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(73) Patenthaver: **Bayer Healthcare LLC, 100 Bayer Boulevard , P.O. Box 915, Whippany, NJ 07981, USA**

(72) Opfinder: **Haury, John, 2514 Nicholson Road, Sewickley, PA 15143, USA**
VON MOGER, Alison, 3/155 Norton Street, Ashfield, NSW 2131, Australien
PROFACA, Mark Silvio, 11 Gillian Parade, West Pymble, NSW 2073, Australien

(74) Fuldmægtig i Danmark: **RWS Group, Europa House, Chiltern Park, Chiltern Hill, Chalfont St Peter, Bucks SL9 9FG, Storbritannien**

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DESCRIPTION

[0001] This application claims the benefit of U.S. Provisional Patent Application No. 62/350,487, filed June 15, 2016.

BACKGROUND

Field of the Technology

[0002] This disclosure relates, generally, to the field of multi-fluid delivery systems and, more particularly, to syringes used in a multi-use disposable set of a multi-fluid delivery system.

Description of Related Art

[0003] In many medical diagnostic and therapeutic procedures, a medical practitioner, such as a physician, injects a patient with one or more medical fluids. In recent years, a number of medical fluid delivery systems for pressurized injection of fluids, such as a contrast solution (often referred to simply as "contrast"), a flushing agent, such as saline, and other medical fluids, have been developed for use in procedures such as angiography, computed tomography (CT), ultrasound, magnetic resonance imaging (MRI), positron emission tomography (PET), and other imaging procedures. In general, these medical fluid delivery systems are designed to deliver a preset amount of fluid at a preset flow rate.

[0004] In some injection procedures, the medical practitioner places a catheter or needle into a vein or artery of the patient. The catheter or needle is connected to either a manual or an automatic fluid injector system by way of tubing, and a connector that interfaces with the fluid injector system. Automatic fluid injector systems typically include at least one syringe connected to at least one fluid injector having, for example, a powered linear piston. The at least one syringe includes, for example, a source of contrast and/or a source of flushing fluid. The medical practitioner enters settings into an electronic control system of the fluid injector for a fixed volume of contrast and/or saline and a fixed rate of injection for each. A single-use disposable set connector and associated tubing is connected to the fluid injector system for delivering one or more fluids to the patient.

[0005] While various manual and automatic fluid delivery systems are known in the medical field, improved multi-fluid delivery systems adapted for use in medical diagnostic and therapeutic procedures where one or more fluids are supplied to a patient during such procedures continue to be in demand. Additionally, improved syringes that may be used with multi-fluid delivery systems for facilitating a delivery of one or more fluids to a patient are also

desired in the medical field. The medical field continues to demand improved medical devices and systems used to supply fluids to patients during various medical procedures WO 97/07841 A2 relates to a syringe with a perpendicular drip flange to prevent fluid from dripping into the fluid injector port.

SUMMARY

[0006] The scope of the invention is defined by the appended claims. In view of the foregoing, a need exists for an improved multi-use disposable set and syringe therefor that allows for more stable positioning of the syringe within a fluid injector. Further, there is a need for an improved syringe that prevents a situation where force applied to the syringe(s) of the multi-use disposable set during fluid deliver or force applied when engaging the multi-use disposable set into the injector may push or dislodge the multi-use disposable set into an off-center, tilted, or angled position within the fluid delivery system. In such an off-center, tilted, or angled position, additional for may cause fluid leakage around the plunger, breakage of the multi-use disposable set, or damage to portions of the fluid injector assembly.

[0007] Therefore, a multi-use disposable set and syringe therefor configured to address some or all of these needs are provided herein. According to a first example of the disclosure, a syringe may include a syringe body having a proximal end and a distal end spaced apart from the proximal end along a longitudinal axis, a cone portion and a nozzle extending distally from the distal end of the syringe body, and a stabilizing element provided on the distal end of the syringe body, the stabilizing element having a support surface extending substantially perpendicular to the longitudinal axis of the syringe body.

[0008] The stabilizing element may be integrally formed on the syringe body. The stabilizing element may include a ring provided on an outer circumferential surface of the distal end of the syringe body. The stabilizing element may include a sleeve provided on an outer circumferential surface of the syringe body. The sleeve may extend from the proximal end of the syringe body to the distal end of the syringe body. The stabilizing element may include a portion of the syringe body that extends axially along a longitudinal axis of the syringe body and protrudes from the cone portion on a distal end of the syringe body. The stabilizing element may include a planar portion and at least two webs connected to the cone portion and the planar portion. The stabilizing element may include at least two substantially triangular extensions including an upper planar surface and a bottom surface connected to the cone portion. The upper planar surface may extend substantially perpendicularly relative to the longitudinal axis of the syringe body. The stabilizing element may include a first planar portion connected to the cone portion via at least one web, and a second planar portion connected to the cone portion via at least one web. The planar portions may be separated from one another on the cone portion. The planar portions may extend substantially perpendicularly relative to the longitudinal axis of the syringe body. The planar portions may be positioned adjacent a discharge conduit defined in the distal end of the syringe body.

[0009] In another example of the disclosure, a multi-use disposable set (MUDS) includes a plurality of syringes, each syringe having a syringe body, proximal end, a distal end spaced apart from the proximal end along a longitudinal axis of the syringe body, a cone portion and a nozzle extending distally from the distal end of the syringe body, a stabilizing element provided on the distal end, the stabilizing element having a support surface extending substantially perpendicular to the longitudinal axis of the syringe body, and a manifold in fluid communication with the distal end of each of the plurality of syringes.

[0010] The stabilizing element may be integrally formed on the syringe body. The stabilizing element may include a ring provided on an outer circumferential surface of the distal end of the syringe body. The stabilizing element may include a sleeve provided on an outer circumferential surface of the syringe body. The sleeve may extend from the proximal end of the syringe body to the distal end of the syringe body. The stabilizing element may include a portion of the syringe body that extends axially along a longitudinal axis of the syringe body and protrudes from the cone portion on a distal end of the syringe body. The stabilizing element may include a planar portion and at least two webs connected to the cone portion and the planar portion. The stabilizing element may include at least two substantially triangular extensions including an upper planar surface and a bottom surface connected to the cone portion. The upper planar surface may extend substantially perpendicularly relative to the longitudinal axis of the syringe body. The stabilizing element may include a first planar portion connected to the cone portion via at least one web, and a second planar portion connected to the cone portion via at least one web. The planar portions may be separated from one another on the cone portion. The planar portions may extend substantially perpendicularly relative to the longitudinal axis of the syringe body. The planar portions may be positioned adjacent a discharge conduit defined in the distal end of the syringe body.

[0011] These and other features and characteristics of multi-use disposable sets and syringes therefor, as well as the methods of operation and functions of the related elements of structures and the combination of parts and economies of manufacture, will become more apparent upon consideration of the following description and the appended claims with reference to the accompanying drawings, all of which form a part of this specification, wherein like reference numerals designate corresponding parts in the various figures. It is to be expressly understood, however, that the drawings are for the purpose of illustration and description only, and are not intended as a definition of the limits of the disclosure. As used in the specification and the claims, the singular form of "a", "an", and "the" include plural referents unless the context clearly dictates otherwise.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012]

FIG. 1A is a perspective view of a multi-fluid delivery system, according to one example of the disclosure;

FIG. 1B is a perspective view of the multi-fluid delivery system of **FIG. 1A** with an access panel in an open position;

FIG. 2 is a schematic view of various fluid paths within the multi-fluid delivery system of **FIG. 1A;**

FIG. 3A is a perspective view of a multi-use disposable set (MUDS) during insertion into a receiving slot on a multi-fluid delivery system;

FIG. 3B is a side view of the MUDS of **FIG. 3A;**

FIG. 4A is a perspective view of the MUDS installed into the receiving slot on the multi-fluid delivery system of **FIG. 3A;**

FIG. 4B is a side view of the MUDS of **FIG. 4A;**

FIG. 4C is a cross-sectional view of the MUDS of **FIG. 4A;**

FIG. 5 is a perspective view of a MUDS having a plurality of syringes according to one example of the present disclosure;

FIG. 6A is a perspective view of a single syringe configured for use with the MUDS according to a one example of the present disclosure;

FIG. 6B is a perspective view of a single syringe configured for use with the MUDS according to a another example of the present disclosure;

FIG. 6C is a perspective view of a single syringe configured for use with the MUDS according to a another example of the present disclosure;

FIG. 6D is a perspective view of a single syringe configured for use with the MUDS according to a another example of the present disclosure;

FIG. 6E is a perspective view of a single syringe configured for use with the MUDS according to another example of the present disclosure;

FIG. 7A is a bottom view of the top plate associated with the injector for restraining the MUDS according to one example of the present disclosure; and

FIG. 7B is a top view of the top plate associated with the injector for restraining the MUDS according to one example of the present disclosure.

DETAILED DESCRIPTION

[0013] For purposes of the description hereinafter, the terms "upper", "lower", "right", "left",

"vertical", "horizontal", "top", "bottom", "lateral", "longitudinal", and derivatives thereof shall relate to the disclosure as it is oriented in the drawing figures. When used in relation to a syringe of a fluid injector of a MUDS, the term "proximal" refers to a portion of a syringe nearest a piston element when the MUDS is installed on a fluid injector system. When used in relation to a syringe of a MUDS, the term "distal" refers to a portion of a syringe nearest to a delivery nozzle or any portion of a syringe from a delivery nozzle to at least a midway point on a body of the syringe. It is also to be understood that the specific devices and processes illustrated in the attached drawings, and described in the following specification, are simply exemplary examples of the disclosure. Hence, specific dimensions and other physical characteristics related to the examples disclosed herein are not to be considered as limiting.

[0014] Referring to the drawings in which like reference characters refer to like parts throughout the several views thereof, the present disclosure is generally directed to a multi-fluid medical injector/injection system **100** (hereinafter "fluid injector system **100"**) having a multi-use disposable set (MUDS) **130** configured for delivering fluid to a patient using a single-use disposable set (SUDS) connector. The fluid injector system **100** includes multiple components as individually described herein. Generally, the fluid injector system **100** has a powered injector administrator or device and a fluid delivery set intended to be associated with the injector to deliver one or more fluids from one or more multi-dose containers under pressure into a patient, as described herein. The various devices, components, and features of the fluid injector system **100,** and the fluid delivery set associated therewith are likewise described in detail herein.

[0015] With reference to **FIG. 1A,** the fluid injector system **100** includes an injector housing **102** having opposed lateral sides **104,** a distal or upper end **106,** and a proximal or lower end **108.** In some examples, the housing **102** may be supported on a base **110** having one or more wheels **112** for rotatable and movable support of the housing **102** on a floor surface. The one or more wheels **112** may be lockable to prevent the housing **102** from inadvertently moving once positioned at a desired location. At least one handle **114** may be provided to facilitate moving and positioning the fluid injector system **100.** In other examples, the housing **102** may be removably or non-removably secured to a fixed surface, such as a floor, ceiling, wall, or other structure. The housing **102** encloses the various mechanical drive components, electrical and power components necessary to drive the mechanical drive components, and control components, such as electronic memory and electronic control devices (hereinafter electronic control device(s)), used to control operation of reciprocally movable piston elements **103** (shown in **FIG. 2**) associated with the fluid injector system **100** described herein. Such piston elements **103** may be reciprocally operable via electro-mechanical drive components such as a ball screw shaft driven by a motor, a voice coil actuator, a rack-and-pinion gear drive, a linear motor, and the like. In some examples, at least some of the mechanical drive components, electrical and power components, and control components may be provided on the base **110.**

[0016] With reference to **FIG. 1B,** and with continued reference to **FIG. 1A,** the fluid injector system **100** has at least one door **116** that encloses at least some of the mechanical drive components, electrical and power components, and control components. The door **116** is

desirably movable between an open position (shown in **FIG. 1B**) and a closed position (shown in **FIG. 1A**). In some examples, the door **116** may be lockable.

[0017] The fluid injector system **100** further includes at least one bulk fluid connector **118** for connection with at least one bulk fluid source **120.** In some examples, a plurality of bulk fluid connectors **118** may be provided. For example, as shown in **FIGS. 1A** and **1B,** three bulk fluid connectors **118** may be provided in a side-by-side or other arrangement. In some examples, the at least one bulk fluid connector **118** may be a spike configured for removably connecting to the at least one bulk fluid source **120,** such as a vial, bottle, or a bag. The at least one bulk fluid connector **118** may have a reusable or non-reusable interface with each new bulk fluid source **120.** The at least one bulk fluid connector **118** may be formed on the multi-use disposable set, as described herein. The at least one bulk fluid source **120** may be configured for receiving a medical fluid, such as saline, contrast solution, or other medical fluid, for delivery to the fluid injector system **100.** The housing **102** may have at least one support member **122** for supporting the at least one bulk fluid source **120** once it is connected to the fluid injector system **100.**

[0018] With reference to **FIG. 1A,** the fluid injector system **100** includes one or more user interfaces **124,** such as a graphical user interface (GUI) display window. The user interface **124** may display information pertinent to a fluid injection procedure involving the fluid injector system **100,** such as flow rate, fluid pressure, and volume remaining in the at least one bulk fluid source **120** connected to the fluid injector system **100.** The user interface **124** may be a touch screen GUI that allows an operator to input commands and/or data for operation of the fluid injector system **100.** In some examples, the user interface **124** may be a tablet that is detachably connected to the housing **102** and is in wired or wirelessly linked communication with the housing **102.** Additionally, the fluid injector system **100** and/or user interface **124** may include at least one control button **126** for tactile operation by an attendant operator of the fluid injector system **100.** In certain examples, the at least one control button may be part of a keyboard for inputting commands and/or data by the operator. The at least one control button **126** may be hard-wired to the electronic control device(s) associated with the fluid injector system **100** to provide direct input to the electronic control device(s). The at least one control button **126** may also be graphically part of the user interface **124,** such as a touch screen. In either arrangement, the at least one control button **126** desirably provides certain individual control features to the attendant operator of the fluid injector system **100,** such as but not limited to: (1) acknowledging that a multi-use disposable set (MUDS) **130** has been loaded or unloaded; (2) locking/unlocking of the MUDS **130;** (3) filling/purging of the fluid injector system **100,** inputting information and/or data related to the patient and/or injection procedure; and (4) initiating/stopping an injection procedure. The user interface **124** and/or any electronic processing units associated with the fluid injector system **100** may be wired or wirelessly connected to an operation and/or data storage system such as a hospital network system.

[0019] With reference to **FIG. 1B,** the fluid injector system includes the MUDS **130** that is removably connected to the fluid injector system **100** for delivering one or more fluids from the one or more bulk fluid sources **120** to the patient. The fluid injector system **100** includes at

least one slot or access port **192** for releasably connecting a SUDS to the MUDS **130,** as described herein. The MUDS **130** may include one or more syringes or pumps **132.** In some examples, the number of syringes **132** may correspond to the number of bulk fluid sources **120.** For example, with reference to **FIG. 1B,** the MUDS **130** has three syringes **132** in a side-by-side arrangement such that each syringe 132 is fluidly connectable to one of the bulk fluid sources **120.** In some examples, one or two bulk fluid sources **120** may be connected to one or more syringes **132** of the MUDS **130.** Each syringe **132** may be fluidly connectable to one of the bulk fluid sources **120** by a corresponding bulk fluid connector **118** and an associated MUDS fluid path **134.** The MUDS fluid path **134** may have a spike element that connects to the bulk fluid connector **118.** In some examples, the bulk fluid connector **118** may be provided directly on the MUDS **130.**

[0020] With further reference to **FIGS. 2-3A,** the MUDS **130** is removably connectable to the housing **102** of the fluid injector system **100.** With specific reference to **FIG. 3B,** the MUDS **130** further includes a frame **154** receiving at least a portion of the proximal end **142** of the at least one syringe **132.** In some examples, the frame **154** may be shaped to receive at least a portion of the proximal end **142** of each syringe **132.** In some examples, the fluid outlet line **152** may be connected to the frame **154.** The frame **154,** in some examples, defines at least a portion of the access port **192** for connecting a single-use disposable set to the MUDS **130.** The frame **154** may have a handle for grasping the MUDS **130** during insertion into and removal from the fluid injector system **100.** In certain examples, the access port **192** may be formed as part of or adhered/welded to the frame **154** to form a single MUDS **130** unit. The syringes **132** may be removably or non-removably connected to the frame **154.** In certain examples, the at least one syringe **132** may be co-molded with the frame **154** or, alternatively, adhered or welded to frame **154.**

[0021] With further reference to **FIG. 3B,** each syringe **132** has an elongated, substantially cylindrical syringe body **138** having a front or distal end **140** and a rear or proximal end **142.** A syringe plunger **144** is disposed within the syringe body **138** and is reciprocally movable within the syringe body **138** due to movement of a piston element **103** associated with the fluid injector system **100.** The distal end **140** of the syringe body **138** is generally conical-shaped and tapers to an apex or cone portion **145** which is adapted to interface with a corresponding apex curve formed in the recess defined in the fluid injector system **100,** as described herein. The syringe apex or cone portion **145** is located along a central longitudinal axis **L** of the syringe body **138.** Each syringe **132** has a discharge outlet or conduit **146** at the terminal end of the apex or cone portion **145.** The discharge outlet **146** of each syringe **132** is in fluid communication with valve **136** which provides fluid communication with a manifold **148** and the bulk fluid connector **118.** The manifold **148** may also provide support for the syringes **132** along with the frame **154** so the syringes **132** can be handled as a single, unitary structure. In some examples, the manifold **148** supports the distal end **140** of each syringe **132** while the frame **154** supports the proximal end **142** of each syringe **132.** The syringes **132** may be arranged in a side-by-side orientation, or any other orientation that retains the relative positioning of the syringes **132.**

[0022] As will be appreciated by one having ordinary skill in the art, it may be desirable to construct at least a portion of the MUDS **130** from a clear medical grade plastic in order to facilitate visual verification that a fluid connection has been established with the fluid injector system **100.** Visual verification is also desirable for confirming that no air bubbles are present within various fluid connections. Alternatively, at least a portion of the MUDS **130** and/or door **116** may include windows (not shown) for visualization of the connection between various components. Various optical sensors (not shown) may also be provided to detect and verify the connections. Additionally, various lighting elements (not shown), such as light emitting diodes (LEDs) may be provided to actuate one or more optical sensors and indicate that a suitable connection has been established between the various components.

[0023] With specific reference to **FIG. 2,** a schematic view of various fluid paths of the fluid injector system **100** is provided. The MUDS **130** may include one or more valves **136,** such as stopcock valves, for controlling which medical fluid or combinations of medical fluids are withdrawn from the multi-dose bulk fluid source **120** and/or are delivered to a patient through each syringe **132.** In some examples, the one or more valves **136** may be provided on the distal end **140** of the plurality of syringes **132** or on the manifold **148.** The manifold **148** may be in fluid communication via valves **136** and/or syringes **132** with a first end of the MUDS fluid path **134** that connects each syringe **132** to the corresponding bulk fluid source **120.** The opposing second end of the MUDS fluid path **134** may be connected to the respective bulk fluid connector **118** that is configured for fluidly connecting with the bulk fluid source **120.** Depending on the position of the one or more valves **136,** fluid may be drawn into the one or more syringes **132,** or it may be delivered from the one or more syringes **132.** In a first position, such as during the filling of the syringes **132,** the one or more valves **136** are oriented such that fluid flows from the bulk fluid source **120** into the desired syringe **132** through a fluid inlet line **150,** such as a MUDS fluid path. During the filling procedure, the one or more valves **136** are positioned such that fluid flow through one or more fluid outlet lines **152** or manifold **148** is blocked. In a second position, such as during a fluid delivery procedure, fluid from one or more syringes **132** is delivered to the manifold **148** through the one or more fluid outlet lines **152** or syringe valve outlet ports. During the delivery procedure, the one or more valves **136** are positioned such that fluid flow through one or more fluid inlet lines **150** is blocked. The one or more valves **136,** fluid inlet lines **150,** and/or fluid outlet lines **152** may be integrated into the manifold **148.** The one or more valves **136** may be selectively positioned to the first or second position by manual or automatic handling. For example, the operator may position the one or more valves **136** into the desired position for filling or fluid delivery. In other examples, at least a portion of the fluid injector system **100** is operable for automatically positioning the one or more valves **136** into a desired position for filling or fluid delivery based on input by the operator.

[0024] Referring again to **FIG. 2,** in some examples, the fluid outlet line **152** may also be connected to a waste reservoir **156** on the fluid injector system **100.** The waste reservoir **156** is desirably separate from the syringes **132** to prevent contamination. In some examples, the waste reservoir **156** is configured to receive waste fluid expelled from the syringes **132** during, for example, a priming operation. The waste reservoir **156** may be removable from the housing

102 in order to dispose of the contents of the waste reservoir **156.** In other examples, the waste reservoir **156** may have a draining port (not shown) for emptying the contents of the waste reservoir **156** without removing the waste reservoir **156** from the housing **102.** In some examples, the waste reservoir **156** is provided as a separate component from the MUDS **130.**

[0025] With the foregoing description of the fluid injector system **100** and the MUDS **130** in mind, exemplary loading of the MUDS **130** into a receiving space **158** (shown in **FIG. 3A**) on the housing **102** will now be described with reference to **FIGS. 3A-4C.** In the following discussion, it is assumed that the MUDS **130** may be connected to the fluid injector system **100** for use with a single patient or multiple patients. Referring initially to **FIG. 3A,** the receiving space **158** has a bottom plate **160** separated from a top plate **162** by a rear sidewall **164.** The bottom plate **160** has a plurality of openings **166** through which the piston elements **103** (shown in **FIG. 2**) of the fluid injector system **100** extend to engage the respective plungers **144** of the MUDS **130.** At least one bottom guide **168** is formed on the bottom plate **160** for guiding the frame **154** of the MUDS **130** as the MUDS **130** is loaded into the fluid injector system **100.** In some examples, the bottom guide **168** may be configured as a pair of walls raised relative to the bottom plate **160** and narrowing in an insertion direction toward the rear sidewall **164.** During insertion, the bottom guide **168** defines a guiding surface that locates the frame **154** of the MUDS **130** and guides the frame **154** toward the rear sidewall **164** of the receiving space **158.** In this manner, the MUDS **130** can be aligned into the receiving space **158** even when MUDS **130** is initially misaligned with receiving space **158.**

[0026] With reference to **FIG. 3B,** and with continued reference to **FIG. 3A,** the top plate **162** is configured to receive the distal end **140** of the at least one syringe **132.** The top plate **162** has one or more syringe slots **170** (shown in **FIG. 3A**) that are shaped to receive at least a portion of the distal end **140** of the syringes **132.** In some examples, when the MUDS **130** is inserted into the receiving space **158,** the syringe slots **170** of the top plate **162** may be disposed between the distal end **140** of the at least one syringe **132** and the manifold **148.** The top plate **162** may be rotatable about a pivot point **PI** (shown in **FIG. 3B**) or it may be movable in a vertical direction relative to the MUDS **130.** In a first position, such as during loading of the MUDS **130** into the receiving space **158,** the top plate **162** may be raised such that the apex or cone portion **145** of the at least one syringe **132** clears a lower surface of the top plate **162.** In some examples, the top plate **162** can default to the first position each time the MUDS **130** is removed from the receiving space **158,** such as by a biasing mechanism. In other examples, the top plate **162** can be urged to the first position as the apex or cone portion **145** of the at least one syringe **132** engages the at least one syringe slot **170.**

[0027] As the MUDS **130** engages the rear sidewall **164,** such as shown in **FIG. 4A,** the MUDS **130** can be locked in the receiving space **158** by moving the top plate **162** to a second position. In the second position, the top plate **162** is lowered such that the apex or cone portion **145** of the at least one syringe **132** engages the lower surface of the top plate **162.** In some examples, the top plate **162** can be urged to the second position by a biasing mechanism (not shown). In other examples, the top plate **162** can be manually moved to the second position by pivoting the top plate **162** in a direction of arrow **A** shown in **FIGS. 4A-4B.** The top plate **162**

can be locked relative to the MUDS **130** to prevent removal of the MUDS **130** from the receiving space **158** by a latch **172.** The latch **172** may be operable to prevent the top plate **162** from rotating about the pivot point **PI.** The latch **172** may be a spring-loaded latch that is pivotable about a pivot point **P2** in a direction of arrow **B** shown in **FIG. 4B.** In some examples, the latch **172** may be an over-center, spring-loaded latch that is pivotable about a pivot point **P2.** With reference to **FIG. 4C,** when the MUDS **130** is locked within the receiving space **158,** the lower surface of the top plate **162** engages the apex or cone portion **145** of the at least one syringe **132.** In the locked position, the longitudinal axis **L** of each syringe **132** is aligned with a center of each syringe slot **170.** Removal of the MUDS **130** from the receiving space **158** when the top plate **162** is in the locked position is prevented by the engagement of the lower surface of the top plate **162** with the apex or cone portion **145** of the at least one syringe **132.** Once locked, the top plate **162** substantially retains the syringes **132** from moving axially during an injection procedure.

[0028] With reference to **FIGS. 5** and **6A,** according to one example of the disclosure, the syringes **132** used in the MUDS **130** may include a stabilizing element **180** provided on the distal end **140** of each syringe **132.** In this example shown in **FIG. 5,** another configuration of the MUDS **130** includes a plurality of bulk fluid connectors **118,** a frame **154,** a plurality of valves **136** provided on a manifold **148,** a fluid path **134** between each valve **136** and the bulk fluid connectors **118,** and a fluid outlet line **152.** The stabilizing element **180** may extend around at least a portion of the distal end **140** of each syringe **132.** In another example, the stabilizing element **180** may extend around at least a portion of the distal end **140** of the syringe **132** around the longitudinal axis **L.** It is contemplated that the stabilizing element **180** may be continuous around the entire circumference or may include a plurality of separate sections isolated by spaces that are defined between each section. The stabilizing element **180** may be positioned at a proximal end of the cone portion **145** of the syringe **132** or any part of the cone portion **145** up to the nozzle **147.** In this example, the stabilizing element **180** may have an inner diameter that substantially corresponds to the outer diameter of the syringe body **138.** The stabilizing element **180** may be a ring that is formed integrally with the syringe body **138** or may be removably or non-removably attached to the syringe body **138,** such as by adhesive, interference fit, welding, or other mechanical connections. The stabilizing element **180** may have a substantially planar upper surface **182** and a substantially planar bottom surface **184.** In one example, the upper surface **182** may extend substantially perpendicular to the longitudinal axis **L** of the syringe **132.** The planar upper surface **182** is provided to stabilize the syringe **132** when the top plate **162** of the fluid injector system **100** is closed on the distal end **140** of the syringe **132** to lock the MUDS **130** within the fluid injector system **100.** In this manner, the upper surface **180** is oriented substantially perpendicular to the longitudinal axis of the movable piston element **103** such that the movable piston element **103** does not impart a radially oriented force on the syringe **132.** The stabilizing element **180** may be made of the same material as the syringe **132.** In one example, stabilizing element **180** may be made of a transparent, medical-grade plastic.

[0029] During insertion of the MUDS **130** into the fluid injector system **100,** the top plate **162** is rotated downwards to bring the syringe slots **170** into engagement with the syringes **132** in the

MUDS **130.** As can often occur during the insertion procedure, the top plate **162** may contact the distal ends **140** of the syringes **132** and position the syringes **132** such that the longitudinal axis **L** of the syringe **132** is out of alignment with the longitudinal axis of the movable piston elements **103.** The top plate **162** may contact the cone portion **145** of the syringes **132** and push the syringes **132** into an off-center position such that the syringes **132** are angled relative to the longitudinal axis of the movable piston elements **103.** Due to the angled surface of the cone portion **145** of the syringes **132,** syringe slots **170,** and resulting forces from fluid delivery (fluid pressure), the top plate **162** may move the syringes **132** away from a desired operating position. For example, when the piston plunger assembly of one or more of the syringes is **132** is moved in a distal direction, such as during a fluid delivery process, the pressure one the fluid and syringes may shift the MUDS to an off-center or tilted position resulting in potential fluid leakage or "blow by" between the circumferential rim of the plunger and the inner syringe wall. To avoid or correct the potential tendency for the MUDS unit to be forced out of alignment with the longitudinal axis, the stabilizing element **180** of the distal end **140** of each syringe **132** ensures that the top plate **132** rests on a planar or flat surface to assure alignment of the longitudinal axis **L** of the syringe **132** with the longitudinal axis of the movable piston elements **103.** As the top plate **162** is rotated downwards towards the syringes **132,** the top plate **162** may contact the stabilizing element **180,** which provides a flat, planar surface that provides an increased surface area for the top plate **162** to contact.

[0030] With reference to **FIG. 6B,** another example of the stabilizing element **186** is shown on a syringe **132.** In this example, the stabilizing element **186** may be a sleeve that is formed or provided around the body **138** (covered in **FIG. 6B** by the stabilizing element **186**) of the syringe **132.** The stabilizing element **186** may be formed integrally with the body **138,** may be removably or non-removably attached to the body **138,** such as by adhesion, welding, or friction fit with the body **138.** The stabilizing element **186** may include a planar upper surface **188** upon which the top plate **162** of the fluid injector system **100** may contact when the MUDS **130** has been inserted into the fluid injector system **100.** In one example, the upper surface **188** may extend substantially perpendicular to the longitudinal axis **L** of the syringe **132.** The stabilizing element **186** may be substantially cylindrical with an inner diameter that is slightly greater than the outer diameter of the body **138.** In another example, the inner diameter of the stabilizing element **186** may be slightly smaller than the outer diameter of the body **138,** but may be resilient to form a friction fit with the body **138.** A distal end of the stabilizing element **186** may be positioned adjacent to the cone portion **145** of the syringe **132.** A proximal end of the stabilizing element **186** may contact a flange **190** provided on the proximal end **142** of the syringe **132.** The stabilizing element **186** may be made of the same material as the syringe **132.** In one example, the stabilizing element **186** may be made of a transparent, medical-grade plastic. Similar to the stabilizing element **180** shown in **FIG. 6A,** the stabilizing element **186** may be provided on the syringe **132** to stabilize the syringe **132** upon insertion of the MUDS **130** into the fluid injector system **100.** The top plate **162** of the fluid injector system **100** may contact the planar upper surface **188** of the stabilizing element **186** to hold the syringe **132** in an upright, centered position relative to the fluid injector system **100.** In another example, the stabilizing element **186** may be a part of the syringe body **138** of the syringe **132,** extending axially along the longitudinal axis **L,** protruding from the cone portion **145** of the

syringe **132.**

[0031] With reference to **FIG. 6C,** another example of the stabilizing element **193** is shown on a syringe **132.** The stabilizing element **193** may include a substantially planar member **194** and a plurality of webs **196** that connect the stabilizing element **193** to the syringe **132.** The planar member **194** may include an upper surface that extends substantially perpendicular to the longitudinal axis **L** of the syringe **132.** An inner circumferential surface of the planar member **194** may be integrally (i.e., monolithically) formed on or removably or non-removably attached to the cone portion **145** of the syringe **132.** It is also contemplated that the inner circumferential surface of the planar member **194** may not be connected to the syringe **132,** but may contact the cone portion **145** of the syringe **132.** A bottom surface of each web **196** may be integrally formed on the syringe **132** or may be removably or non-removably attached to the syringe **132.** An upper surface of each web **196** may be integrally formed on or remoavbly or non-removably connected to a bottom surface of the planar member **194.** In one example, the webs **196** may be triangular in shape. The stabilizing element **193** may be made of the same material as the syringe **132.** In one example, the stabilizing element **193** may be made of a transparent, medical-grade plastic. Similar to the stabilizing element **180** shown in **FIG. 6A,** the stabilizing element **193** may be provided on the syringe **132** to stabilize the syringe **132** within the MUDS **130** upon insertion of the MUDS **130** into the fluid injector system **100.** The top plate **162** of the fluid injector system **100** may contact the planar member **194** of the stabilizing element **193** to hold the syringe **132** in an upright, centered position relative to the fluid injector system **100.**

[0032] With reference to **FIG. 6D,** another example of a stabilizing element **198** is shown on a syringe **132.** The stabilizing element **198** is similar to the webs **196** depicted in **FIG. 6C.** In one example, at least two stabilizing elements **198** may be provided on the syringe **132.** It is also contemplated that a plurality of stabilizing elements **198** may be provided around the outer circumferential surface of the syringe **132.** The stabilizing element **198** is substantially triangular and includes a bottom surface **200** that is formed integrally with or adhesively attached to the cone portion **145** of the syringe **132.** The stabilizing element **198** may have a planar upper surface **202** that extends outwardly from the cone portion **145.** The upper surface **202** may extend perpendicular to the longitudinal axis **L** of the syringe **132.** The stabilizing element **198** may be made of the same material as the syringe **132.** In one example, the stabilizing element **198** may be made of a transparent, medical-grade plastic. Similar to the stabilizing element **180** shown in **FIG. 6A,** the stabilizing element **198** may be provided on the syringe **132** to stabilize the syringe **132** upon insertion of the MUDS **130** into the fluid injector system **100.** The top plate **162** of the fluid injector system **100** may contact the upper surface **202** of the stabilizing element **198** to hold the syringe **132** in an upright, centered position relative to the fluid injector system **100.**

[0033] With reference to **FIG. 6E,** another example of a stabilizing element **204** is shown on a syringe **132.** In one example, at least two stabilizing elements **204** may be provided on the syringe **132.** In another example, more than two stabilizing elements **204** may be provided on the syringe **132.** It is also contemplated that the stabilizing element **204** may extend around the

entire outer circumferential surface of the cone portion **145** of the syringe **132.** The stabilizing element **204** may include a planar member **206** and a plurality of webs **208** provided to connect the planar member **206** to the syringe **132.** The stabilizing element **204** may be integrally formed on or removably or non-removably attached to the syringe **132.** The stabilizing element **204** may be provided entirely on the cone portion **145** of the syringe **132.** The planar member **206** may include an upper surface that extends substantially perpendicular to the longitudinal axis **L** of the syringe **132.** The planar member **206** may be positioned adjacent the discharge conduit **146** of the syringe **132.** An inner circumferential surface of the planar member **206** may be integrally formed on or removably or non-removably attached to the cone portion **145** of the syringe **132.** It is also contemplated that the inner circumferential surface of the planar member **206** may not be connected to the syringe **132,** but may contact the cone portion **145** of the syringe **132.** A bottom surface of each web **208** may be integrally formed on the syringe **132** or may be removably or non-removably attached to the syringe **132.** An upper surface of each web **208** may be integrally formed on or removably or non-removably connected to a bottom surface of the planar member **206.** In one example, the webs **208** may be triangular in shape. The stabilizing element **204** may be made of the same material as the syringe **132.** In one example, the stabilizing element **204** may be made of a transparent, medical-grade plastic. Similar to the stabilizing element **180** shown in **FIG. 6A,** the stabilizing element **204** may be provided on the syringe **132** to stabilize the syringe **132** within the MUDS **130** upon insertion of the MUDS **130** into the fluid injector system **100.** The top plate **162** of the fluid injector system **100** may contact the planar member **206** of the stabilizing element **204** to hold the syringe **132** in an upright, centered position relative to the fluid injector system **100.**

[0034] Figures **7A, 7B** illustrate an embodiment of the top side and the bottom side of the top plate **162.** Referring first to **FIG. 7A,** top plate **162** has a bottom surface **240** and three syringe slots **170** for receiving the distal ends of syringes **132.** Each syringe slot **170** has an interior conical portion **245** and stabilizing element contact surface **250** and an optional recessed surface **260.** The stabilizing element contact surface **250** has a surface perpendicular to the longitudinal axis **L** of the MUDS when the top plate **162** is in the inserted and locked position, such that the stabilizing element contact surface **250** is in flush surface-to-surface contact with the planar upper surface **(182, 188, 194, 202,** or **206)** of the stabilizing element **180, 193, 186, 198,** or **204,** respectively). The flush surface-to-surface contact between the stabilizing element contact surface **250** and the planar upper surface prevents tilting or off-center alignment of the MUDS relative the longitudinal axis of the piston path. Optional recessed surface **260** comprises a recessed area relative to the stabilizing element contact surface **250** near the back side of top plate **162** and prevents contact with the syringe stabilizing element during the loading process as the top plate **162** is lowered to engage the MUDS. This may allow for balanced loading of the syringe stabilizing element without displacing or miss-aligning the MUDS as the top plate **162** is lowered due to contact between the stabilizing element upper surface and the rear portion of syringe slot **170.** Referring to **FIG. 7B,** a top surface **230** of top plate **162** is illustrated. Syringe slots **170** can be seen along with recessed surfaces **260** at the rear portion of syringe slots **170.** The edge of the stabilizing element contact surface **250** may be seen near the front of syringe slots **170.**

[0035] While several examples of multi-use disposable sets and syringes therefor are shown in the accompanying figures and described hereinabove in detail, other examples will be apparent to, and readily made by, those skilled in the art without departing from the scope of the invention as defined by the appended claims. Accordingly, the foregoing description is intended to be illustrative rather than restrictive.

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- US62350487 **[0001]**
- WO9707841A2 **[0005]**

Patentkrav

1. Engangssæt til flere formål (MUDS - multi-use disposable set) (130), der omfatter:
en flerhed af sprøjter (132), idet hver sprøjte (132) har et sprøjtelegeme (138), en proksimal ende (142), en distal ende (140), der er placeret i en afstand fra den proximale ende (142) langs en længdeakse af sprøjtelegemet (138), en kegledel (145) og en dyse (147), der strækker sig distalt fra den distale ende (140) af sprøjtelegemet (138), og et stabiliserende element (180), der er tilvejebragt på en proksimal ende af kegledelen (145), hvor det stabiliserende element (180) har en bæreflade (182), der strækker sig i det væsentlige vinkelret på sprøjtelegemets (138) længdeakse for at tilvejebringe stabil lodret opretning for flerheden af sprøjter (132) med bevægelige stempelelementer (103) for en fluiduminjektor (100), når en plan overflade på en topplade (162) i injektoren (100) kommer i kontakt med det stabiliserende element (180)
en ramme (154) til at modtage mindst en del af den proksimale ende (142) af flerheden af sprøjter (132) og til at interagere med en bundføring (168) for fluiduminjektoren (100) for at justere MUDS (130) i et modtagerum (158) i fluiduminjektoren (100)
og
en fordeler (148) i fluidummæssig forbindelse med den distale ende (140) af hver af de flere sprøjter (132).

2. MUDS ifølge krav 1, hvor det stabiliserende element (180) er udformet på sprøjtelegemet på en integrerende måde (138).

3. MUDS ifølge krav 1, hvor det stabiliserende element (180) omfatter en ring, der er tilvejebragt på en ydre overflade langs omkredsen af sprøjtelegemets (138) distale ende (140).

4. MUDS ifølge krav 1, hvor det stabiliserende element (180) omfatter et hylster med en plan, øvre bæreflade (188), der strækker sig i det væsentlige vinkelret på sprøjtens (132)

længdeakse, og som er tilvejebragt på en ydre overflade langs omkredsen af sprøjtelegemet (138), idet hylsteret strækker sig fra sprøjtelegemets (138) proksimale ende (142) til sprøjtelegemets (138) distale ende (140).

5. MUDS ifølge krav 1, hvor det stabiliserende element (180) omfatter en del af sprøjtelegemet (138), der strækker sig aksialt langs en længdeakse af sprøjtelægemet (138) for at danne en plan, øvre bæreflade (188), der strækker sig i det væsentlige vinkelret på den længdeakse, der strækker sig ud fra kegledelen (145) på en distal ende (140) af sprøjtelegemet (138).

6. MUDS ifølge krav 1, hvor det stabiliserende element (180) omfatter en plan del (194) og mindst to ribber (196), der er forbundet med kegledelen (140) og den plane del (194).

7. MUDS ifølge krav 1, hvor det stabiliserende element (180) omfatter mindst to i det væsentlige trekantede forlængelser, der indeholder en øvre, plan overflade (202) og en bundflade (200), som er forbundet med kegledelen (145).

8. MUDS ifølge krav 7, hvor den øvre, plane overflade (202) strækker sig i det væsentlige vinkelret i forhold til sprøjtelegemets (138) længdeakse.

9. MUDS ifølge krav 1,
hvor det stabiliserende element (180) omfatter en første plan del (206), der er forbundet med kegledelen (145) gennem mindst en ribbe (208), og en anden plan del (206), der er forbundet med kegledelen (145) gennem mindst en anden ribbe (208), og hvor de plane dele (206) er adskilt fra hinanden på kegledelen (145).

10. MUDS ifølge krav 9,
hvor de plane dele (206) strækker sig i det væsentlige vinkelret i forhold til sprøjtelegemets (138) længdeakse, og
hvor de plane dele (206) er placeret tilstødende en

udløbsledning (146), der afgrænses i den distale ende (140) af sprøjtelegemet (138).

DRAWINGS

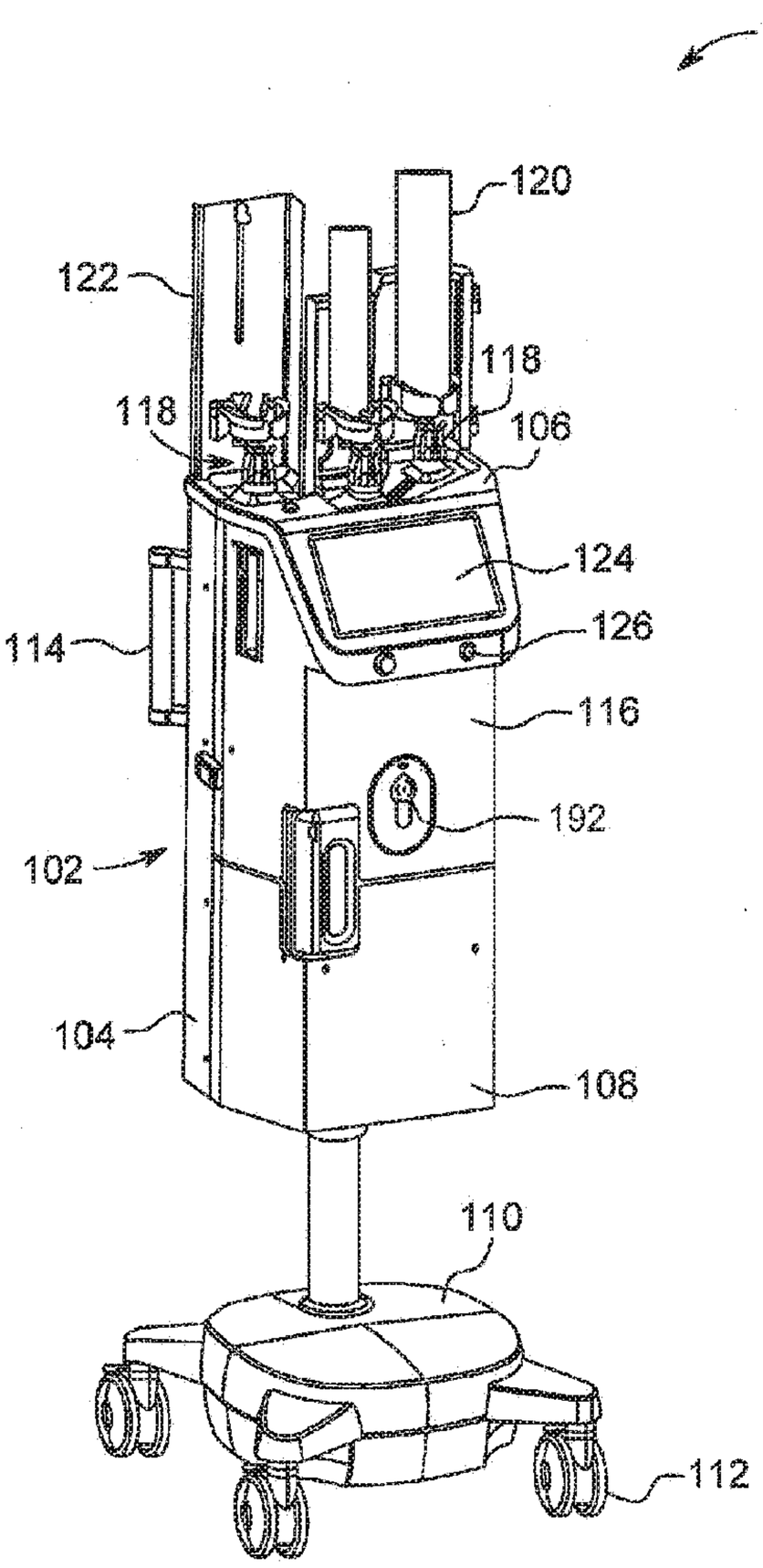
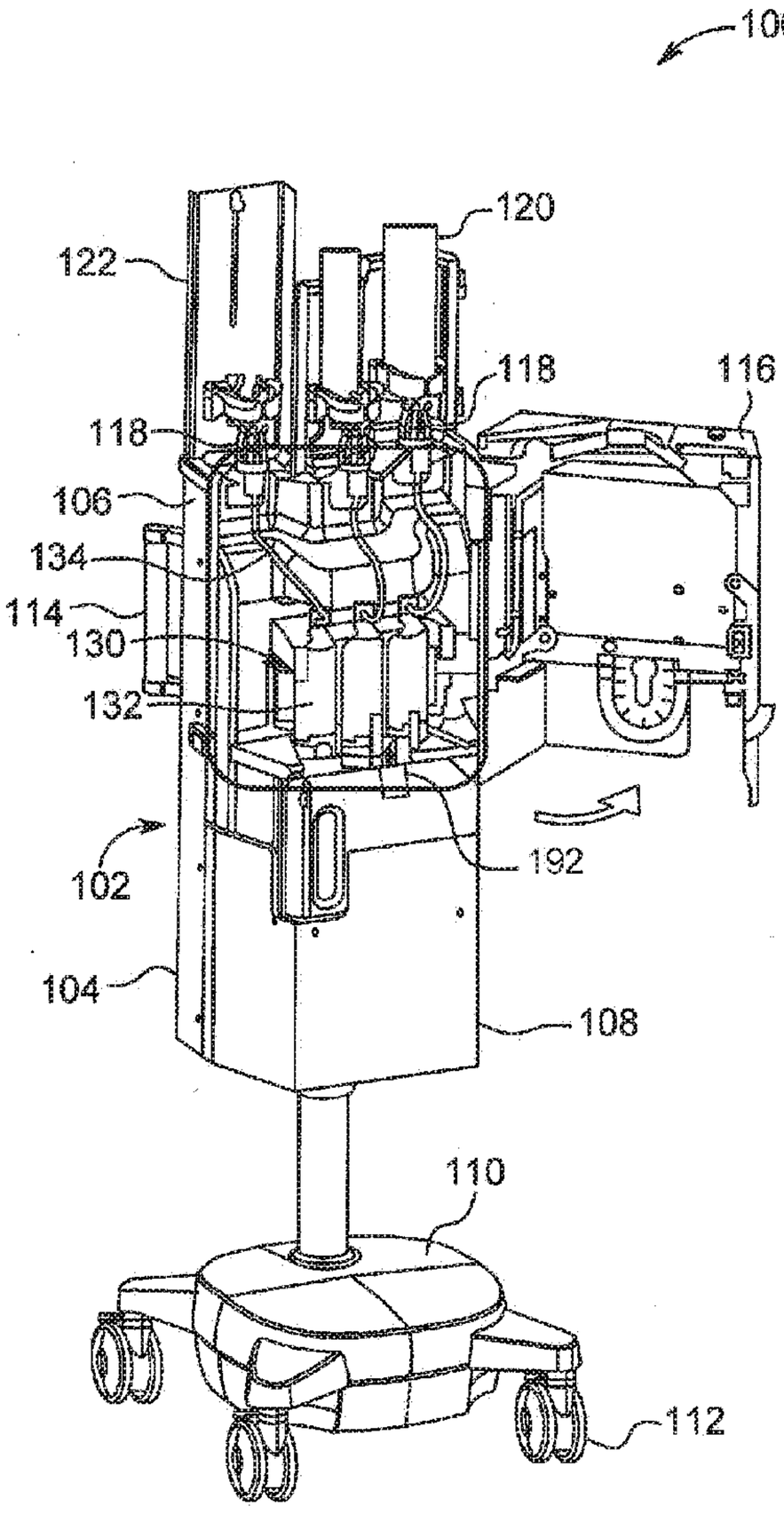


FIG. 1A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106
134
114
130
132
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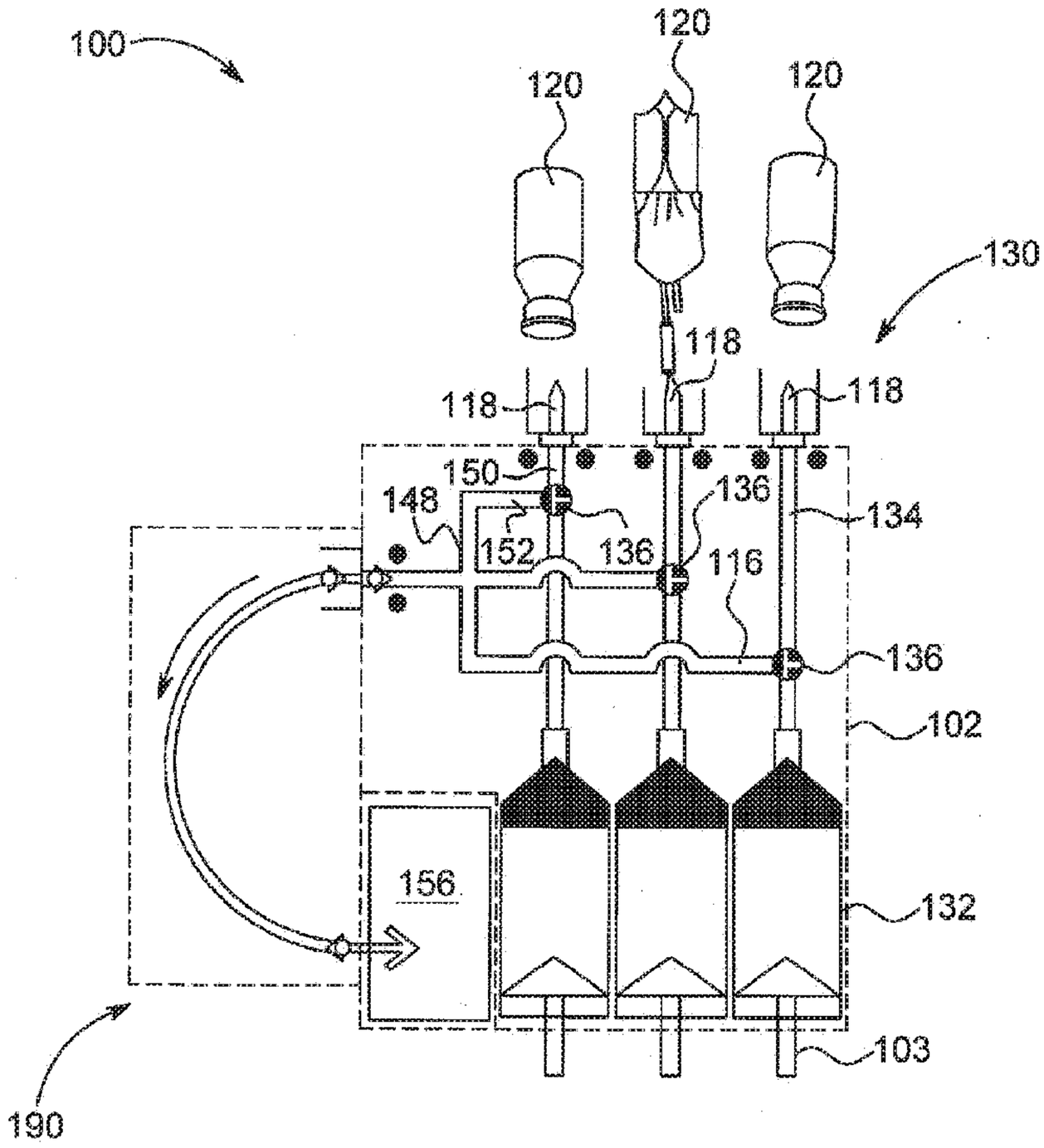
110
112

FIG. 1B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120
120
120
130
118
118
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150
148
152
136
136
136
134
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190

FIG. 2

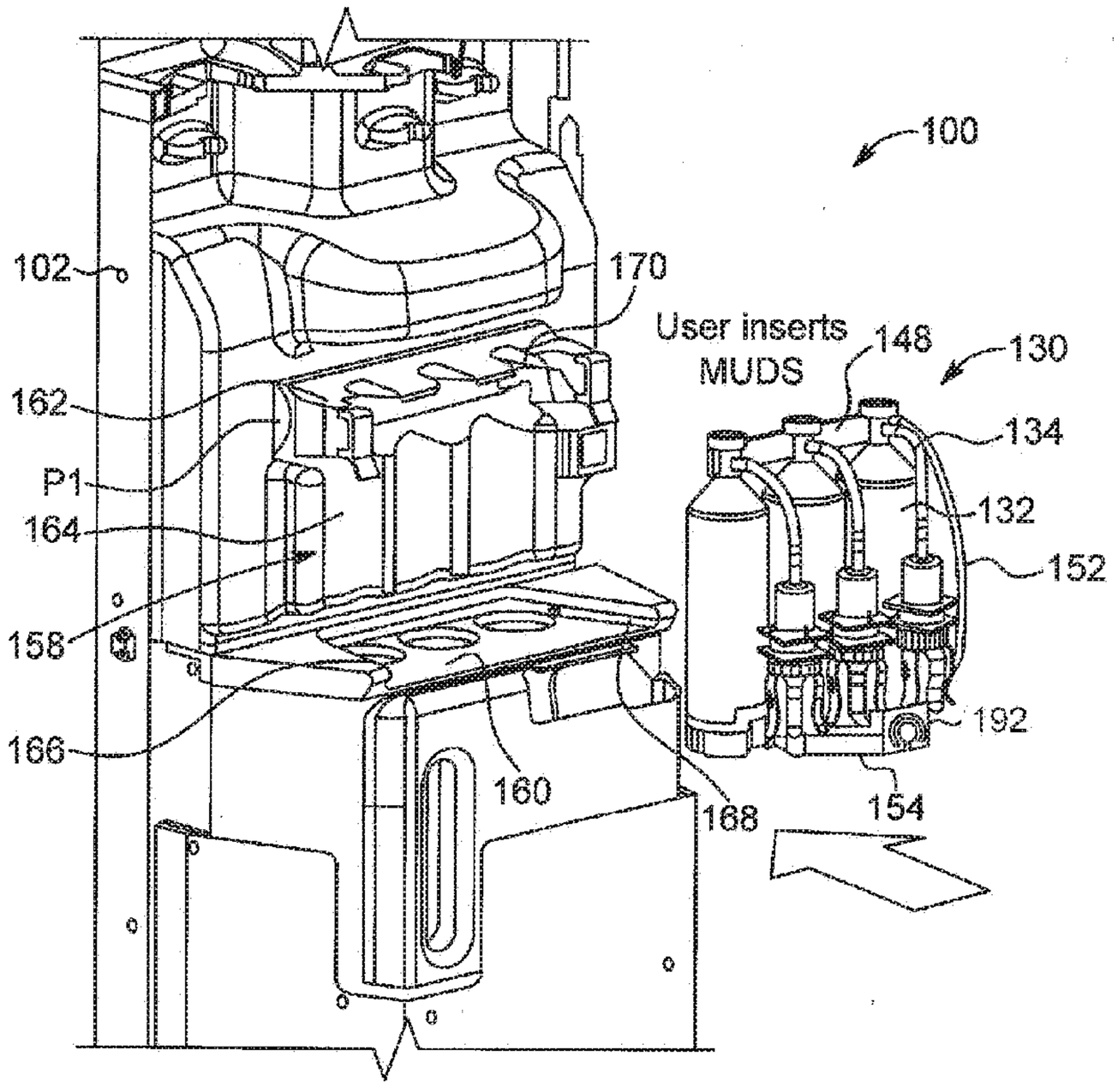
100
102
170
User inserts
MUDS
148
130
162
134
P1
132
164
152
158
192
166
160
168
154

FIG. 3A

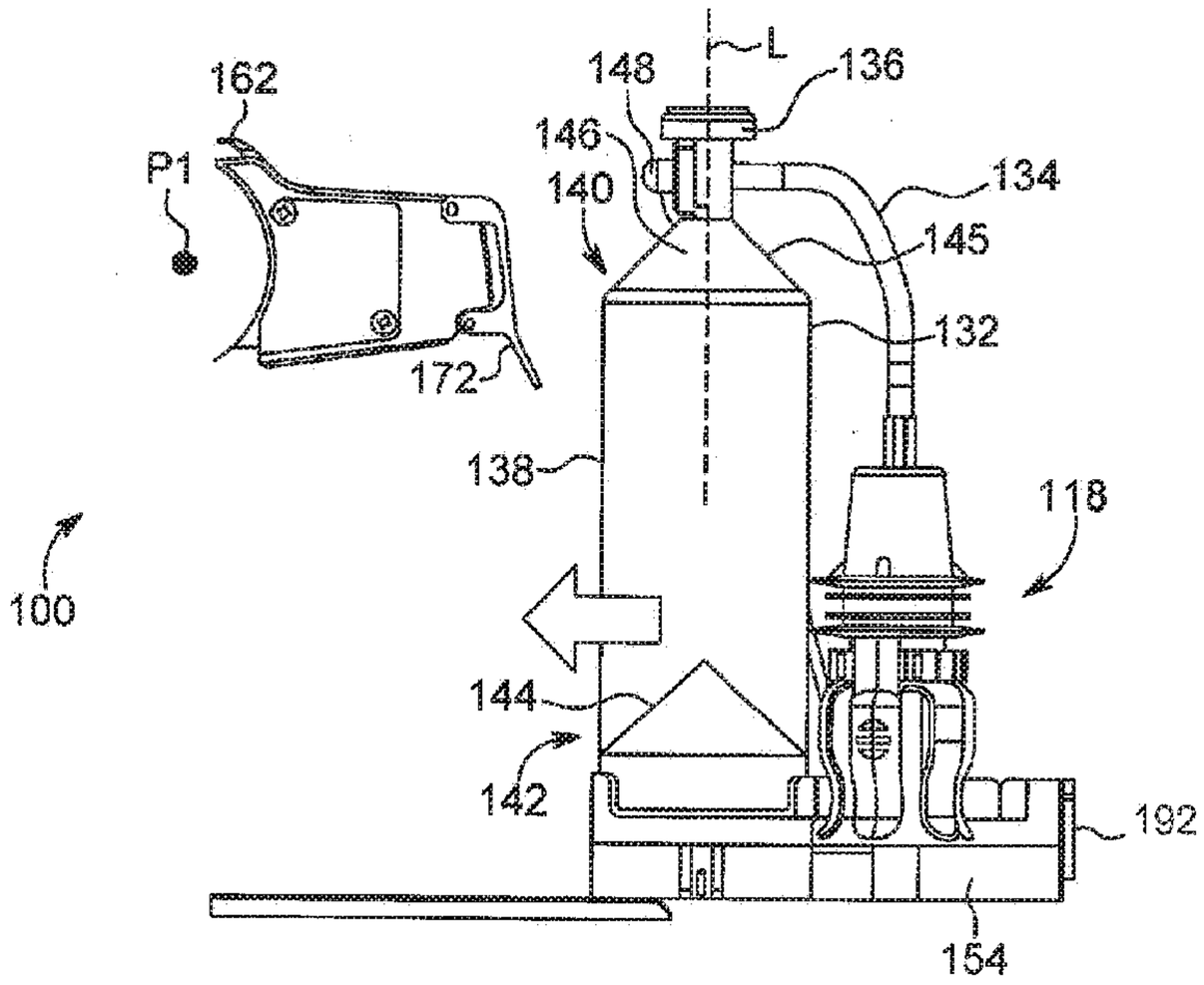
162
P1
172
148
L
136
146
140
134
145
132
138
118
100
144
142
192
154

FIG. 3B

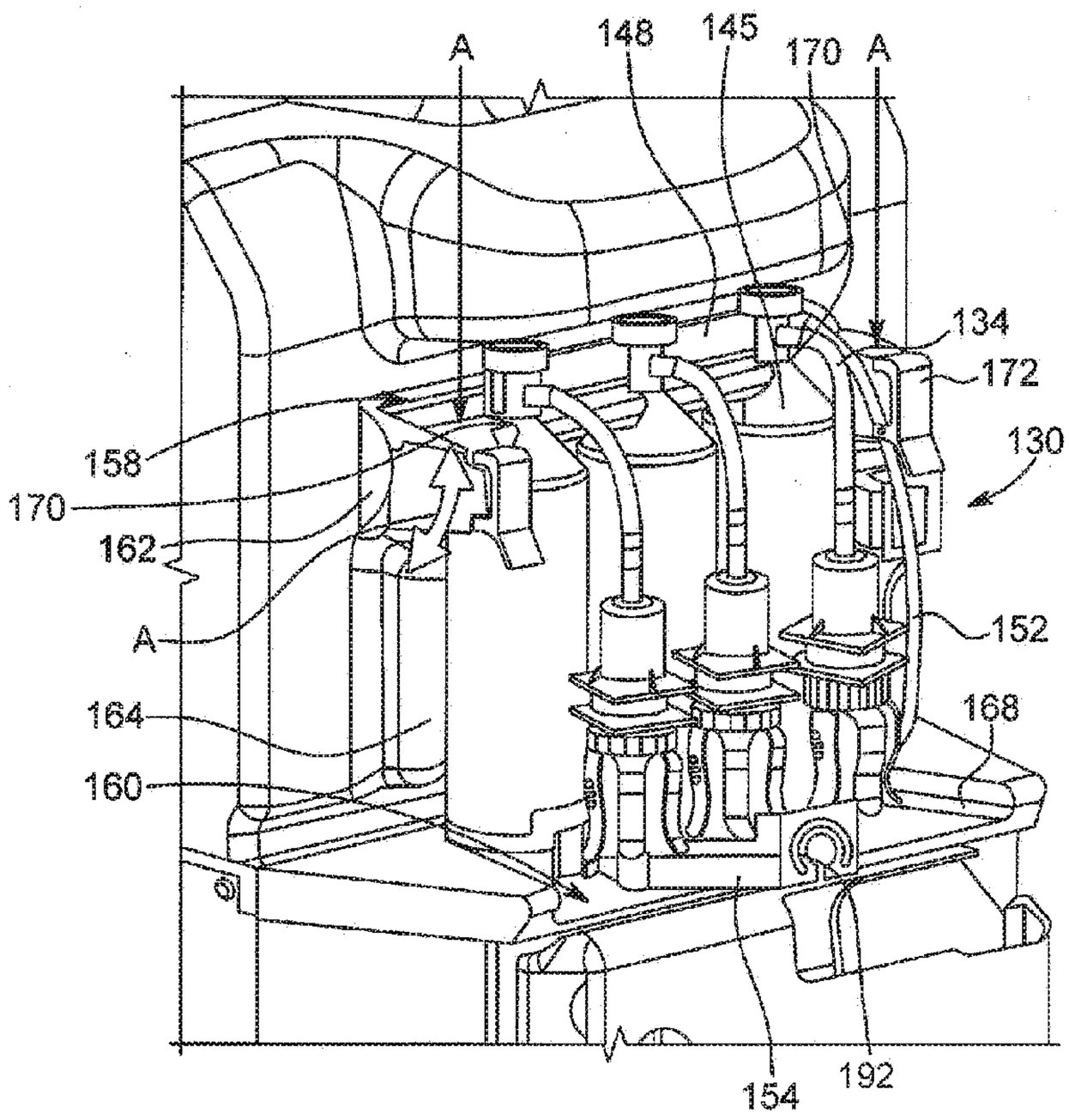

FIG. 4A

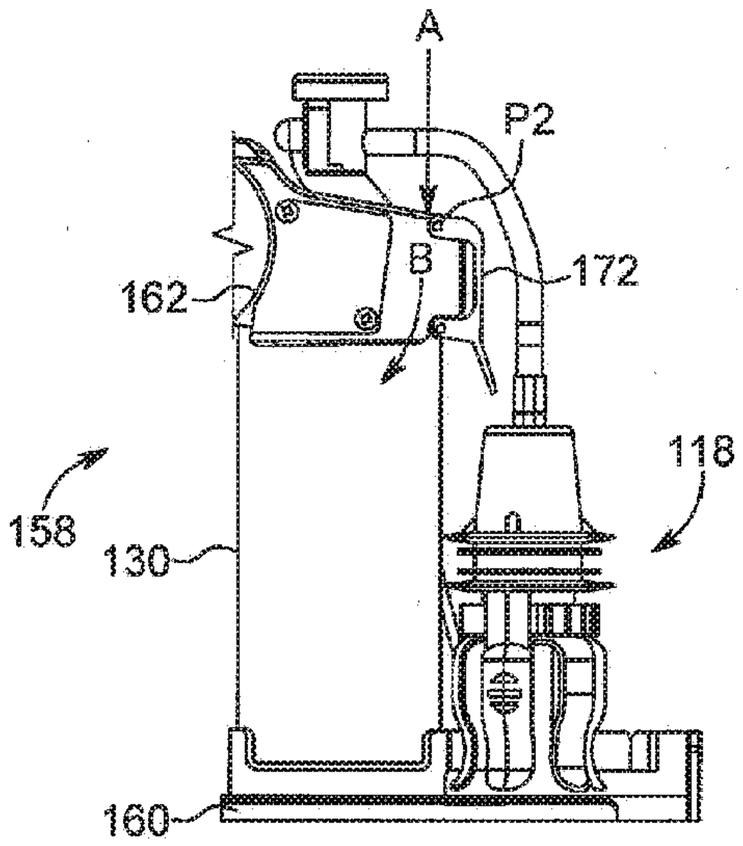

FIG. 4B

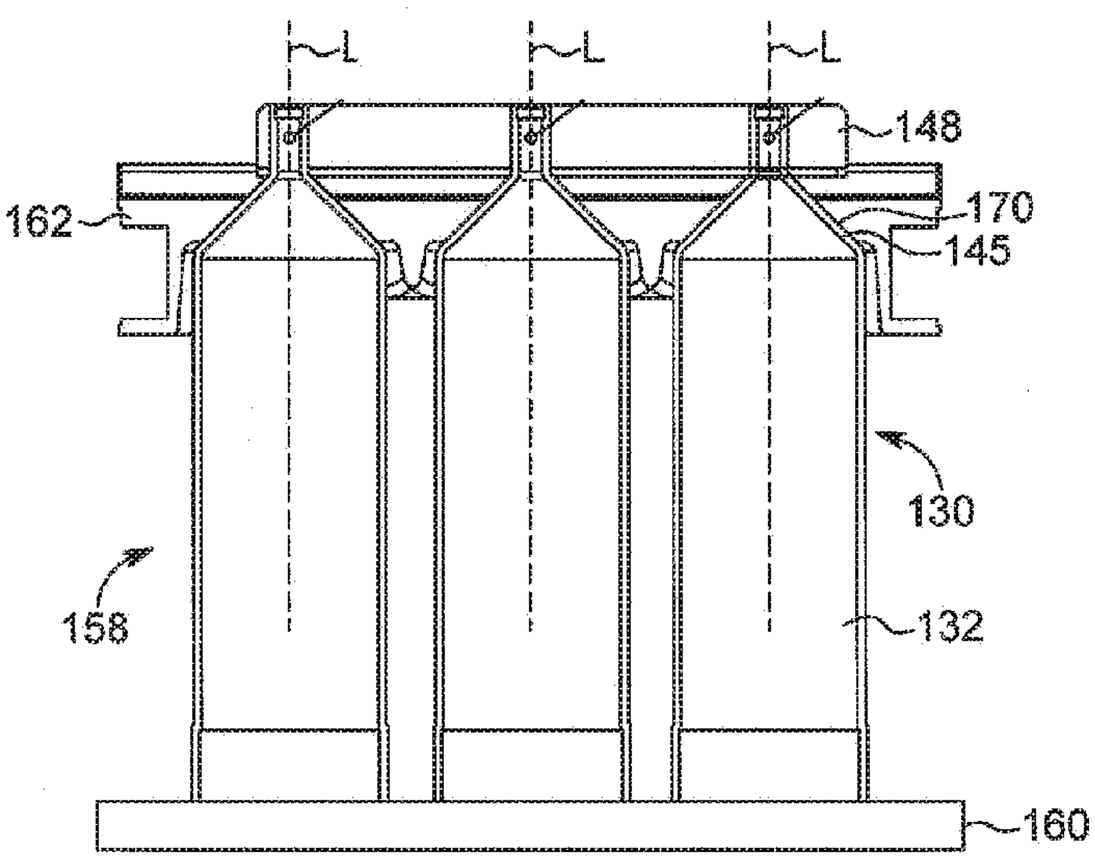

FIG. 4C

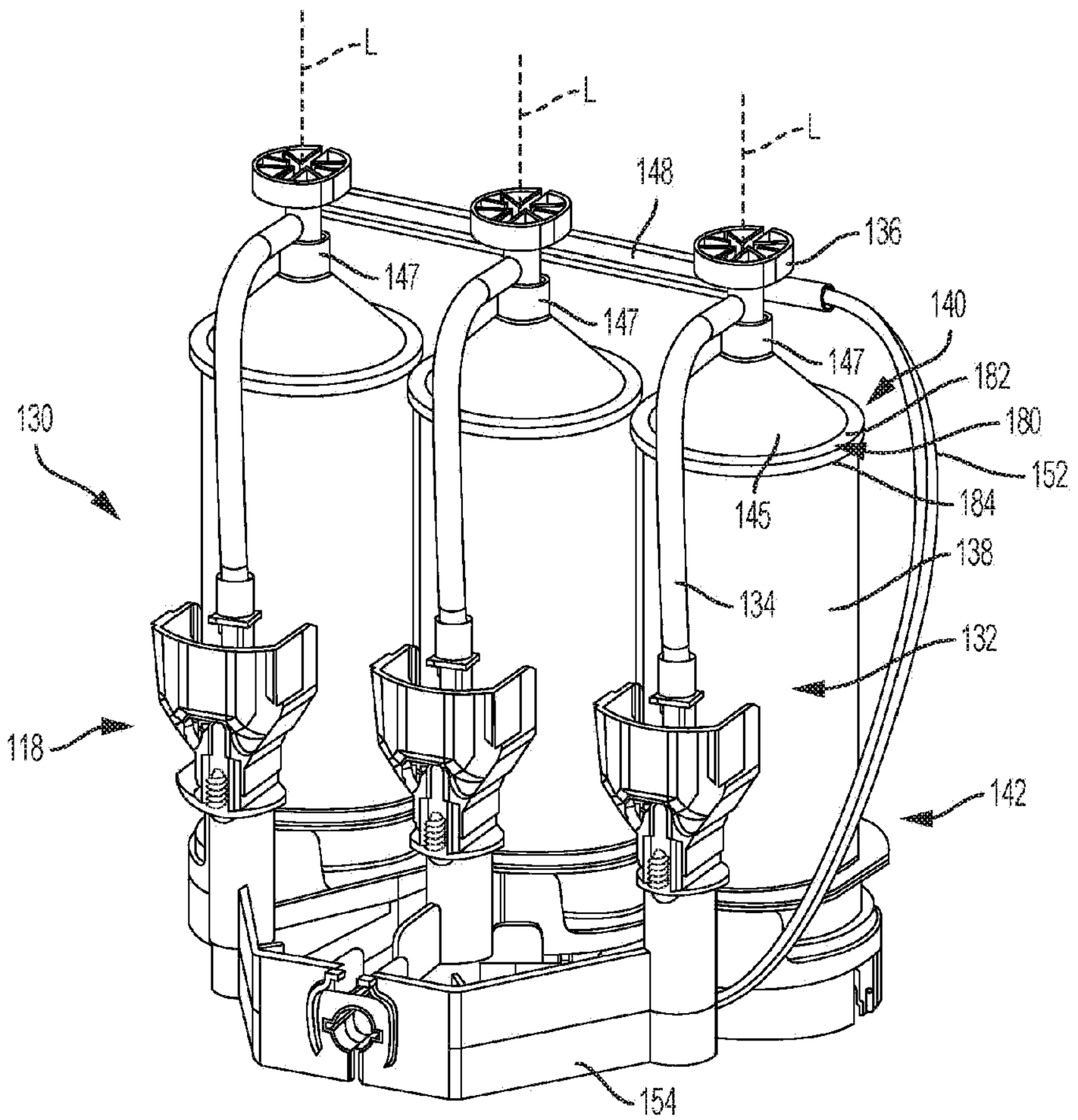
L
L
L
148
136
147
147
147
140
182
180
152
184
138
134
132
142
145
130
118
154

FIG. 5

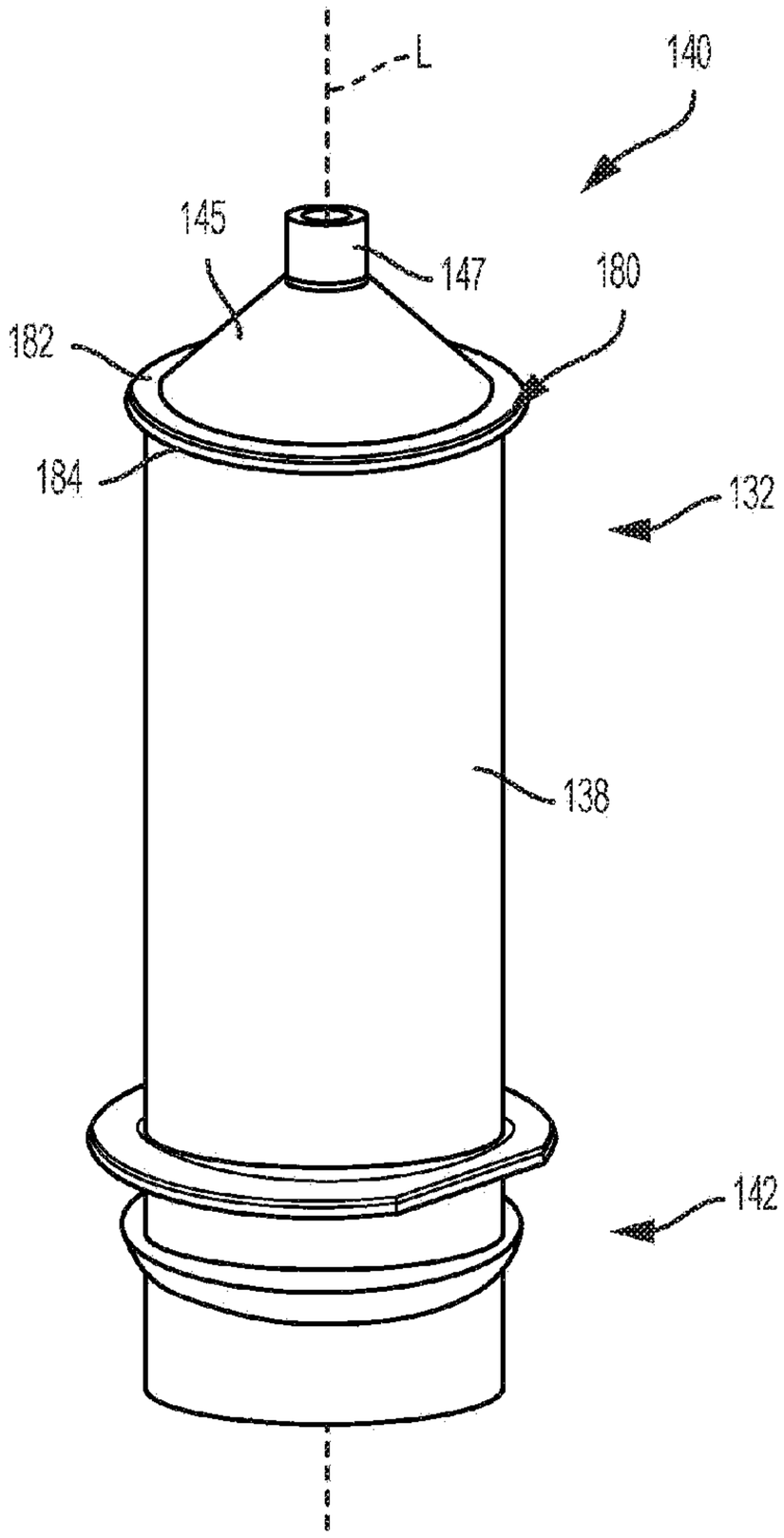

FIG. 6A

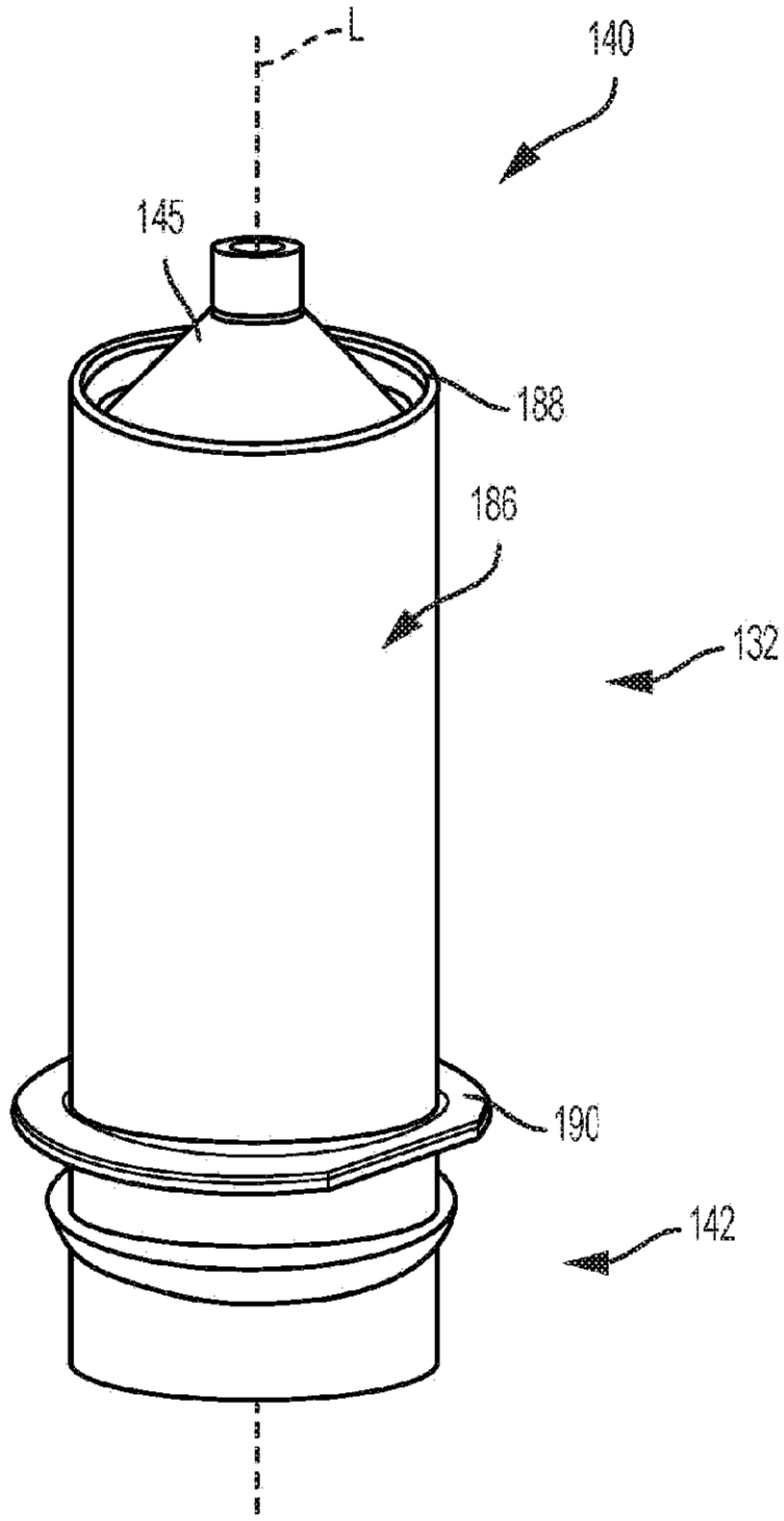

FIG. 6B

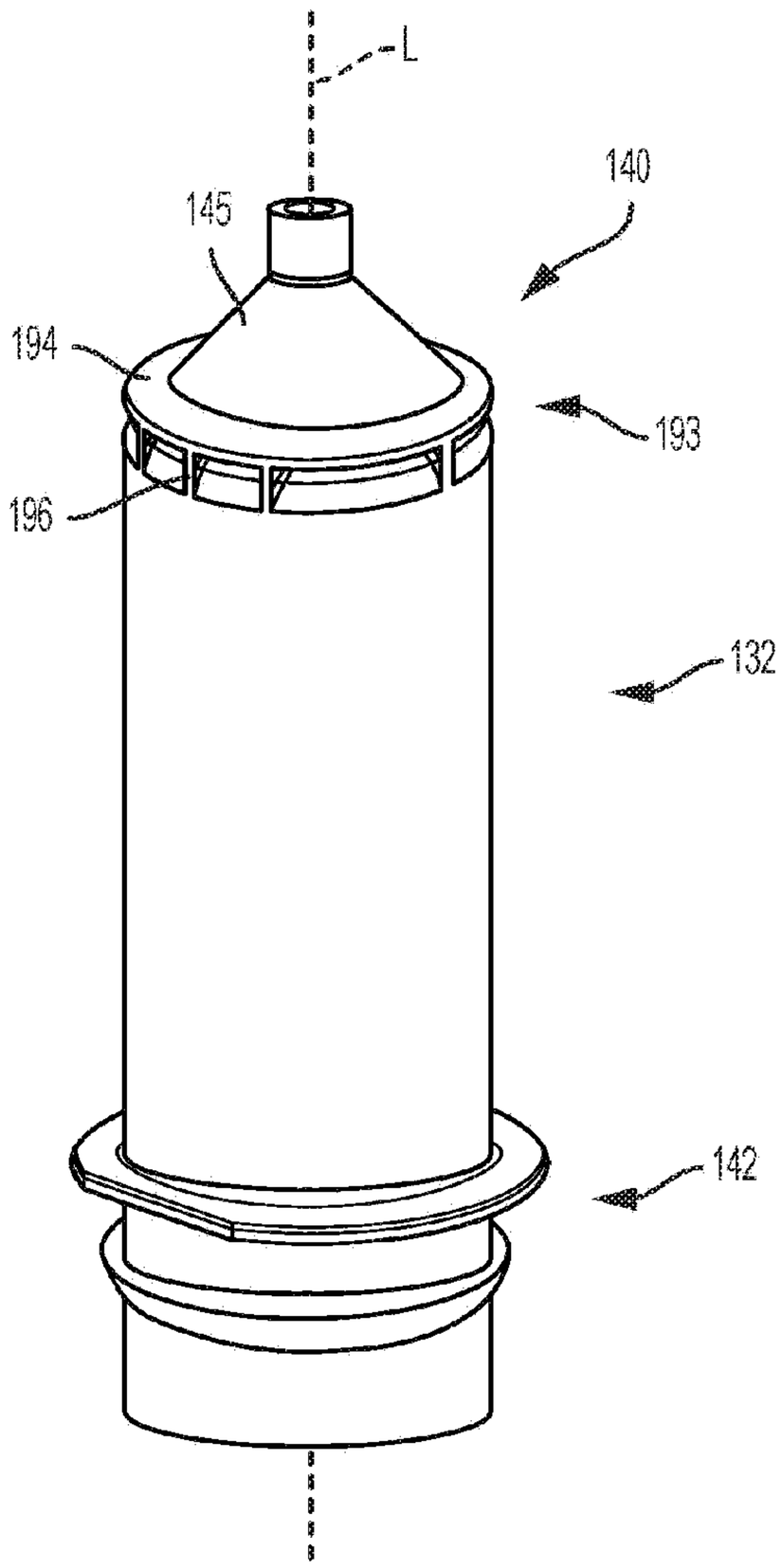

FIG. 6C

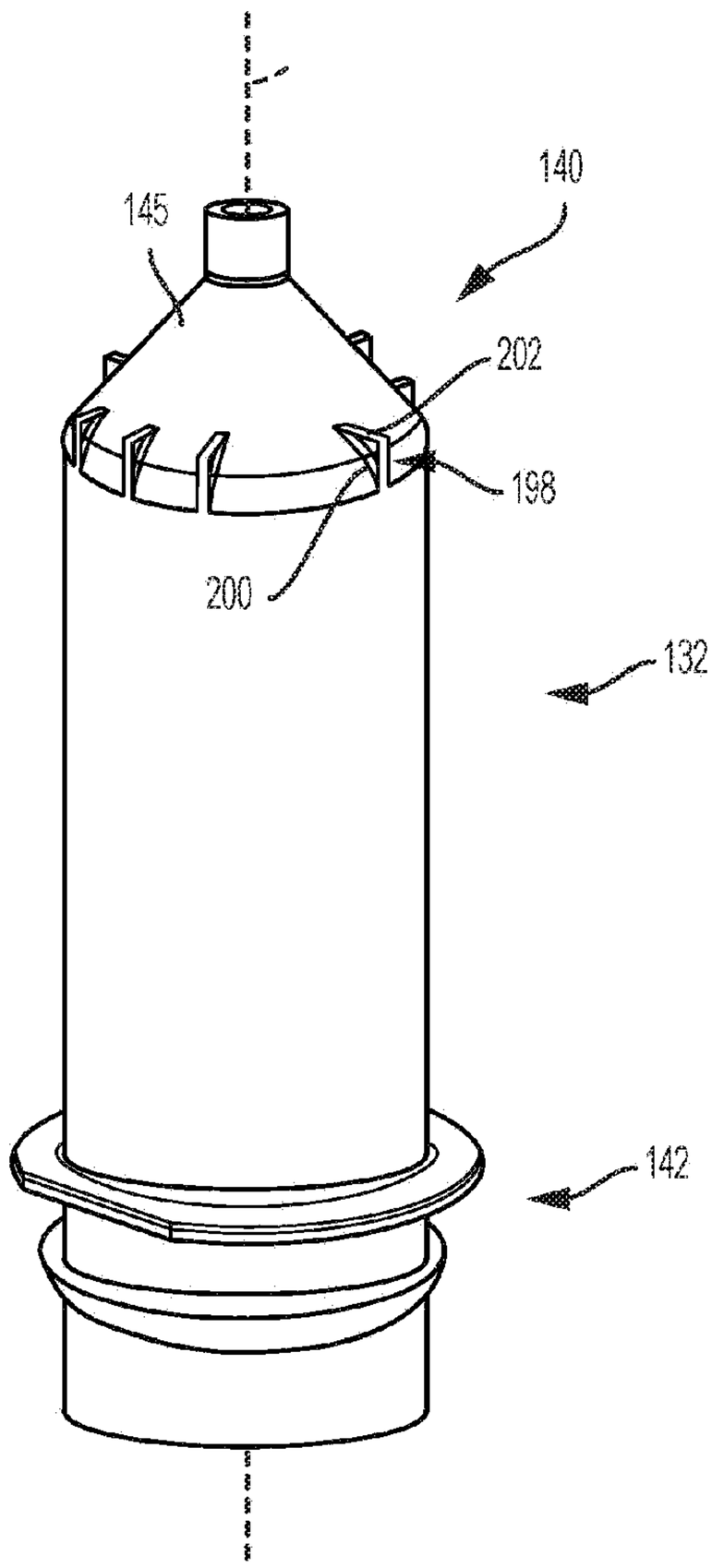

FIG. 6D

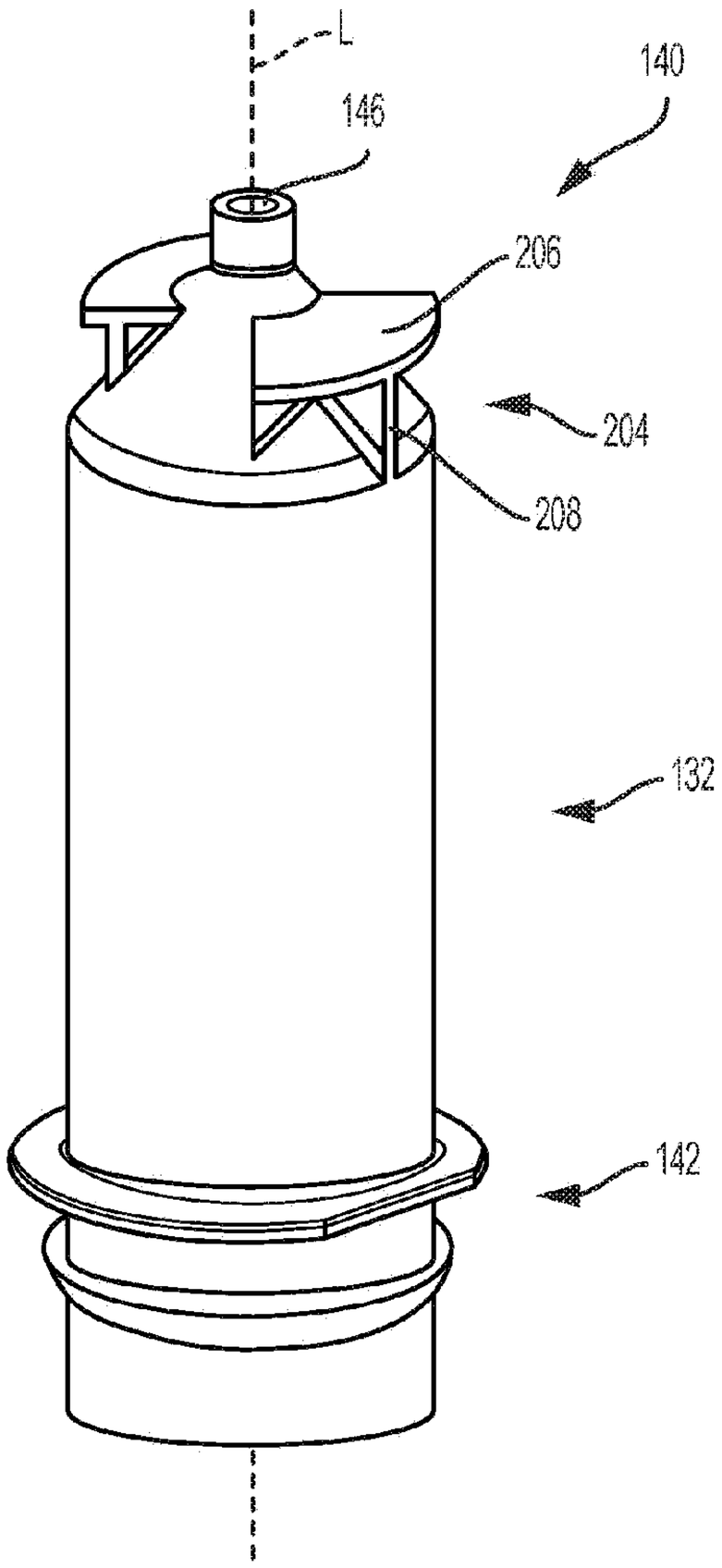

FIG. 6E

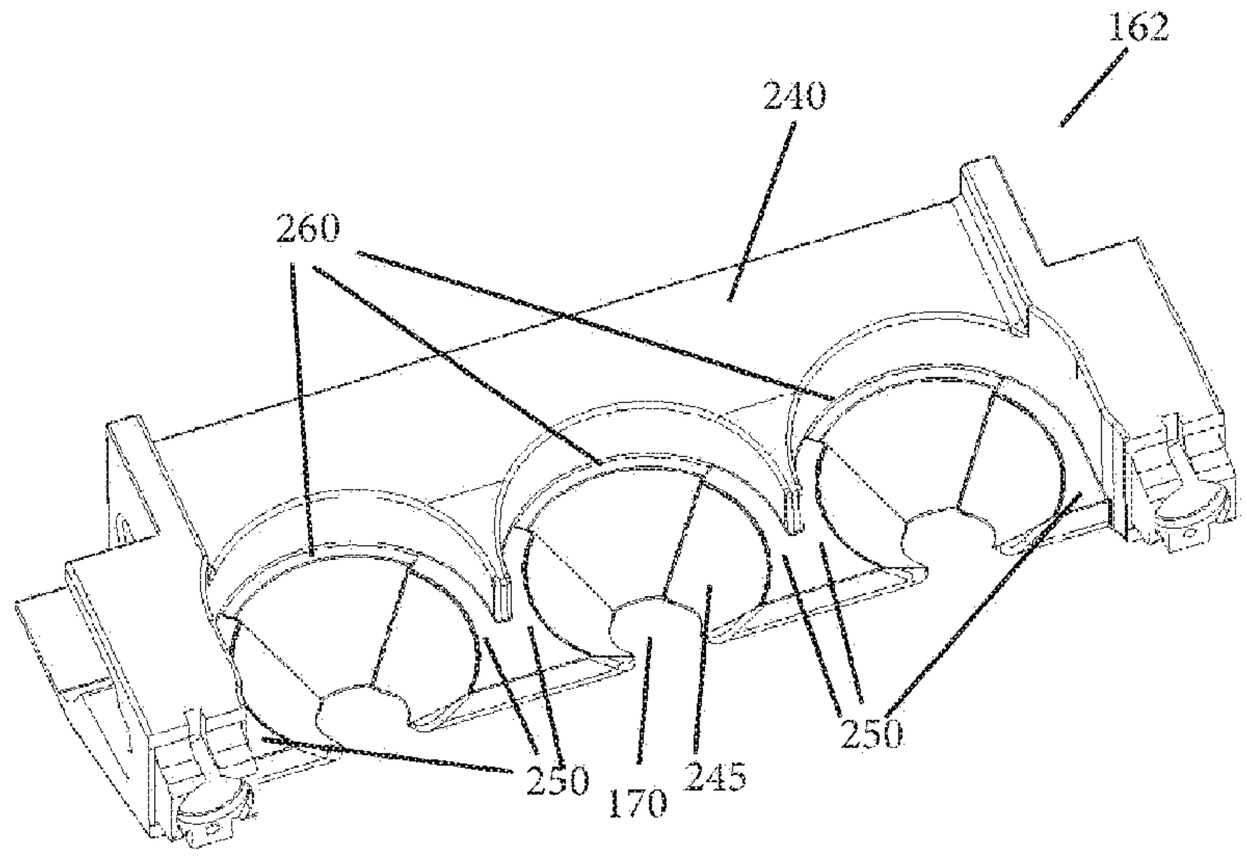
162
240
260
250
170
245
250

FIG. 7A

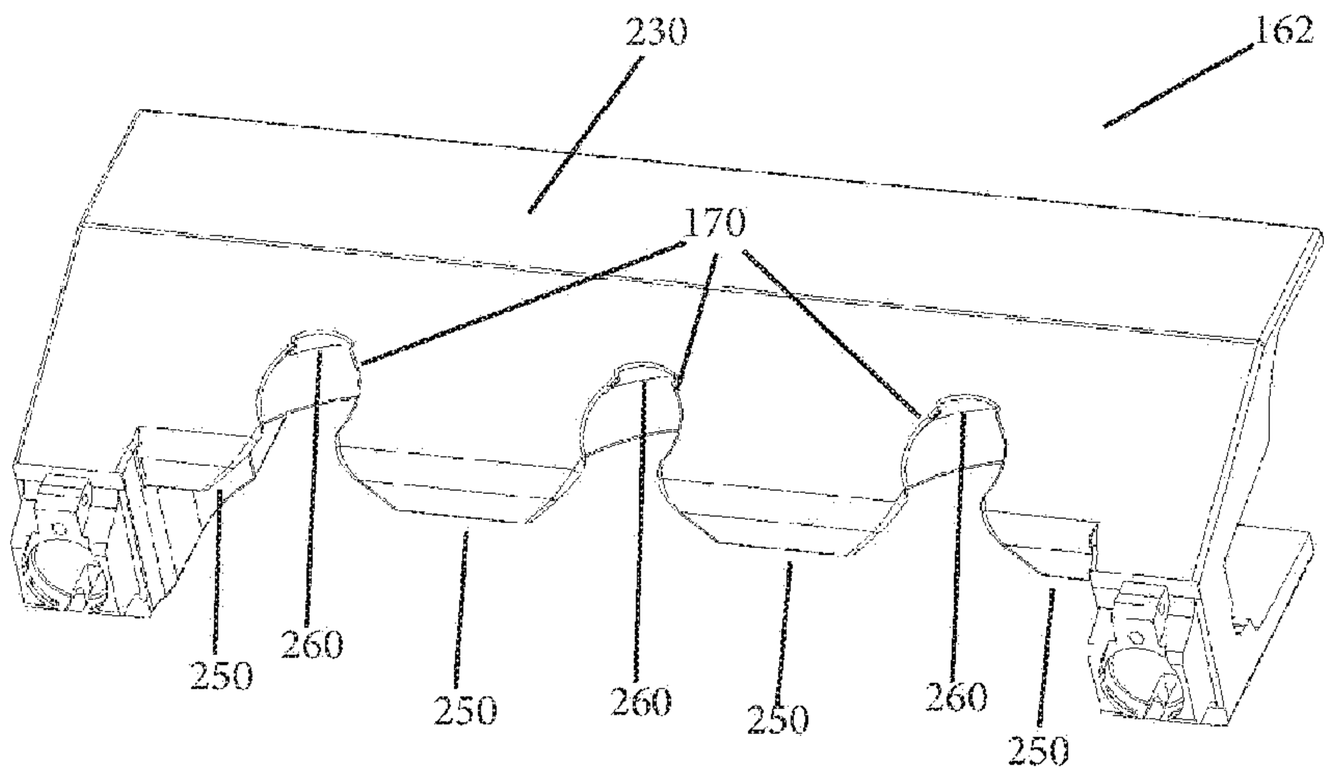
230
162
170
250
260
250
260
250
260
250

FIG. 7B