riser tube module comprising a top end, a bottom end and an outer wall defining an interior fluid conduit for the passage of a liquid, the top end and bottom end having an outer periphery that is substantially the same cross-section as the outer periphery of the central section of the at least first planter module;

wherein the riser tube module is configured to operatively and securely attach to the bottom end of the at least first planter module; and

wherein the riser tube module outer wall is free from growth basket receptacles.

31. The kit recited in Claim 30, further comprising at least a first plant support module, the first plant support module comprising:

a central section having a top end, a bottom end and an outer wall defining an interior fluid conduit for the passage of a liquid therethrough; and

a plant support tray operatively disposed around a periphery of the central section, the plant support tray comprising a top surface that extends outwardly from the central section and is configured to support portions of a plant thereupon,

wherein the central section is configured to operatively and securely attach to the bottom end of the at least first planter module.

32. The kit recited in Claim 31, wherein the top surface of the plant support tray is concave.

33. The kit recited in any one of Claims 30 to 32, further comprising at least a first growth basket spacer that is configured to be placed on a top surface of the growth basket receptacle to enable a growth basket to be placed over the growth basket spacer.

34. The kit recited in any one of Claims 30 to 33, further comprising at least a first growth basket receptacle lid that is configured to be operatively placed over a growth basket receptacle.

35. A plant growth structure comprising a plurality of planter modules, the planter modules comprising:

a central section having a top end, a bottom end, and a sidewall defining an interior fluid conduit therethrough for the passage of a liquid;

at least a first growth basket receptacle disposed on a periphery of the central section, the first growth basket receptacle having an outer diameter and being in fluid communication with the fluid conduit; and

at least a first flow guide disposed on the interior fluid conduit, the first flow guide comprising a projection extending outwardly from the fluid conduit.

36. The plant growth structure recited in Claim 35, further comprising a flow direction plate extending across the interior fluid conduit, the flow direction plate comprising at least a first liquid aperture disposed in the flow direction plate and adjacent

the outer wall of the central section, and wherein the first liquid aperture is disposed over the first flow guide.

37. The plant growth structure recited in Claim 36, wherein the flow direction plate comprises a substantially convex upper surface.

38. The plant growth structure recited in any one of Claims 36 or 37, wherein the first liquid aperture has a teardrop shape.

39. The plant growth structure recited in any one of Claims 35 to 38, further comprising a first growth basket disposed within the first growth basket receptacle.

40. The plant growth structure recited in Claim 39, wherein the first growth basket comprises at least a first flange disposed along an outer edge of the growth basket and wherein the first flange is configured to be placed in a seam of the growth basket receptacles.

41. A plant growth basket that is configured to be placed within a growth basket receptacle in a vertically-oriented plant growing system, the growth basket comprising:

a sidewall, a bottom wall, a top rim and a top orifice for receiving plant growing matter within the interior of the growth basket;

a plurality of fluid apertures disposed in the sidewall;

a plurality of fluid apertures disposed in the bottom wall; and

at least first and second flanges disposed along an exterior surface of the growth basket sidewall.

42. The plant growth basket recited in Claim 41, wherein the sidewall has a substantially circular cross-section.

43. The plant growth basket recited in any one of Claims 41 or 42, wherein the first and second flanges are disposed on opposites sides of the growth basket sidewall.

44. The plant growth basket recited in any one of Claims 41 to 43, wherein the exterior surface of the growth basket sidewall tapers inwardly from the top rim to the bottom wall.

45. The plant growth basket recited in Claim 44, wherein the width of the first and second flanges increases as the first and second flanges extend from the top rim towards the bottom wall.

46. The plant growth basket recited in any one of Claims 41 to 45, wherein the growth basket comprises an attachment element that is configured to secure the growth basket in a growth basket receptacle.

47. The plant growth basket recited in Claim 46, wherein the attachment element is disposed on a top rim of the growth basket.

48. The plant growth basket recited in Claim 47, wherein the attachment element comprises a tab extending from the top rim of the growth basket.

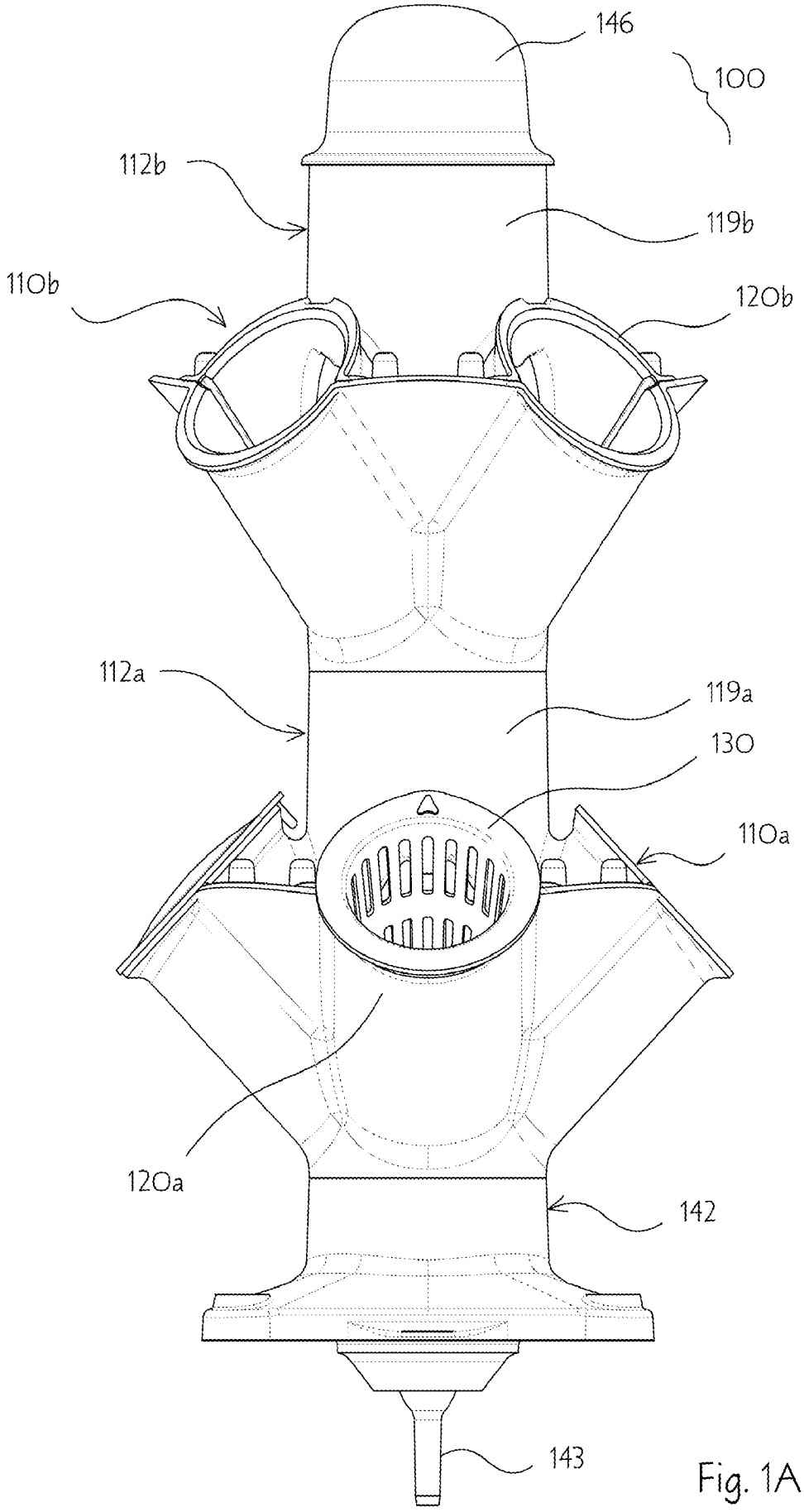

Fig. 1A

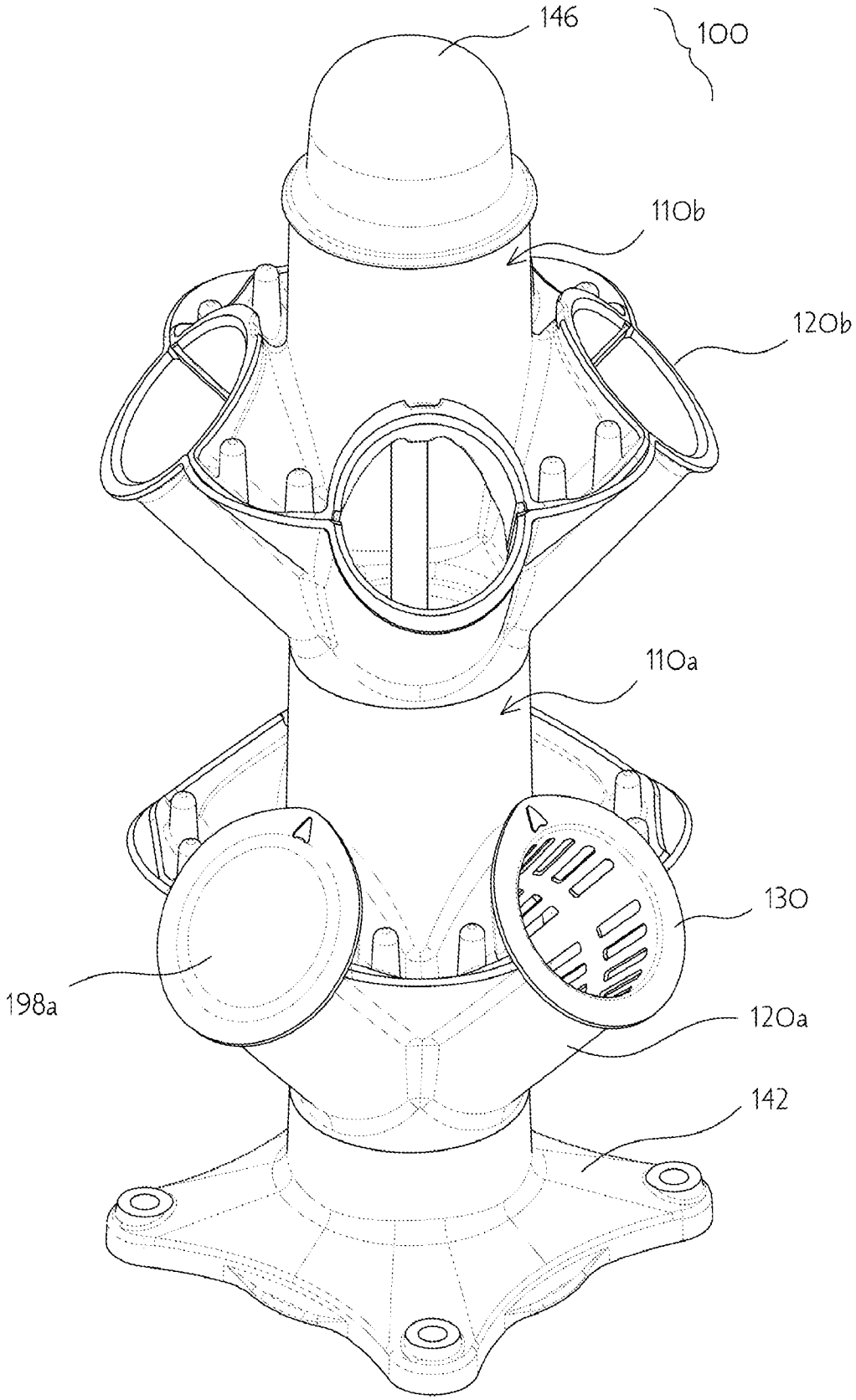

Fig. 1B

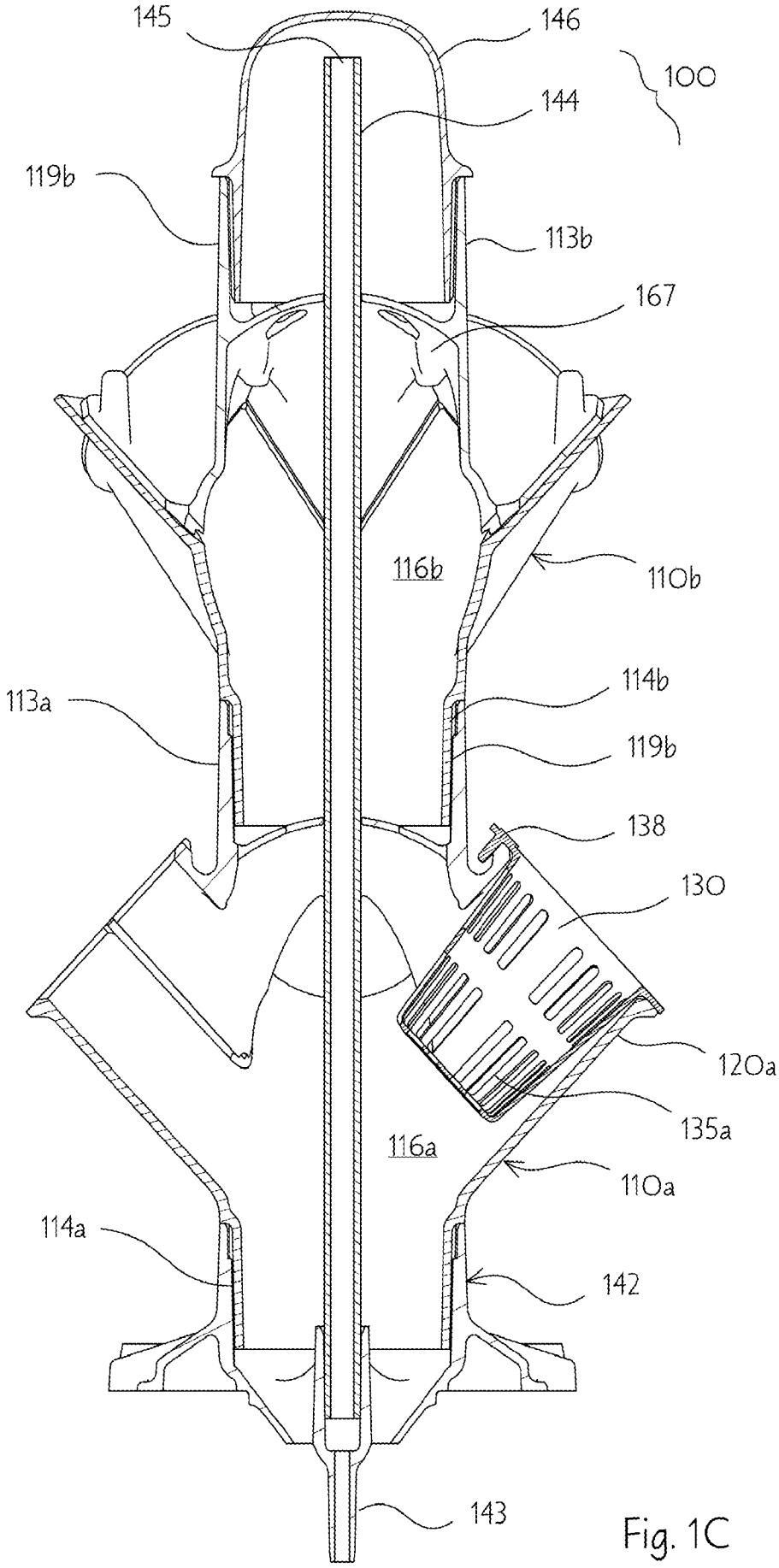
145
146
100
144
119b
113b
167
116b
110b
113a
114b
119b
138
130
120a
135a
116a
110a
114a
142
143

Fig. 1C

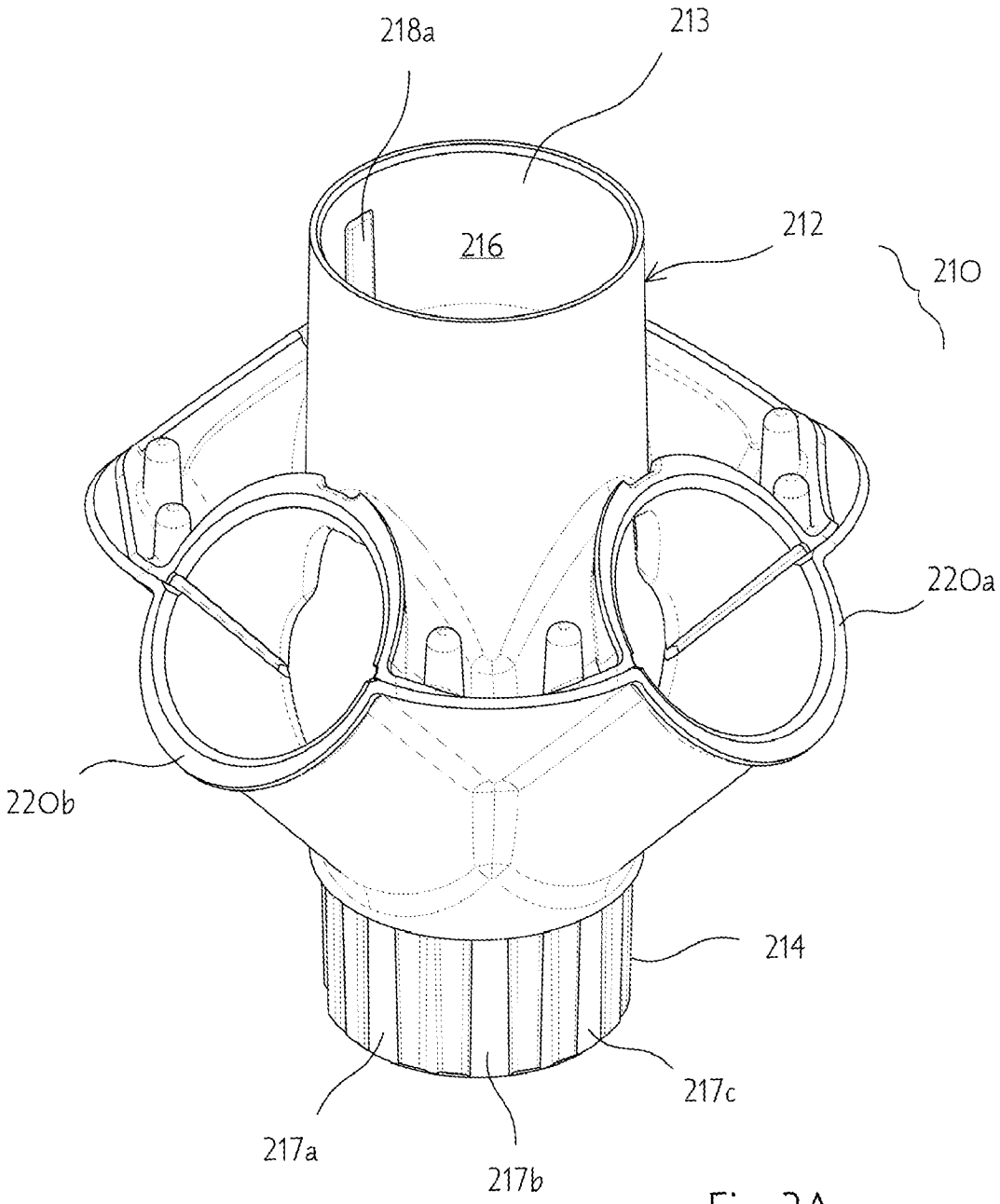

Fig. 2A

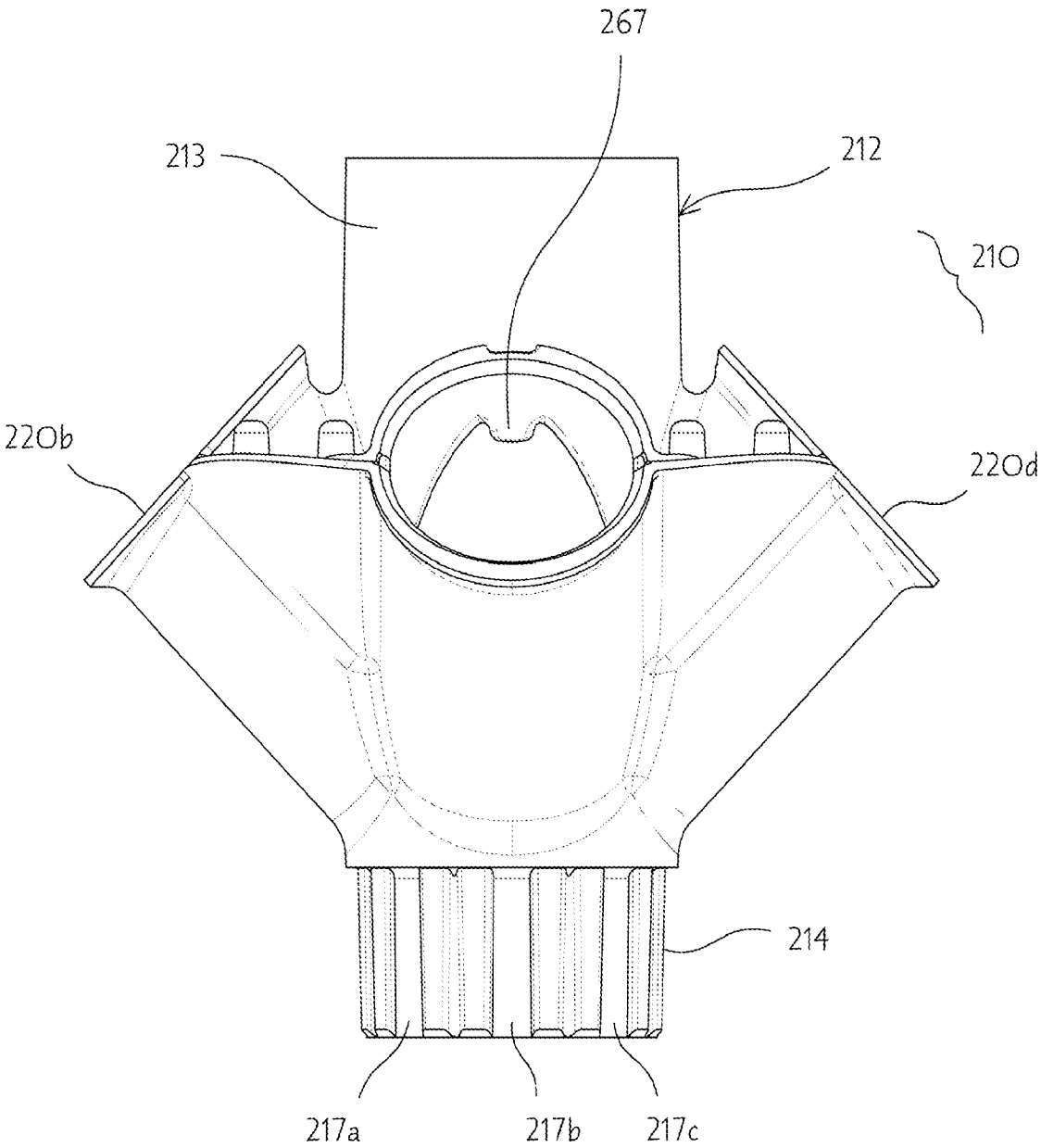

Fig. 2B

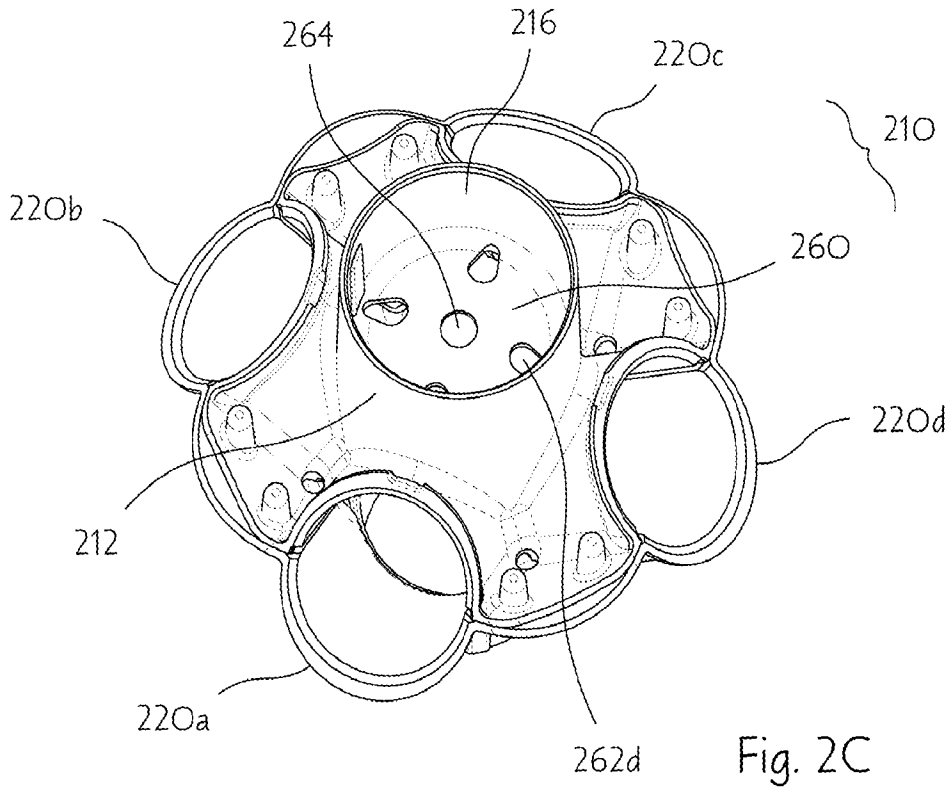
264
216
220c
210
220b
260
220d
212
220a
262d

Fig. 2C

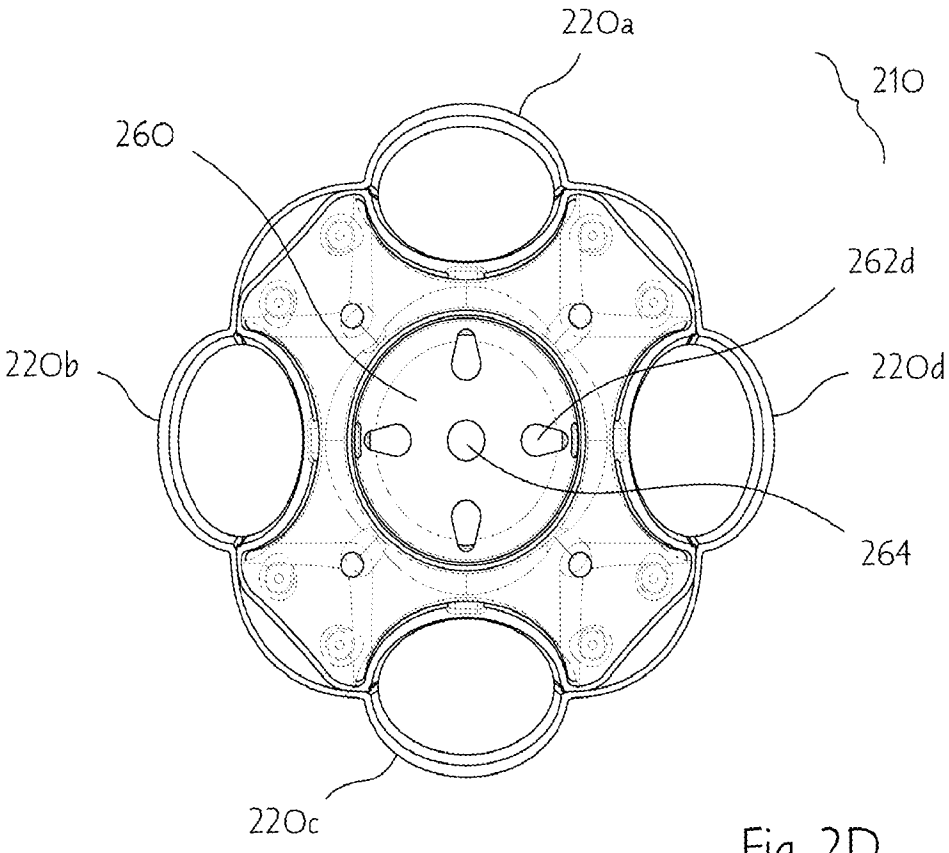
220a
210
260
262d
220b
220d
264
220c

Fig. 2D

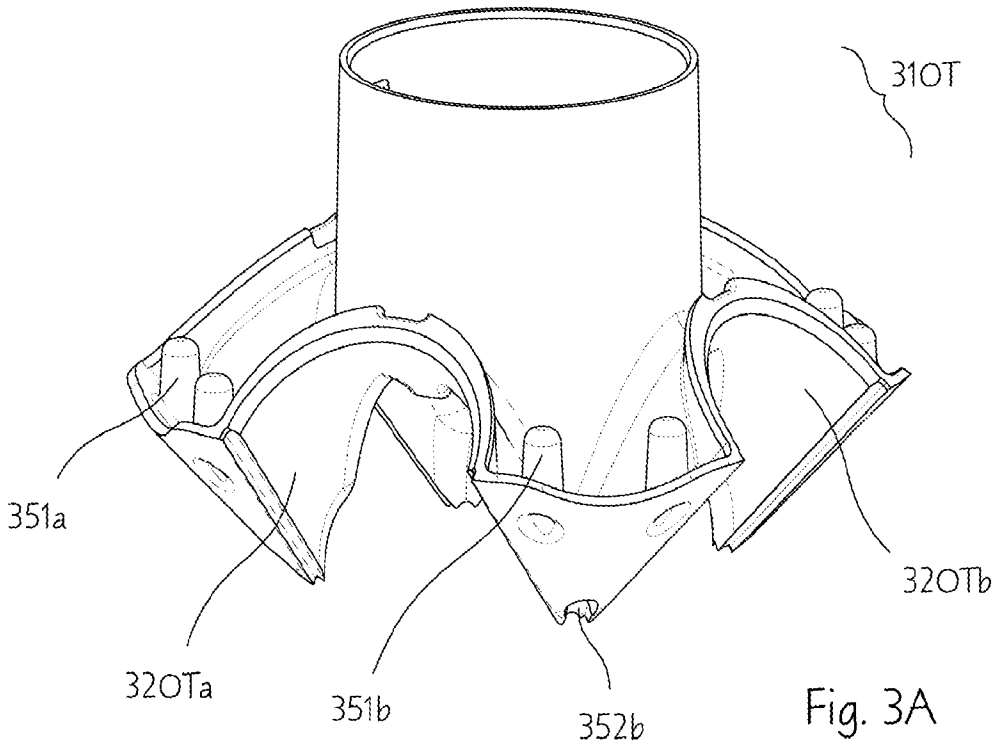

Fig. 3A

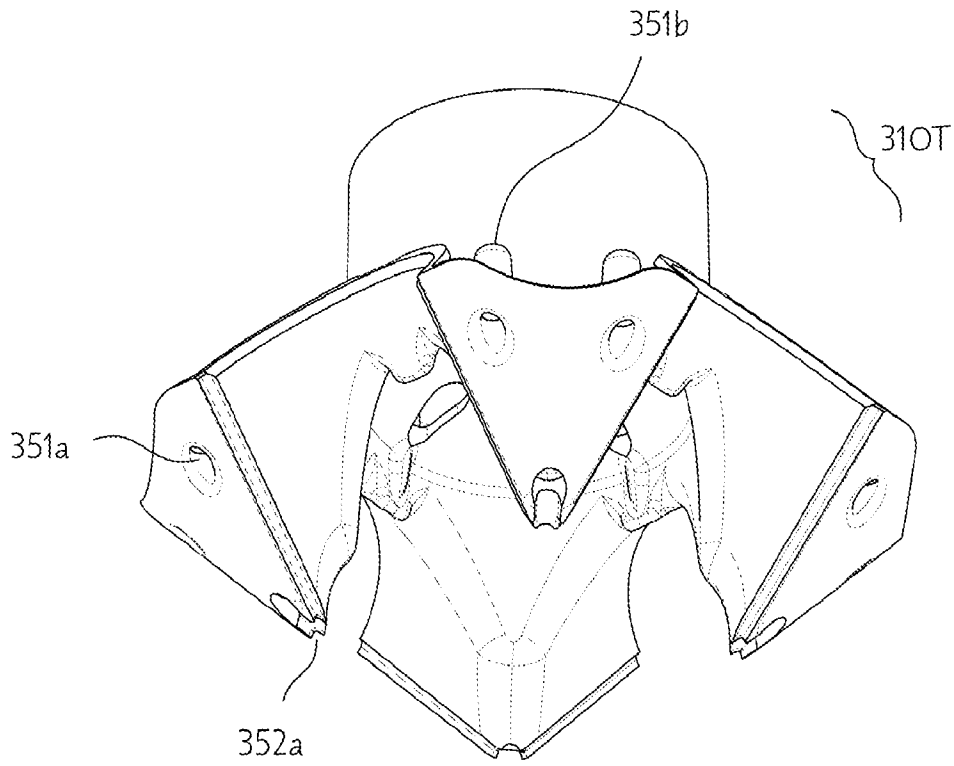

Fig. 3B

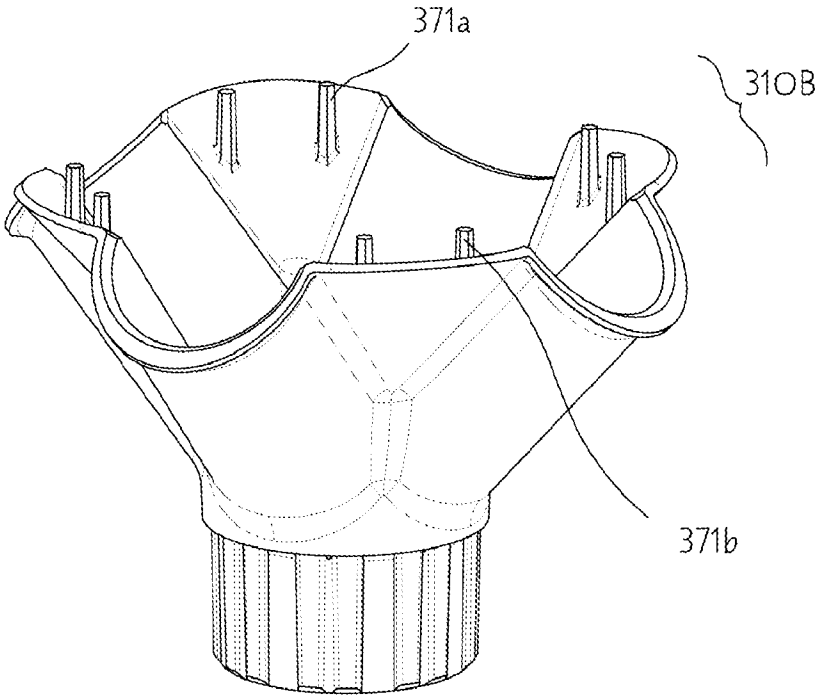

Fig. 3C

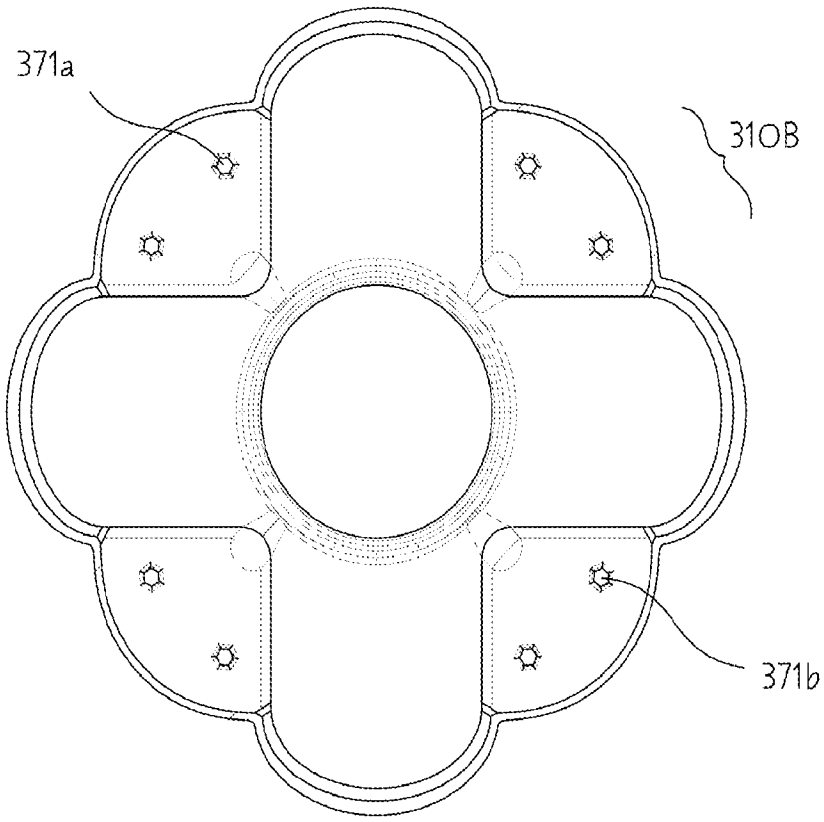

Fig. 3D

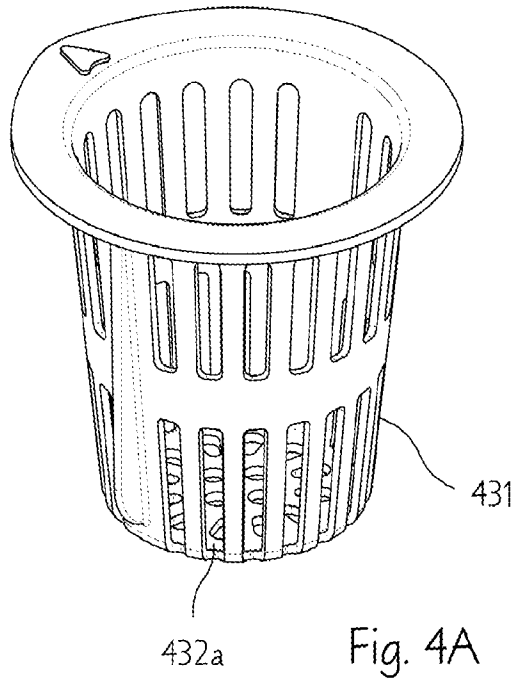

Fig. 4A

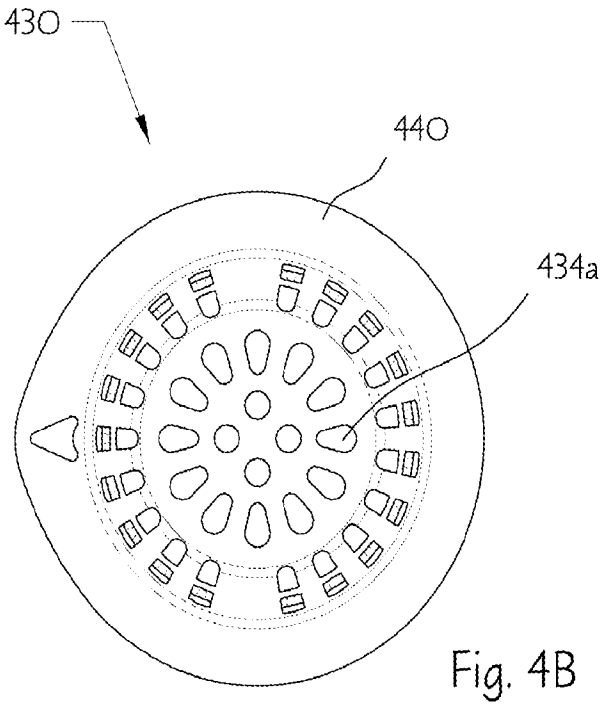

Fig. 4B

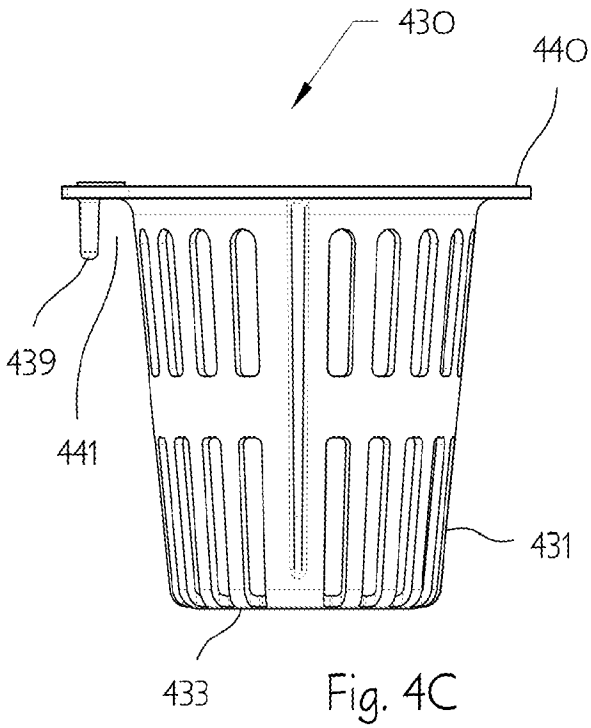

Fig. 4C

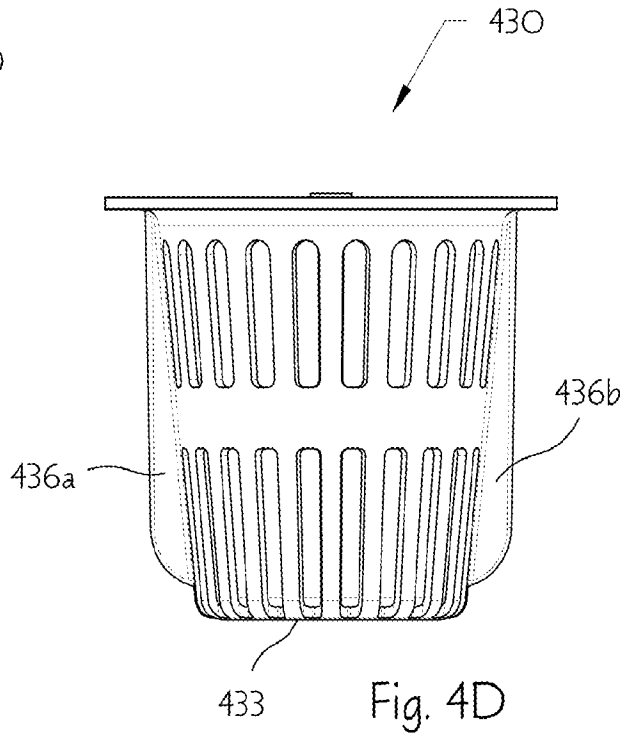

Fig. 4D

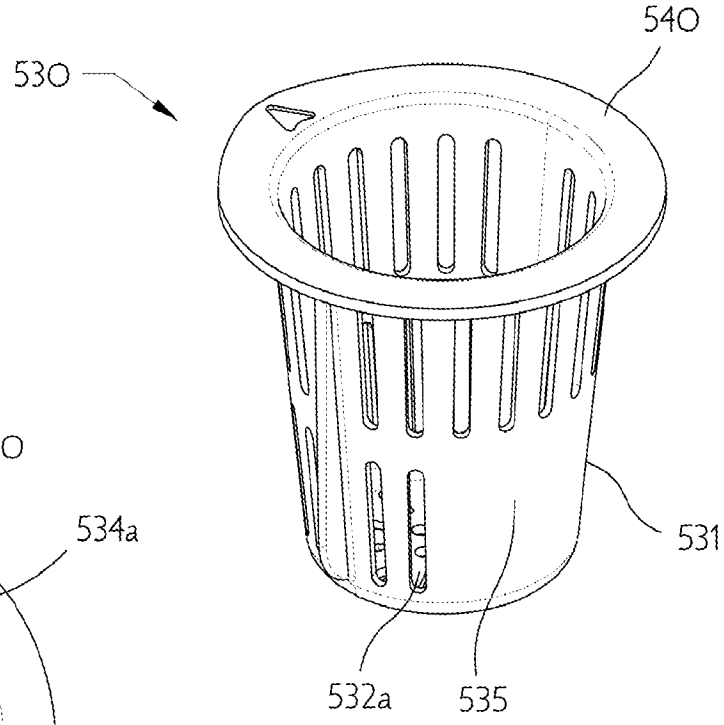

Fig. 5A

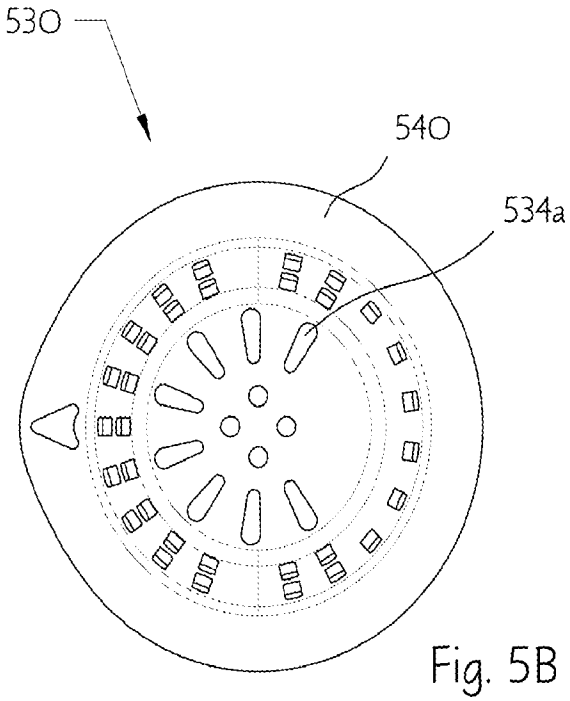

Fig. 5B

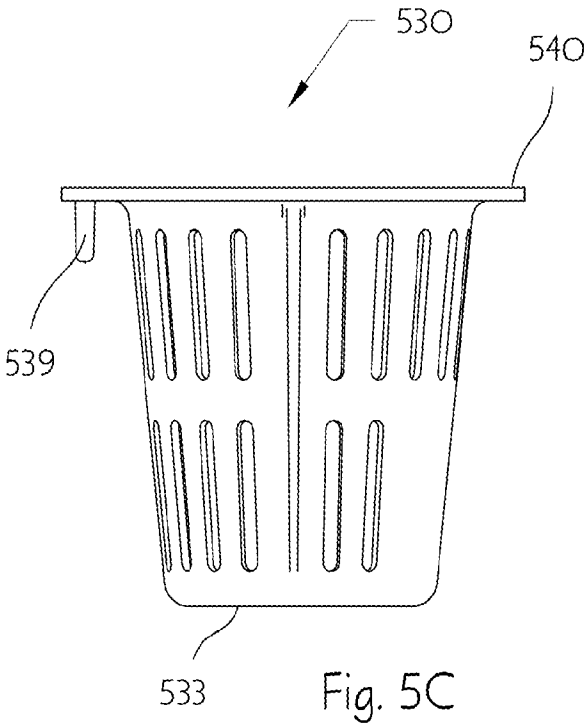

Fig. 5C

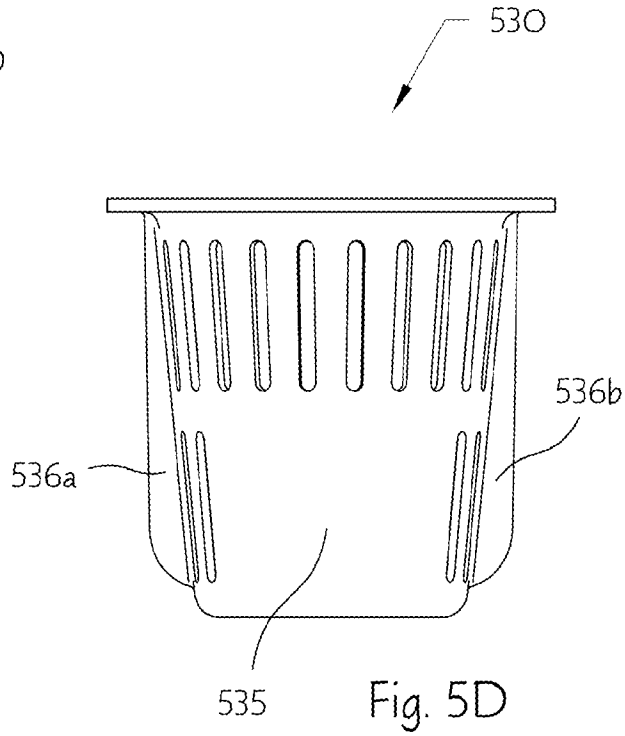

Fig. 5D

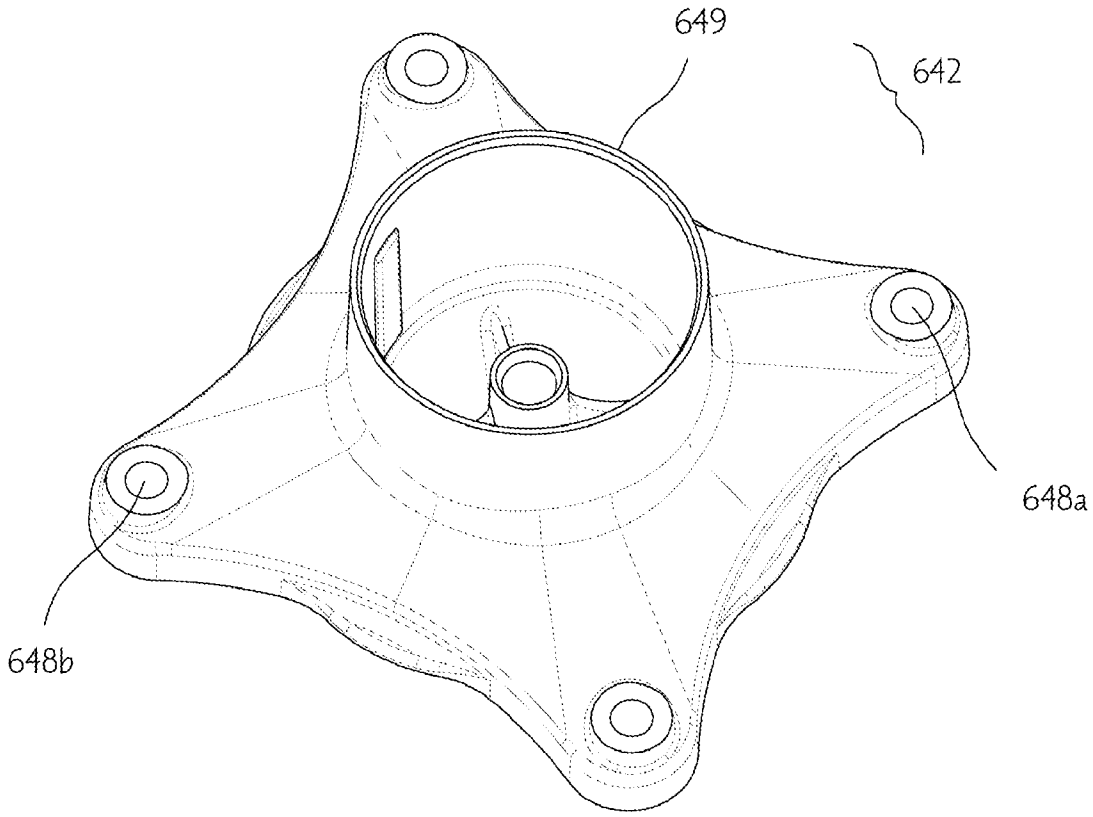

Fig. 6A

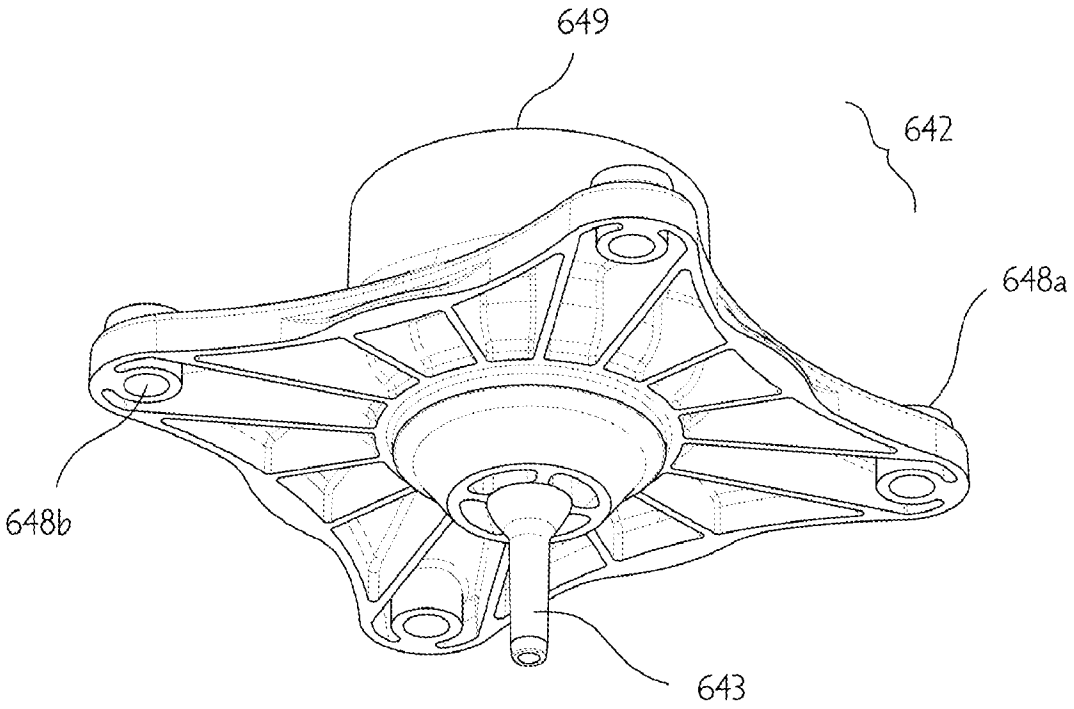

Fig. 6B

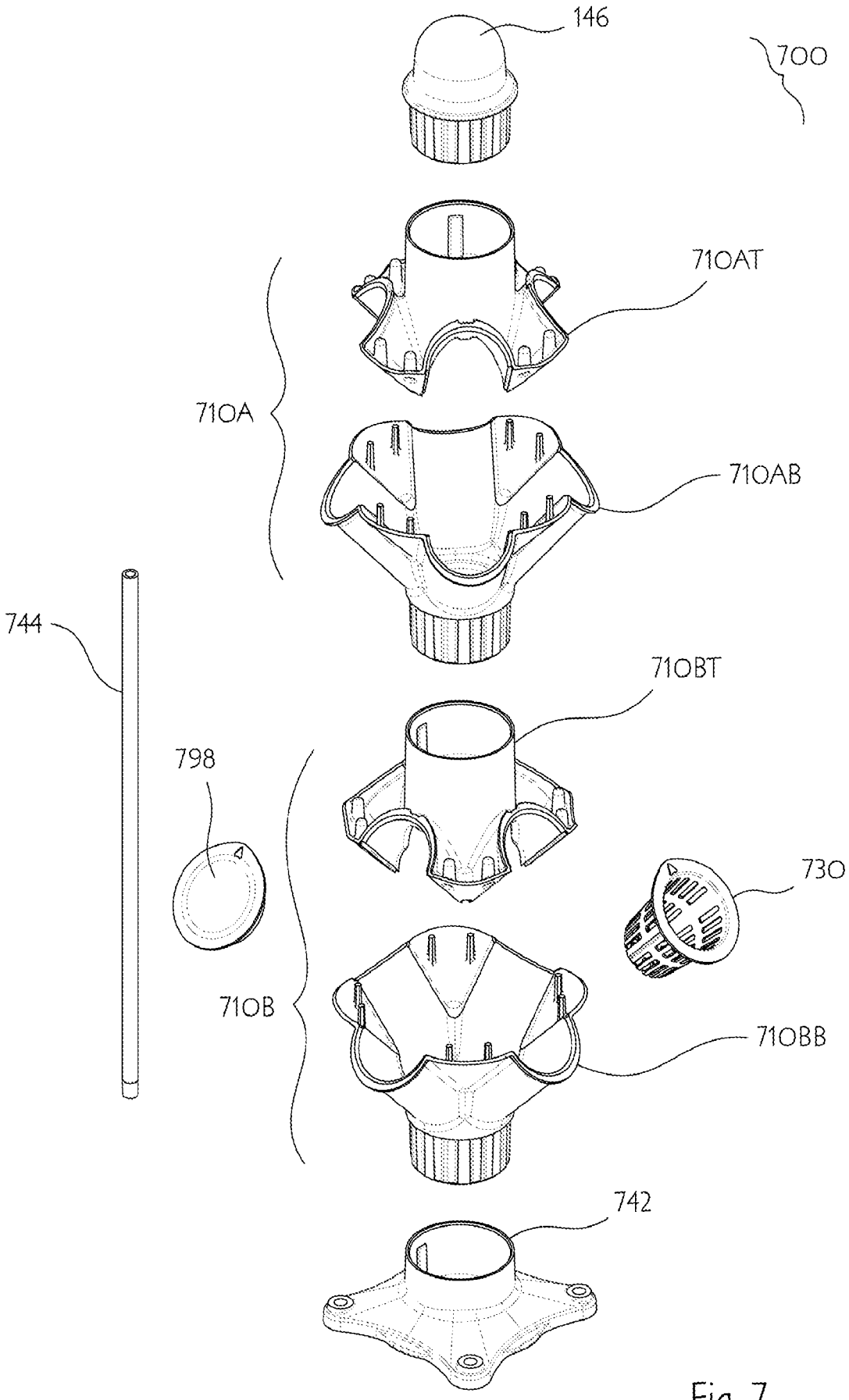

Fig. 7

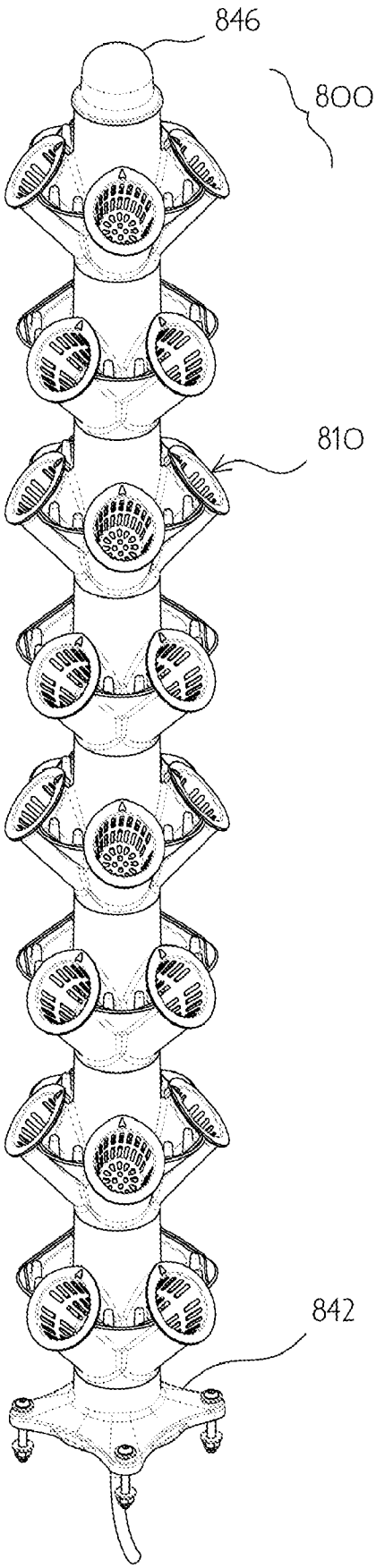

Fig. 8A

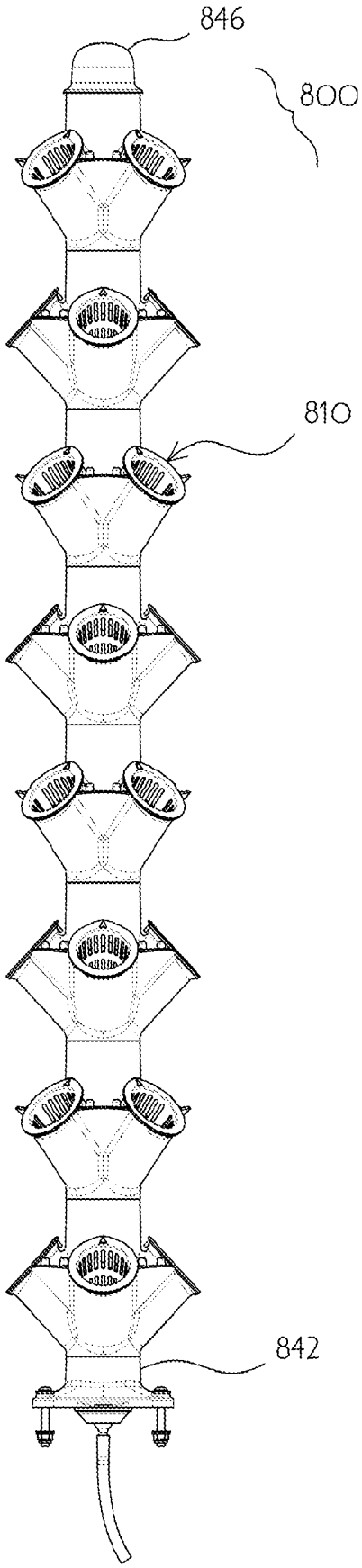

Fig. 8B

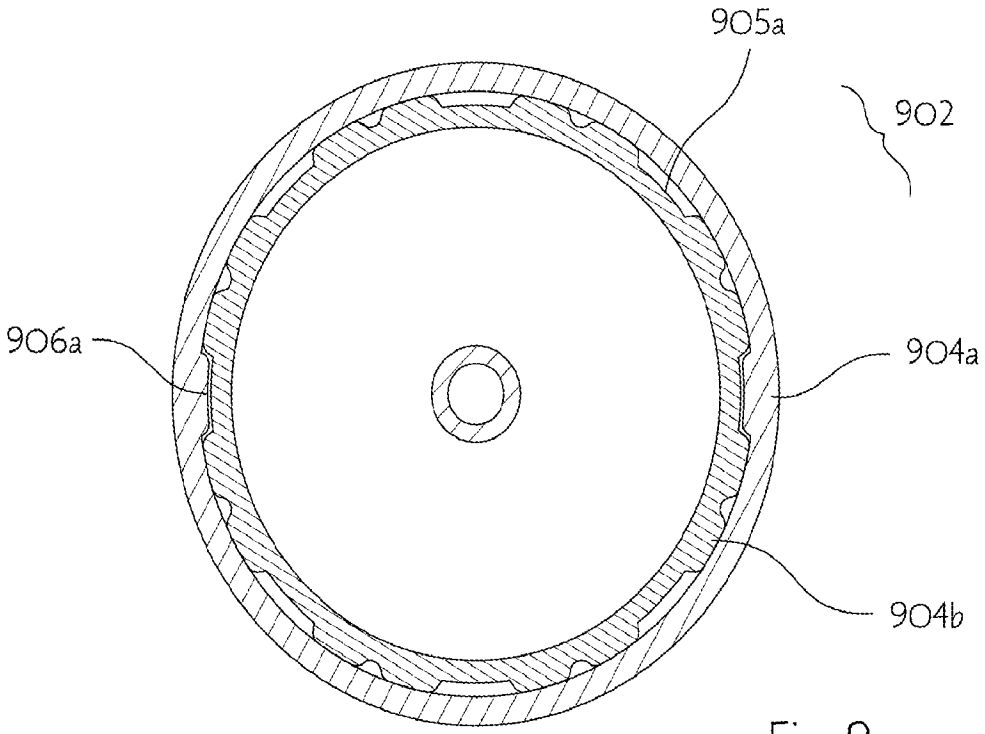
905a
902
906a
904a
904b

Fig. 9

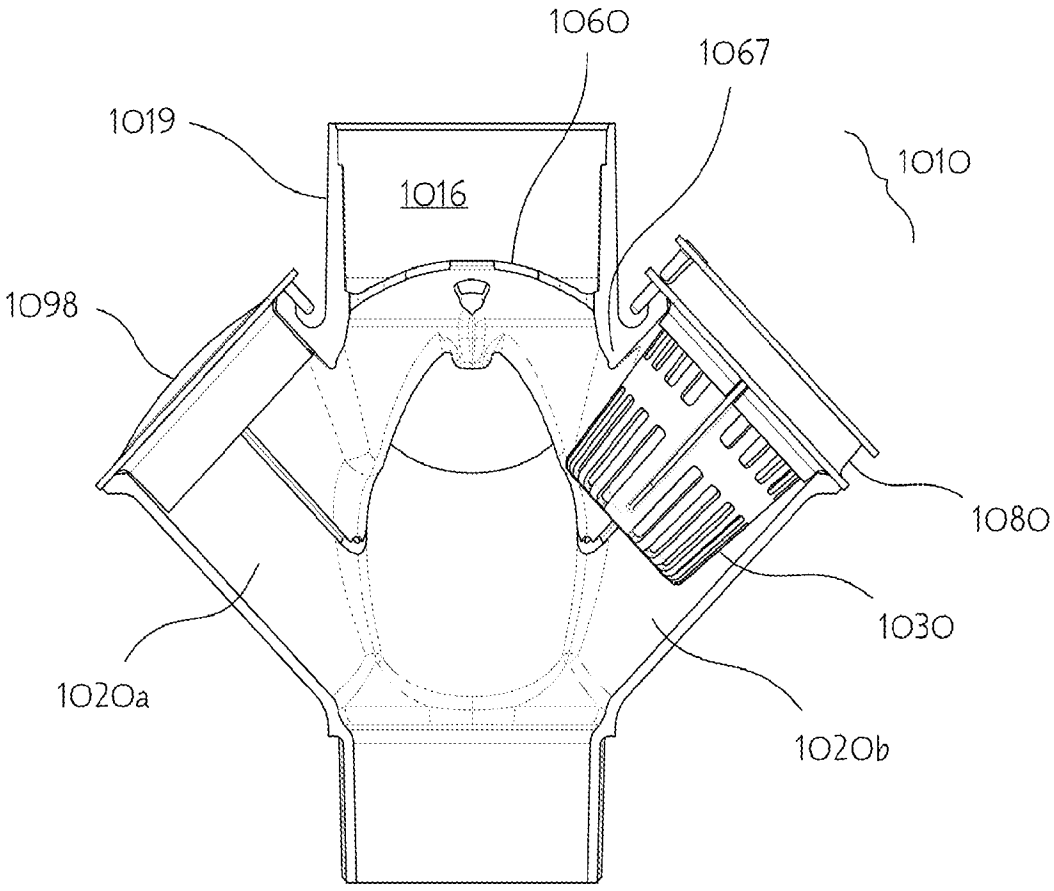
1060
1067
1019
1010
1016
1098
1080
1030
1020a
1020b

Fig. 10

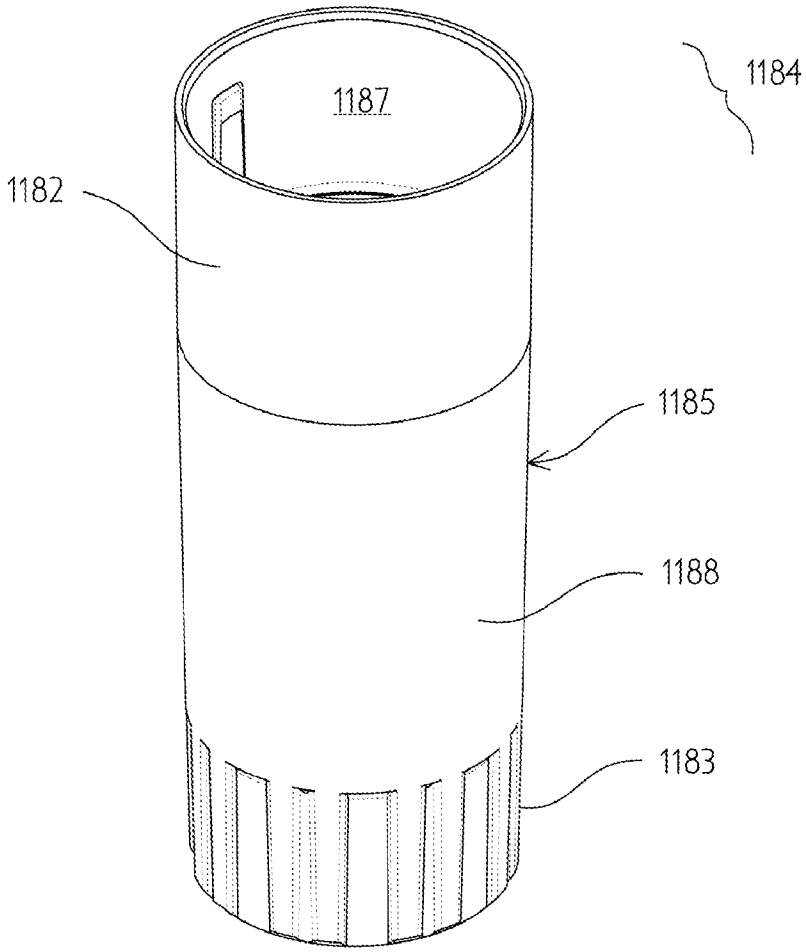

Fig. 11

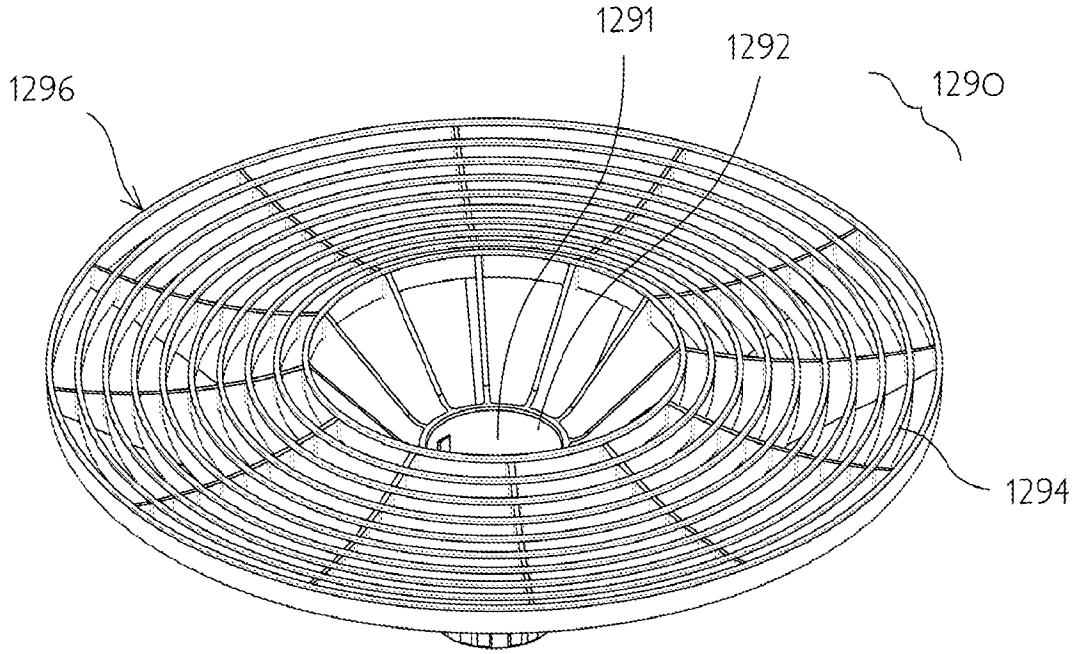

Fig. 12A

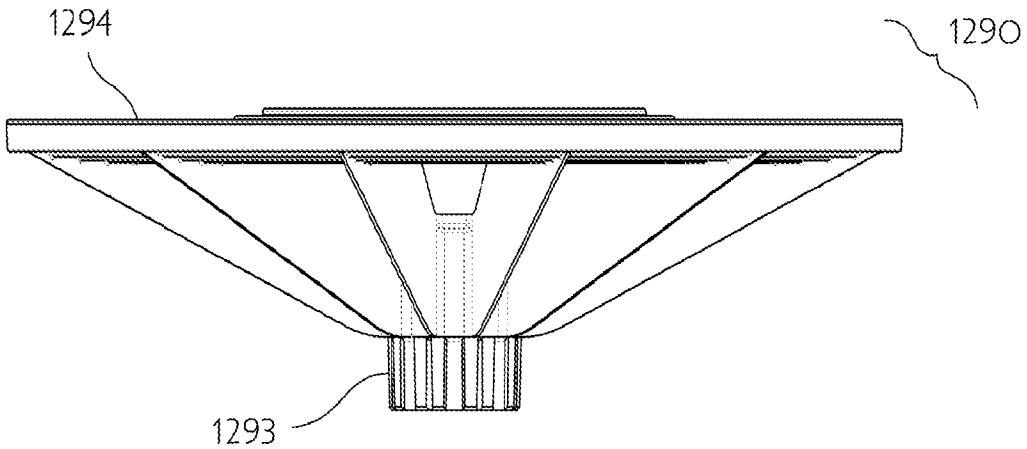

Fig. 12B

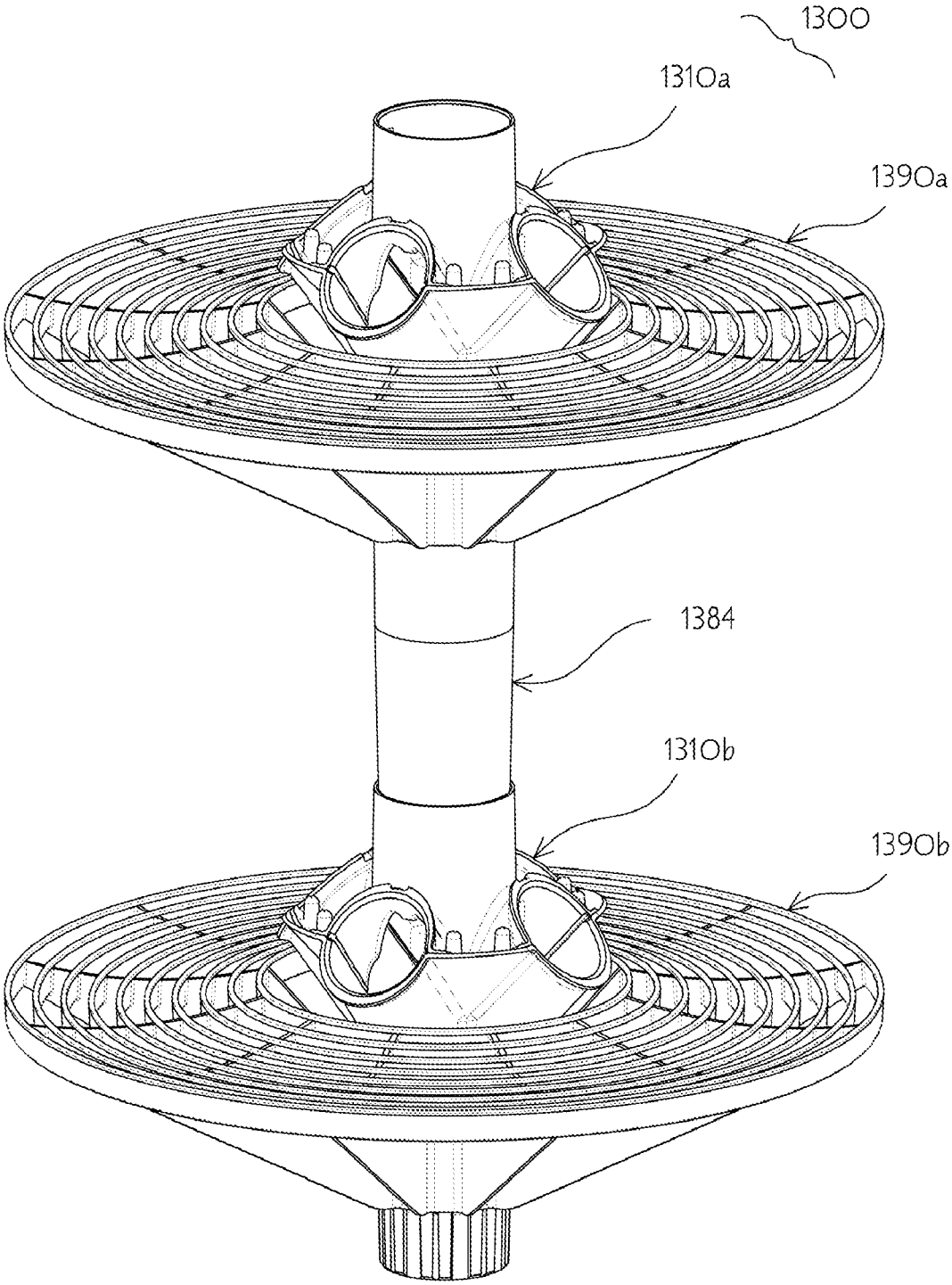

Fig. 13

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US22/47776

A. CLASSIFICATION OF SUBJECT MATTER

IPC - INV. A01G 9/02; A01G 9/24; A01G 31/06 (2023.01)
ADD. A01G 27/02 (2023.01)

CPC - INV. A01G 9/023; A01G 9/247; A01G 27/006; A01G 31/06
ADD. A01G 27/02

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 database consulted during the international search (name of database 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	SYLVAINH9. "Hydroponic 3D Printed Tower" 1-8. [online]. 28 October 2020; [Retrieved on 27 December 2022]. Retrieved from the internet: <URL: https://web.archive.org/web/20201028003947/https://www.instructables.com/Hydroponic-3D-Printed-Tower> pages 1-8	1, 3/1 --- 2, 3/2
X --- Y	WO 2021/010882 A1 (PARI PLAST AB) 21 January 2021; figures 3-4	35-36 --- 37-38
X	CN 212306431 U (CHU YONGJIN) 08 January 2021; figures 1-2, 6; see machine translation: abstract; claim 1	41-43
Y	US 2017/0105372 A1 (TOWER GARDEN, LLC) 20 April 2017; figures 9-13; paragraph [0037]	2, 3/2
Y	US 4,779,378 A (MASON JR STANLEY I) 25 October 1988; figures 5, 9; column 3, lines 1-15	37, 38/37
Y	WO 2009/109761 A1 (MADDISON DAVID EDWARD) 11 September 2009; page 9, last paragraph	38
A	US 2007/0144069 A1 (GOTTLIEB JOHN) 28 June 2007; entire docuement	1-3, 35-38, 41-43
A	WO 2016/162856 A1 (EDEN GREEN HYDROPONICS INTERNATIONAL) 13 October 2016; entire document	1-3, 35-38, 41-43
A	WO 2020/076729 A1 (GARDYN INC.) 16 April 2020; entire document	1-3, 35-38, 41-43

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

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

Date of the actual completion of the international search	Date of mailing of the international search report
23 February 2023 (23.02.2023)	MAR 27 2023
Name and mailing address of the ISA/ Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-8300	Authorized officer Shane Thomas Telephone No. PCT Helpdesk: 571-272-4300

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US22/47776

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

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

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

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

3. ☒ Claims Nos.: 4-29, 34, 39-40, 44-48
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

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

This International Searching Authority found multiple inventions in this international application, as follows:
-***-Please See Supplemental Page-***-

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

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

3. ☒ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
Group I: Claims 1-3; Group III: Claims 35-38; Group IV: Claims 41-43

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

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

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

☒ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US22/47776

-***-Continued From Box No. III: Observations where unity of invention is lacking-***-

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

Group I: Claims 1-3 are directed toward a plant growth structure comprising a plurality of planter modules, the planter modules comprising: wherein the peripheral density of the growth basket receptacles disposed around the central section is at least about 0.6.

Group II: Claims 30-33 are directed toward a kit for the construction of a plant growth structure, comprising: at least a first riser tube module; and wherein the riser tube module outer wall is free from growth basket receptacles.

Group III: Claims 35-38 are directed toward a plant growth structure comprising a plurality of planter modules, the planter modules comprising: at least a first flow guide disposed on the interior fluid conduit, the first flow guide comprising a projection extending outwardly from the fluid conduit.

Group IV: Claims 41-43 are directed toward a plant growth basket that is configured to be placed within a growth basket receptacle in a vertically-oriented plant growing system, the growth basket comprising: a plurality of fluid apertures disposed in the bottom wall; and at least first and second flanges disposed along an exterior surface of the growth basket sidewall.

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

Group I include a plant growth structure comprising a plurality of planter modules, the planter modules comprising: a central section having a top end, a bottom end and an outer wall defining an interior fluid conduit therethrough for the passage of a liquid (which are not present in Group IV), and at least three growth basket receptacles disposed in a substantially horizontal plane around a periphery of the central section (which are not present in Groups II-IV), the growth basket receptacles having an outer diameter and being configured so that when a growth basket is placed in a growth basket receptacle, at least a lower portion of the growth basket is in fluid communication with the fluid conduit (which are not present in Group IV), wherein the peripheral density of the growth basket receptacles disposed around the central section is at least about 0.6 (which are not present in Groups II-IV).

Group II include a kit for the construction of a plant growth structure, comprising: at least a first planter module, the first planter module comprising; a central section having a top end, a bottom end and an outer wall defining an interior fluid conduit therethrough for the passage of a liquid, and a plurality of growth basket receptacles disposed around a periphery of the central section, the growth basket receptacles being in fluid communication with the interior fluid conduit (which are not present in Group IV), at least a first riser tube module, the first riser tube module comprising a top end, a bottom end and an outer wall defining an interior fluid conduit for the passage of a liquid, the top end and bottom end having an outer periphery that is substantially the same cross-section as the outer periphery of the central section of the at least first planter module; wherein the riser tube module is configured to operatively and securely attach to the bottom end of the at least first planter module; and wherein the riser tube module outer wall is free from growth basket receptacles (which are not present in Groups I and III-IV).

Group III include a plant growth structure comprising a plurality of planter modules, the planter modules comprising: a central section having a top end, a bottom end, and a sidewall defining an interior fluid conduit therethrough for the passage of a liquid; at least a first growth basket receptacle disposed on a periphery of the central section, the first growth basket receptacle having an outer diameter and being in fluid communication with the fluid conduit (which are not present in Group IV); and at least a first flow guide disposed on the interior fluid conduit, the first flow guide comprising a projection extending outwardly from the fluid conduit (which are not present in Groups I-II and IV).

Group IV include a plant growth basket that is configured to be placed within a growth basket receptacle in a vertically-oriented plant growing system, the growth basket comprising: a sidewall, a bottom wall, a top rim and a top orifice for receiving plant growing matter within the interior of the growth basket; a plurality of fluid apertures disposed in the sidewall; a plurality of fluid apertures disposed in the bottom wall; and at least first and second flanges disposed along an exterior surface of the growth basket sidewall (which are not present in Groups I-III).

The common technical features of Groups I-IV are a plant growth basket that is configured to be placed within a growth basket receptacle in a plant growing system/structure.

The common technical features of Groups I-III are a plant growth structure comprising a plurality of planter modules, the planter modules comprising: a central section having a top end, a bottom end and an outer wall defining an interior fluid conduit therethrough for the passage of a liquid, and a plurality of growth basket receptacles around a periphery of the central section, the growth basket receptacles having an outer diameter and being configured so that when a growth basket is placed in a growth basket receptacle, at least a lower portion of the growth basket is in fluid communication with the fluid conduit.

The common technical features of Groups I-IV are disclosed by US 2017/0105372 A1 (TOWER). Tower discloses a plant growth basket (47; figures 9-11) that is configured to be placed within a growth basket receptacle (46) in a plant growing system/structure (10).

The common technical features of Groups I-III are disclosed by Tower. Tower discloses a plant growth structure (10; figures 9-13) comprising a plurality of planter modules (78, 80), the planter modules comprising: a central section having a top end, a bottom end and an outer wall defining an interior fluid conduit therethrough for the passage of a liquid (modules 78 and 80 have a central section as shown with top and bottom ends and an outer wall indicated at 78 and 80 through which fluid flows downwards as shown by the arrows), and a plurality of growth basket receptacles (46) around a periphery of the central section (as shown), the growth basket receptacles having an outer diameter (as shown) and being configured so that when a growth basket (47) is placed in a growth basket receptacle, at least a lower portion of the growth basket is in fluid communication with the fluid conduit (as shown in figure 11).

Since the common technical features are previously disclosed by the Tower reference, the common features are not special and so Groups I-IV lack unity.