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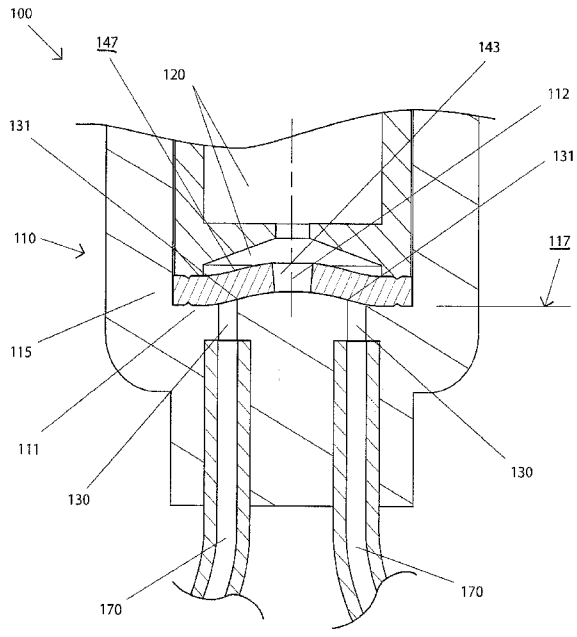

Fig. 1B

(57) Abstract: A device for mixing and dispensing fluids has first and second walls that form a chamber connected to a nozzle. Inlets each configured to receive one fluid are arranged in the first wall. Proximate edges of the inlets are an equal distance from a central point on the first wall. A seal having top and bottom surfaces and a center through hole is secured in the chamber. The center hole is substan - tially aligned with the central point. A surface area of the top surface is greater than a sum of the sectional areas of the inlets. A dispensing pump moves the seal between a sealed position in which the bottom surface seals the inlets and an open position in which the bottom surface is spaced away from the inlets to open the inlets to draw the fluids into the chamber to form the mixture for dispensing through the nozzle.

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MIXING AND DISPENSING DEVICE

PRIORITY

[0001] This application claims priority to U.S. Provisional Application No. 61/962,510, entitled "Mixing and Dispensing Device," filed on November 7, 2013.

BACKGROUND

[0002] Various devices are known in the art to dispense fluids. Typically, dispensers hold a single fluid. However, it is often desirable for multiple fluids to be stored in separate storage containers within a single device, and then mixed and immediately dispensed as a mixture from the device. In various industries, including the cosmetic industry, it is desirable to have a device that is configured to proportionally adjust the volumetric ratio of each fluid that makes up the mixture, in order to provide a customized product that includes each of a plurality of fluids.

SUMMARY

[0003] In an aspect, a device for dispensing a mixture of at least two fluids contained in at least two containers is disclosed, comprising: a body comprising first and second walls that form a chamber that is connected to a nozzle; at least two spaced-apart inlets to the chamber arranged in an array in the first wall of the body such that proximate edges of the at least two inlets are an equal distance from a generally central point on the first wall, each of the inlets having a sectional area, and each of the inlets being configured to receive the fluid from one of the at least two containers; a seal having a top surface, a bottom surface, and a center through hole secured in the chamber around a perimeter of the seal such that the center through hole is substantially aligned with the central point; wherein a surface area of the top surface is greater than a sum of the sectional areas of the at least two inlets; wherein the seal is moveable between a sealed position in which the bottom surface seals the at least two inlets and an open position in which the bottom surface is spaced away from the at least two inlets to open the inlets to the chamber through the hole; and a dispensing pump that is operable to move the seal between the sealed and the open positions; wherein the nozzle is configured to dispense the mixture upon activation.

[0004] In another aspect, a device for dispensing a mixture of at least two fluids contained in at least two containers, comprising: a body comprising first and second walls

that form a chamber that is connected to a nozzle; at least two spaced-apart inlets to the chamber arranged in an array in the first wall of the body such that proximate edges of the at least two inlets are an equal distance from a generally central point on the first wall, each of the inlets having a sectional area, and each of the inlets being configured to receive the fluid from one of the at least two containers; a seal having a top surface, a bottom surface, and a central shaft secured in the chamber by securing the central shaft in the first wall at the central point such that the central shaft of the seal is substantially aligned with the central point; wherein a surface area of the top surface is greater than a sum of the sectional areas of the at least two inlets; wherein the seal is moveable between a sealed position in which the bottom surface seals the at least two inlets and an open position in which the bottom surface is spaced away from the at least two inlets to open the inlets to the chamber; and a dispensing pump that is operable to move the seal between the sealed and the open positions; wherein the nozzle is configured to dispense the mixture upon activation.

BRIEF DESCRIPTION OF THE DRAWINGS

[0005] Fig. 1 is a cross-sectional front view of an aspect of the mixing and dispensing device taken through the body and the flow channels and showing a planar seal and a planar first wall (A) as a partial assembly and (B) in the assembled state;

[0006] Fig. 2 is a cross-sectional front view of an aspect of the mixing and dispensing device taken through the body and the flow channels and showing a contoured seal and a planar first wall (A) as a partial assembly and (B) in the assembled state;

[0007] Fig. 3 is a cross-sectional front view of an aspect of the mixing and dispensing device taken through the body and the flow channels and showing a seal having a shaft as a partial assembly;

[0008] Fig. 4 is an orthographic front view of an aspect of the device (with the body, the seal, and the flow channels shown in cross-section for clarity) (A) in a resting mode, (B) in a dispensing mode, and (C) in a rebound mode;

[0009] Fig. 5 is an orthographic front view of an aspect of the device (with the body, the seal, and the flow channels shown in cross-section for clarity);

[0010] Fig. 6 is an aspect of the device, showing (A) an exploded view of the device, (B) an exploded view of a container, and (C) a container having a bladder;

[0011] Fig. 7 is an exploded isometric view of showing the device having inlets and flow channels (A) each having an equal sectional area and (B) each having different sectional areas.

DETAILED DESCRIPTION

[0012] As shown generally in the Figures, aspects of a device **100** for dispensing a mixture of fluids are disclosed. As described above, the device **100** comprises a body **105** comprising first and second walls **111, 115** that form a chamber **120** that is connected to a nozzle **160.** At least two spaced-apart inlets **130** to the chamber **120** are arranged in an array in the first wall **111,** each of the inlets **130** being configured to receive the fluid from one of the at least two containers **105.** A seal **140** for sealing the inlets **130** is positioned in the chamber **120.** A dispensing pump **150** is operable to move the seal **140** from a sealed position (Figs. 4A, 4B) to an open position (Fig. 4C) and to draw the fluids from the containers **105** through the at least two inlets **130** into the chamber **120** to form the mixture. The nozzle **160** is configured to dispense the mixture upon activation.

[0013] The device **100** is configured for use with at least two containers **105** positioned in an array. In certain aspects, the containers **105** may be positioned in a linear array (Fig. 6A) or a non-linear array (not shown). Each container **105** is configured to hold a fluid. In various aspects, the fluid may be a fragrance oil, a solvent, a pigment, an ink, a dye, a medication, a cream, a lotion, a dietary supplement, a flavoring, a spirit, a cleaning substance, or any other such substance available in a liquid form. Various optional features of the container **105** are shown in Figs. 6A-6C and are described in detail below.

[0014] Referring to Figs. 1-3, a body **110** has first and second walls **111, 115** that form a chamber **120.** The first wall **111** has an interior surface **117** and a central point **112** thereon. As described in greater detail below, the inlets **130** are positioned in the first wall **111** relative to the central point **112.** The interior surface **117** of the first wall **111** may be substantially, or in some cases, completely, flat (Figs. 2, 4, 5, **7)** or may vary in, for example, contours, tapers or other features (Fig. 1) to vary sealing characteristics of the seal. For example, the interior surface **117** of the first wall **111** may have a protrusion into the chamber **120,** such as a convex or conical interior surface.

[0015] As shown generally in the Figures, at least two inlets **130** to the chamber **120** are configured to receive the fluid from the at least two containers **105.** Each inlet **130** has a sectional area and at least one edge **131.** The sectional area of each of the inlets **130** may be

equal (Fig. 7A), or the sectional area of at least one of the inlets may be smaller than a sectional area of other of the at least two inlets (Fig.7B). As shown generally in the Figures, at least two inlets **130** are spaced-apart and arranged in a linear or non-linear array in the first wall **111** of the body **110** relative to the central point **112.** As illustrated in Figs. 1 and 2, proximate edges **131** of the inlets **130** may be an equal distance from the central point **112** on the interior surface **117** of the first wall **111.**

[0016] Each inlet **130** is configured to receive fluid from one of the containers **105.** In an aspect, the device **100** comprises at least two flow channels **170** each configured to carry fluid from one of the containers **105** to the chamber **120** through a corresponding inlet **130.** *See, e.g.,* Figs. 4A-4C. As illustrated in Fig. 6, each flow channel **170** is connected at a first end **171** to a corresponding one of the containers **105** and at a second end **172** to a corresponding inlet **130** into the chamber **120.** Each flow channel **170** has a sectional area. The flow channels **170** may be compressible or pliable, such as an elastomeric material made of, for example, extruded PVC, silicone, etc., or the flow channels may be made of a semi-rigid or rigid material. The sectional area of each flow channel **170** may be equal (Figs. 6A, 7A), and a volumetric ratio of each fluid comprising the mixture may be adjusted by an adjustable valve **180** (Fig. 6A) that independently adjusts the mass flow rate of each one of the fluids that is drawn from a container **105** through the corresponding flow channel **170** during operation of the device **100.** Alternatively, the sectional area of at least one of the flow channels **170** may be smaller than a sectional area of other flow channels **170** (Fig.7B) such that the volumetric ratio of each fluid comprising the mixture may be directly proportional to the sectional area of each flow channel **170,** which may determine the mass flow rate of the fluid therethrough during operation of the device **100.**

[0017] As illustrated generally in the Figures, a seal **140** having a top surface **147** having a surface area, a bottom surface **148,** and a center through hole **143** is secured in the chamber **120** around a perimeter of the seal **140.** The surface area of the top surface **147** of the seal **140** is greater than a sum of the sectional areas of the at least two inlets **130** and of a sectional area of the central through hole **143.** As shown in Figs. 1 and 2, the center through hole **143** is substantially aligned with the central point **112** on the interior surface **117** of the first wall **111.** The seal **140** may be resilient, such as a material made of silicone or a solvent-resistant thermoplastic elastomer, semi-rigid, or rigid.

[0018] The **140** seal may be a planar member (Figs. 1, 7) or may vary in, for example, shape, size, and/or thickness, and may include contours, tapers or other features (Fig. 2) to

vary sealing and opening characteristics of the inlets **130.** As illustrated in Figs. 2 and 5, the seal **140** may be secured about a peripheral edge and may include retention or sealing features such as a rim **145** or indenting sealing features. The seal **140** also may have a rim **145** around a peripheral edge and/or a perimeter of the hole (not shown).

[0019] As described above, the seal **140** may be secured around its perimeter in the chamber **120.** As illustrated in Figs. 1, 2, and 4, in an aspect, a bottom surface **157** of the pump body **151** wall may engage the top surface **147** of the seal **140.** As illustrated in Fig. 5, in an aspect, there may be an engaging member **190** in the chamber **120** proximal to the seal **140.** The engaging member **190** has a surface **197** that engages the top surface **147** of the seal **140.** The surface **197** of the engaging member **190** may comprise a rigid rim **195** that compressingly engages the top surface **147** of the seal **140** to secure the seal **140** in the chamber **120.** In an aspect (not shown) the seal **140** may be secured to one of the walls **111, 112** of the body **110,** such as a rim **145** around the outer perimeter of the seal **140** that may engage a complementary groove (not shown) in the second wall **112** of the body **110** to secure the seal **140** in the chamber **120.**

[0020] The seal **140** is moveable between a sealed position (Figs. IB, 2B, 4A, 4B) and an open position (Fig. 4C). The seal position is controlled by operation of the dispensing pump **150,** as described in greater detail below. As illustrated in Figs. IB, 2B, 4A, and 4B, in the sealed position, the bottom surface **148** of the seal **140** seals the at least two inlets **130** in order to substantially, or in some cases completely, prevent the anterograde flow of fluid into the chamber **120** or cross-flow between inlets **130.** As illustrated in Fig. 4C, in the open position, the bottom surface **148** of the seal **140** is spaced away from the at least two inlets **130** to open the inlets **130** to the chamber **120** to draw fluids from the containers **105** through the inlets **130** into the chamber **120** through the hole **143** to form the mixture.

[0021] As illustrated in Figs. 4 and 6, a dispensing pump **150** is positioned downstream from the chamber **120** and is configured to communicate with a downstream nozzle **160.** The dispensing pump **150** may be any appropriate pump known to those skilled in the art. The dispensing pump **150** may be manually actuated or electronically actuated with a manually actuated button that electronically operates the dispensing pump assembly **150** by means of a motor drive, for example.

[0022] The nozzle **160** may be configured for communication with the dispensing pump **150** and may be configured to dispense the mixture when the device **100** is in operation. The nozzle **160** may be any of a variety of types of nozzle that is configured to

dispense a spray, mist, drop, stream, etc. of a mixture of fluids. The dispensing pump may be any appropriate such pump used, for example, for fragrances, creams, and the like and comprising injection molded components, such as for example, a nozzle, a piston-type pump in a dispensing chamber, a return spring, and having a check valve between the piston and the nozzle.

[0023] As described above, and as illustrated in Fig. 6A, the device **100** is configured for connection to at least two containers **105** each configured to contain a fluid. In an aspect, each container **105** may be removable and refillable or replaceable. In another aspect, each container **105** may be permanently affixed to the device **100.** The containers **105** may be of differing or the same volume capacity, length, or diameter. In aspects, the containers **105** may be made from, by way of example, glass, plastic, metallic materials, collapsible or pliable materials such as a bladder, or materials that are resistant to degradation by the fluids contained or to be contained therein. In an aspect, the containers **105** may be clear to render the fluid contents visible. Optionally, a window (not shown) is positioned in a wall of an opaque container **105** to show the fluid contents thereof.

[0024] As illustrated in Figs. 6A, 6B, each container **105** has a closure device **101,** such as a cap, seal, or the like that substantially closes the container **105** so that the fluid contained therein does not leak out. The closure device **101** may be either integral with the container **105** or assembled. A port (not shown) may be positioned in or integral with the closure device **101** to provide communication between the container **105** and the corresponding flow channel **170** when the port is in the opened position. The port may be configured to receive a first end **171** of the corresponding flow channel **170** or a coupling (not shown), such as a spike, needle, nipple, zerk, or other such connector, that connects or couples the distal end of the corresponding flow channel **170** to the container **105.** In an aspect, the port may be a pierceable septum.

[0025] The container may be attached to a receptacle **102** by any means known to those skilled in the art. In an aspect illustrated in Fig. 6A, the receptacle **102** may be configured to receive a neck of the container **105.** The neck and the receptacle **102** may threadably engage or the container **105** may snap-fit into the receptacle **102.**

[0026] As illustrated in Fig. 6B, each container **105** has a vent **103** that is configured for entry of atmospheric air into the container **105** as fluid is drawn out by operation of the dispensing pump **105.** The vent **103** substantially eliminates the buildup of vacuum in the container **105** and is configured to substantially prevent leakage of the fluid from the

container **105.** In aspects, the vent **103** may be positioned within or is integral with the closure device **101** or the port. By way of example, the vent **103** may be an elastomeric duck-bill valve, a flapper valve, an umbrella valve, a diaphragm, etc. In another example, the vent **103** may be a spring-loaded assembly such as a ball or ball plunger that engages a sealing aperture.

[0027] Optionally, as illustrated in Fig. 6B, a conduit **104,** such as a sipper tube, may be included in each container configured to draw fluid from the interior of the container **105** and to communicate with the distal end of the corresponding flow channel **170.**

[0028] In certain aspects and as illustrated in Fig. 6C, a bladder **106** configured to hold the fluid may be positioned in the interior of the container **105.** The port may be in communication with the interior of the bladder **106.** In aspects, the bladder **106** may be at least one of flexible, removable, replaceable, and refillable.

[0029] In aspects, the containers **105** and the body **110** may be enclosed in a housing (not shown). In aspects, the housing may be comprised of a single component or multiple components. In an aspect, a portion of the housing may be removable or may be configured to open or close to provide or restrict access, respectively, to the containers **105,** for example, as useful to remove and replace a container **105.** The housing may be made of plastic, such as injection molded polycarbonates, polystyrenes, etc.

[0030] Device **100** is shown in a resting mode in Fig. 4A. At rest, seal **140** is in the sealed position. A sealing force against the inlets is achieved by a preload stress upon the perimeter of the top surface of the seal which passes through the seal to the bottom surface of the seal positioned over the at least two inlets to seal the inlets. A contoured bottom surface of the seal positioned against a planar interior first wall contributes to the preload stress by deforming the seal. The bottom surface of the seal forms a contact with the interior of the first wall so that the seal is substantially, or in some cases completely, sealed against the at least two inlets. In another aspect *(see, e.g.,* Fig. IB), contoured forms such as a conical or domed form, protruding from the interior of the first wall of the chamber, contribute to the preload stress by deforming the seal. The bottom surface of the seal forms a contact with the interior of the first wall so that the seal is substantially, or in some cases completely, sealed against the at least two inlets.

[0031] Device **100** is shown in a dispensing mode in Fig. 4B. In the dispensing mode, seal **140** is in the sealed position. The sealing force between the bottom surface **148** of the seal **140** and the edges of the inlets **130** seals fluid flow through the inlets **130.** The

sealing force is increased by the increasing fluid pressure within the chamber **120** which results from the movement of the piston into the chamber **120** which decreases the volume of the fluid within chamber **120** as the fluid is dispensed through the nozzle **160.**

[0032] Device **100** is shown in a rebound mode in Fig. 4C. In the rebound mode, seal **140** is moved to the open position. The piston rises within the chamber **120** creating a negative pressure which acts upon the top surface **147** of the seal **140** to draw the bottom surface **148** of the seal **140** away from the interior surface **117** of the first wall **111,** which draws fluid from the container **105** into the flow channels **170** and through the inlets **130** and the hole **143** into the chamber **120** to refill the chamber **120.**

[0033] Another aspect of a device for dispensing a mixture of at least two fluids is illustrated in Fig. 3. As described above, the component parts and surfaces of the device designated as **100** were referred to with corresponding reference numbers in the **100** series. The component parts of the device shown in Fig. 3 are referred to with reference numbers in the **200** series. For example, the body of device **100** is designated **110,** while the body of the device shown in Fig. 3 is designated **210.** The body **210,** inlets **230,** dispensing pump **250,** nozzle, and each of their respective component parts and surfaces of the device shown in Fig. 3 are the same as the corresponding parts and surfaces of device **100** and therefore the description of these parts is not repeated herein with respect to the device **200** shown in Fig. 3.

[0034] As discussed above with respect to device **100,** the device shown in Fig. 3 comprises a body **210** comprising first and second walls **211, 215** that form a chamber **220** that is connected to a nozzle **260.** There are at least two spaced-apart inlets **230** to the chamber **220** arranged in the first wall **211** of the body **210** such that proximate edges of the at least two inlets **230** are an equal distance from a generally central point **212** on the first wall **211,** each of the inlets **230** having a sectional area, and each of the inlets **230** configured to receive the fluid from one of the at least two containers **205.**

[0035] As illustrated in Fig. 3, a seal **240** having a top surface **247,** a bottom surface **248,** and a central shaft **246** is secured in the chamber **220** by securing the central shaft **246** in the first wall **211** at the central point **212** such that the central shaft **246** of the seal **240** is substantially aligned with the central point **212,** of the interior of the first wall **217.**

[0036] The surface area of the top surface **247** of the seal **240** is greater than a sum of the sectional areas of the at least two inlets **230.** The seal may be of low compliance force so as to be drawn easily open by the dispensing pump to draw fluid through the at least two

inlets **230.** The seal **240** may be resilient, such as a material made of silicone or a solvent-resistant thermoplastic elastomer, semi-rigid, or rigid.

[0037] The seal **240** is moveable between a sealed position and an open position. The sealed position is controlled by operation of the dispensing pump **250.** In the sealed position, the bottom surface **248** of the seal **240** seals the at least two inlets **230** in order to substantially, or in some cases completely, prevent the anterograde flow of fluid into the chamber **220** or cross-flow between the at least two inlets **230,** each independently associated with fluid flow from one of the at least two containers. In the open position, the bottom surface **248** of the seal **240** is spaced away from the at least two inlets **230** to open the inlets **230** to the chamber **220** to draw fluids from the containers (not shown) through the inlets **230** into the chamber **220** to form the mixture.

[0038] Referring still to Fig. 3, as described above with respect to device **100,** a dispensing pump **250** is operable to move the seal **240** from the sealed position to the open position to draw the fluids from the containers **205** through the at least two inlets **230** into the chamber **220** to form the mixture. The nozzle (not shown) is configured to dispense the mixture upon activation.

[0039] While the foregoing has been set forth in considerable detail, it is to be understood that the drawings and detailed aspects are presented for elucidation and not limitation. Design variations, especially in matters of shape, size and arrangements of parts may be made but are within the principles described herein. Those skilled in the art will realize that such changes or modifications of the invention or combinations of elements, variations, equivalents or improvements therein are still within the scope of the system and device as defined in the appended claims.

We claim:

1. A device for dispensing a mixture of at least two fluids contained in at least two containers, comprising:

a body comprising first and second walls that form a chamber that is connected to a nozzle;

at least two spaced-apart inlets to the chamber arranged in an array in the first wall of the body such that proximate edges of the at least two inlets are an equal distance from a generally central point on the first wall, each of the inlets having a sectional area, and each of the inlets being configured to receive the fluid from one of the at least two containers;

a seal having a top surface, a bottom surface, and a center through hole secured in the chamber around a perimeter of the seal such that the center through hole is substantially aligned with the central point;

wherein a surface area of the top surface is greater than a sum of the sectional areas of the at least two inlets;

wherein the seal is moveable between a sealed position in which the bottom surface seals the at least two inlets and an open position in which the bottom surface is spaced away from the at least two inlets to open the inlets to the chamber through the hole; and

a dispensing pump that is operable to move the seal between the sealed and the open positions;

wherein the nozzle is configured to dispense the mixture upon activation.

2. The device as in claim 1, further comprising the at least two containers, each container configured to hold one of the at least two fluids.

3. The device as in claim 1, further comprising at least two flow channels, each flow channel having a first end connected to one of the containers and a second end connected to one of the inlets.

4. The device as in claim 3, wherein a sectional area of at least one of the at least two flow channels is smaller than a sectional area of the other of the at least two flow channels.

5. The device as in claim 1, further comprising at least two independently actuable valves, each valve for controlling a flow of one of the fluids into the chamber.

6. The device as in claim 1, further comprising an engaging member positioned in the chamber proximal to the seal and having a surface that engages the top surface of the seal.

7. The device as in claim 1, further comprising an engaging member positioned in the chamber proximal to the seal and having a surface comprising a rim that compressingly engages the top surface of the seal.

8. The device as in claim 1, wherein the surface area of the top surface is greater than a sectional area of the center through hole.

9. The device as in claim 1, wherein an interior surface of the first wall is substantially planar.

10. The device as in claim 1, wherein an interior surface of the first wall is contoured to protrude into the chamber.

11. The device as in claim 1, wherein at least one of the top surface and the bottom surface of the seal is planar.

12. The device as in claim 1, wherein at least one of the top surface and the bottom surface of the seal is contoured.

13. The device as in claim 1, wherein at least one of the top surface and the bottom surface is tapered.

14. The device as in claim 1, wherein the top surface of the seal comprises a rim.

15. The device as in claim 1, wherein the bottom surface of the seal comprises a rim.

16. The device as in claim 1, wherein the dispensing pump is operable to move the seal to the open position to draw the fluids from the containers through the at least two inlets into the

chamber through the hole to form the mixture and to move the seal from the open position to the sealed position.

17. A device for dispensing a mixture of at least two fluids contained in at least two containers, comprising:

a body comprising first and second walls that form a chamber that is connected to a nozzle;

at least two spaced-apart inlets to the chamber arranged in an array in the first wall of the body such that proximate edges of the at least two inlets are an equal distance from a generally central point on the first wall, each of the inlets having a sectional area, and each of the inlets being configured to receive the fluid from one of the at least two containers;

a seal having a top surface, a bottom surface, and a central shaft secured in the chamber by securing the central shaft in the first wall at the central point such that the central shaft of the seal is substantially aligned with the central point;

wherein a surface area of the top surface is greater than a sum of the sectional areas of the at least two inlets;

wherein the seal is moveable between a sealed position in which the bottom surface seals the at least two inlets and an open position in which the bottom surface is spaced away from the at least two inlets to open the inlets to the chamber; and

a dispensing pump that is operable to move the seal between the sealed and the open positions;

wherein the nozzle is configured to dispense the mixture upon activation.

18. The device as in claim 17, further comprising the at least two containers, each container configured to hold one of the at least two fluids.

19. The device as in claim 17, further comprising at least two flow channels, each flow channel having a first end connected to one of the containers and a second end connected to one of the inlets.

20. The device as in claim 19, wherein a sectional area of at least one of the at least two flow channels is smaller than a sectional area of the other of the at least two flow channels.

21. The device as in claim 17, further comprising at least two independently actuable valves, each valve for controlling a flow of one of the fluids into the chamber.

22. The device as in claim 17, wherein the dispensing pump is operable to move the seal to the open position to draw the fluids from the containers through the at least two inlets into the chamber to form the mixture and to move the seal from the open position to the sealed position.

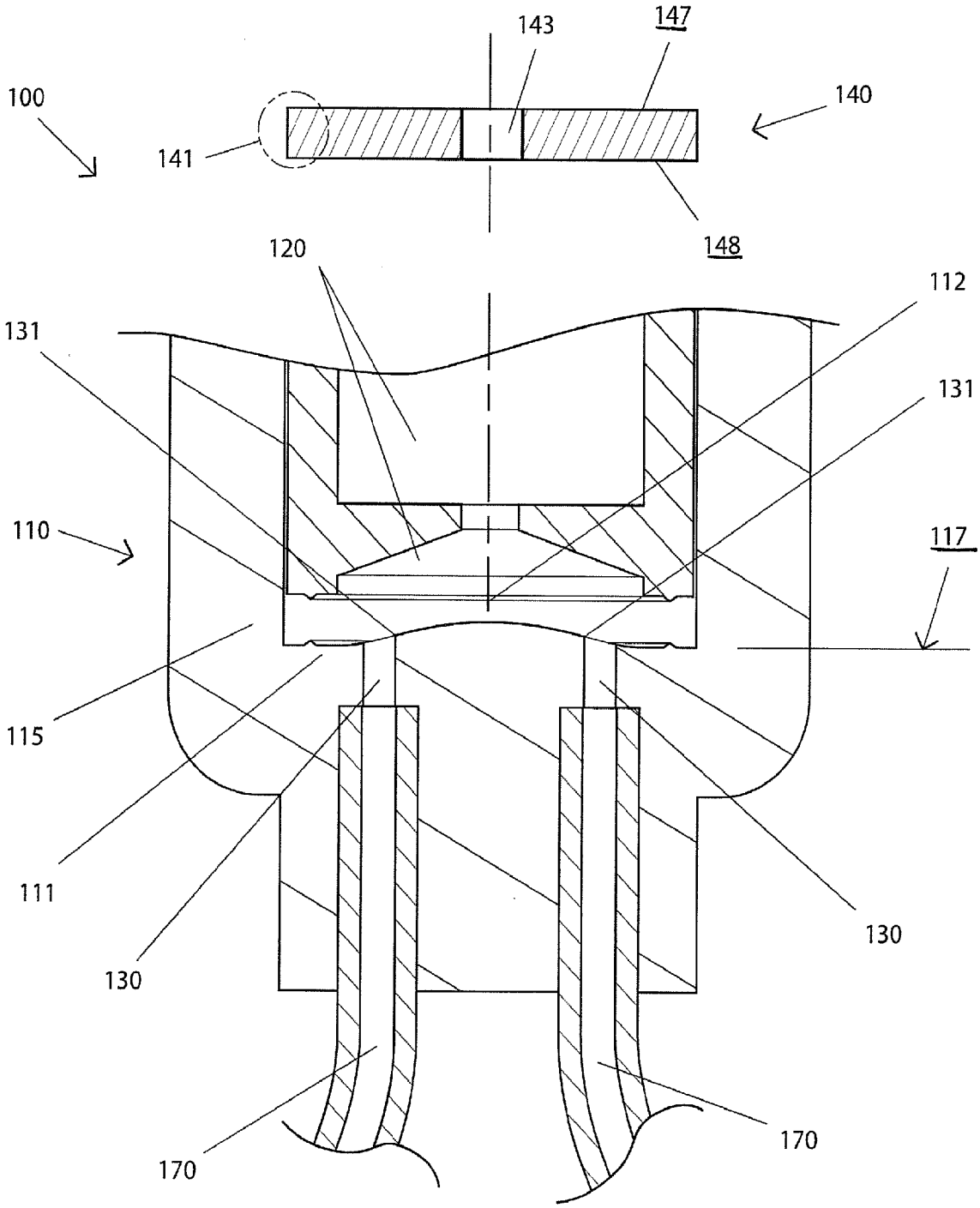
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Fig. 1A

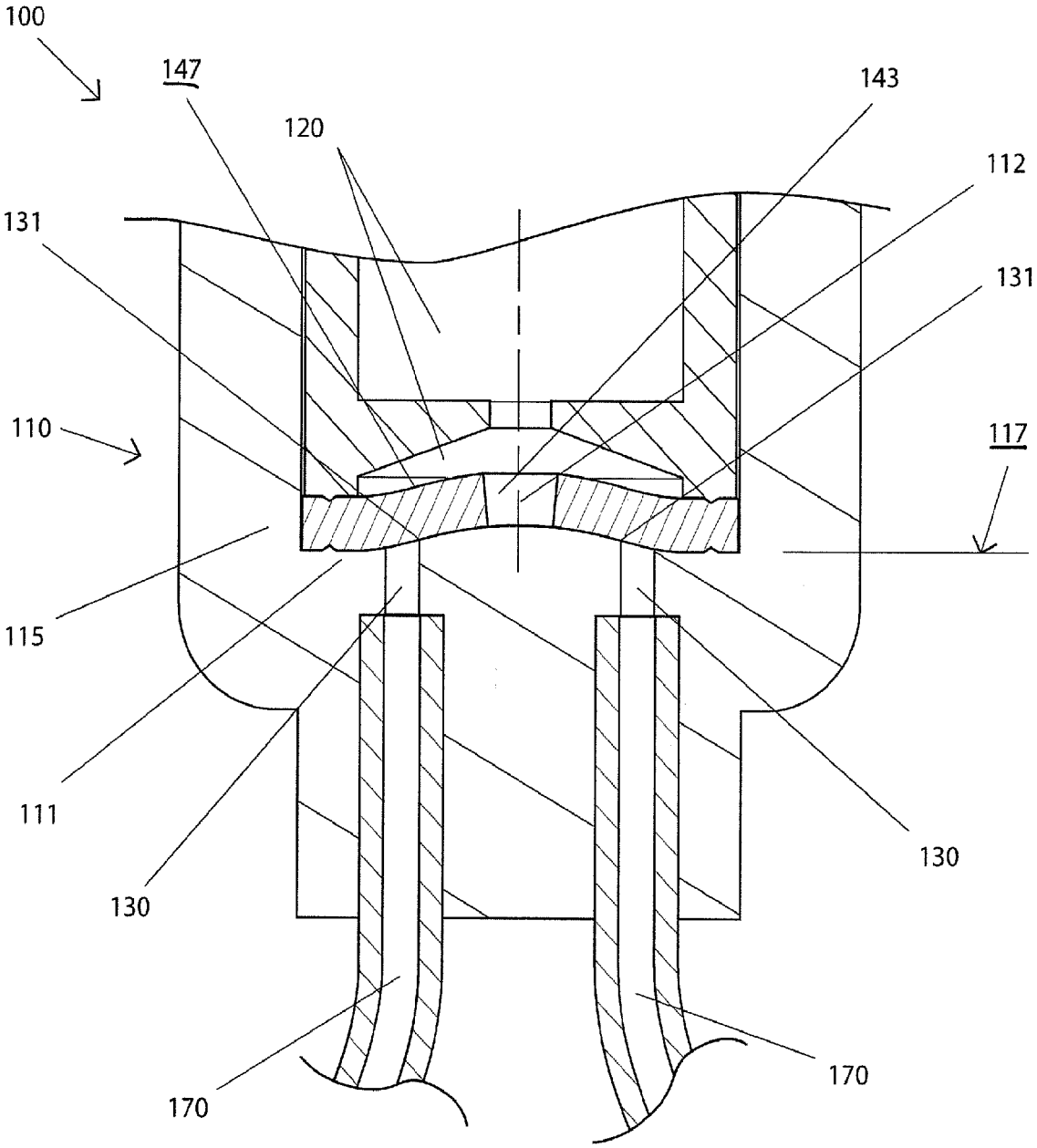

Fig. 1B

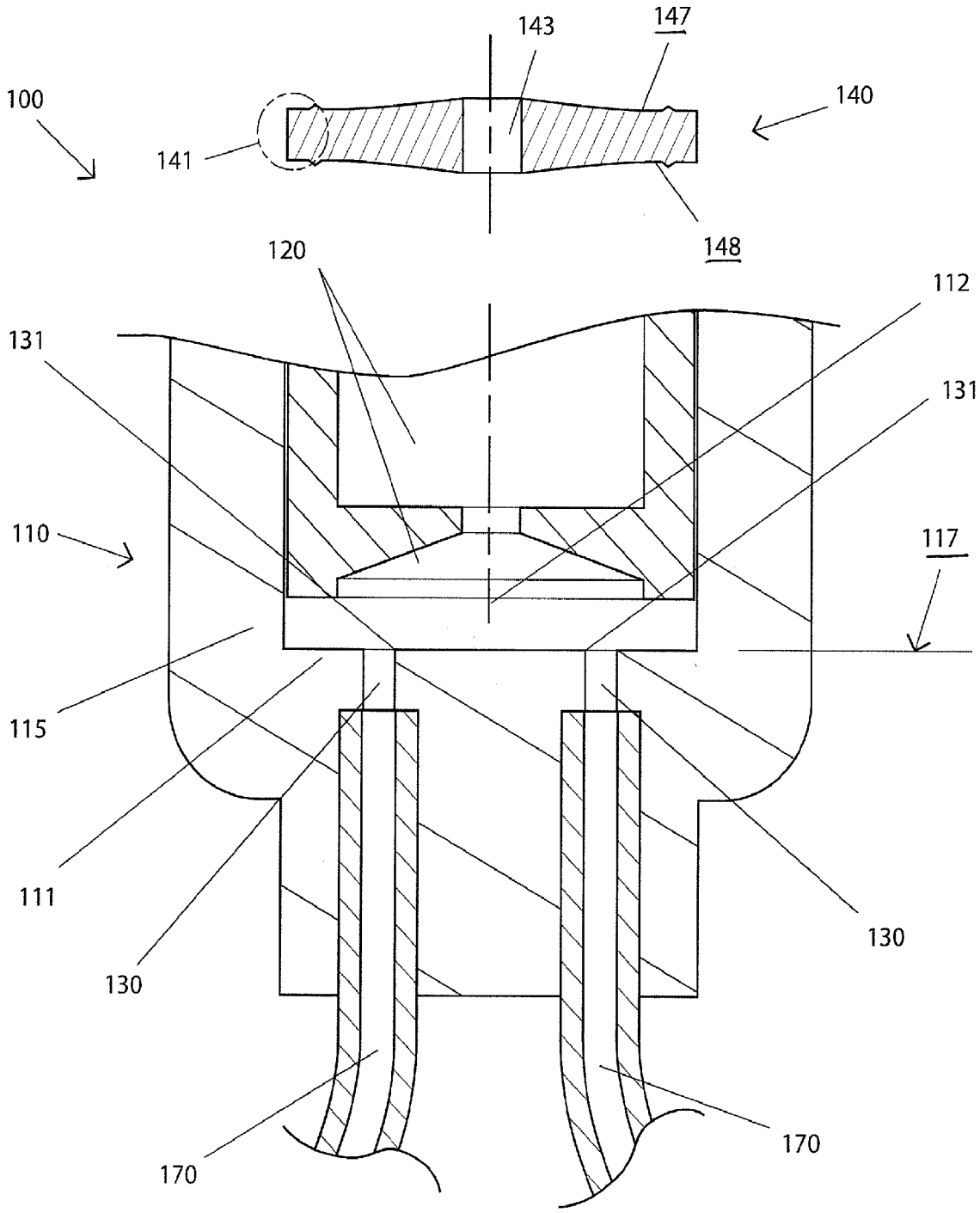
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Fig. 2A

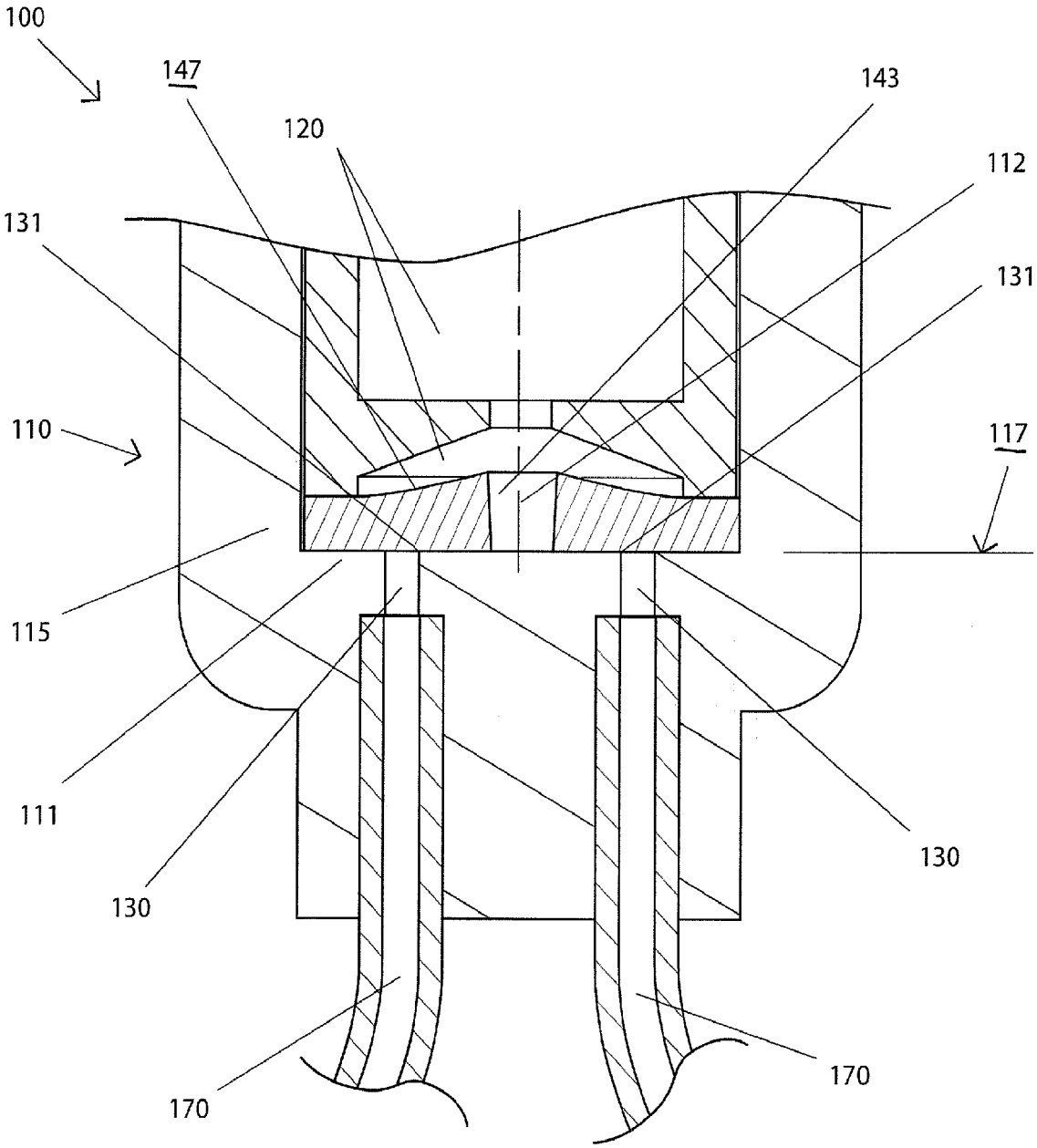

Fig. 2B

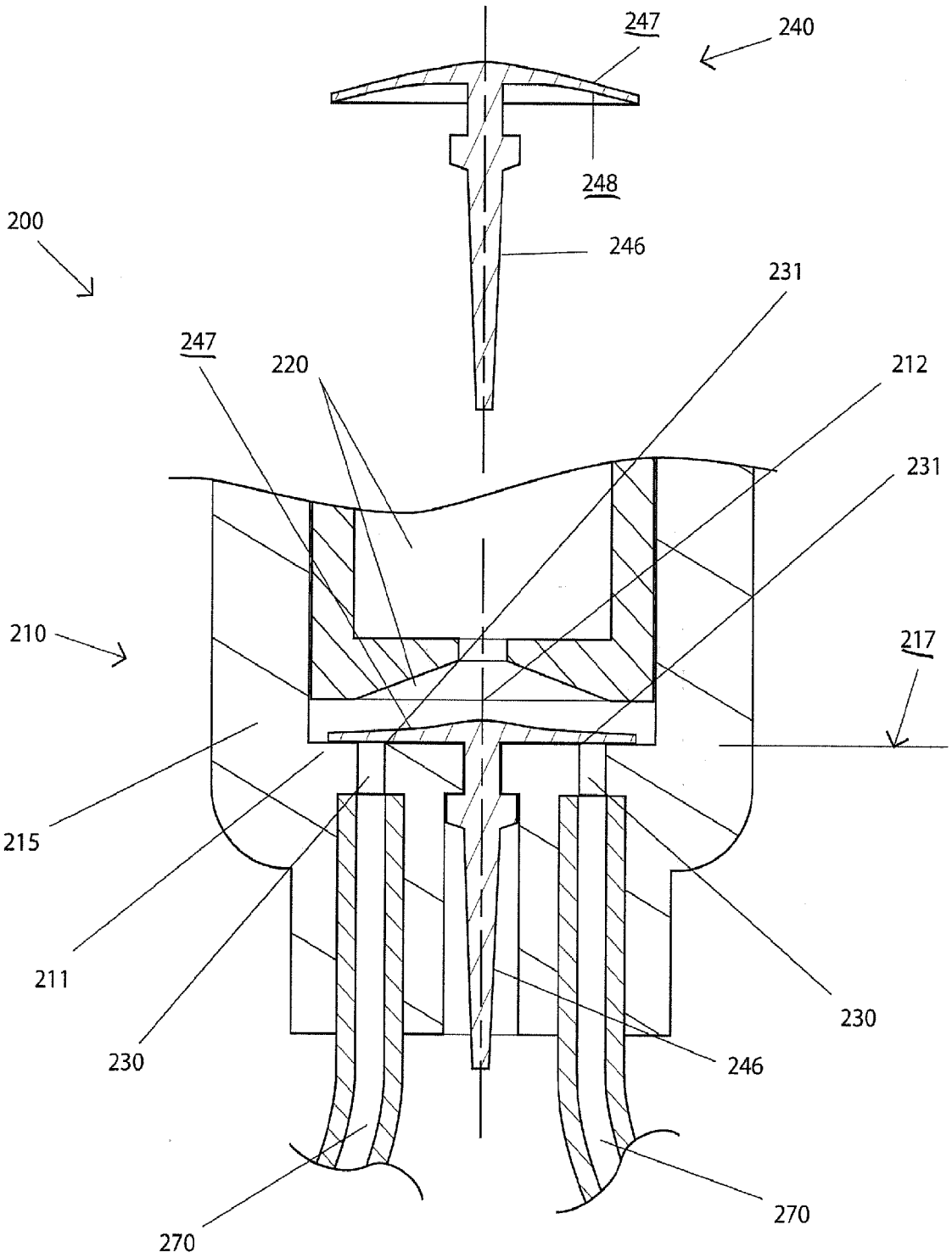
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Fig. 3

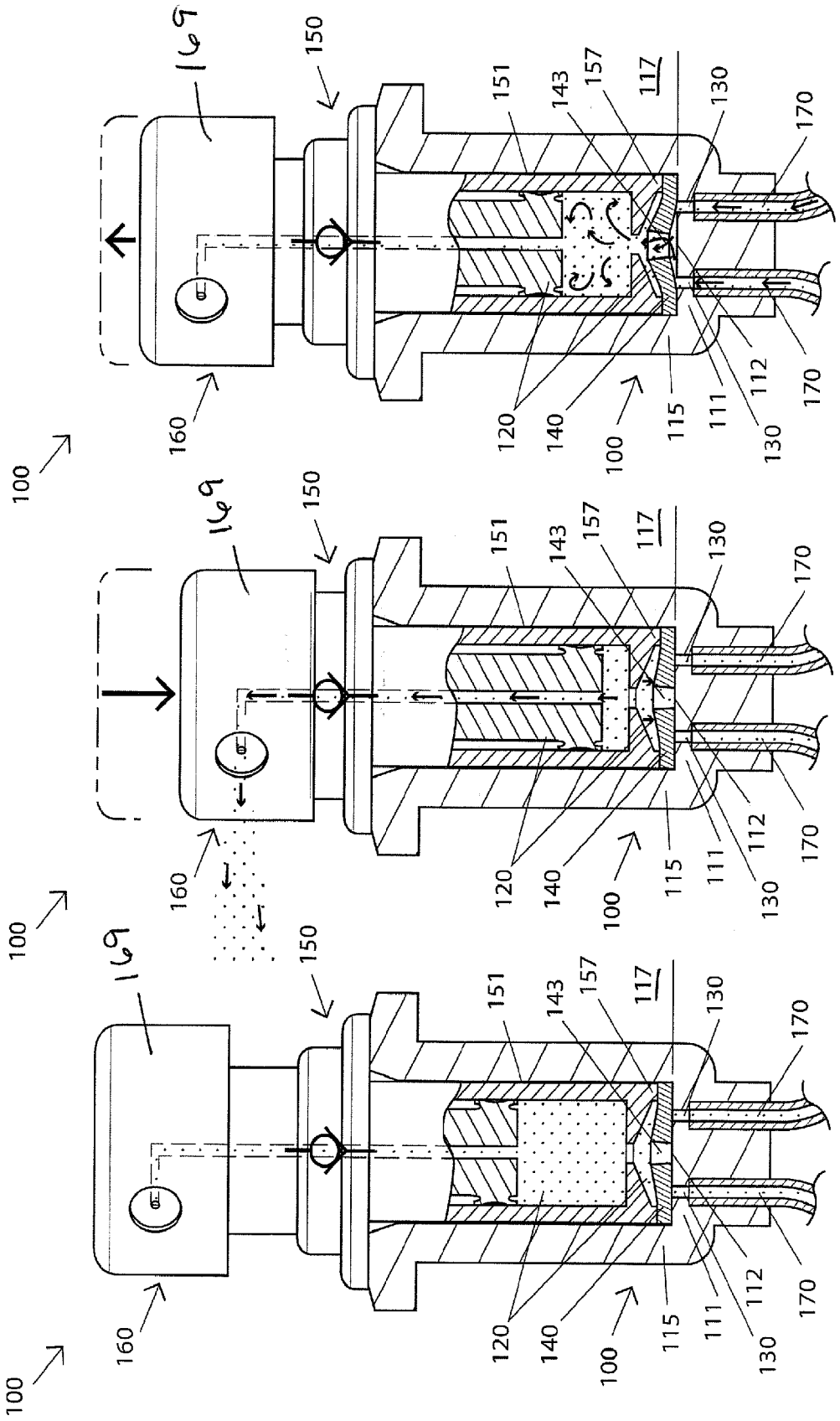


Fig. 4A

Fig. 4B

Fig. 4C

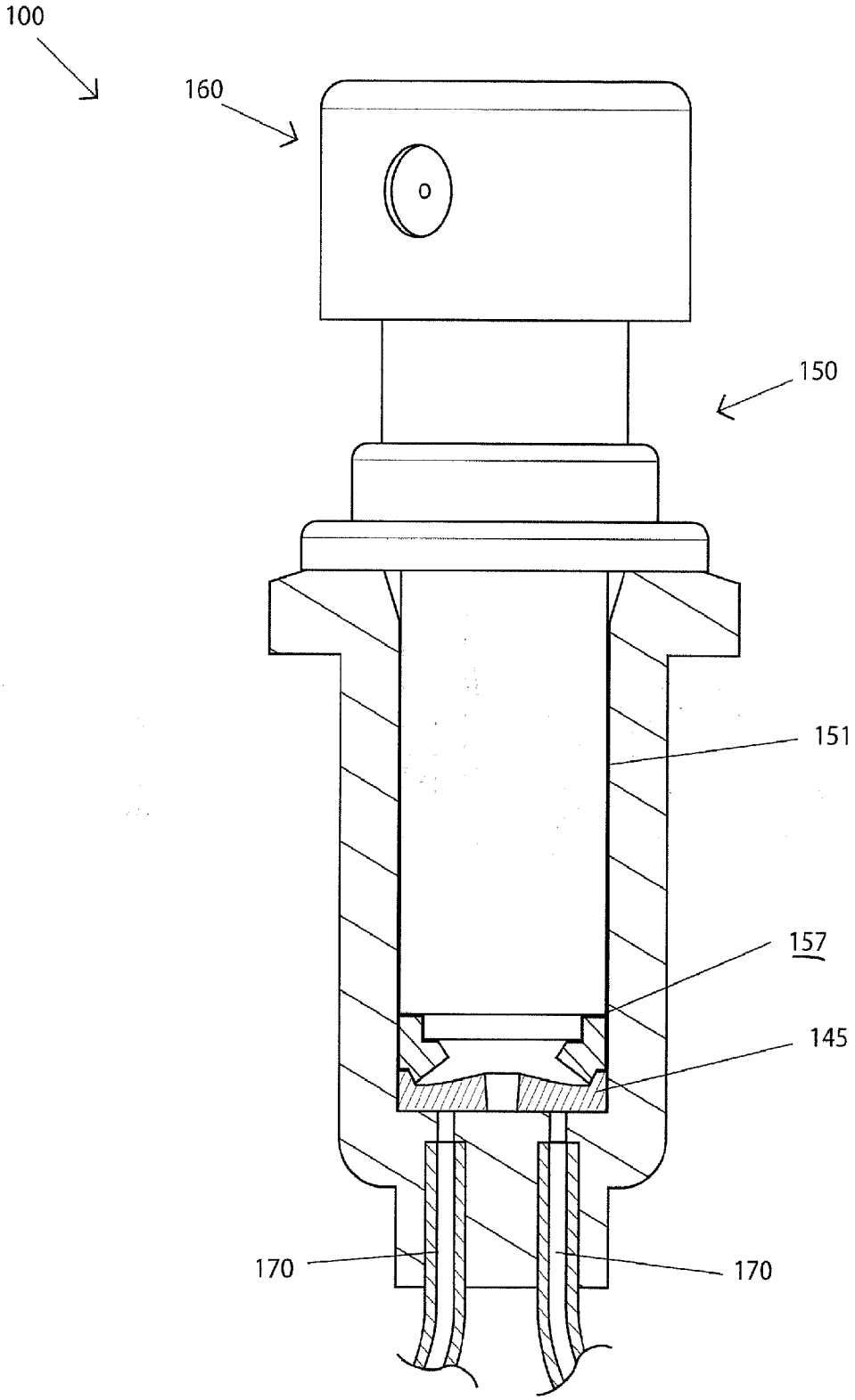
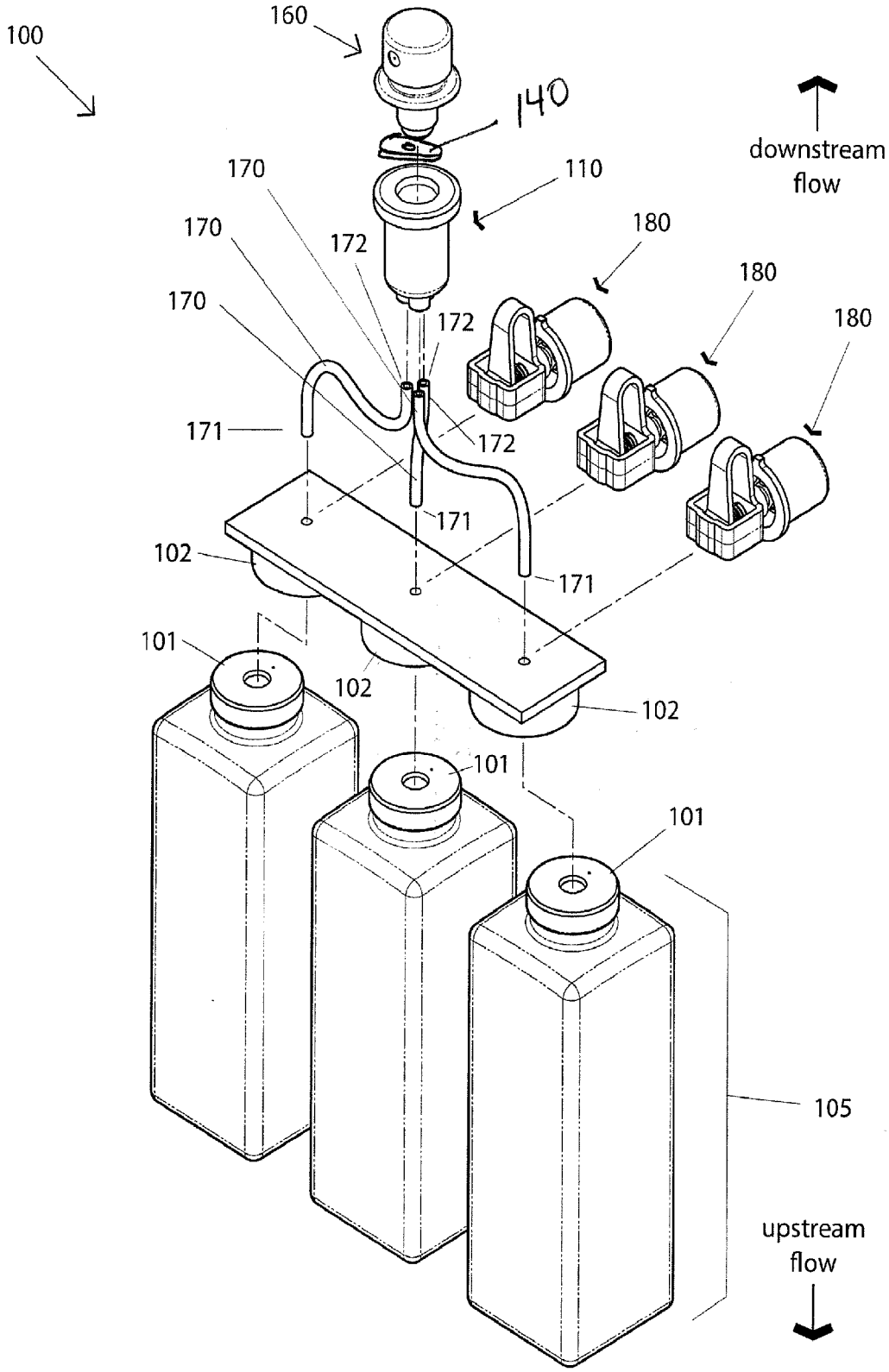


Fig. 5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102
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101
101
105
upstream flow

Fig. 6A

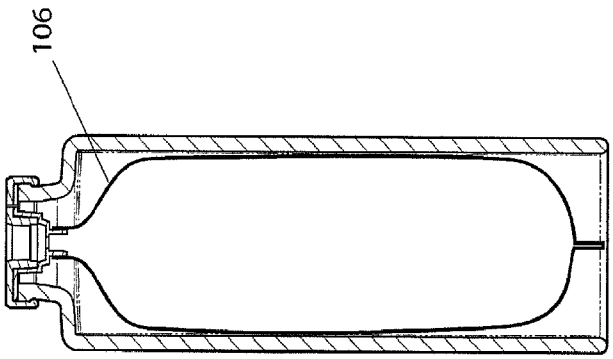

Fig. 6C

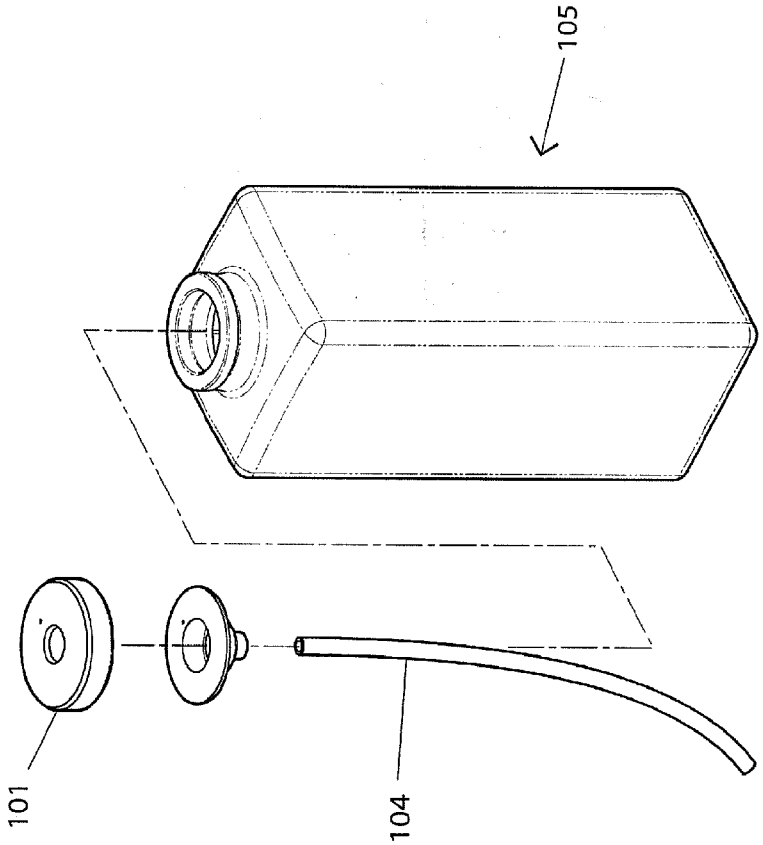

Fig. 6B

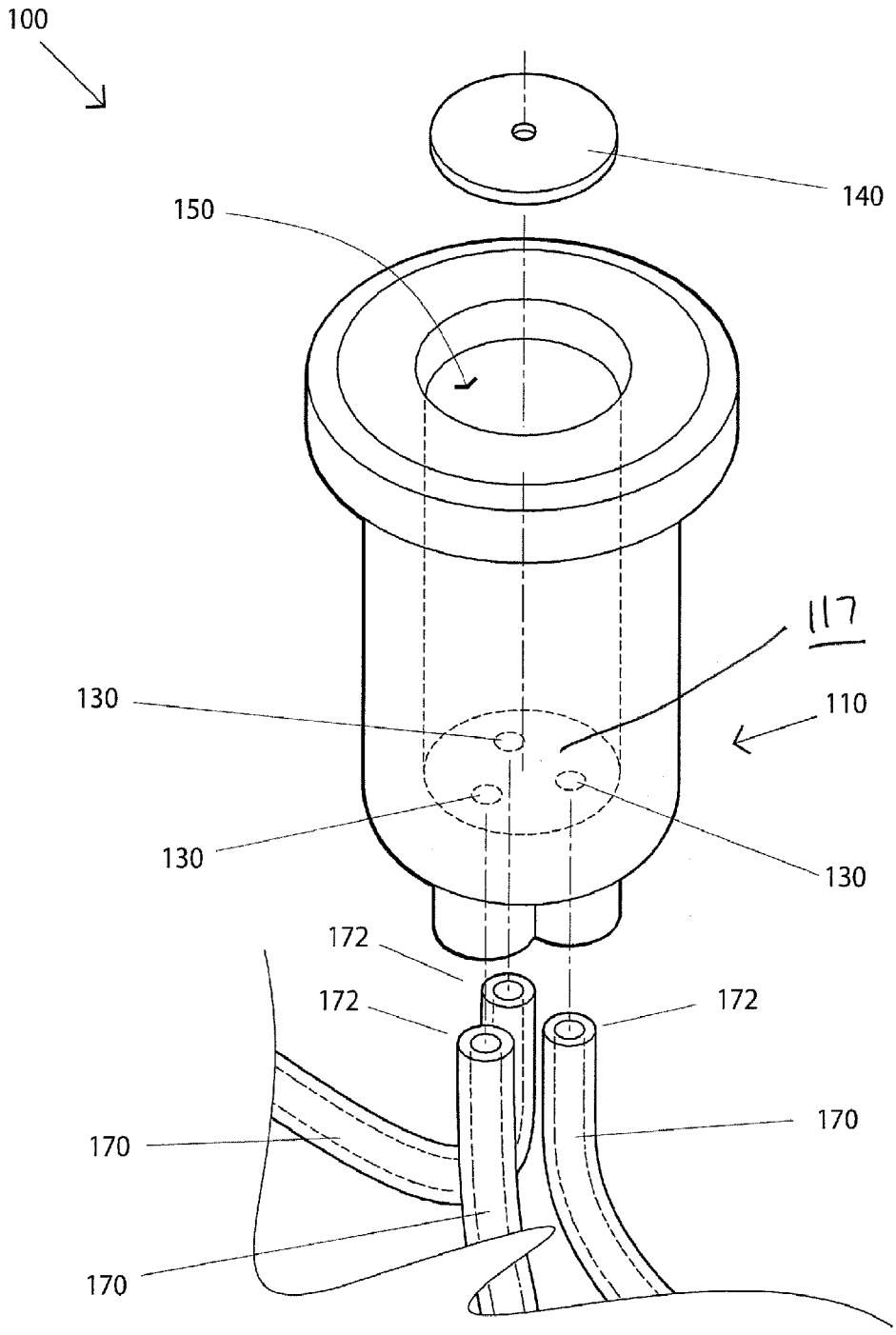

Fig. 7A

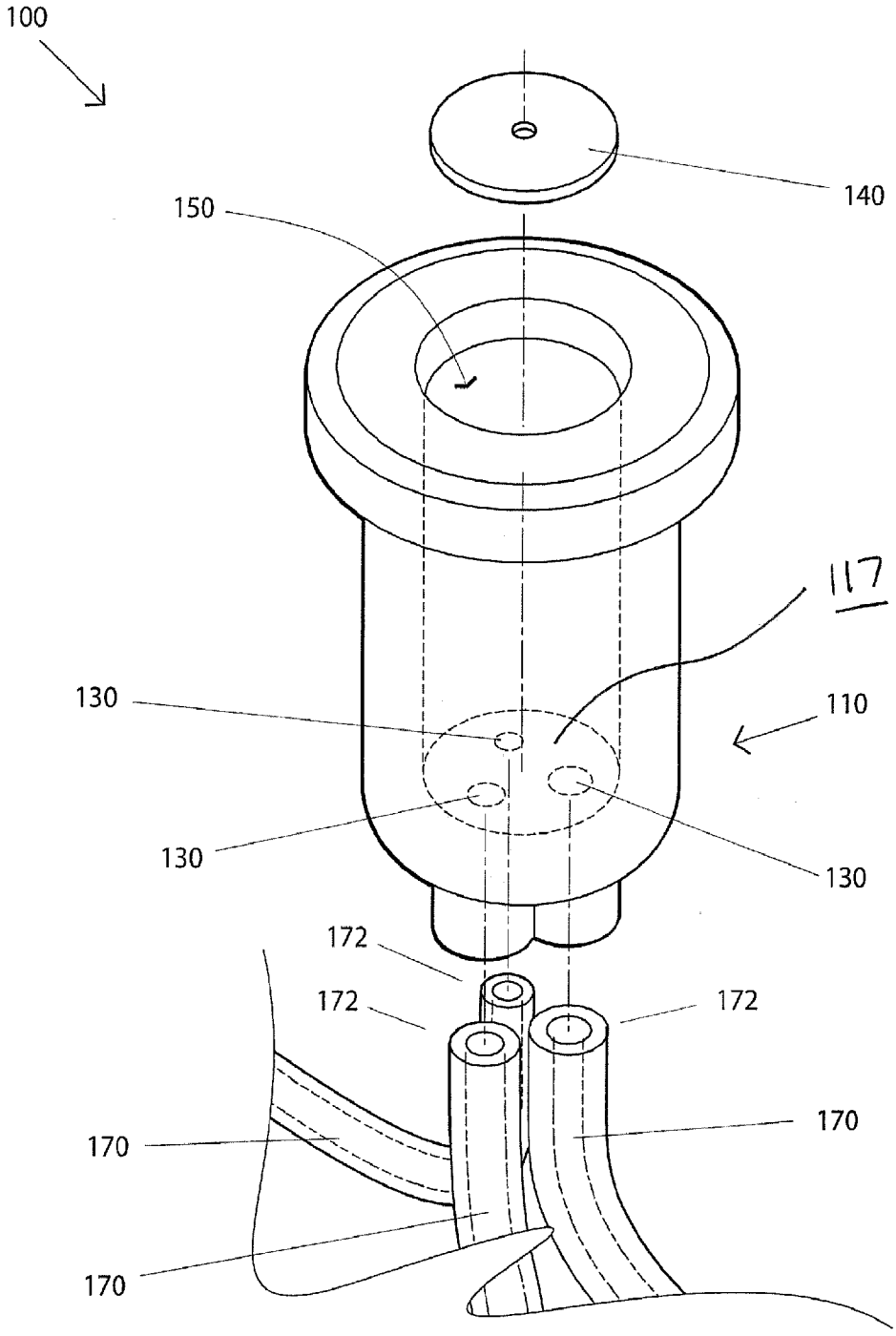

Fig. 7B

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2014/064683

A. CLASSIFICATION OF SUBJECT MATTER
INV. B05B11/00
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
B05B

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 2012/279990 A1 (WERNER MELANIE R [US] ET AL) 8 November 2012 (2012-11-08) paragraph [0040] - paragraph [0040] ; figures ---	1-22

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

☒ See patent family annex.

* Special categories of cited documents :

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"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) orwhich 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
27 January 2015	02/03/2015

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

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/US2014/064683

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 2012279990 Al	08-11-2012	CA 2870139 Al	08-11-2012
		EP 2704985 A2	12-03-2014
		US 2012279990 Al	08-11-2012
		US 2014076930 Al	20-03-2014
		WO 2012151295 A2	08-11-2012