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(54) Title: MANUAL PUMP FOR INTRAVENOUS FLUIDS

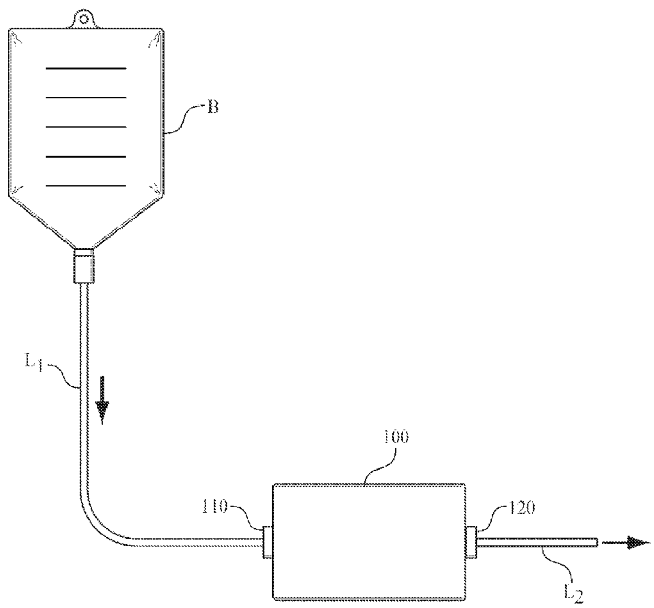

Fig. 1

(57) Abstract: A manual intravenous pump (100, 200, 300, 400, 500, 800, 900, 1000, 1100, 1400) includes an input line (L1, 630a,b, 730a,b, 1430a,b), a fluid reservoir (330, 440, 610a,b, 710a,b, 950, 1040, 1140, 1440a,b) operatively connected to the input line (U, 630a,b, 730a,b, 1430a,b), and an output line (L2, 640a,b, 740a,b, 1450a,b) operatively connected to the fluid reservoir (330, 440, 610a,b, 710a,b, 950, 1040, 1140, 1440a,b). The manual intravenous pump (100, 200, 300, 400, 500, 800, 900, 1000, 1100, 1400) further includes a manually operable actuator (240, 515, 840, 1415), configured to facilitate the flow of fluid from the input line (Li, 630a,b, 730a,b, 1430a,b), through the fluid reservoir (330, 440, 610a,b, 710a,b, 950, 1040, 1140, 1440a,b), and to the output line (L2, 640a,b, 740a,b, 1450a,b).

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MANUAL PUMP FOR INTRAVENOUS FLUIDS

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of priority of U.S. Provisional Application No. 61/164,763, filed on March 30, 2009.

FIELD OF INVENTION

[0002] The present application relates to devices for infusing intravenous fluids. More particularly, the present application relates to a manual pump for infusing intravenous fluids into a subject.

BACKGROUND

[0003] In the medical and veterinary setting, the need may arise to rapidly infuse intravenous fluid into a subject. Saline and lactated ringers are examples of commonly used intravenous fluids. Such fluids may be used to maintain or elevate blood pressure and promote adequate perfusion. In the shock-trauma setting or in septic shock, fluid resuscitation is often first-line therapy to maintain or improve blood pressure.

[0004] Currently, a first responder, such as emergency medical technicians or military field medics, are known to administer intravenous fluids with a gravity drip, having a fluid bag, a fluid line, and an needle or intravenous catheter. When the needle or intravenous catheter is inserted into a subject, gravity causes the fluid to flow from the fluid bag, through the fluid line and needle, and into the subject. To increase the speed at which intravenous fluids are infused into the subject, the technician may apply pressure on the bag. Pressure may be applied by hand, by employing a blood pressure cuff, or other external pneumatic pressure device on the fluid bag itself.

[0005] Additionally, intraosseous (I.O.) lines have gained wider use in pediatric subjects, as well as adult subjects. Intraosseous infusion is a process of injection directly into the marrow of a subject's bone. Intraosseous lines often have a relatively slow rate of infusion.

[0006] There also exist several types of electronic pumps that infuse intravenous fluids. Such electronic pumps are often very costly and complex, and may require special training to operate. Further, such pumps may be delicate and not suited for field use. A first responder company will require several of these, adding to cost. Lastly, electronic pumps require a power source, such as a battery or wall socket, and may not necessarily be friendly to the environment.

SUMMARY OF THE INVENTION

[0007] A manual intravenous pump includes an input line, a fluid reservoir operatively connected to the input line, and an output line operatively connected to the fluid reservoir. The manual intravenous pump further includes a manually operable actuator, configured to facilitate the flow of fluid from the input line, through the fluid reservoir, and to the output line.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] In the accompanying drawings, structures are illustrated that, together with the detailed description provided below, describe exemplary embodiments of the claimed invention.

[0009] In the drawings and description that follows, like elements are identified with the same reference numerals. It should be understood that elements shown as a single component may be replaced with multiple components, and elements shown as multiple components may be replaced with a single component. The drawings are not to scale and the proportion of certain elements may be exaggerated for the purpose of illustration.

[0010] **Figure 1** is a schematic drawing of a manual intravenous pump in combination with a fluid bag and a fluid line;

[0011] **Figure 2** is a top view of one embodiment of a manual intravenous pump having a crank;

[0012] **Figure 3** is a top cutaway view of one embodiment of a manual intravenous pump having a crank and rotary chambers;

[0013] **Figure 4** is a top cutaway view of an alternative embodiment of a manual intravenous pump having a crank and a bulb;

[0014] **Figure 5** is an exploded perspective view of an alternative embodiment of a manual intravenous pump having an actuator housing and a reservoir housing;

[0015] **Figures 6A** and **6B** are cross-sections of one embodiment of a reservoir housing having a pair of asymmetric diaphragm pumps;

[0016] **Figures 7A** and **7B** are cross-sections of one embodiment of a reservoir housing having a pair of symmetric diaphragm pumps;

[0017] **Figures 8** is a side view of an alternative embodiment of a manual intravenous pump having a trigger;

[0018] **Figure 9** is a side cutaway view of an alternative embodiment of a manual intravenous pump having a trigger and a bulb;

[0019] **Figure 10** is a side cutaway view of another alternative embodiment of a manual intravenous pump having a trigger and a piston;

[0020] **Figure 11** is a side cutaway view of another alternative embodiment of a manual intravenous pump having a trigger and rotary chambers;

[0021] **Figure 12** is a perspective view of an exemplary twin spring motor for use in a manual intravenous pump having a trigger;

[0022] **Figure 13** is a perspective view of an exemplary sextupled spring motor for use in a manual intravenous pump having a trigger;

[0023] **Figure 14** is a perspective view of another alternative embodiment of a manual intravenous pump having at least one pivoting handle;

[0024] **Figure 15** is a side view of the manual intravenous pump having at least one pivoting handle;

[0025] **Figure 16** is an exploded perspective view of an actuator housing of the manual intravenous pump having at least one pivoting handle;

[0026] **Figure 17** is a cross section of the actuator housing of the manual intravenous pump having at least one pivoting handle;

[0027] **Figure 18** is a cross section of a reservoir housing for a manual intravenous pump; and

[0028] **Figure 19** is a cut away view of an alternative embodiment of a pump for use in a manual intravenous pump.

DETAILED DESCRIPTION

[0029] Multiple embodiment of intravenous pumps are shown and described herein. It should be understood that the disclosed pumps may be employed to pump any known intravenous fluids, including, without limitation, saline, lactated ringers, colloid solution, platelets, and blood. Further, the use of the disclosed pumps is not limited to the intravenous application of fluids. It should be understood that the pumps may be used, for example, for wound irrigation or other cleaning or sterilization purposes. For such uses, the pumps may be used with water, alcohol, or other sterilants.

[0030] **Figure 1** is a schematic drawing of a manual intravenous pump **100** in combination with a fluid bag **B** and a fluid line **L**. In the illustrated embodiment, the fluid line **L** includes a first line $\mathbf{L_1}$ and a second line $\mathbf{L_2}$. The first fluid line $\mathbf{L_1}$ is connected to an output of the fluid bag **B** and an input **110** of the manual intravenous pump **100**. The first fluid line **L** leads to an internal fluid reservoir (not shown) in the manual intravenous pump **100**. The manual intravenous pump **100** further includes one or more mechanisms (not shown) to facilitate the flow of fluid through the internal fluid reservoir. In one embodiment, the input **110** of the manual intravenous pump **100** is a one-way valve. In alternative embodiments, the input may be a 2-way valve, or an adjustable, bi-directional valve.

[0031] The second fluid line $\mathbf{L_2}$ is connected to an output **120** of the manual intravenous pump **100** and leads to a subject, usually by a needle or intravenous catheter. Alternatively, the manual intravenous pump **100** may employ central line catheters and interosseous lines. In one embodiment, the output **120** is also a one-way valve. One-way valves allows the fluid only to flow from the fluid bag **B**, to the subject, and not in a reverse direction. In alternative embodiments, however, the output may be a 2-way valve, or an adjustable, bi-directional valve.

[0032] The manual intravenous pump **100** may be used in-line (i.e., in series) as described above. Alternatively, the manual intravenous pump **100** may also be used in a bypass-type configuration (i.e., in parallel) to allow a gravity drip to continue.

[0033] The manual intravenous pump **100** further includes a manually operable actuator (not shown), configured to force fluid from the input **110** of the manual intravenous pump **100** to the output **120**. Various types of manually operable actuators may be employed. Exemplary manual operable actuators are discussed below. These examples are not intended to be limiting.

[0034] **Figure 2** illustrates a top view of one embodiment of a manual intravenous pump **200** having an input **210**, an output **220**, and a body **230**. In this embodiment, the manually operable actuator is a crank **240**. This type of manual intravenous pump may be referred to as a "crank design," "crank pump," or "hand crank." The crank **240** includes a lever arm **250** rotatably connected to the body **230** of the manual intravenous pump **200**. In the illustrated embodiment, the crank **240** further includes a handle **260** connected to the lever arm **250**. The handle **260** may be rotatably or fixedly connected to the lever arm **250**. In one embodiment, the crank **240** is a single, unitary piece including a lever arm portion and handle portion.

[0035] In the illustrated embodiment, the manual intravenous pump **200** further includes a pair of handles **270**. The handles **270** may be solid or flexible. The handles may be ergonomically shaped for the comfort of the user. Further, the handles may be located in an ergonomic position for the comfort of the user. In an alternative embodiment (not shown), the manual intravenous pump includes three or more handles. In another alternative embodiment (not shown), the manual intravenous pump includes a single handle. In yet another alternative embodiment (not shown), the manual intravenous pump does not include any handles, and could have contours that are designed for ergonomic handling.

[0036] With continued reference to **Figure 2**, the body **230** of the manual intravenous pump **200** has an approximately cubic shape, with rounded edges. However, it should be understood that this shape is merely exemplary, and any shape may be employed. In one embodiment, the body may have an ergonomic shape.

[0037] Although **Figure 2** is described as a top view, it should be understood that the crank **260** and optional handles **270** may be located on any surface of the manual intravenous pump **200**, such as a side or bottom surface. Further, in one embodiment, the manual intravenous pump **200** is designed to be positioned in multiple orientations, so that the operator may position the device in a comfortable orientation for operation.

[0038] The manual intravenous pump **200** may be constructed of various materials. Exemplary materials include polymeric materials and metal materials. Exemplary metal materials include, without limitation, steel, nickel aluminum, copper, iron, and other metals and alloys. Exemplary polymeric materials include, without limitation, EPDM Rubber, latex, polypropylene, polyethylene, and blends of the same. In one embodiment, where the manual intravenous pump is configured for field use (i.e., in an ambulance, or at an accident site), the device may be constructed of materials that are lightweight and durable. Of course, such materials may also be suitable for a device configured for clinical use. In one embodiment, the casing **230**, the crank **240**, and the handles **270** are all constructed of substantially the same material. In an alternative embodiment, one or more of these components are constructed of different materials.

[0039] **Figure 3** is a top cutaway view of one embodiment of a manual intravenous pump **300**. The illustrated embodiment is one example of the internal components of the crank design of a manual intravenous pump **200** shown in **Figure 2**.

[0040] In the illustrated embodiment, the crank **240** is connected to a rod **310** having a plurality of partitions **320** extending therefrom. The rod **310** and partitions **320** are positioned inside a cylinder **330** that defines an internal fluid reservoir of the manual intravenous pump **300**. The cylinder **330** has a first opening **340** in fluid communication with the input **210** of the manual intravenous pump **300** and a second opening **350** in fluid communication with the output **220** of the manual intravenous pump **300**. The rod **310** and partitions **320** form a plurality of rotary chambers **360** in the cylinder **330**. In the illustrated embodiment, the rod **310** includes three partitions **320** extending therefrom, which form three rotary chambers **360** in the cylinder **330**. However, it should be understood that any number of partitions may be employed, including a single partition.

[0041] In addition to the components shown, various gear configurations may be employed to create a mechanical advantage and/or cause the rod **310** and partitions **320** to rotate at a rate different from the rate at which the crank **240** is turned.

[0042] Various materials may be used to construct the rod **310,** partitions **320**, and cylinder **330**. Exemplary materials include polymeric materials and metal materials. In one embodiment, the rod **310,** partitions **320**, and cylinder **330** are constructed of polymeric materials that resist corrosion after prolonged exposure to saline solutions and other commonly used intravenous fluids. In one embodiment, the rod **310,** partitions **320**, and cylinder **330** are all constructed of substantially the same material. In an alternative embodiment, one or more of these components are constructed of different materials.

[0043] With continued reference to **Figure 3**, the partitions **320** extend from the rod **310** to an inner surface of the cylinder **330**. In one embodiment, at least the ends of the partitions are constructed of rubber, or another pliable, non-porous material, to form a seal. It should be understood, however, that various other materials may be employed. In an alternative embodiment, the partitions **320** do not extend to the inner surface of the cylinder **330**.

[0044] In operation, the input **210** of the manual intravenous pump **300** is connected to a first fluid line leading to a fluid bag, and the output **220** is connected to a fluid line leading to a subject. In one embodiment, both the input **210** and the output **220** are one-way valves. In one embodiment, when a fluid line is connected to the input **210**, fluid immediately begins to flow from the fluid bag, through the fluid line and input **210**, and into the first of the plurality of chambers **360**. In an alternative embodiment, fluid will not begin to flow until the input **210** is opened (e.g., by turning or pressing a valve).

[0045] Once the fluid lines have been connected to the fluid bag, the manual intravenous pump **300**, and the subject, and the fluid has begun to flow, an operator may turn the crank **240** of the manual intravenous pump **300**. As the crank **240** is turned, the partitions **320** rotate at a corresponding speed and force the fluid from the first opening **340** of the cylinder **330** towards the second opening **350**. In the illustrated embodiment, the crank **240** may be turned in either a clockwise or a counter-clockwise direction. Turning the crank **240** at a faster rate may increase the rate at which fluid flows through the output **350** and to a subject, while turning the crank **240** at a slower rate may decrease the rate at which fluid flows through the output **220** and to a subject. The operator may control the speed at which the crank **220** is turned, according to perceived need.

[0046] **Figure 4** is a top cutaway view of an alternative embodiment of a manual intravenous pump **400**. The illustrated embodiment is another example of the internal components of the crank design of a manual intravenous pump **200** shown in **Figure 2**.

[0047] In the illustrated embodiment, the crank **240** is connected to a disc **410** having a plurality of spaced apart, projections **420** extending therefrom. The disc **410** may be substantially circular or eccentric. The manual intravenous pump **400** further includes an internal fluid line **430** having a bulb **440** that defines an internal fluid reservoir of the manual intravenous pump **400**. The internal fluid line **430** is in fluid communication with both the input **210** and the output **220** of the manual intravenous pump **400**. The disc **410** and projections **420** are positioned adjacent the bulb **440**, such that the projections **420** contact and deform the bulb **440** when the disc **410** is rotated. In the illustrated embodiment, the disc **410** includes three projections **420** extending therefrom. However, it should be understood that any number of projections may be employed, including a single projection.

[0048] In the illustrated embodiment, the bulb **440** abuts a platform to facilitate compression upon contact with a projection **420**. In an alternative embodiment (not shown), the bulb **440** may abut a wall of the manual pump **400**. In another alternative embodiment (not shown), the bulb does not abut any surfaces.

[0049] In addition to the components shown, various gear configurations may be employed to create a mechanical advantage and/or cause the disc **410** and projections **420** to rotate at a rate different from the rate at which the crank **240** is turned.

[0050] With continued reference to **Figure 4**, the bulb **440** is constructed of rubber, or another pliable, non-porous material. It should be understood, however, that various other materials may be employed. Further, various materials may be used to construct the disc **410** and projections **420**. Exemplary materials include polymeric materials and metal materials. In one embodiment, the disc **410** and projections **420** are constructed of substantially the same material. For example, the disc **410** and projections **420** may be one unitary member. In an alternative embodiment, the disc **410** and projections **420** are constructed of different materials.

[0051] In operation, the input **210** of the manual intravenous pump **400** is connected to a first fluid line leading to a fluid bag, and the output **220** is connected to a fluid line leading to a subject. In one embodiment, both the input **210** and the output **220** are one-way valves. In one embodiment, when a fluid line is connected to the input **210**, fluid immediately begins to flow from the fluid bag, through the fluid line and input **210**, and into the internal fluid line **430**. In an alternative embodiment, fluid will not begin to flow until the input **210** is opened (e.g., by turning or pressing a valve).

[0052] In the illustrated embodiment, once the fluid lines have been connected to the fluid bag, the manual intravenous pump **400**, and the subject, and the fluid has begun to flow, an operator may turn the crank **240** of the manual intravenous pump **400** in a counterclockwise direction. As the crank **240** is turned in a counter-clockwise direction, the disc **410** and projections **420** rotate at a corresponding speed and act as a cam on the bulb **440**, compressing the bulb **440** and forcing the fluid towards the output **220**. Because the projections **420** are spaced apart, spacing allows the bulb **440** to inflate with fluid by negative pressure before the next projection **420** compresses the bulb **440**.

[0053] It should be understood that, although in the illustrated embodiment a counter-clockwise rotation of the crank **240** is required to force fluid towards the output **220**, the components may be re-oriented to require clockwise rotation. In either embodiment, rotation of the crank in a first direction will force fluid to move in a first direction, while rotation of the crank in the opposite direction will force fluid to move in an opposite direction. To prevent the crank from being rotated in an undesired direction, a ratchet and pawl (not shown) or other know stopping mechanism may be employed.

[0054] It should be understood that turning the crank **240** at a faster rate may increase the rate at which fluid flows through the output **220** and to a subject, while turning the crank **240** at a slower rate may decrease the rate at which fluid flows through the output **220** and to a subject. The operator may control the speed at which the crank **240** is turned, according to perceived need.

[0055] **Figure 5** illustrates an exploded perspective view of an alternative embodiment of a manual intravenous pump **500** having an actuator housing **505** and at least one reservoir housing **510**. The actuator housing **505** includes a manually operable member in the form of a crank **515** having a lever arm **520** and a handle **525**. The handle **525** may be fixedly or rotatably connected to the lever arm **520**. In an alternative embodiment (not shown), other known manually operable members may be employed in place of a crank.

[0056] In the illustrated embodiment, the lever arm **520** is operatively connected to a shaft **530** that turns a series of gears **535** mounted on a base **540**. While two gears are shown in the illustrated embodiment, it should be understood that three or more gears may be employed. Alternatively, gears may be omitted.

[0057] The series of gears **535** rotates a disc **545** having a plunger **550** pivotally attached thereto. The plunger is one example of a facilitating member configured to facilitate a flow of fluid through a reservoir. The plunger **550** is configured to operatively connect to a pump (not shown) in the reservoir housing **510**. The actuator housing **505** may further include a second disc and plunger (not shown) mounted on the opposite side of the base **540** and configured to operatively connect to a second pump (not shown) in the reservoir housing **510**.

[0058] In the illustrated embodiment, the gears **535** have a fixed gear ratio. In an alternative embodiment (not shown), a gear shift mechanism may be employed to vary the gear ratio. In such an embodiment, an operator may choose to shift gears to increase or decrease the flow of fluid.

[0059] The reservoir housing **510** may be configured to be removably attached to the actuator housing **505**. In such an embodiment, the reservoir housing **510** may be removed and replaced with a replacement reservoir housing (not shown). For example, the reservoir housing **510** may be replaced after each use for sterility or safety reasons, or to comply with FDA standards, hospital standards, or other standards. In such an embodiment, the reservoir housing **510** may be kept in sterile packaging prior to use. Additionally, the reservoir housing **510** may be filled with fluid prior to packaging, such that no priming is required when a new reservoir housing **510** is attached to the actuator housing **505**. In an alternative embodiment (not shown), the reservoir housing may be permanently attached to the actuator housing.

[0060] In the illustrated embodiment, the reservoir housing **510** includes a set of rails **555** on opposing sides, configured to slidably receive prongs **560** of the base **540** of the actuator housing **505**. The prongs **560** and the sides of the reservoir housing **510** have corresponding apertures **565** configured to receive fasteners **570**. In the illustrated embodiment, the fasteners **570** are shown as screws. However, it should be understood that any fasteners may be employed. Exemplary fasteners include bolts, pins, ties, and other known fasteners. In an alternative embodiment (not shown), the apertures and fasteners may be omitted. Instead, the reservoir housing **510** may be attached to the actuator housing **505** by a press fit, a snap fit, clamps, or other attachment means.

[0061] The actuator housing **510** includes two input lines (not shown) and two output lines **575**. The two input lines may be connected to a single input line (not shown) by a y-connector (not shown). Similarly, the two output lines **575** may be connected to a single output line (not shown) by a y-connector (not shown).

[0062] The internal components of two exemplary embodiments of reservoir housings **510** are shown in **Figures 6A**, **6B**, **7A**, and **7B**.

[0063] **Figures 6A** and **6B** illustrate cross-sections of one embodiment of a reservoir housing **600**. The reservoir housing **600** includes two fluid reservoirs defined by a first asymmetric diaphragm pump **610a** and a second asymmetric diaphragm pump **610b**. The first and second asymmetric diaphragm pumps **610a**,**b** are collapsible bellows or diaphragms that inflate and deflate with fluid. The first asymmetric diaphragm pump **610a** is connected to a first piston **620a**, a first input line **630a**, and a first output line **640b**. The second asymmetric diaphragm pump **610b** is connected to a second piston **620b**, a second input line **630b**, and a second output line **640b**.

[0064] In the illustrated embodiment, the first asymmetric diaphragm pump **610a** is out of phase with the second asymmetric diaphragm pump **610b**. When the first piston **620a** collapses the first asymmetric diaphragm pump **610a**, as shown in **Figure 6A**, fluid in the first asymmetric diaphragm pump **610a** is forced through the first output line **640a**. The second piston **620b** opens the second asymmetric diaphragm pump **610b** concurrently, and fluid flows through the second input line **630b** into the second asymmetric diaphragm pump **610b**. As the cycle continues, as shown in **Figure 6B**, the second piston **620b** collapses the second asymmetric diaphragm pump **610b**, forcing fluid out of the second diaphragm pump **610b** and through the second output line **640b**. The first piston **620a** opens the first asymmetric diaphragm pump **610a** concurrently, and fluid flows through the first input line **630a** into the first asymmetric diaphragm pump **610a**. Each of the first and second asymmetric diaphragm pumps **610a**,**b** may have check valves (not shown) associated therewith.

[0065] In one embodiment, fluid would flow through the asymmetric diaphragm pumps **610a**,**b** and the output lines **640a**,**b**, even when the pumps were not being actuated. In an alternative embodiment, fluid would only flow through the asymmetric diaphragm pumps **610a**,**b** upon actuation. In another alternative embodiment (not shown), the system includes a flow regulation mechanism (*i.e.*, a safety, or an on/off switch) that would allow an operator to prevent fluid from flowing through the output lines **640a**,**b**. Such a flow regulation mechanism may be located on the reservoir housing **600**.

[0066] In an alternative embodiment (not shown), the first and second asymmetric diaphragm pumps **610a**,**b** may operate in phase. In another alternative embodiment (not shown), the reservoir housing **600** includes a single asymmetric diaphragm pump. In yet another alternative embodiment (not shown), the reservoir housing **600** includes three or more asymmetric diaphragm pumps.

[0067] **Figures 7A** and **7B** illustrate cross-sections of another embodiment of a reservoir housing **700**. The reservoir housing **700** is substantially the same as the reservoir housing **700**, except that it includes two fluid reservoirs defined by a first symmetric diaphragm pump **710a** and a second symmetric diaphragm pump **710b**. The first and second symmetric diaphragm pumps **710a,b** are collapsible bellows or diaphragms that inflate and deflate with fluid. The first symmetric diaphragm pump **710a** is connected to a first piston **720a**, a first input line **730a**, and a first output line **740b**. The second symmetric diaphragm pump **710b** is connected to a second piston **720b**, a second input line **730b**, and a second output line **740b**.

[0068] In the illustrated embodiment, the first symmetric diaphragm pump **710a** is out of phase with the second symmetric diaphragm pump **710b**, and the pumps operate in the same manner as described in **Figures 7A** and **7B**. In an alternative embodiment (not shown), the first and second symmetric diaphragm pumps **710a,b** may operate in phase. In another alternative embodiment (not shown), the reservoir housing **700** includes a single symmetric diaphragm pump. In yet another alternative embodiment (not shown), the reservoir housing **700** includes three or more symmetric diaphragm pumps.

[0069] **Figure 8** illustrates a side view of an alternative embodiment of a manual intravenous pump **800** having an input **810**, an output **820**, and a body **830**. In this embodiment, the manually operable actuator is a trigger **840**. This type of manual intravenous pump may be referred to as a "trigger design," "trigger pump," or a "manual piston." The trigger **840** may be configured to pivot or slide transversely with respect to the body **830** of the manual intravenous pump **800**. In one embodiment, the trigger **840** is sized to accommodate a single finger of an operator. In an alternative embodiment, the trigger **840** is sized to accommodate two or more fingers of an operator.

[0070] With continued reference to **Figure 8**, the body **830** of the manual intravenous pump **800** bears resemblance to a pistol. However, it should be understood that this shape is merely exemplary, and any shape may be employed. In one embodiment, the body may have an ergonomic shape.

[0071] Although **Figure 8** is described as a side view, it should be understood that the manual intravenous pump **800** may be positioned in multiple orientations, so that the operator may position the device in a comfortable orientation for operation.

[0072] The manual intravenous pump **800** may be constructed of various materials. Exemplary materials include polymeric materials and metal materials. Exemplary metal materials include, without limitation, steel, nickel aluminum, copper, iron, and other metals and alloys. Exemplary polymeric materials include, without limitation, EPDM Rubber, polypropylene, polyethylene, and blends of the same. In one embodiment, where the manual intravenous pump is configured for field use (i.e., in an ambulance, or at an accident site), the device may be constructed of materials that are lightweight and durable. Of course, such materials may also be suitable for a device configured for clinical use. In one embodiment, the casing **830** and the trigger **840** are all constructed of substantially the same material. In an alternative embodiment, one or more of these components are constructed of different materials.

[0073] **Figure 9** is a side view of internal components of one embodiment of a manual intravenous pump **900**. The illustrated embodiment is one example of the internal components of the trigger design of a manual intravenous pump **800** shown in **Figure 8**.

[0074] In the illustrated embodiment, the trigger **840** is pivotally connected to a series of gears **910**, which are, in turn, connected to a disc **920** having a plurality of spaced apart, projections **930** extending therefrom. In the illustrated embodiment, two gears are shown. However, it should be understood that any number of gears may be employed. In an alternative embodiment (not shown), no gears are employed, and the trigger is instead directly connected to the disc.

[0075] The illustrated manual intravenous pump **900** further includes an internal fluid line **940** having a bulb **950** that defines an internal fluid reservoir. The internal fluid line **940** is in fluid communication with both the input **810** and the output **820** of the manual intravenous pump **900**. The disc **920** and projections **930** are positioned adjacent the bulb **950**, such that the projections **930** contact and deform the bulb **950** when the disc **920** is rotated. In the illustrated embodiment, the disc **920** includes three projections **930** extending therefrom. However, it should be understood that any number of projections may be employed, including a single projection.

[0076] In the illustrated embodiment, the bulb **950** abuts a platform to facilitate compression upon contact with a projection **930**. In an alternative embodiment (not shown), the bulb **950** may abut a wall of the manual pump **900**. In another alternative embodiment (not shown), the bulb does not abut any surfaces.

[0077] With continued reference to **Figure 9**, the bulb **950** is constructed of rubber, or another pliable, non-porous material. It should be understood, however, that various other materials may be employed. Further, various materials may be used to construct the disc **920** and projections **930**. Exemplary materials include polymeric materials and metal materials. In one embodiment, the disc **920** and projections **930** are constructed of substantially the same material. For example, the disc **920** and projections **930** may be one unitary member. In an alternative embodiment, the disc **920** and projections **930** are constructed of different materials.

[0078] In operation, the input **810** of the manual intravenous pump **900** is connected to a first fluid line leading to a fluid bag, and the output **820** is connected to a fluid line leading to a subject. In one embodiment, both the input **810** and the output **820** are one-way valves. In one embodiment, when a fluid line is connected to the input **810**, fluid immediately begins to flow from the fluid bag, through the fluid line and input **810**, and into the internal fluid line **940**. In an alternative embodiment, fluid will not begin to flow until the input **810** is opened (e.g., by turning or pressing a valve).

[0079] In the illustrated embodiment, once the fluid lines have been connected to the fluid bag, the manual intravenous pump **900**, and the subject, and the fluid has begun to flow, an operator may squeeze the trigger **840** of the manual intravenous pump **900**. As the trigger **840** is squeezed, gears **910** cause the disc **920** and projections **930** to rotate and act as a cam on the bulb **950**, compressing the bulb **950** and forcing the fluid towards the output **820**. Because the projections **930** are spaced apart, spacing allows the bulb **950** to inflate with fluid by negative pressure before the next projection **930** compresses the bulb **950**. When the trigger **840** is released, a ratcheting mechanism (not shown) or other such mechanism may be employed to prevent the disc **920** and projections **930** from moving in the reverse direction.

[0080] It should be understood that squeezing the trigger **840** at a faster rate may increase the rate at which fluid flows through the output **820** and to a subject, while squeezing the trigger **840** at a slower rate may decrease the rate at which fluid flows through the output **820** and to a subject. The operator may control the speed at which the trigger **840** is squeezed, according to perceived need.

[0081] **Figure 10** is a cutaway side view of internal components of one embodiment of a manual intravenous pump **700**. The illustrated embodiment is one example of the internal components of the trigger design of a manual intravenous pump **800** shown in **Figure 8**.

[0082] In the illustrated embodiment, the trigger **840** is pivotally connected to the casing **830** and is further connected to a piston **1010**. The piston **1010** is biased towards the trigger **840** by a biasing mechanism **1020**. In the illustrated embodiment, the biasing mechanism **1020** is shown as a spring. However, it should be understood that any known biasing mechanism may be employed. The piston **1010** and biasing mechanism **1020** are housed in a cylinder **1030** that is part of a larger fluid reservoir **1040**. The fluid reservoir is connected to the input **810** and output **820**. In the illustrated embodiment, both the input **810** and output **820** are one-way valves.

[0083] In operation, an operator squeezes the trigger **840**, which pushes the piston **1020** into the cylinder **1030**, compressing the biasing mechanism **1020**. When the piston **1020** is pushed into the cylinder **1030**, the volume of the fluid reservoir **1040** is reduced, forcing fluid through the output **820**. When the trigger is released, the biasing mechanism **1020** pushes the piston **1020** back out of the cylinder, expanding the volume of the fluid reservoir **1040** and drawing more fluid in through the input **810**. The one way valves of the input **810** and output **820** prevent the fluid from flowing in an undesired direction.

[0084] **Figure 11** is a side cutaway view of one embodiment of a manual intravenous pump **1100**. The illustrated embodiment is another example of the internal components of the trigger design of a manual intravenous pump **800** shown in **Figure 8**.

[0085] In the illustrated embodiment, the trigger **840** is connected to a series of gears **1110**, which are connected rod **1120** having a plurality of partitions **1130** extending therefrom. While two gears **1110** are illustrated, it should be understood that three or more gears may be employed. Alternative, the trigger **840** may be directly connected to the rod **1120** without the use of intervening gears.

[0086] With continued reference to **Figure 11**, the rod **1120** and partitions **1130** are positioned inside a cylinder **1140** that defines an internal fluid reservoir. The cylinder **1140** has a first opening **1150** in fluid communication with the input **810** of the manual intravenous pump **1100** and a second opening **1160** in fluid communication with the output **820** of the manual intravenous pump **1100**. The rod **1120** and partitions **1130** form a plurality of rotary chambers **1170** in the cylinder **1140**. In the illustrated embodiment, the rod **1120** includes three partitions **1130** extending therefrom, which form three rotary chambers **1170** in the cylinder **1140**. However, it should be understood that any number of partitions may be employed, including a single partition.

[0087] In addition to the components shown, various gear configurations may be employed to create a mechanical advantage and/or cause the rod **1120** and partitions **1130** to rotate at a rate different from the rate at which the trigger **840** is squeezed.

[0088] With continued reference to **Figure 11**, the partitions **1130** extend from the rod **1120** to an inner surface of the cylinder **1140**. In one embodiment, at least the ends of the partitions are constructed of rubber, or another pliable, non-porous material, to form a seal. It should be understood, however, that various other materials may be employed. In an alternative embodiment, the partitions **1130** do not extend to the inner surface of the cylinder **1140**.

[0089] Various materials may be used to construct the rod **1120,** partitions **1130**, and cylinder **1140**. Exemplary materials include polymeric materials and metal materials. In one embodiment, the rod **1120,** partitions **1130**, and cylinder **1140** are constructed of polymeric materials that resist corrosion after prolonged exposure to saline solutions and other commonly used intravenous fluids. In one embodiment, the rod **1120,** partitions **1130**, and cylinder **1140** are all constructed of substantially the same material. In an alternative embodiment, one or more of these components are constructed of different materials.

[0090] In operation, the input **810** of the manual intravenous pump **1100** is connected to a first fluid line leading to a fluid bag, and the output **820** is connected to a fluid line leading to a subject. In one embodiment, both the input **810** and the output **820** are one-way valves. In one embodiment, when a fluid line is connected to the input **810**, fluid immediately begins to flow from the fluid bag, through the fluid line and input **810**, and into the first of the plurality of chambers **1170**. In an alternative embodiment, fluid will not begin to flow until the input **810** is opened (e.g., by turning or pressing a valve).

[0091] Once the fluid lines have been connected to the fluid bag, the manual intravenous pump **1100**, and the subject, and the fluid has begun to flow, an operator may squeeze the trigger **840** of the manual intravenous pump **1100**. As the trigger **840** is squeezed, the partitions **1130** rotate at a corresponding speed and force the fluid from the first opening **1150** of the cylinder **1140** towards the second opening **1160**. Squeezing the trigger **840** at a faster rate may increase the rate at which fluid flows through the output **820** and to a subject, while squeezing the trigger **840** at a slower rate may decrease the rate at which fluid flows through the output **820** and to a subject. The operator may control the speed at which the trigger **840** is squeezed, according to perceived need.

[0092] In another alternative embodiment, the trigger pump may employ one or more spring motors to facilitate pumping. For example, **Figure 12** illustrates a perspective view of an exemplary twin spring motor **1200** which may be employed in a trigger pump. As another example, **Figure 13** illustrates a perspective view of an exemplary sextupled spring motor **1300** which may be employed in a trigger pump. In either example, the spring motor may be configured to coil and store energy when a trigger is depressed. When the trigger is released, the spring motor releases energy to compress a pump. In yet another embodiment, an electric motor may be employed to actuate the pumps.

[0093] In still another alternative embodiment (not shown), the trigger pump employs a separate reservoir housing, such as the reservoir housing **505** shown in **Figure 5**, reservoir housing **600** shown in **Figures 6A,B**, or reservoir housing **700** shown in **Figures 7A,B**. Such a reservoir housing may be removably attached to the device, such that the reservoir housing may be removed and replaced as desired.

[0094] **Figures 14** and **15** illustrate a perspective view and side view, respectively, of another alternative embodiment of a manual intravenous pump **1400** having an actuator housing **1405** and at least one reservoir housing **1410**. The actuator housing **1405** includes a manually operable member in the form of a pivotal handle **1415** that is pivotally connected to a stationary handle **1420**. Accordingly, this type of manual intravenous pump may be referred to as a “pivoting handle design” or “pivoting handled pump.” In this embodiment, the pump is actuated by pivoting the pivotal handle **1415**

towards the stationary handle **1420**. In an alternative embodiment (not shown), the actuator housing may include two pivotal handles.

[0095] The reservoir housing **1410** may be configured to be removably attached to the actuator housing **1405**. In such an embodiment, the reservoir housing **1410** may be removed and replaced with a replacement reservoir housing (not shown). For example, the reservoir housing **1410** may be replaced after each use for sterility or safety reasons, or to comply with FDA standards, hospital standards, or other standards. In such an embodiment, the reservoir housing **1410** may be kept in sterile packaging prior to use. Additionally, the reservoir housing **1410** may be filled with fluid prior to packaging, such that no priming is required when a new reservoir housing **1410** is attached to the actuator housing **1405**. In an alternative embodiment (not shown), the reservoir housing may be permanently attached to the actuator housing.

[0096] **Figure 16** illustrates an exploded perspective view of the actuator housing **1405** pivoting handled pump **1400**. In the illustrated embodiment, the actuator housing includes a first actuator housing **1405a** that is fastened to a second actuator housing **1405b** by a plurality of fasteners. In addition to housing the pivotal handle **1415** and the stationary handle **1420**, the actuator housing additionally houses a first gear **1425** having teeth configured to engage corresponding teeth of the pivotal handle **1415**. The teeth of the first gear **1425** are further configured to engage teeth of a second gear **1430**, which rotates about an axis of a spring loaded gear box **1435**. The spring loaded gear box **1435** is configured to store and release energy, using springs such as those shown in **Figures 12** and **13**. While the illustrated embodiment shows two gears **1425**, **1430**, it should be understood that a single gear may be employed. In an alternative embodiment (not shown), three or more gears may be employed.

[0097] **Figure 17** illustrates a cross-section of the actuator housing **1405**, and further shows the pivotal handle **1415** engaging the first gear **1425**, which, in turn, engages the second gear **1430**. The pivotal handle **1415** is connected to a biasing member, such as a spring, that biases the pivotal handle **1415** away from the stationary handle **1420**. In one embodiment, the pivotal handle **1415** is configured such that its teeth engage the teeth of the first gear **1425** when the pivotal handle **1415** is pivoted towards the stationary handle **1420**, but the teeth disengage when the pivotal handle **1415** pivots away from the stationary handle **1420**. In this embodiment, a large amount of energy may be stored at one time, which may then be released by the spring loaded gear box. In an alternative embodiment, the teeth of the pivotal handle **1415** remain engaged with the teeth of the first gear **1425** when the pivotal handle pivots away from the stationary handle **1420**.

[0098] **Figure 18** illustrates a cross section of the reservoir housing **1410**. In the illustrated embodiment, the reservoir housing has substantially the same components as the reservoir housing **700**, including first and second symmetric diaphragm pumps **1440a**,**b** connected to first and second input lines **1445a**,**b** and first and second output lines **1450a**,**b**. In the illustrated embodiment, the first and second symmetric diaphragm pumps **1440a**,**b** operate out of phase with respect to each other. In an alternative embodiment (not shown), the first and second symmetric diaphragm pumps **1440a**,**b** operate in phase with respect to each other. In another alternative embodiment (not shown), asymmetric diaphragm pumps may be employed.

[0099] **Figure 19** illustrates a cut away view of an alternative embodiment of a pump **1900** for use in a manual intravenous pump. The pump **1900** is an axial flow pump having an outer housing **1910** and a bladed rotor **1920**, and may be employed with any embodiment of a manual intravenous pump described herein. The pump **1900** may be employed as a single pump, or in combination with one more additional pumps.

[0100] In the illustrated embodiment, the outer housing **1910** has a first a projection **1930** along a first axis and the rotor has a second projection **1940**. The second projection **1940** may be located on the first axis, or it may be located along a second axis different from the first axis. The bladed rotor **1920** is disposed in the outer housing **1910** in a manner providing clearance between an outer surface of the bladed rotor **1920** and an inner surface of the outer housing **1910**. This clearance defines one or more flow channels **1950** for a fluid.

[0101] The bladed rotor **1920** further includes at least one hydrodynamic bearing. In the illustrated embodiment, the rotor includes a first hydrodynamic bearing **1960** and a second hydrodynamic bearing **1970**. The first and second hydrodynamic bearings **1960**, **1970** are larger and wider than the area between blades where fluid flows. In an alternative embodiment (not shown), the first and second hydrodynamic bearings **1960**, **1970** are narrower than the area between blades where fluid flows.

[0102] The bladed rotor **1920** is configured to rotate within the outer housing **1910**, thereby facilitating a flow of fluid. The bladed rotor **1920** may be rotated by activation of a manual actuator or with the use of magnets or electronics.

[0103] To the extent that the term “includes” or “including” is used in the specification or the claims, it is intended to be inclusive in a manner similar to the term "comprising" as that term is interpreted when employed as a transitional word in a claim. Furthermore, to the extent that the term "or" is employed (e.g., A or B) it is intended to mean "A or B or both." When the applicants intend to indicate "only A or B but not both" then the term "only A or B but not both" will be employed. Thus, use of the term "or" herein is the inclusive, and not the exclusive use. See, Bryan A. Garner, A Dictionary of Modern Legal Usage 624 (2d. Ed. 1995). Also, to the extent that the terms "in" or "into" are used in the specification or the claims, it is intended to additionally mean "on" or "onto." Furthermore, to the extent the term "connect" is used in the specification or claims, it is intended to mean not only "directly connected to," but also "indirectly connected to" such as connected through another component or components.

[0104] While the present application has been illustrated by the description of embodiments thereof, and while the embodiments have been described in considerable detail, it is not the intention of the applicants to restrict or in any way limit the scope of the appended claims to such detail. Additional advantages and modifications will readily appear to those skilled in the art. Therefore, the application, in its broader aspects, is not limited to the specific details, the representative apparatus and method, and illustrative examples shown and described. Accordingly, departures may be made from such details without departing from the spirit or scope of the applicant's general inventive concept.

CLAIMS

What is claimed is:

1. A manual intravenous pump (100, 500, 1400) comprising:

an actuator housing (505, 1405) including a manually operable member (515, 1415) operatively connected to at least one facilitating member (550, 1435); and

a reservoir housing (510, 600, 700, 1410) removably attached to the actuator housing (505, 1405), wherein the reservoir (510, 1410) housing includes:

at least one fluid input line (630a,b, 730a,b, 1430a,b);

at least one fluid reservoir (610a,b, 710a,b, 1440a,b) operatively connected to the at least one fluid input line (610a,b, 710a,b, 1440a,b); and

at least one fluid output line (640a,b, 740a,b, 1450a,b) operatively connected to the at least one fluid reservoir (610a,b, 710a,b, 1440a,b),

wherein the at least one facilitating member (550, 620a,b, 720a,b, 1435) is configured to facilitate flow of a fluid through the at least one fluid reservoir (610a,b, 710a,b, 1440a,b) upon actuation of the manually operable member (515, 1415).

2. The manual intravenous pump (100, 500, 1400) of claim 1, wherein the at least one fluid input line (630a,b, 730a,b, 1430a,b) includes a first fluid input line (630a, 730a, 1430a) and a second fluid input line (630b, 730b, 1430b), the at least one fluid reservoir (610a,b, 710a,b, 1440a,b) includes a first fluid reservoir (610a, 710a, 1440a) and a second fluid reservoir (610b, 710b, 1440b), the at least one fluid output line (640a,b, 740a,b, 1450a,b) includes a first fluid output line (640a, 740a, 1450a) and a second fluid output

line (640b, 740b, 1450b), and the at least one facilitating member (550, 620a,b, 720a,b, 1435) includes a first facilitating member (620a, 720a) and a second facilitating member (620b, 720b), wherein the first facilitating member (620a, 720a) is configured to facilitate flow of a fluid through the first reservoir (610a, 710a, 1440a) and the second facilitating member (620a, 720a) is configured to facilitate flow of a fluid through the second reservoir (610b, 710b, 1440b).

3. The manual intravenous pump (100, 500, 1400) of claim 3, wherein the first facilitating member (620a, 720a) is configured to operate out of phase with the second facilitating member (620b, 720b).

4. The manual intravenous pump (100, 500, 1400) of claim 3, wherein the first facilitating member (620a, 720a) is configured to operate in phase with the second facilitating member (620b, 720b).

5. The manual intravenous pump (100, 500, 1400) of claim 1, wherein the at least one reservoir (610a,b, 710a,b, 1440a,b) is an asymmetric diaphragm pump (610a,b).

6. The manual intravenous pump (100, 500, 1400) of claim 1, wherein the at least one reservoir (610a,b, 710a,b, 1440a,b) is a symmetric diaphragm pump (710a,b, 1440a,b).

7. The manual intravenous pump (100, 500, 1400) of claim 1, wherein the manually operable (515, 1415) member is a crank (515).

8. The manual intravenous pump (100, 500, 1400) of claim 1, wherein the manually operable member (515, 1415) is a trigger.

9. The manual intravenous pump (100, 500, 1400) of claim 1, wherein the manually operable member (515, 1415) includes at least one pivoting handle (1415).

10. A manually operable device (100, 200, 300, 400, 500, 800, 900, 1000, 1100, 1400) comprising:

an input line (L_1, 630a,b, 730a,b, 1430a,b);

a fluid reservoir (330, 440, 610a,b, 710a,b, 950, 1040, 1140, 1440a,b) operatively connected to the input line (L_1, 630a,b, 730a,b, 1430a,b);

an output line (L_2, 640a,b, 740a,b, 1450a,b) operatively connected to the fluid reservoir (330, 440, 610a,b, 710a,b, 950, 1040, 1140, 1440a,b); and

a manually operable actuator (240, 515, 840, 1415), configured to facilitate the flow of fluid from the input line (L_1, 630a,b, 730a,b, 1430a,b), through the fluid reservoir (330, 440, 610a,b, 710a,b, 950, 1040, 1140, 1440a,b), and to the output line (L_2, 640a,b, 740a,b, 1450a,b).

11. The manually operable device (100, 200, 300, 400, 500, 800, 900, 1000, 1100, 1400) of claim 10, wherein the manually operable actuator (240, 515, 840, 1415) is a crank (240, 515).

12. The manually operable device (100, 200, 300, 400, 500, 800, 900, 1000, 1100, 1400) of claim 10, wherein the manually operable actuator (240, 515, 840, 1415) is a trigger (840).

13. The manually operable device (100, 200, 300, 400, 500, 800, 900, 1000, 1100, 1400) of claim 10, wherein the manually operable actuator (240, 515, 840, 1415) includes at least one pivoting handle (1415).

14. The manually operable device (100, 200, 300, 400, 500, 800, 900, 1000, 1100, 1400) of claim 10, further comprising a reservoir housing (510, 600, 700, 1410) configured to house the fluid reservoir (610a,b, 710a,b, 1440a,b).

15. The manually operable device (100, 200, 300, 400, 500, 800, 900, 1000, 1100, 1400) of claim 14, further comprising an actuator housing (505, 1405) configured to house the manually operable actuator (515, 1415), wherein the reservoir housing (510, 600, 700, 1410) is removably attached to the actuator housing (505, 1405).

16. The manually operable device (100, 200, 300, 400, 500, 800, 900, 1000, 1100, 1400) of claim 10, wherein the fluid reservoir (330, 440, 610a,b, 710a,b, 950, 1040, 1140, 1440a,b) is a diaphragm pump (610a,b, 710a,b, 1440a,b).

17. The manually operable device (100, 200, 300, 400, 500, 800, 900, 1000, 1100, 1400) of claim 10, wherein the fluid reservoir (330, 440, 610a,b, 710a,b, 950, 1040, 1140, 1440a,b) is defined by a cylinder (330, 1140).

18. The manually operable device (100, 200, 300, 400, 500, 800, 900, 1000, 1100, 1400) of claim 10, wherein the fluid reservoir (330, 440, 610a,b, 710a,b, 950, 1040, 1140, 1440a,b) is defined by a bulb (440, 950).

19. An intravenous fluid pumping kit comprising:

a fluid bag (B);

a fluid line (L_1, L_2); and

a pump (100, 200, 300, 400, 500, 800, 900, 1000, 1100, 1400) including:

a housing (230, 505, 510, 600, 700, 830, 1405, 1410);

a fluid reservoir (330, 440, 610a,b, 710a,b, 950, 1040, 1140, 1440a,b) having a fluid input (L_1, 630a,b, 730a,b, 1430a,b) and a fluid output (L_2, 640a,b, 740a,b, 1450a,b); and

means (240, 515, 840, 1415) for facilitating flow of fluid through the fluid reservoir from the fluid input (L_1, 630a,b, 730a,b, 1430a,b) to the fluid output (L_2, 640a,b, 740a,b, 1450a,b).

20. The intravenous fluid pumping kit of claim 18, wherein the pump housing (230, 505, 510, 600, 700, 830, 1405, 1410) includes a first housing (505, 1405) and a second housing (510, 600, 700, 1410).

AMENDED CLAIMS
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1. A manual intravenous pump (100, 500, 1400) comprising:

an actuator housing (505, 1405) including a manually operable member (515, 1415) operatively connected to at least one facilitating member (550, 1435); and

a reservoir housing (510, 600, 700, 1410) removably attached to the actuator housing (505, 1405), wherein the reservoir (510. 1410) housing includes:

at least one fluid input line (630a,b, 730a,b, 1430a,b), having a first end and a second end, the first end configured to be operatively connected to a fluid source (B);

at least one fluid reservoir (610a,b, 710a,b, 1440a,b) operatively connected to the second end of the at least one fluid input line (610a,b, 710a,b, 1440a,b); and

at least one fluid output line (640a,b, 740a,b, 1450a,b) operatively connected to the at least one fluid reservoir (610a,b, 710a,b, 1440a,b),

wherein the at least one facilitating member (550, 620a,b, 720a,b, 1435) is configured to facilitate flow of a fluid through the at least one fluid reservoir (610a,b, 710a,b, 1440a,b) during manual actuation of the manually operable member (515, 1415) and is further configured to cease facilitating flow of a fluid through the at least one fluid reservoir (610a,b, 710a,b, 1440a,b) substantially upon cessation of manual actuation of the manually operable member (515. 1415).

2. The manual intravenous pump (100, 500, 1400) of claim 1, wherein the at least one fluid input line (630a,b, 730a,b, 1430a,b) includes a first fluid input line (630a, 730a, 1430a) and a second fluid input line (630b, 730b, 1430b), the at least one fluid reservoir (610a,b, 710a,b, 1440a,b) includes a first fluid reservoir (610a, 710a, 1440a) and a second fluid reservoir (610b, 710b, 1440b), the at least one fluid output line (640a,b, 740a,b, 1450a,b) includes a first fluid output line (640a, 740a, 1450a) and a second fluid output line (640b, 740b, 1450b), and the at least one facilitating member (550, 620a,b, 720a,b, 1435) includes a first facilitating member (620a, 720a) and a second facilitating member (620b, 720b), wherein the first facilitating member (620a, 720a) is configured to facilitate flow of a fluid through the first reservoir (610a, 710a, 1440a) and the second facilitating member (620a, 720a) is configured to facilitate flow of a fluid through the second reservoir (610b, 710b, 1440b).

3. The manual intravenous pump (100, 500, 1400) of claim 2, wherein the first facilitating member (620a, 720a) is configured to operate out of phase with the second facilitating member (620b, 720b).

4. The manual intravenous pump (100. 500, 1400) of claim 3. wherein the first facilitating member (620a, 720a) is configured to operate in phase with the second facilitating member (620b, 720b).

5. The manual intravenous pump (100, 500, 1400) of claim 1, wherein the at least one reservoir (610a,b, 710a,b, 1440a,b) is an asymmetric diaphragm pump (610a,b).

6. The manual intravenous pump (100, 500, 1400) of claim 1, wherein the at least one reservoir (610a,b, 710a,b, 1440a,b) is a symmetric diaphragm pump (710a,b, 1440a,b).

7. The manual intravenous pump (100, 500, 1400) of claim 1, wherein the manually operable (515, 1415) member is a crank (515).

8. The manual intravenous pump (100, 500, 1400) of claim 1, wherein the manually operable member (515, 1415) is a trigger.

9. The manual intravenous pump (100, 500, 1400) of claim 1, wherein the manually operable member (515, 1415) includes at least one pivoting handle (1415).

10. A manually operable device (100, 200, 300, 400, 500, 800, 900, 1000, 1100, 1400) comprising:

an input line (L_1, 630a,b, 730a,b, 1430a,b) operatively connected to a fluid source (B);

a fluid reservoir (330, 440, 610a,b, 710a,b, 950, 1040, 1140, 1440a,b) operatively connected to the input line (L_1, 630a,b, 730a,b, 1430a,b);

an output line (L_2, 640a,b, 740a,b, 1450a,b) operatively connected to the fluid reservoir (330, 440, 610a,b, 710a,b, 950, 1040, 1140, 1440a,b); and a manually operable actuator (240, 515, 840, 1415), configured to facilitate a flow of fluid from the input line (L_1, 630a.b, 730a,b, 1430a,b), through the fluid reservoir (330, 440, 610a,b, 710a,b, 950, 1040, 1140, 1440a,b), and to the output line (L_2, 640a,b, 740a.b, 1450a,b) during manual operation of the manually operable actuator (240, 515, 840, 1415), and further configured to cease facilitation of the flow of fluid from the input line (L_1, 630a,b, 730a,b, 1430a.b), through the fluid reservoir (330, 440, 610a,b, 710a,b, 950, 1040, 1140, 1440a,b), and to the output line (L_2, 640a,b, 740a,b, 1450a,b) substantially upon cessation of the manual operation of the manually operable actuator (240, 515, 840, 1415).

11. The manually operable device (100, 200, 300, 400, 500, 800, 900, 1000, 1100, 1400) of claim 10, wherein the manually operable actuator (240, 515, 840, 1415) is a crank (240, 515).

12. The manually operable device (100, 200, 300, 400, 500, 800, 900, 1000, 1100, 1400) of claim 10, wherein the manually operable actuator (240, 515, 840, 1415) is a trigger (840).

13. The manually operable device (100, 200, 300, 400, 500, 800, 900, 1000, 1100, 1400) of claim 10, wherein the manually operable actuator (240, 515, 840, 1415) includes at least one pivoting handle (1415).

14. The manually operable device (100, 200, 300, 400, 500, 800, 900, 1000, 1100, 1400) of claim 10, further comprising a reservoir housing (510, 600, 700, 1410) configured to house the fluid reservoir (610a,b, 710a,b, 1440a,b).

15. The manually operable device (100, 200, 300, 400, 500, 800, 900, 1000, 1100, 1400) of claim 14, further comprising an actuator housing (505, 1405) configured to house the manually operable actuator (515, 1415), wherein the reservoir housing (510, 600, 700, 1410) is removably attached to the actuator housing (505, 1405).

16. The manually operable device (100, 200, 300, 400, 500, 800, 900, 1000, 1100, 1400) of claim 10, wherein the fluid reservoir (330, 440, 610a,b, 710a,b, 950, 1040, 1140, 1440a,b) is a diaphragm pump (610a,b, 710a,b, 1440a,b).

17. The manually operable device (100, 200, 300, 400, 500, 800, 900, 1000, 1100, 1400) of claim 10, wherein the fluid reservoir (330, 440, 610a,b, 710a,b, 950, 1040, 1140, 1440a,b) is defined by a cylinder (330, 1140).

18. The manually operable device (100, 200, 300, 400, 500, 800, 900, 1000, 1100, 1400) of claim 10, wherein the fluid reservoir (330, 440, 610a,b, 710a,b, 950, 1040, 1140, 1440a,b) is defined by a bulb (440, 950).

19. An intravenous fluid pumping kit comprising:

a fluid bag (B);

a fluid line (L_1, L_2); and

a pump (100, 200, 300, 400, 500, 800, 900, 1000. 1100, 1400) including:

a housing (230, 505, 510, 600, 700, 830, 1405, 1410);

a fluid reservoir (330, 440, 610a,b, 710a,b, 950, 1040, 1140, 1440a,b) having a fluid input (L_1, 630a,b, 730a,b, 1430a,b) and a fluid output (L_2, 640a,b, 740a,b, 1450a,b); and

means (240, 515, 840, 1415) for facilitating flow of fluid through the fluid reservoir (330, 440, 610a,b, 710a,b. 950, 1040, 1140, 1440a,b) from the fluid bag (B), through the fluid input (L_1, 630a,b, 730a,b, 1430a,b), and to the fluid output (L_2, 640a,b, 740a,b, 1450a,b).

20. The intravenous fluid pumping kit of claim 19, wherein the pump housing (230. 505, 510, 600, 700, 830, 1405, 1410) includes a first housing (505, 1405) and a second housing (510, 600, 700, 1410).

Applicant has amended claims 1, 3, 10, 19, and 20 of the present application for purposes of clarification. Support for the amendment is provided in the specification and in the drawings. The amendment to claims 1, 3, 10, 19, and 20 have no impact on the description and the drawings since they are fully supported by the description and the drawings.

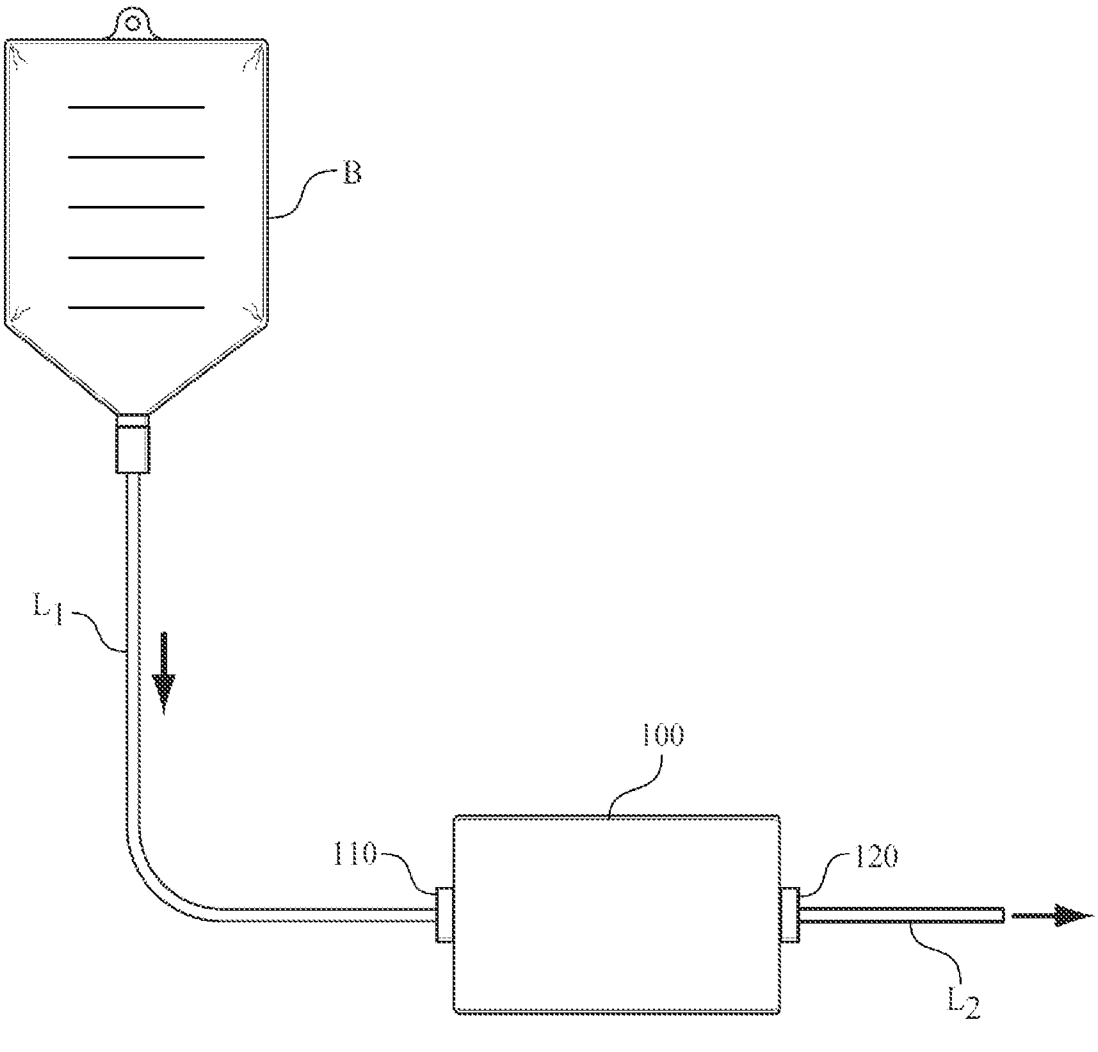

Fig. 1

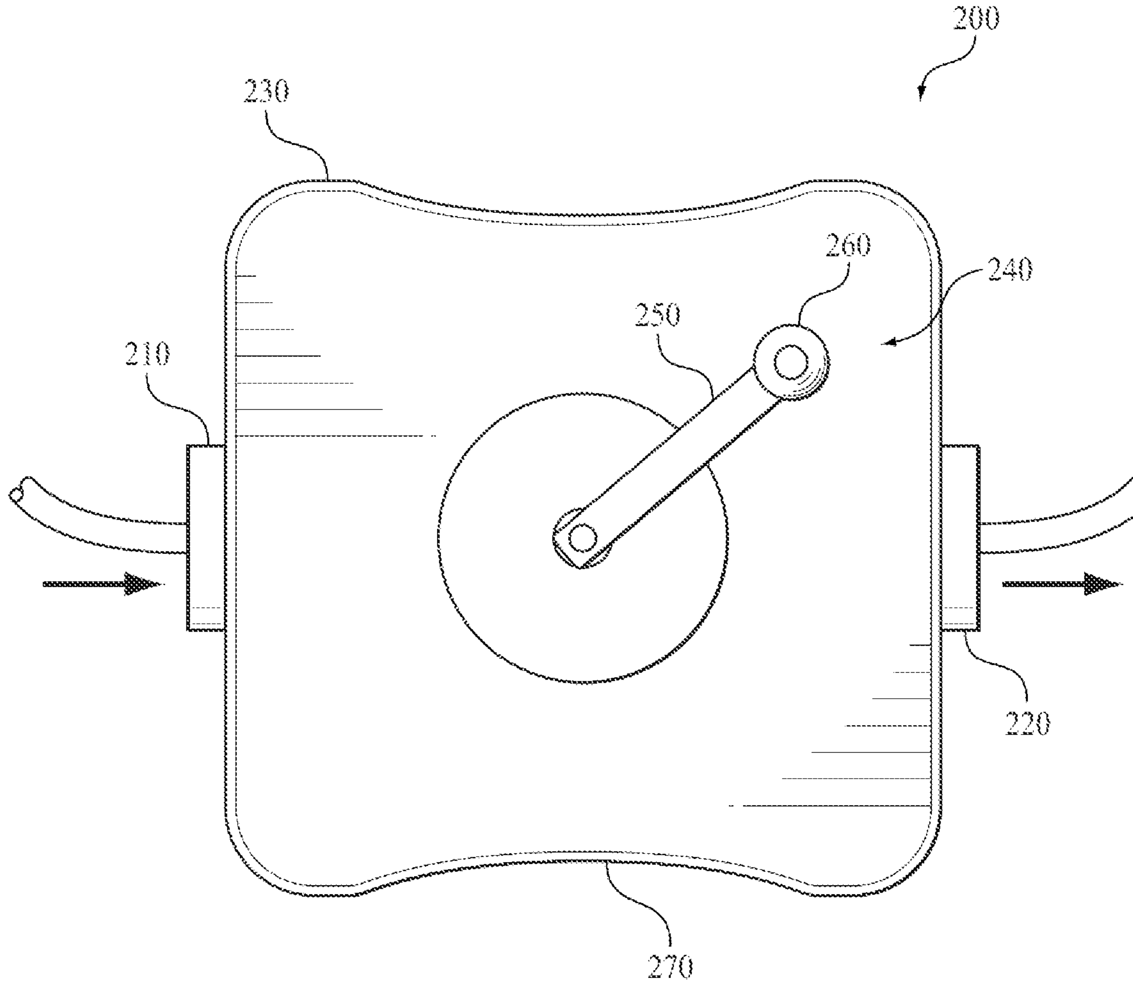

Fig. 2

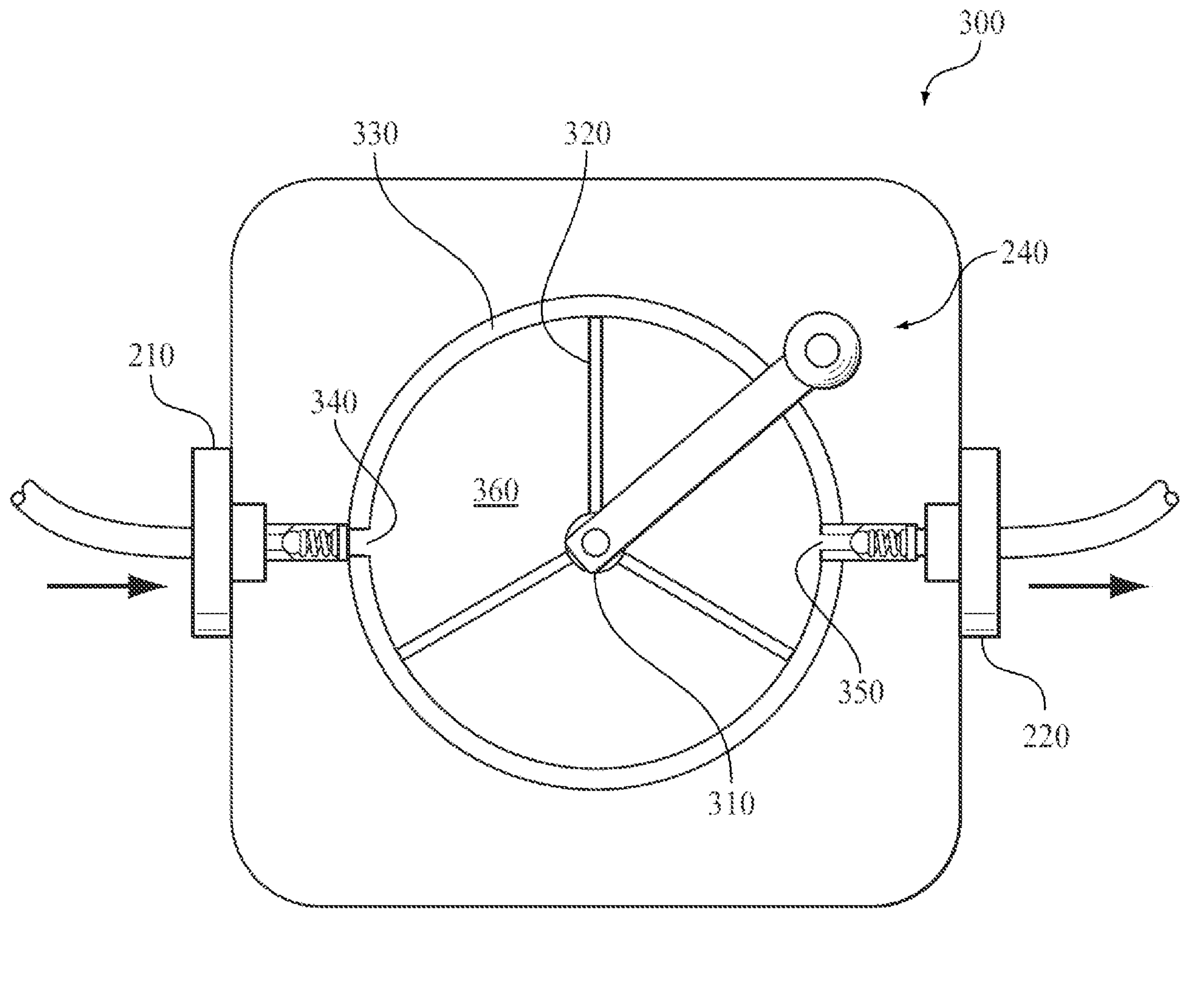

Fig. 3

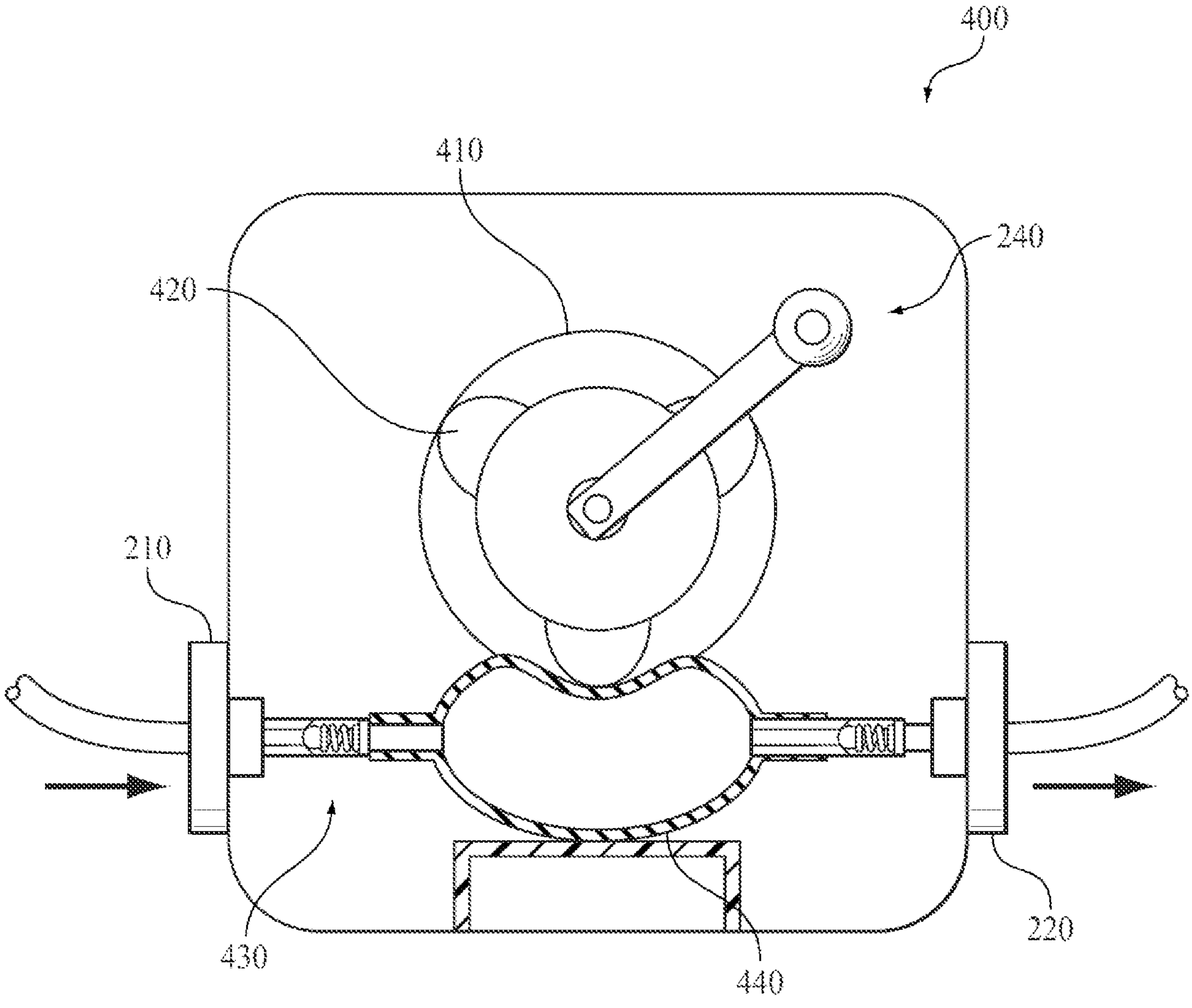

Fig. 4

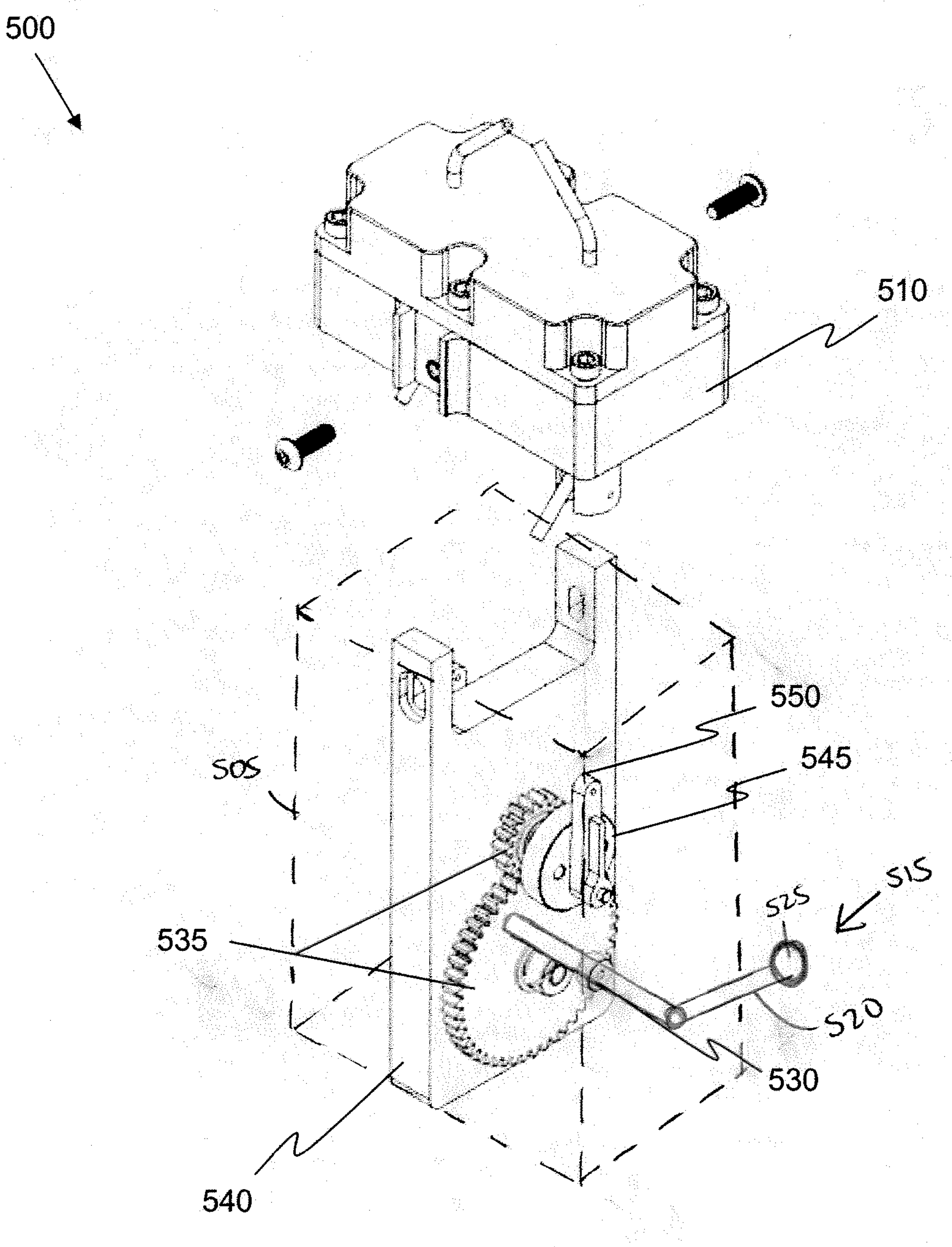

Fig. 5

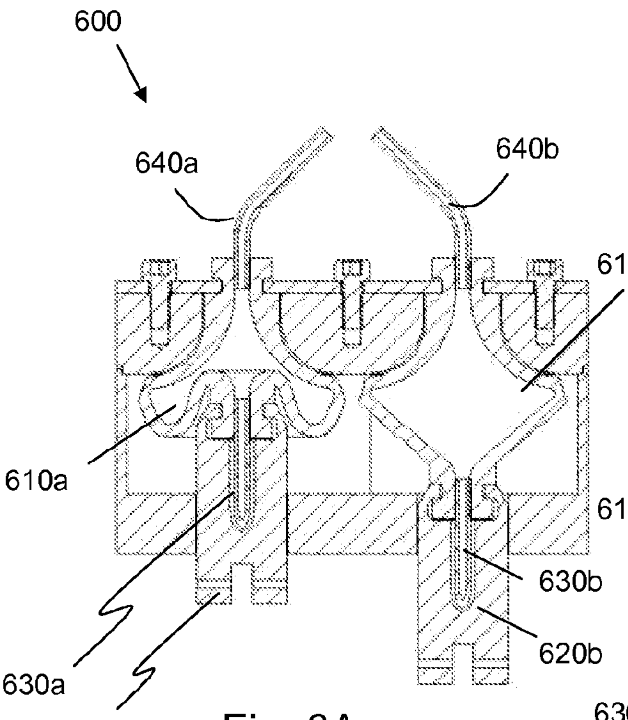

Fig. 6A

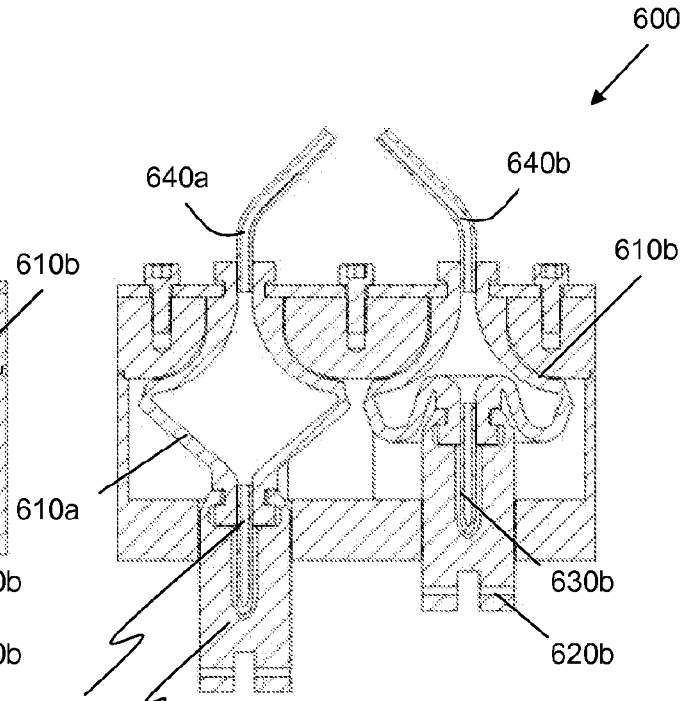

Fig. 6B

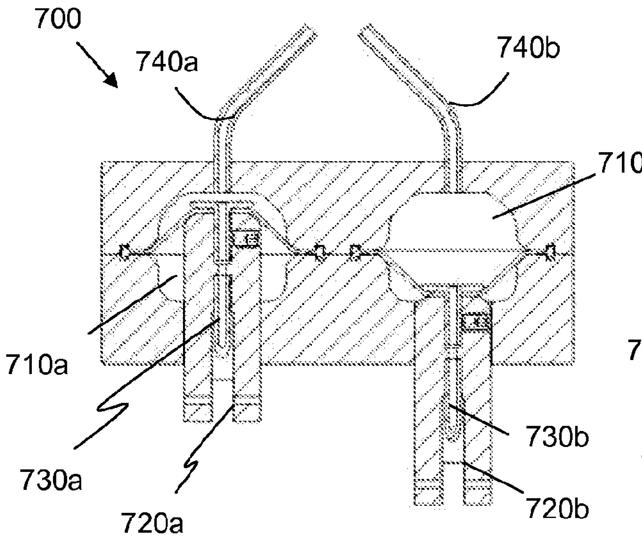

Fig. 7A

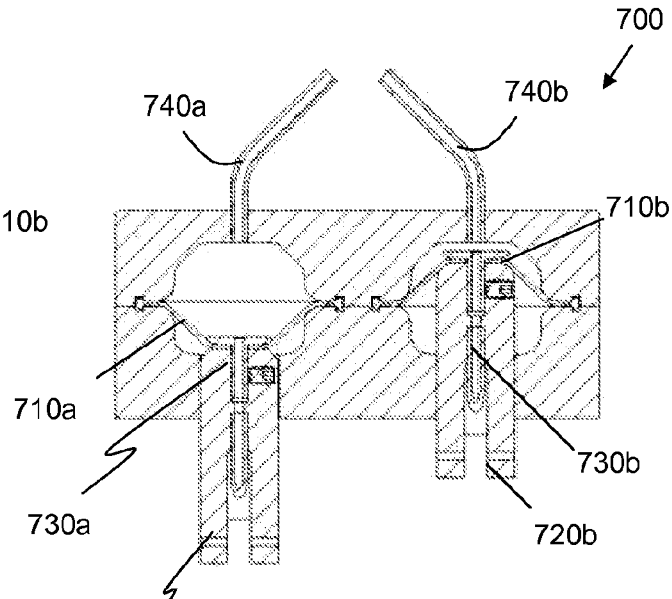

Fig. 7B

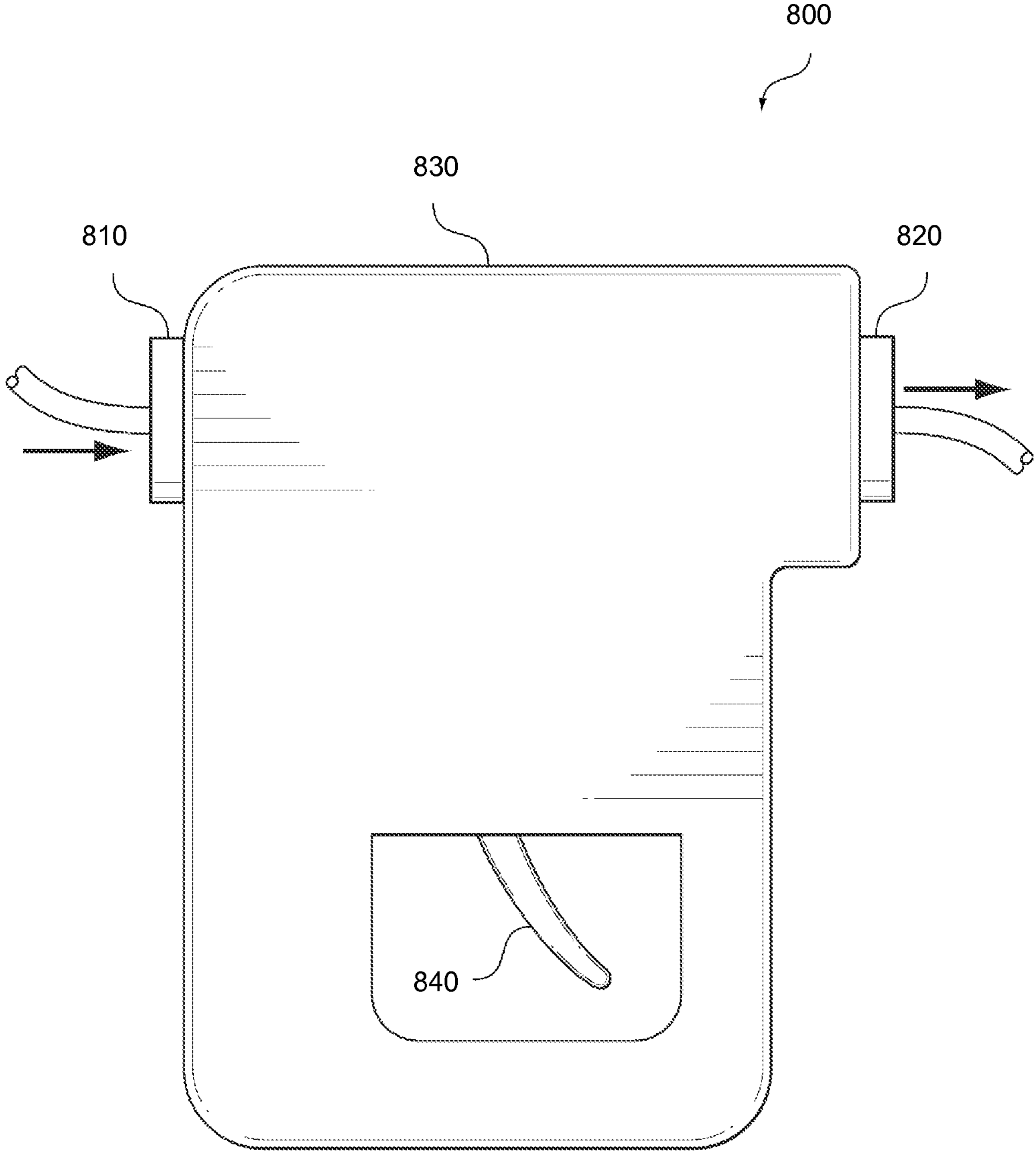

Fig. 8

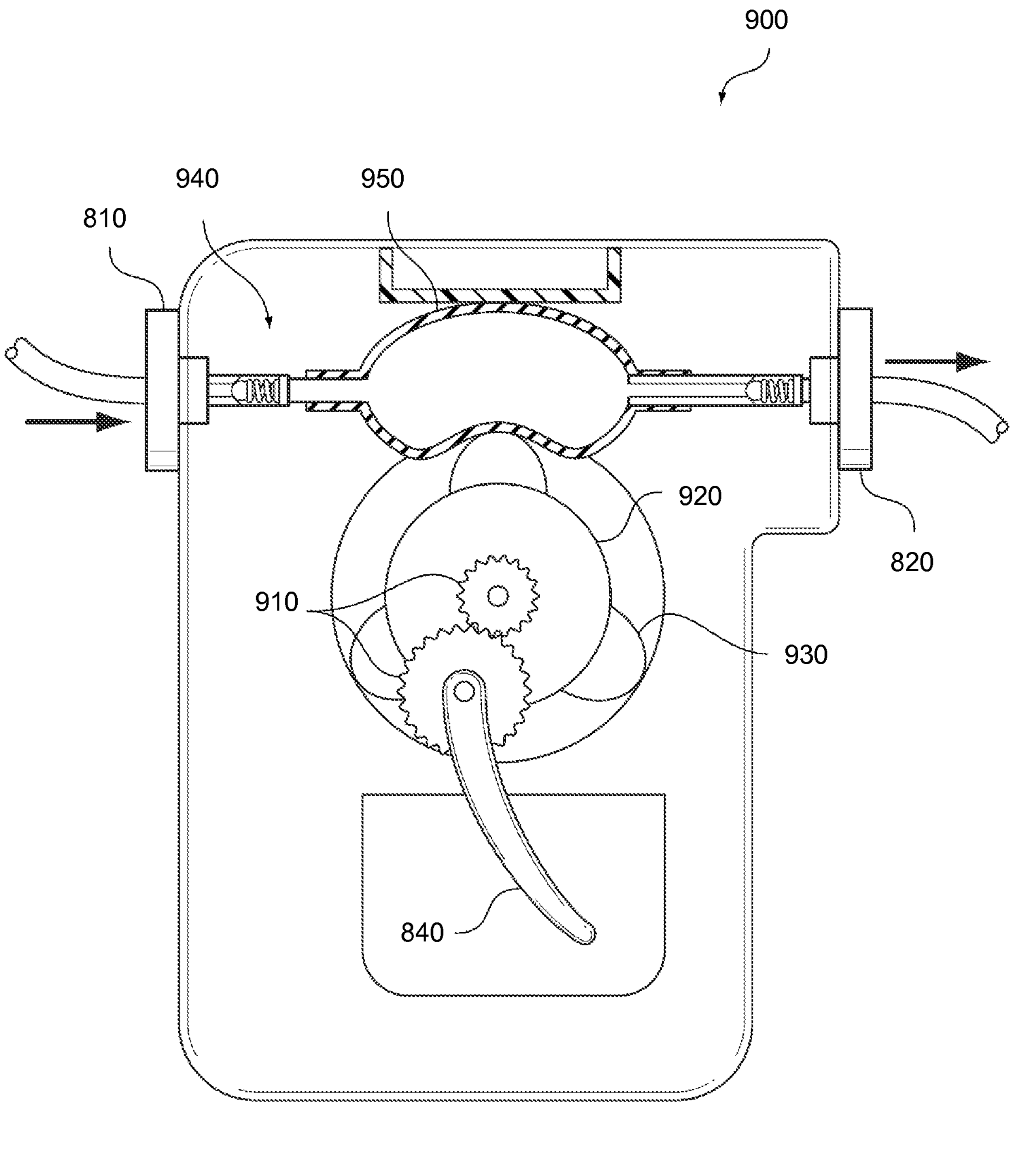

Fig. 9

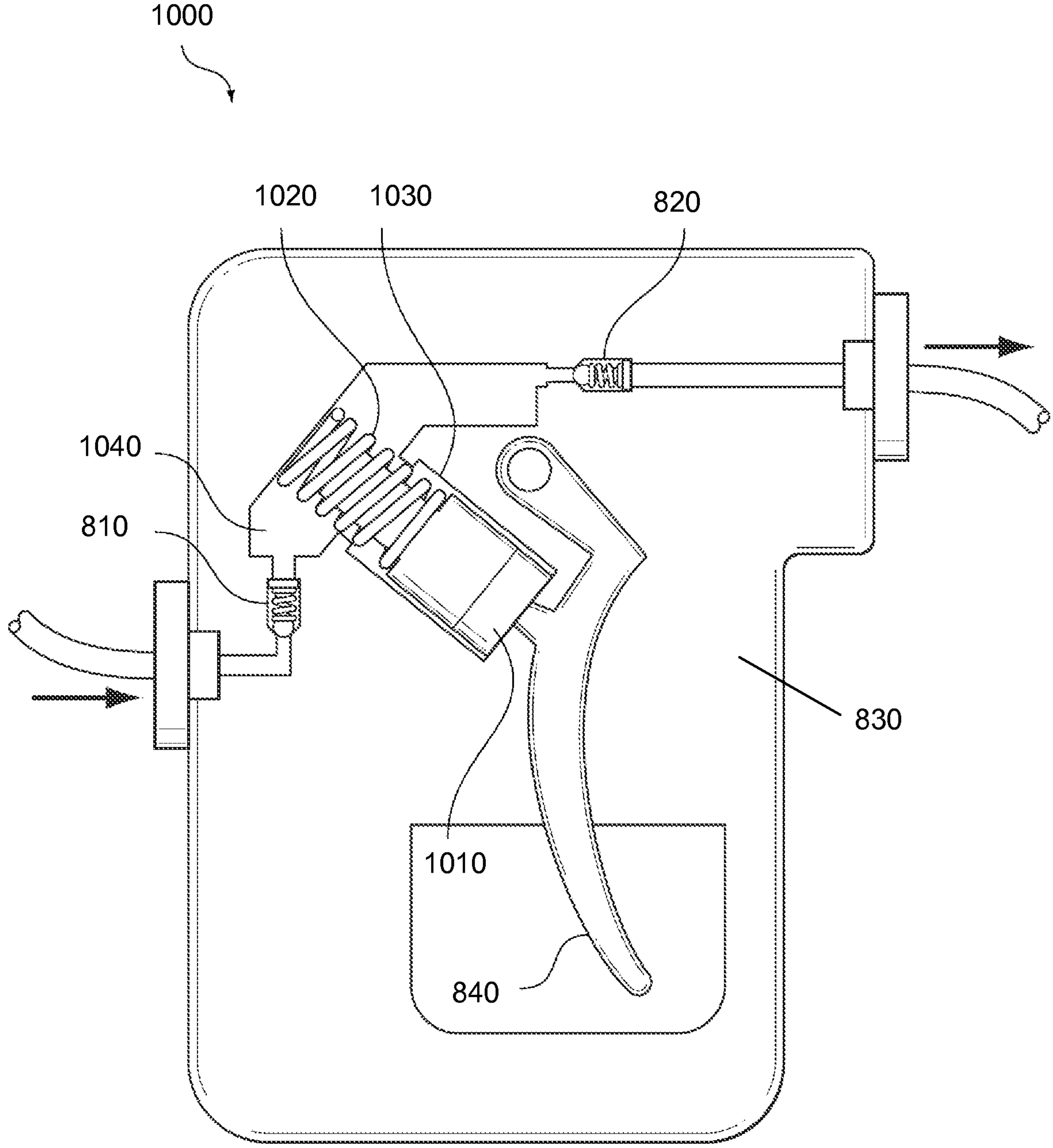

Fig. 10

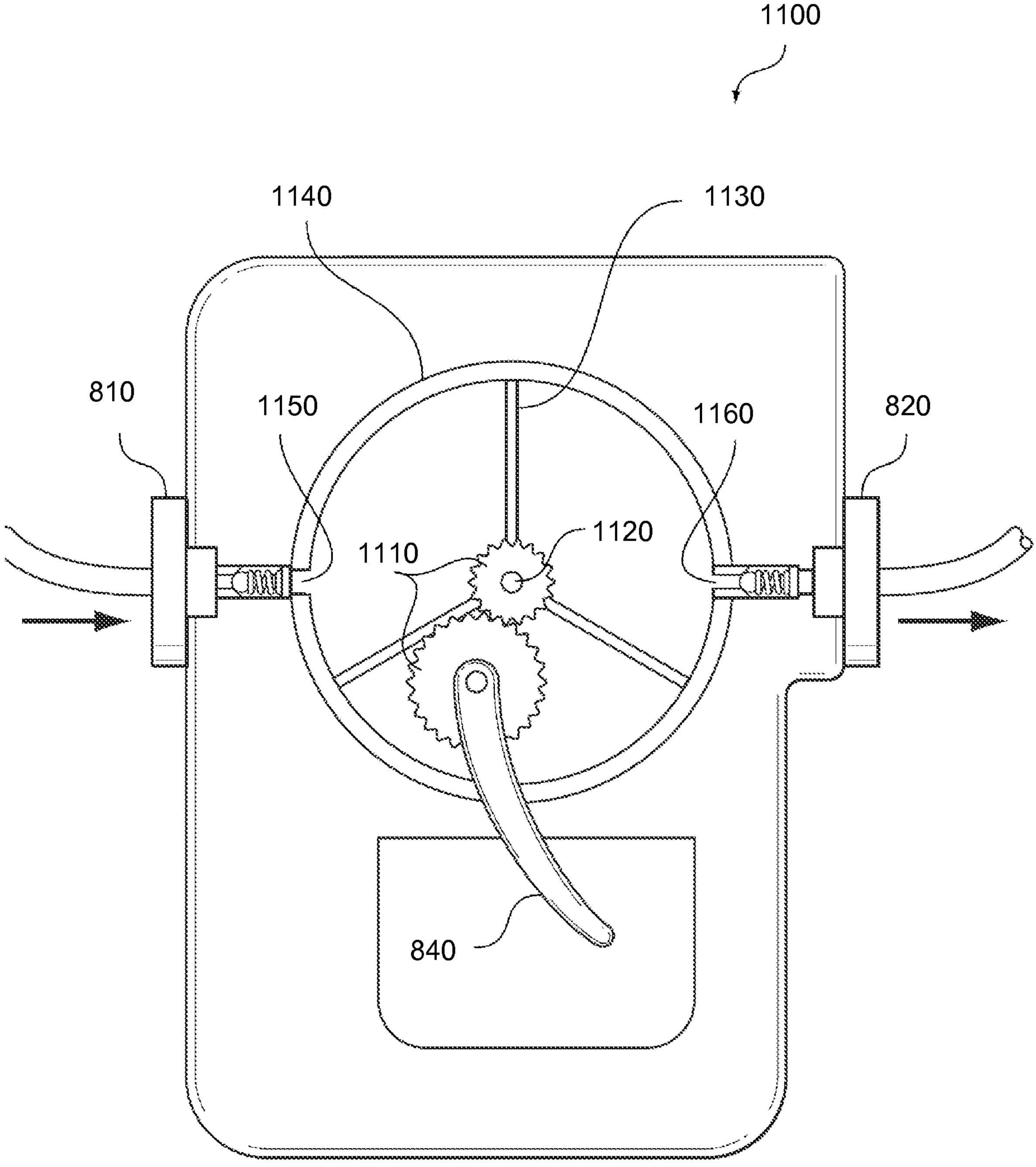

Fig. 11

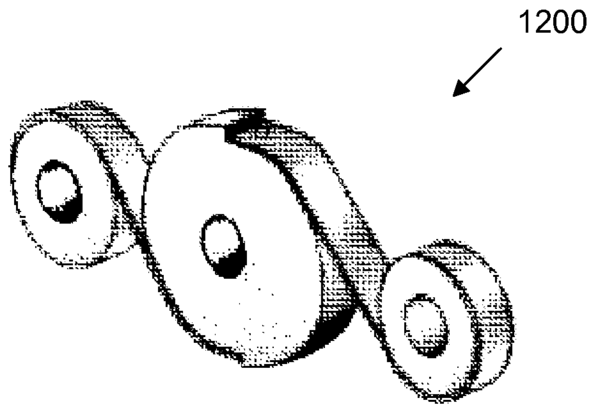

Fig. 12

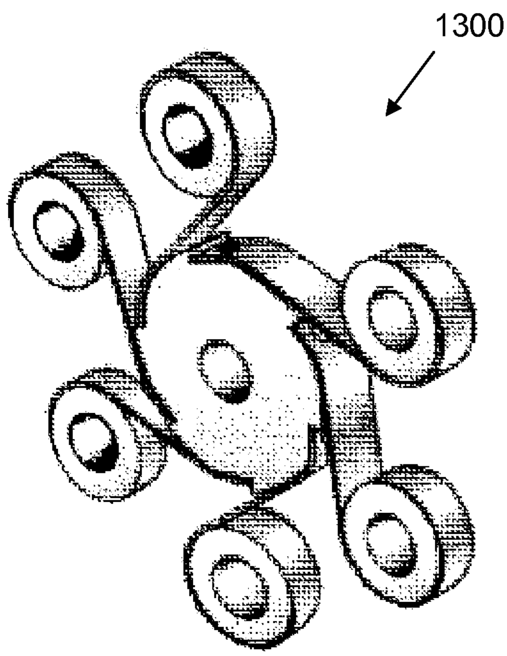

Fig. 13

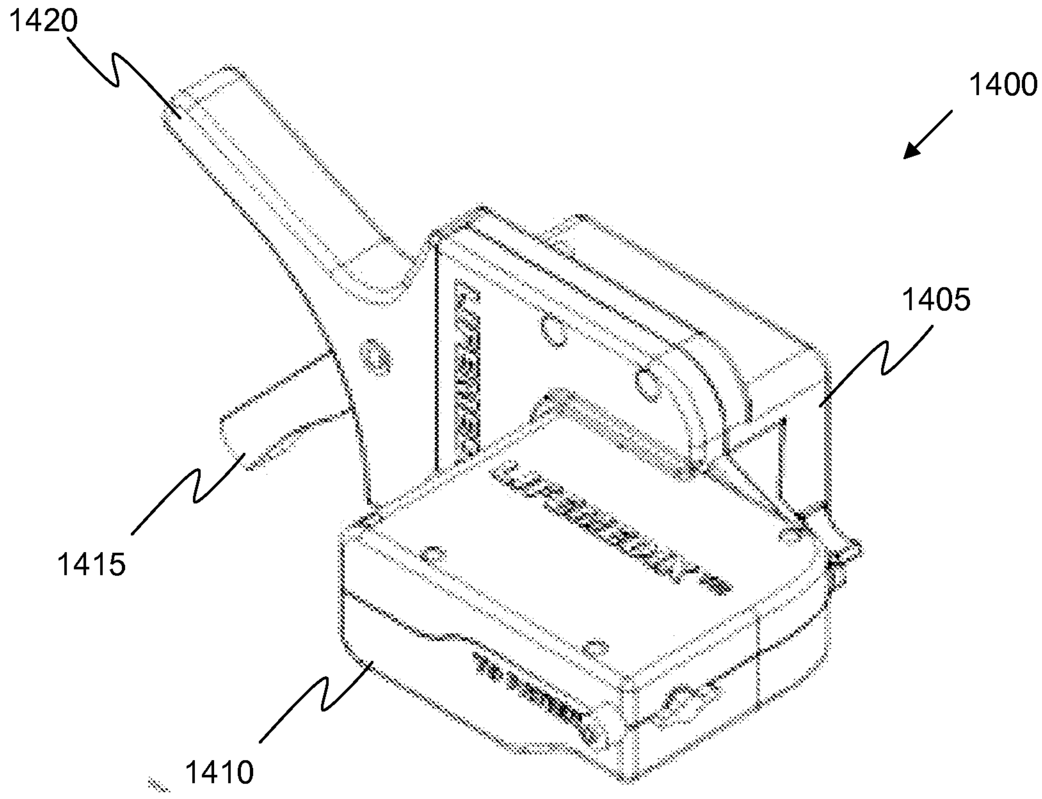

Fig. 14

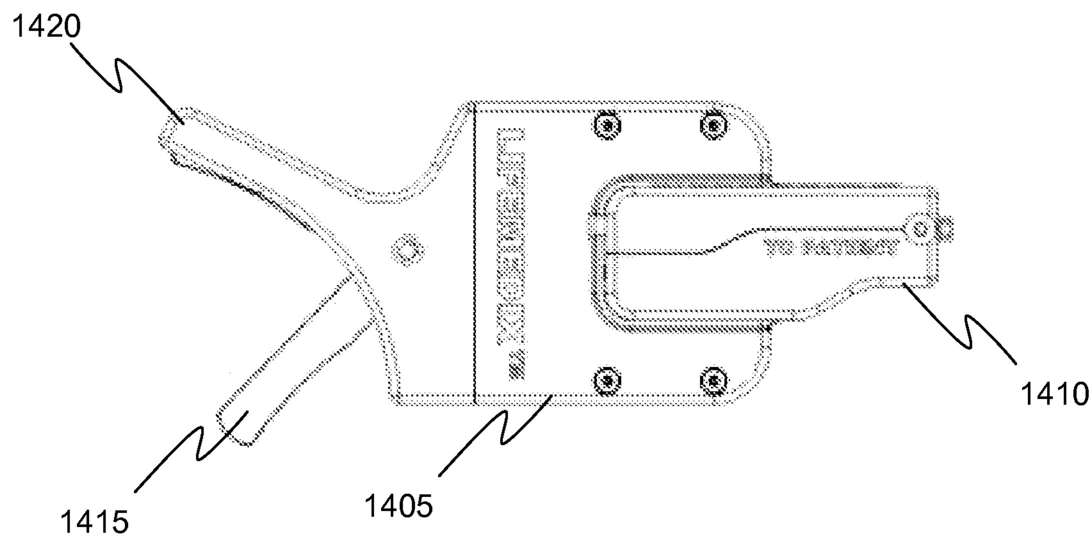

Fig. 15

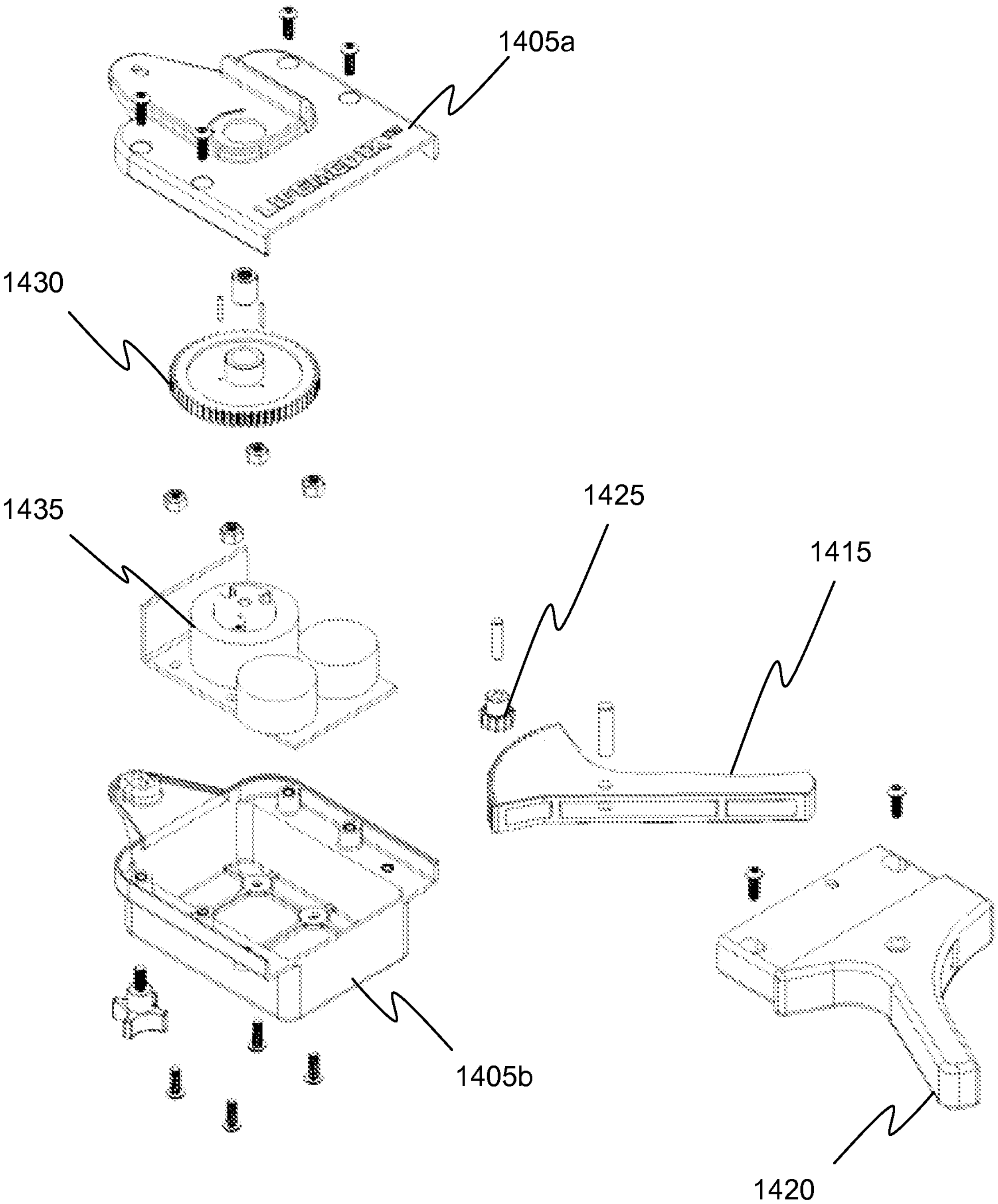

Fig. 16

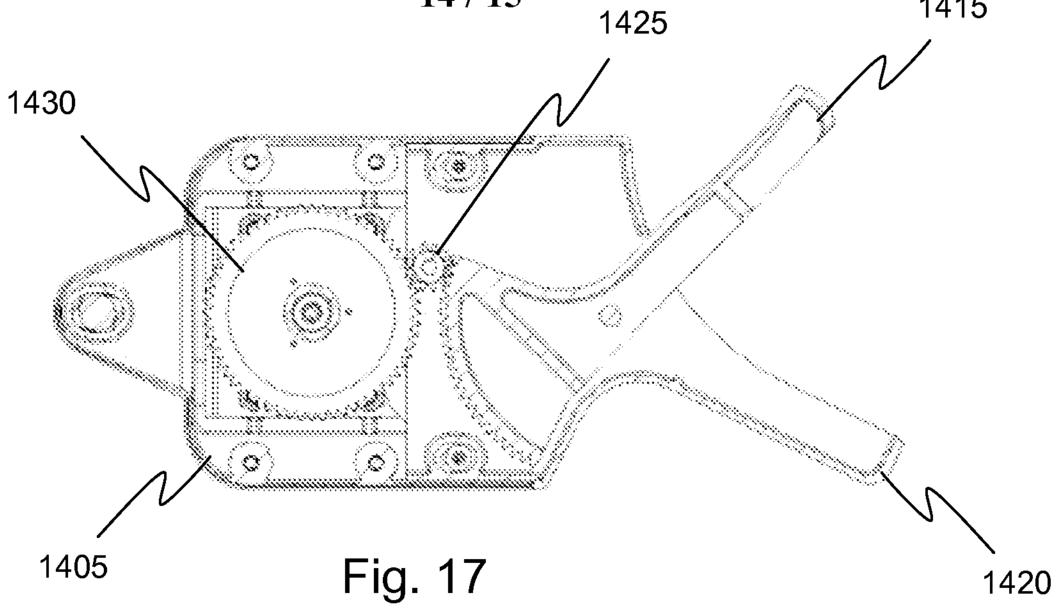
1425
1415
1430
1405
1420

Fig. 17

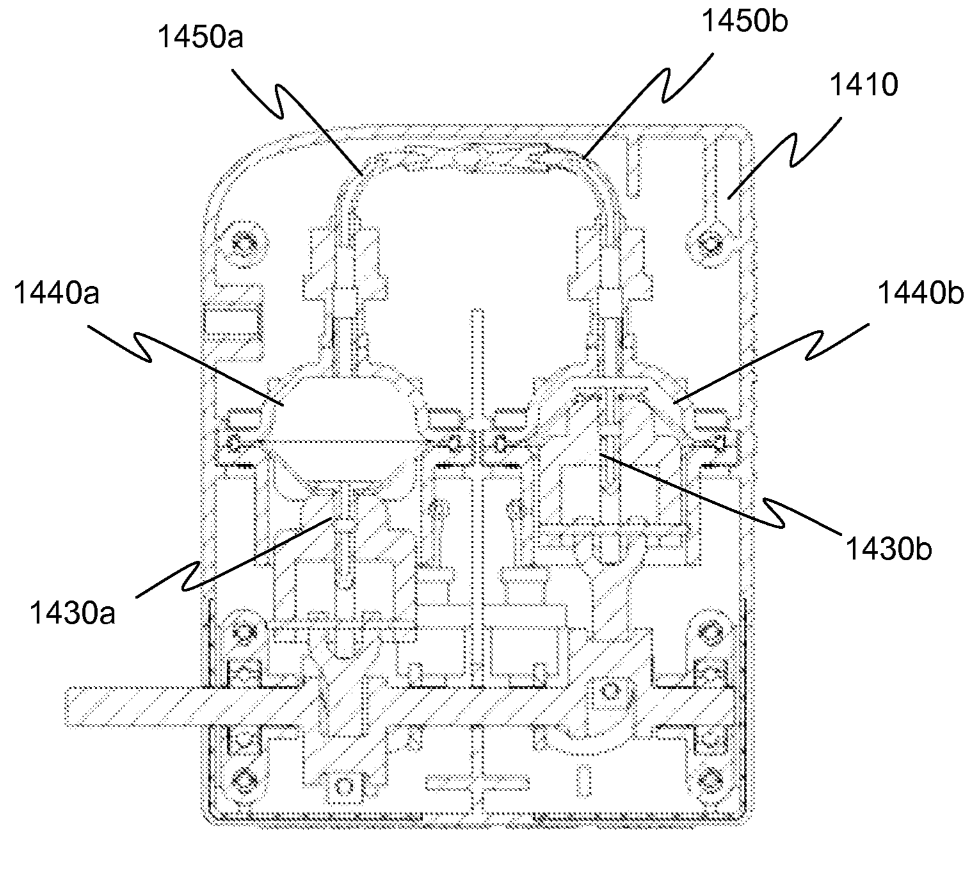
1450a
1450b
1410
1440a
1440b
1430b
1430a

Fig. 18

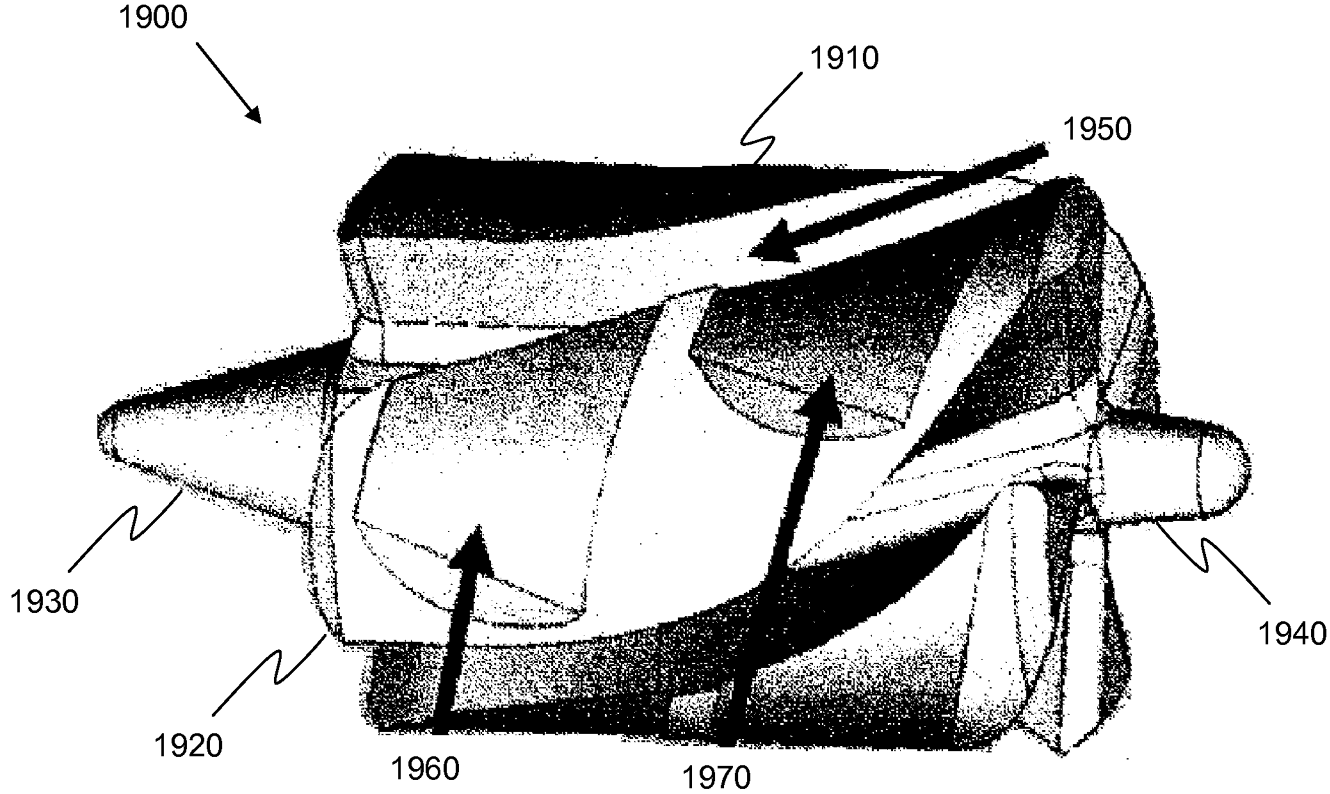

Fig. 19

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2010/029185

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - A61M 5/00 (2010.01)
USPC - 604/890.1
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)
IPC(8) - A61M 05/00 (2010.01)
USPC - 604/890.1, 151, 240-249, 250-259, 260-269

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)
MicroPatent

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 7,503,903 B2 (CARLISLE et al) 17 March 2009 (17.03.2009) entire document	1-4,10,14,15,19 --- 5-9,11-13,16-18,20
Y	US 7,337,922 B2 (RAKE et al) 04 March 2008 (04.03.2008) entire document	7-9, 11-13, 16-18,20
Y	US 7,500,962 B2 (CHILDERS et al) 10 March 2009 (10.03.2009) entire document	5, 6
A	US 7,326,186 B2 (TROMBLEY, III et al) 05 February 2008 (05.02.2008) entire document	1-20
A	US 7,182,750 B2 (LAMPROPOULOS et al) 27 February 2007 (27.02.2007) entire document	1-20

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

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

Date of the actual completion of the international search	Date of mailing of the international search report
15 May 2010	24 MAY 2010

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