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(54) MULTI-FLUID DELIVERY SYSTEM

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(60) Provisional application No. 60/614,868, filed on Sep. 30, 2004.

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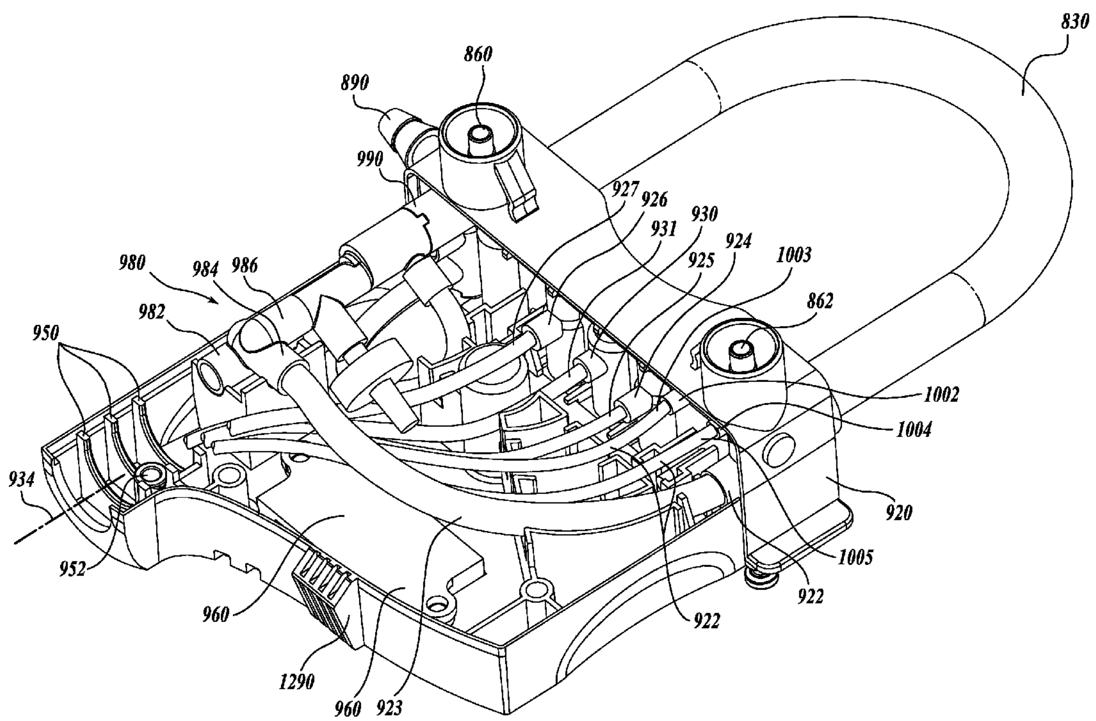
(57) **ABSTRACT**

A proximal connector of an endoscope shaft can be manually attached to and detached from a console, such that the connector and endoscope shaft can be provided as a single use device. An interface between the proximal connector and console can include a sliding plate moveable to operably make and break at least some of the connections between the console and endoscope shaft. A fluid reservoir may be separately connected to the proximal connector and hang from a mount on the interface.



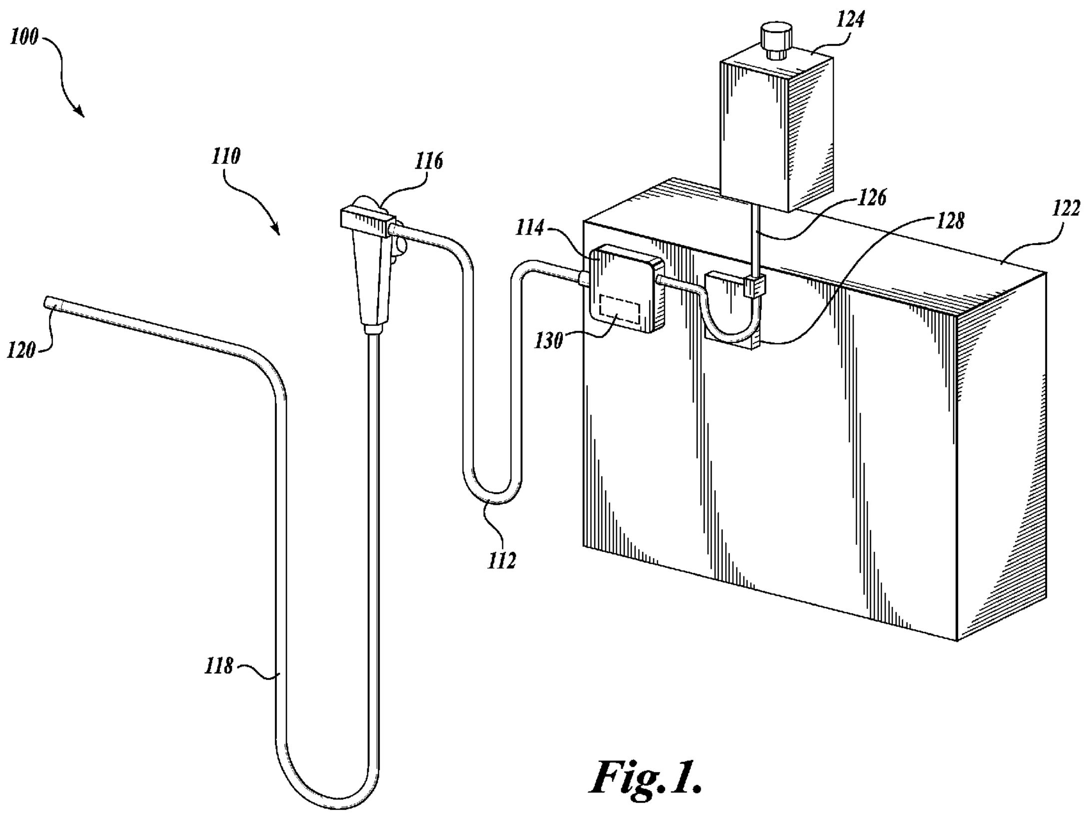
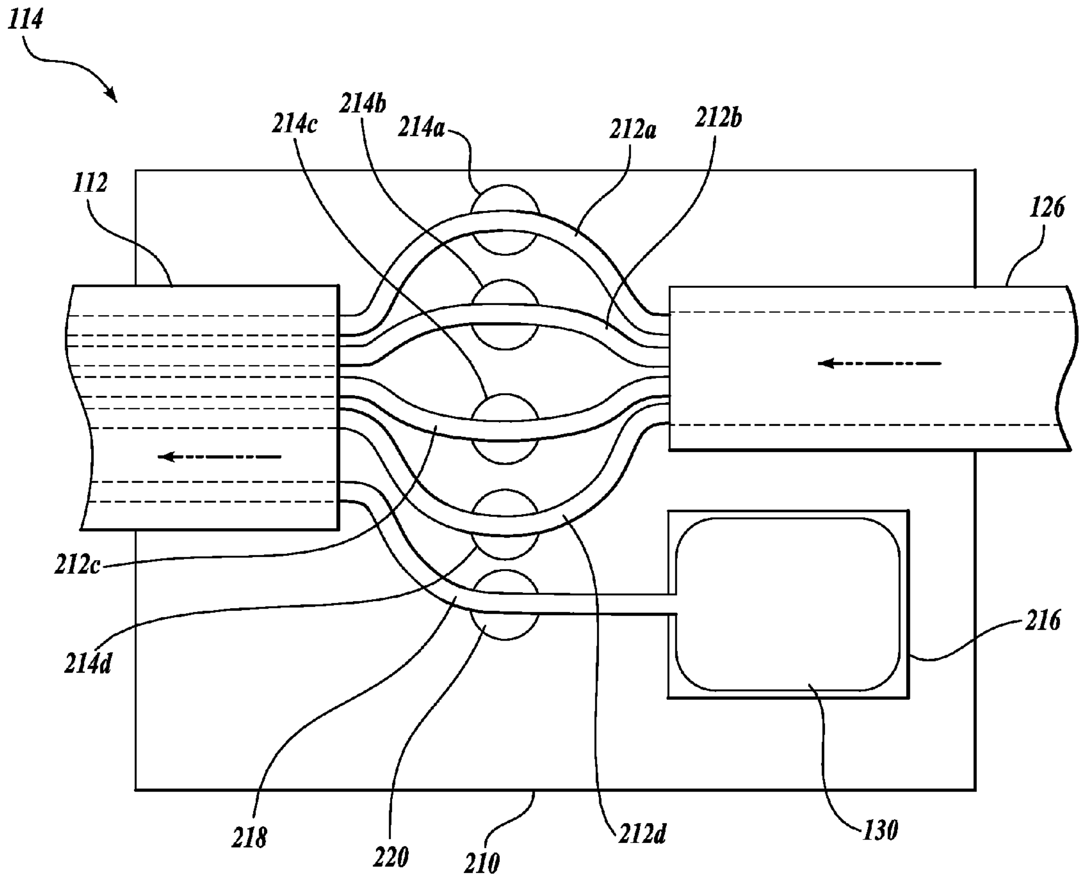


Fig.1.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214b
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214a
212a
212b
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212c
214d
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212d
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Fig.2.

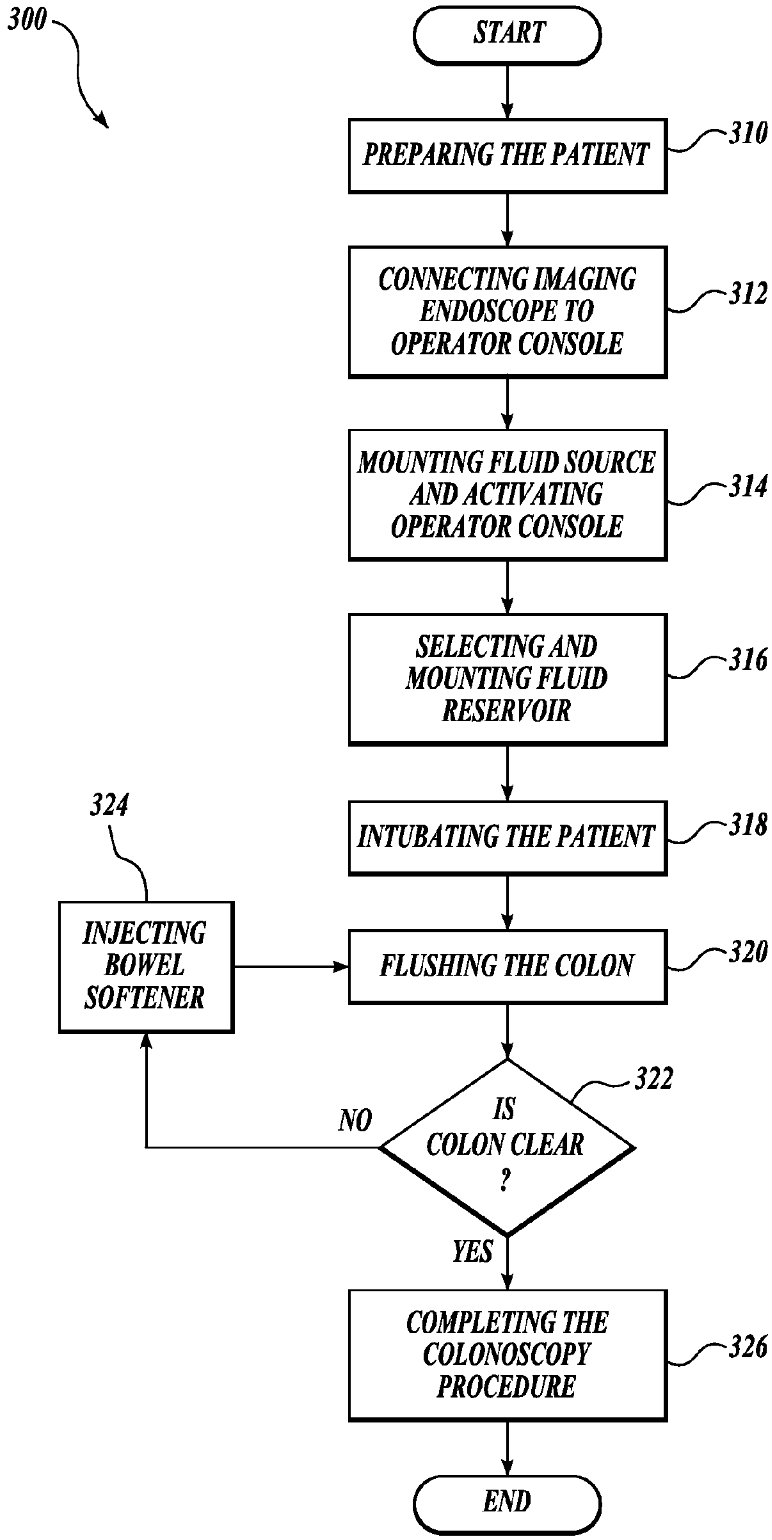

300
START
PREPARING THE PATIENT
310
CONNECTING IMAGING ENDOSCOPE TO OPERATOR CONSOLE
312
MOUNTING FLUID SOURCE AND ACTIVATING OPERATOR CONSOLE
314
SELECTING AND MOUNTING FLUID RESERVOIR
316
INTUBATING THE PATIENT
318
324
INJECTING BOWEL SOFTENER
FLUSHING THE COLON
320
322
NO
IS COLON CLEAR ?
YES
COMPLETING THE COLONOSCOPY PROCEDURE
326
END

Fig.3.

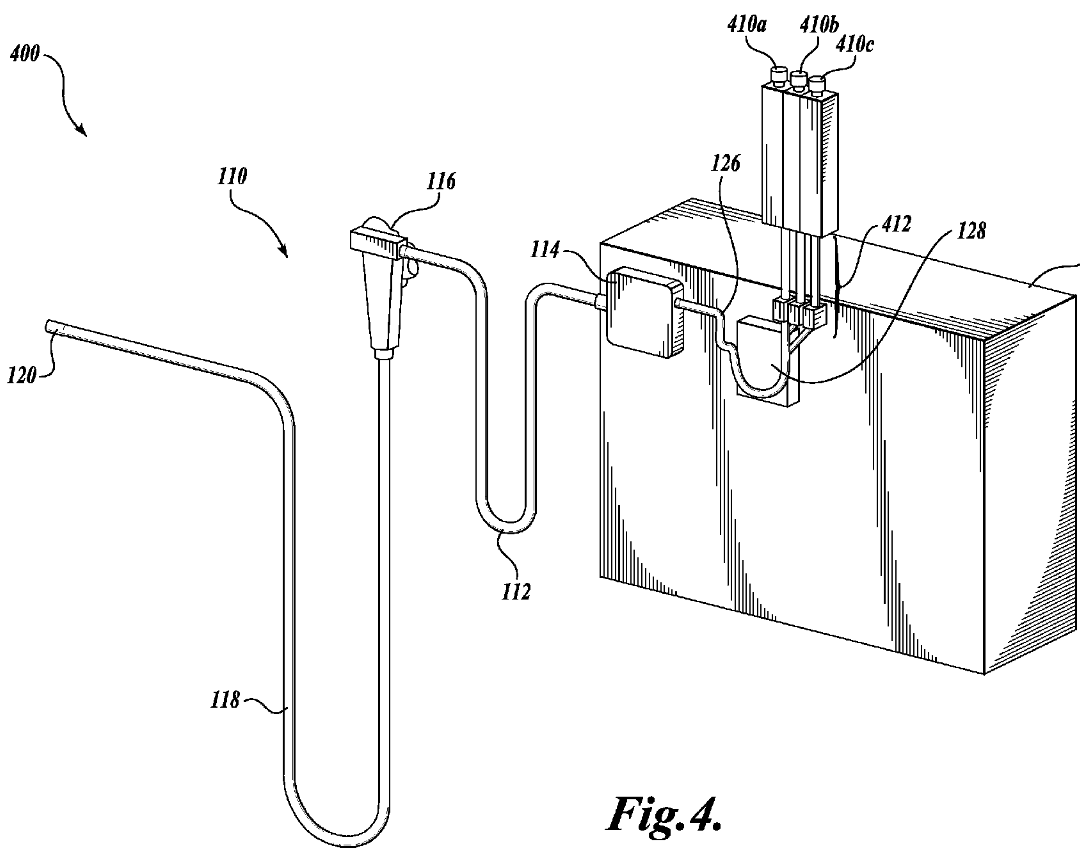
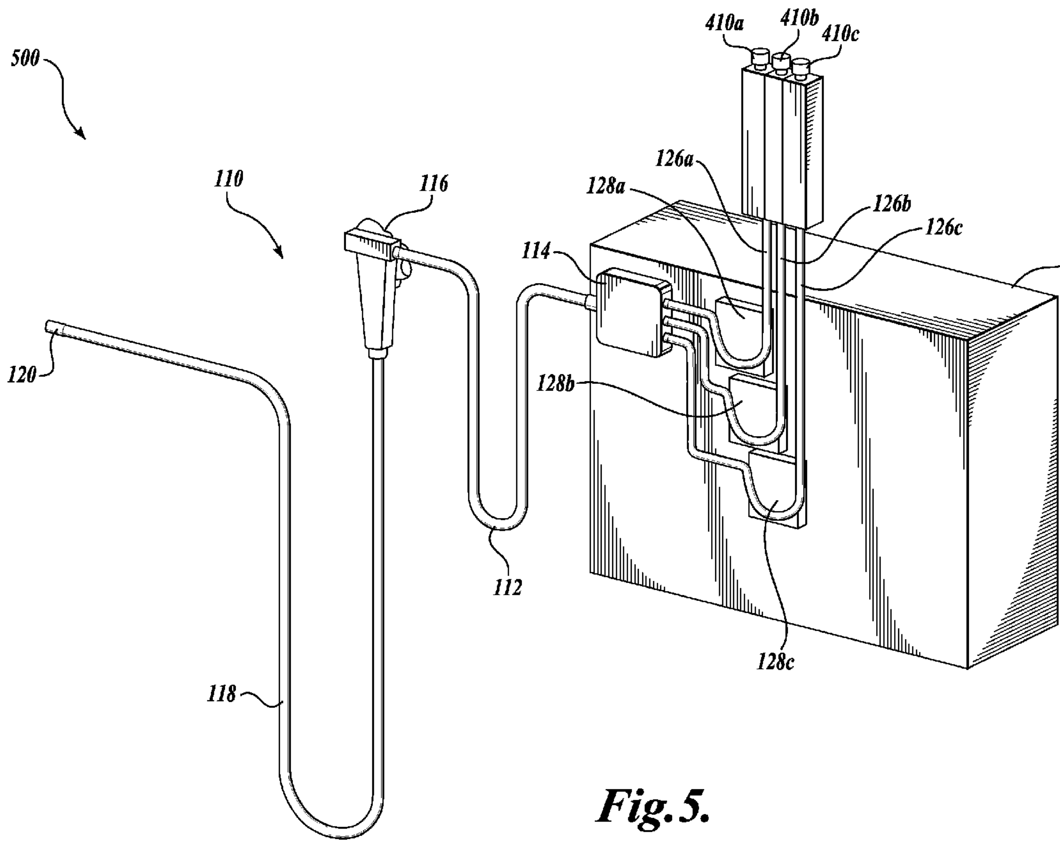


Fig.4.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410a
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410c
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126b
126c
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114
120
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118
128c

Fig.5.

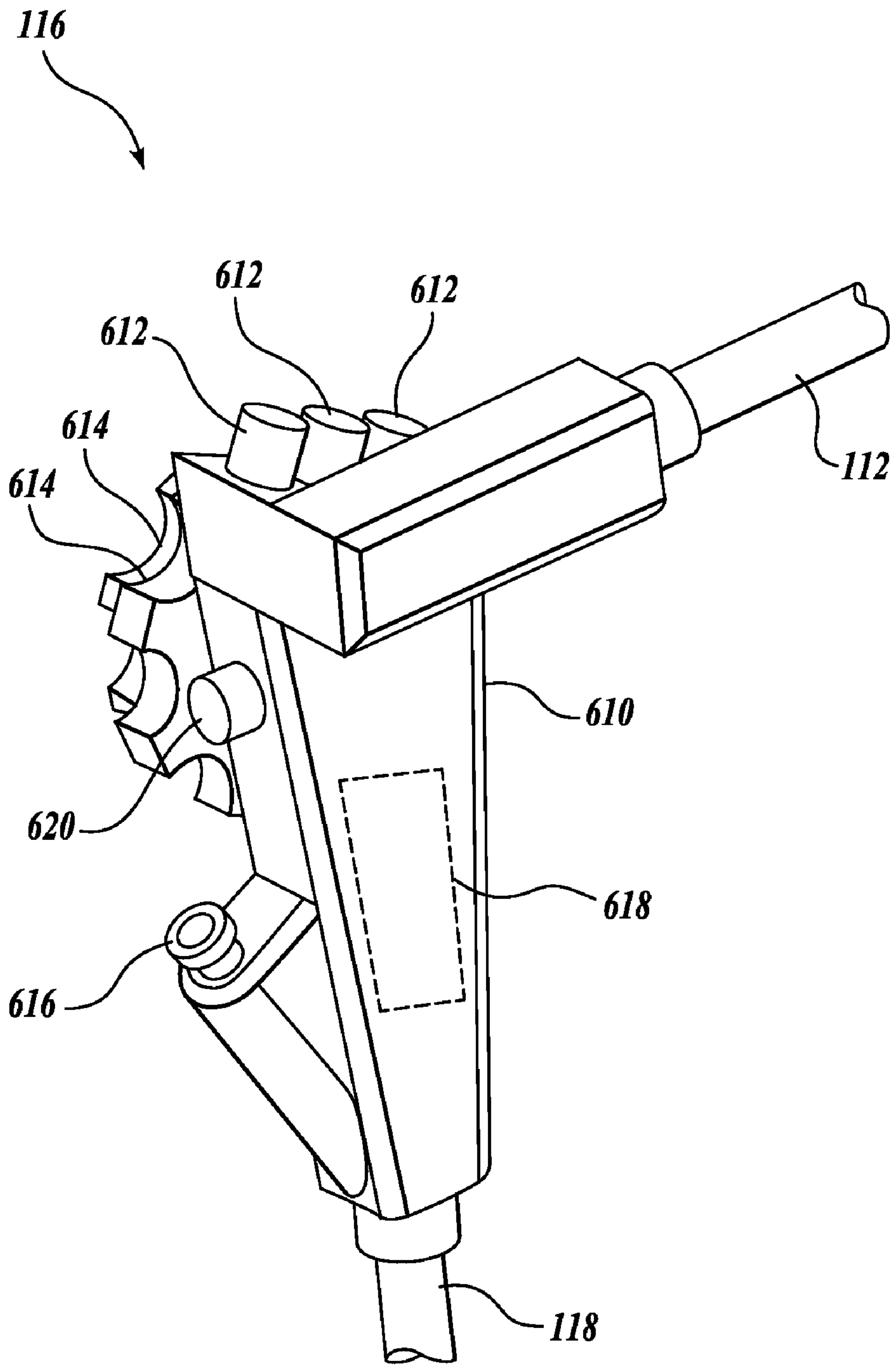


Fig. 6.

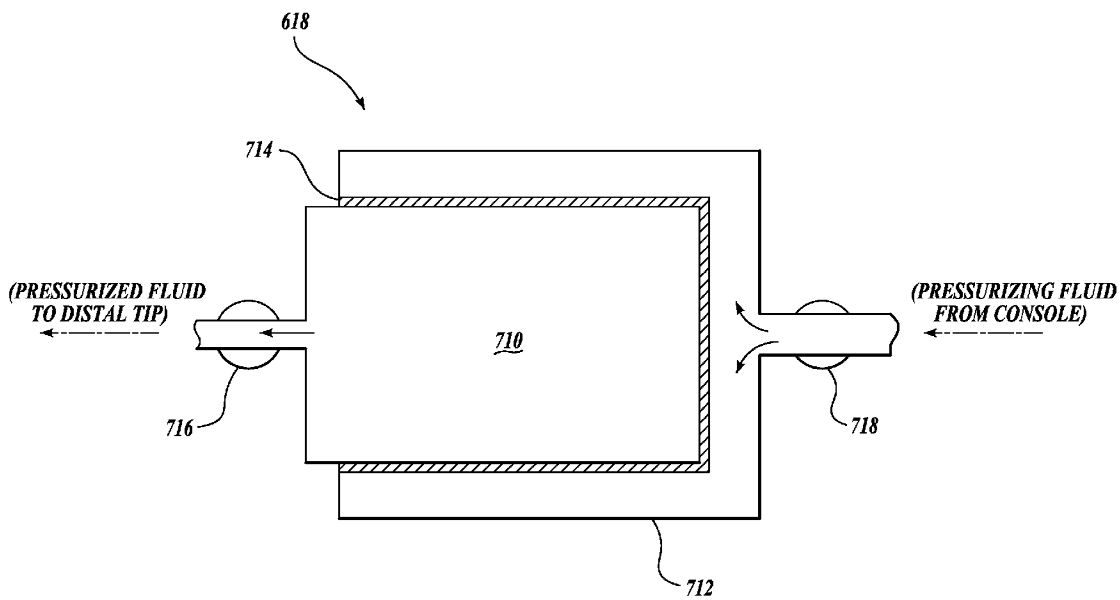

618
714
(PRESSURIZED FLUID
TO DISTAL TIP)
710
(PRESSURIZING FLUID
FROM CONSOLE)
716
718
712

Fig. 7.

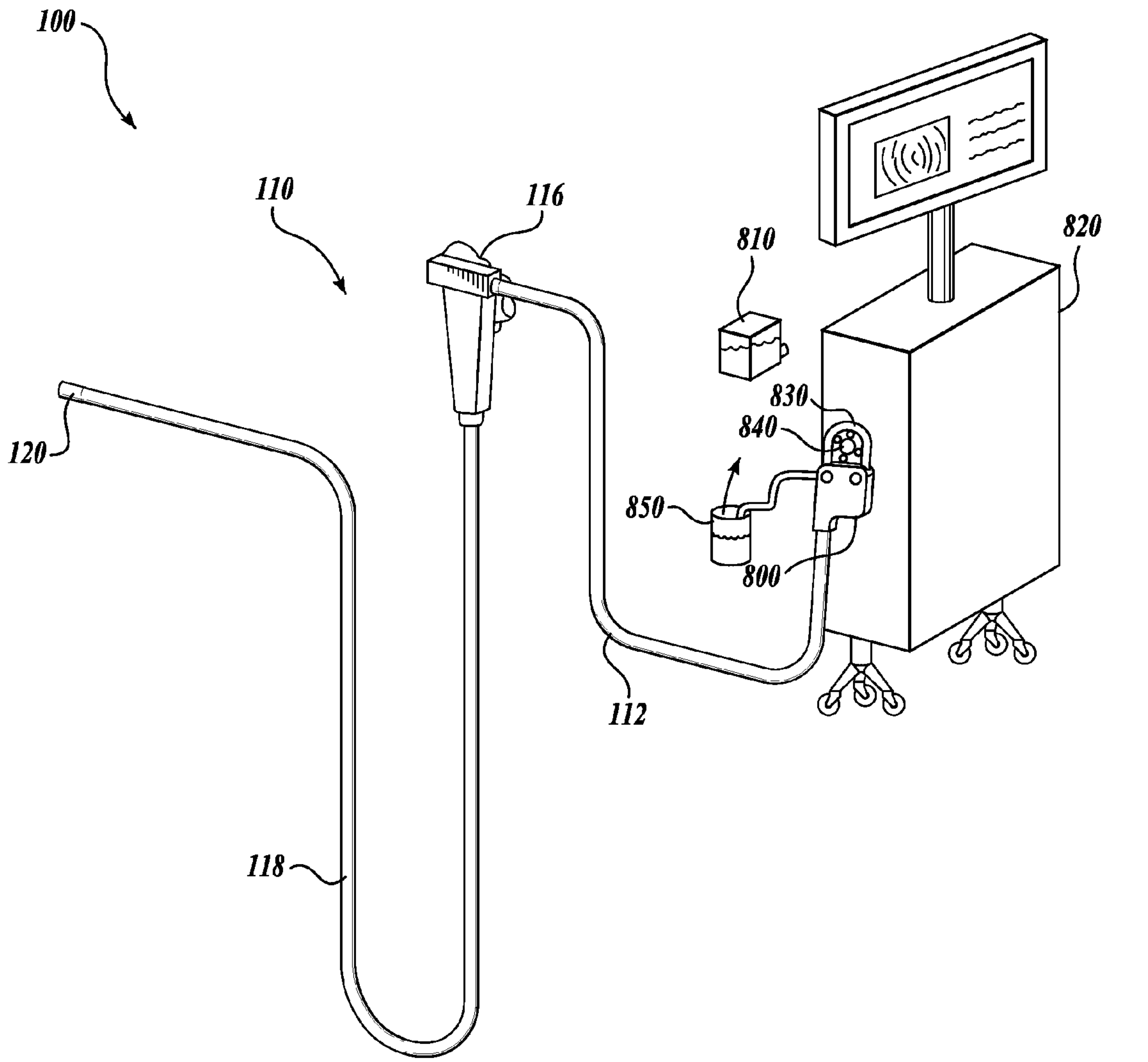


Fig.8.

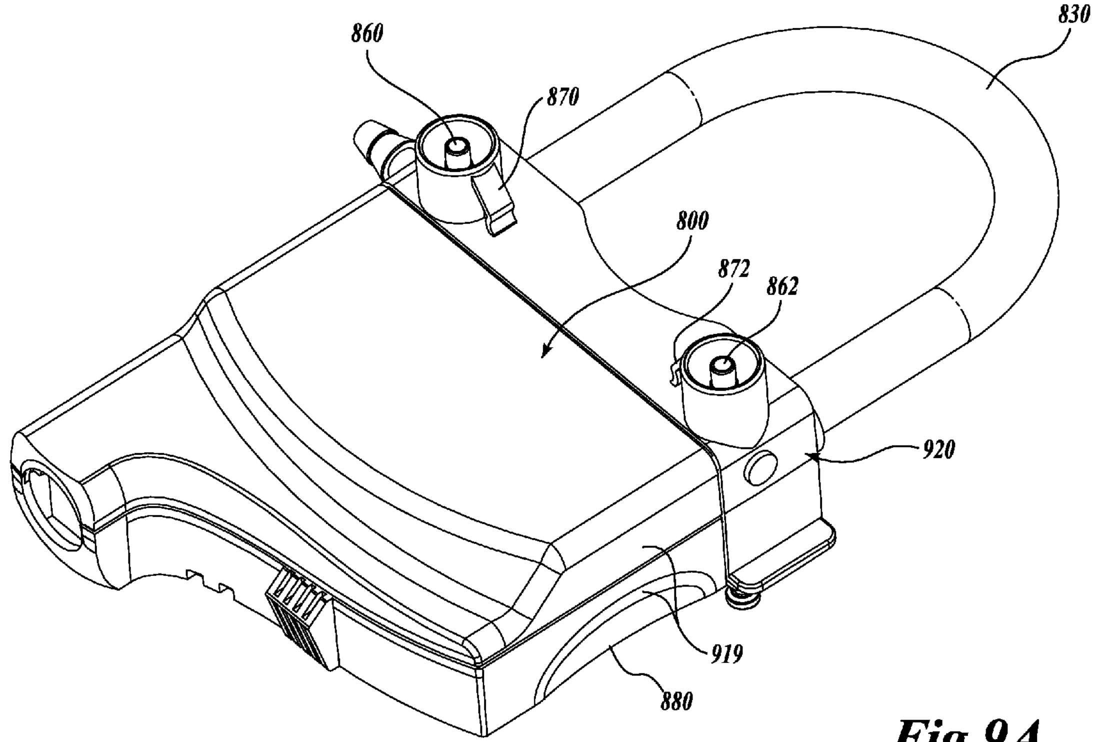


Fig.9A.

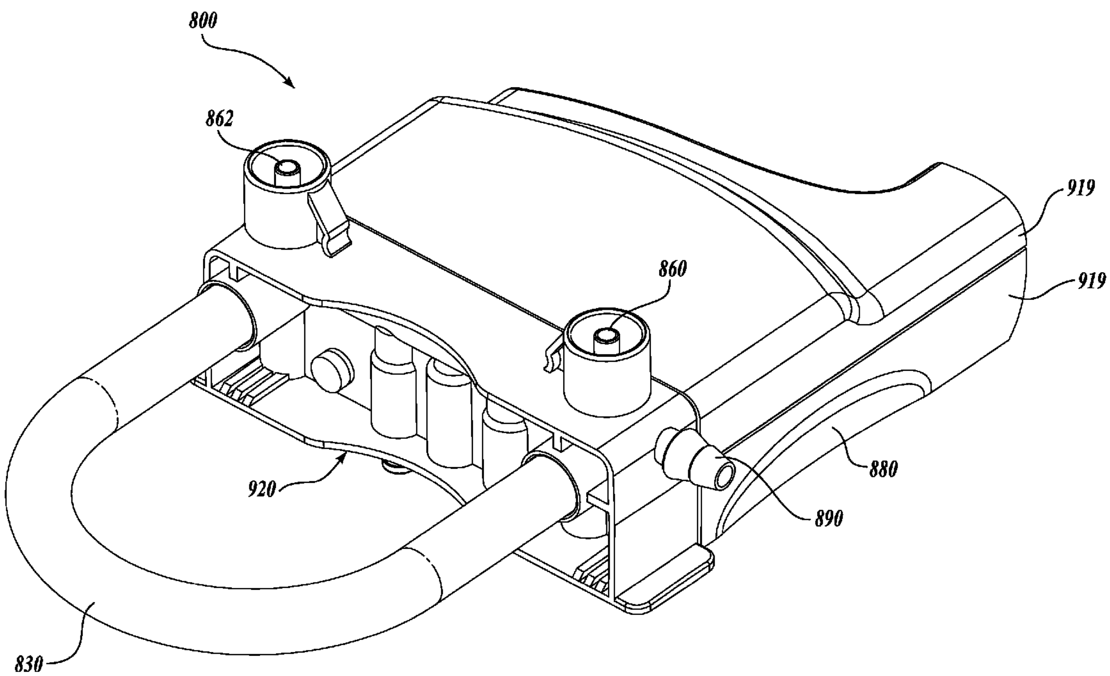
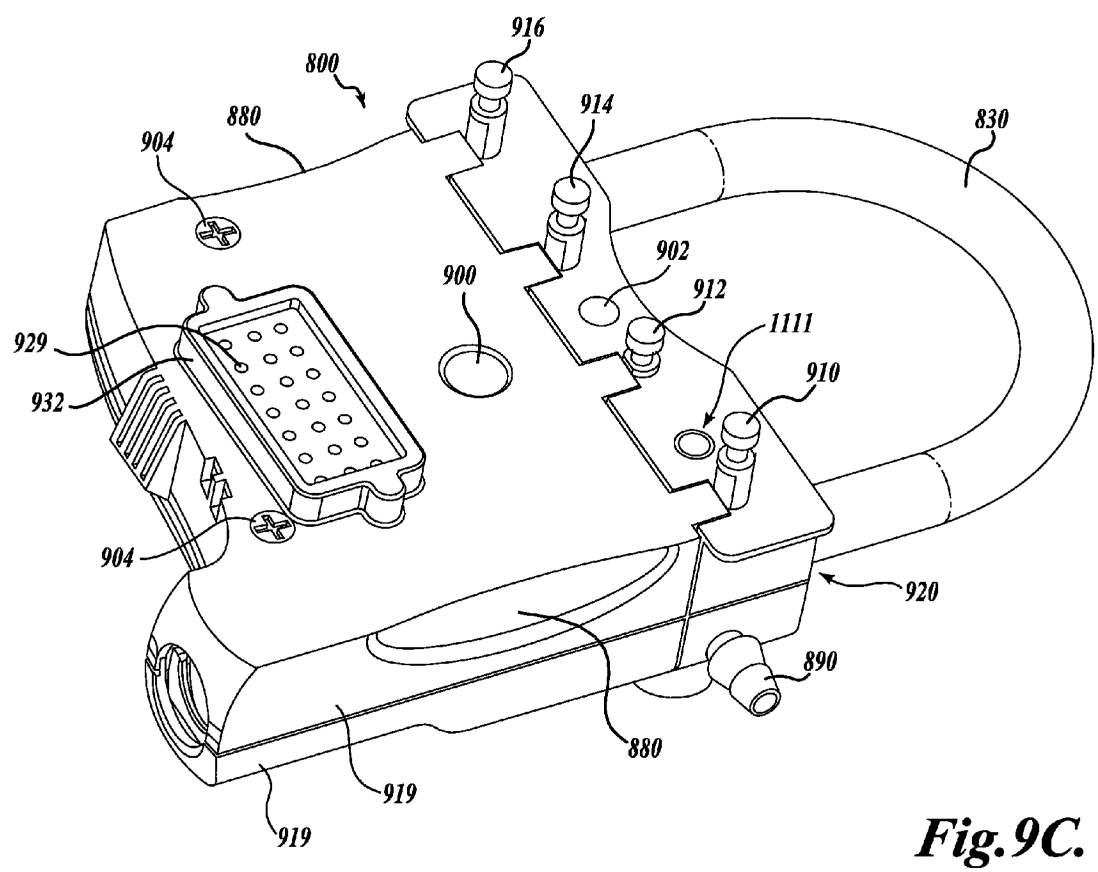


Fig.9B.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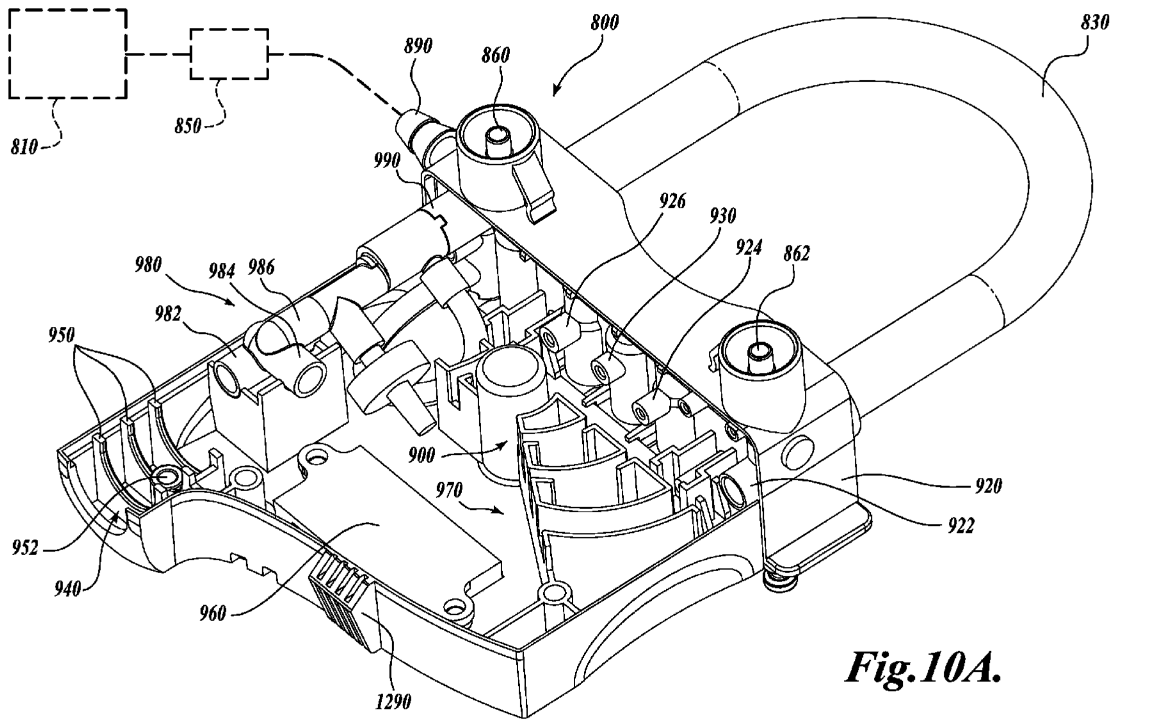
919

Fig.9C.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940
960
1290

Fig.10A.

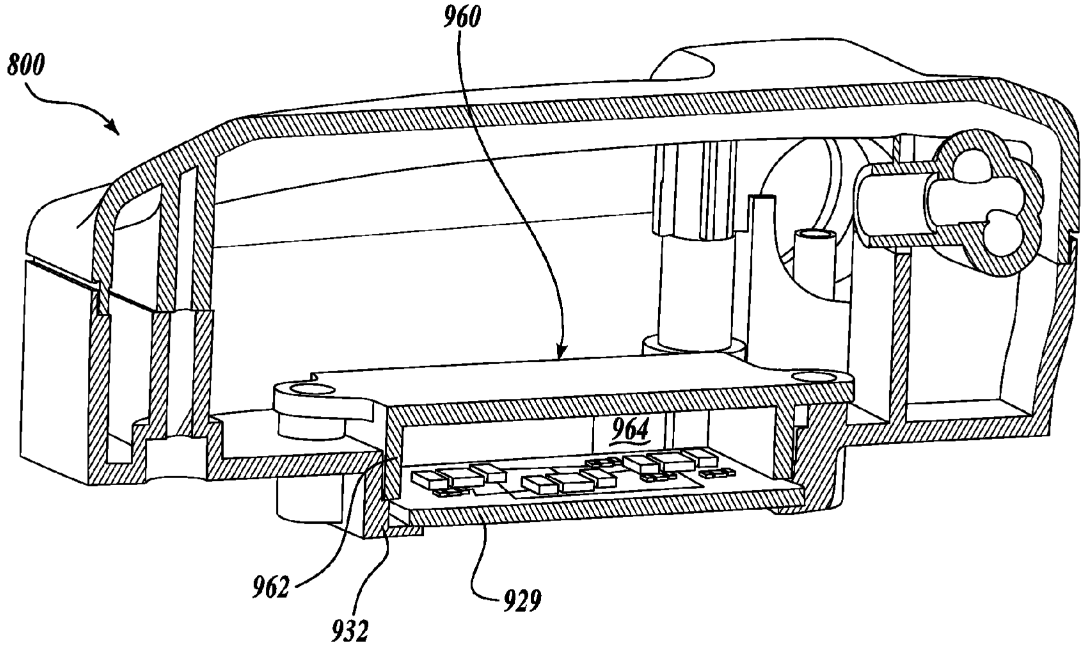
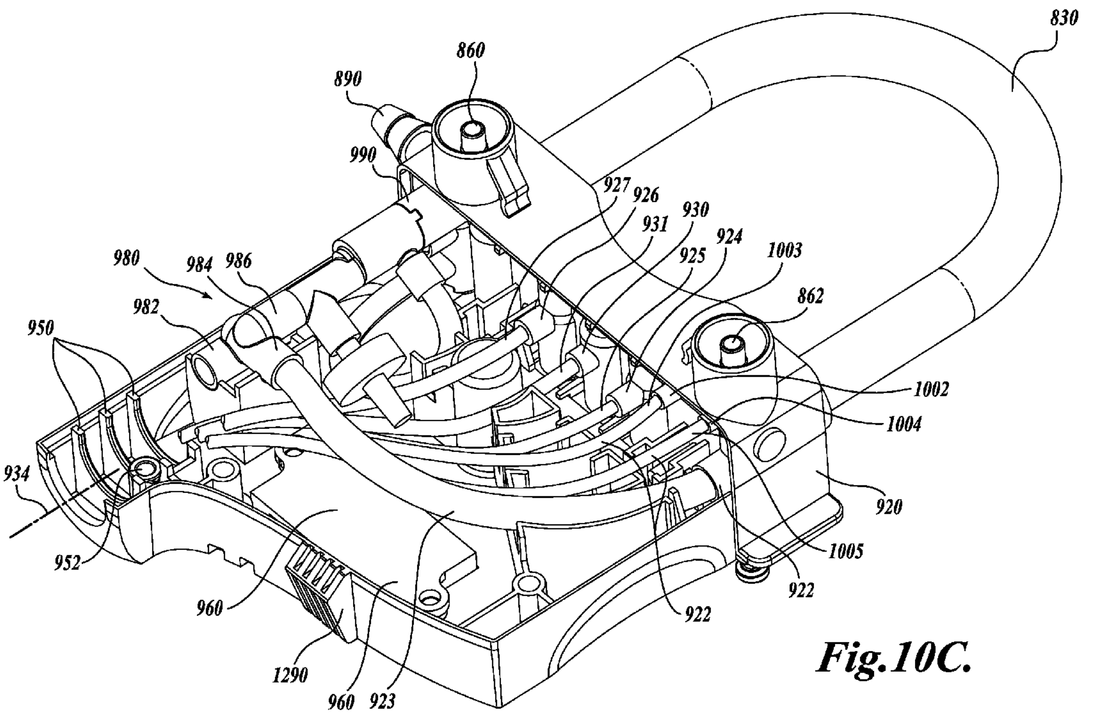


Fig.10B.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920
952
1005
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1290
960
923

Fig.10C.

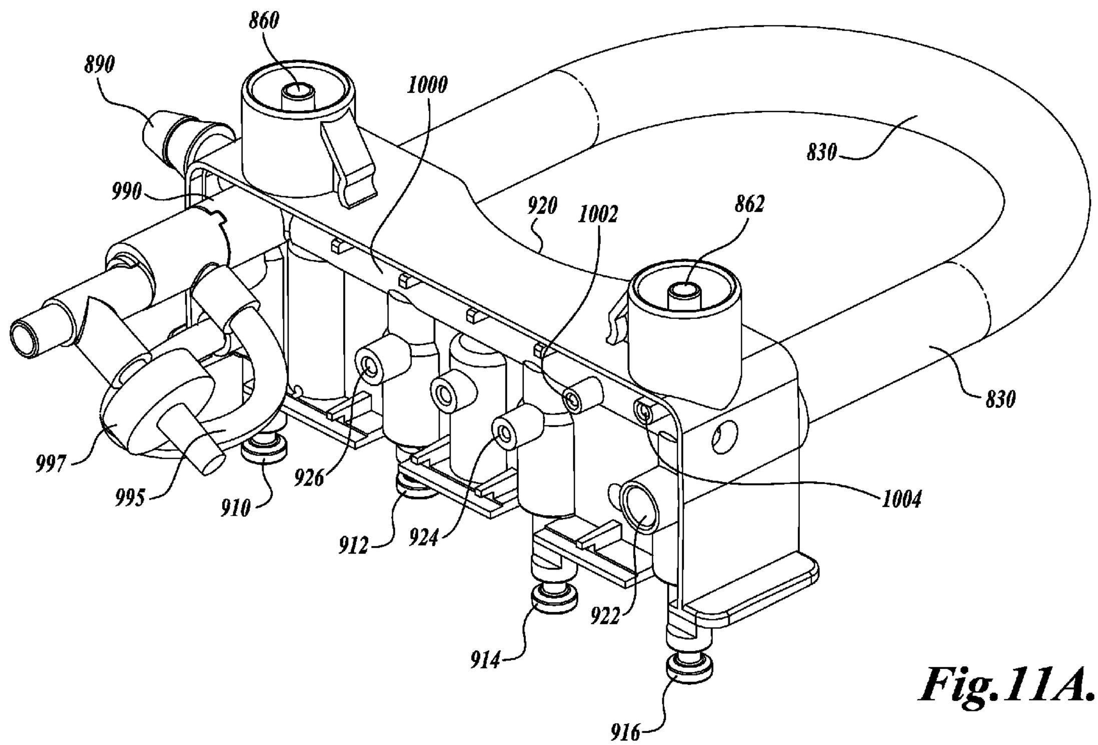
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Fig.11A.

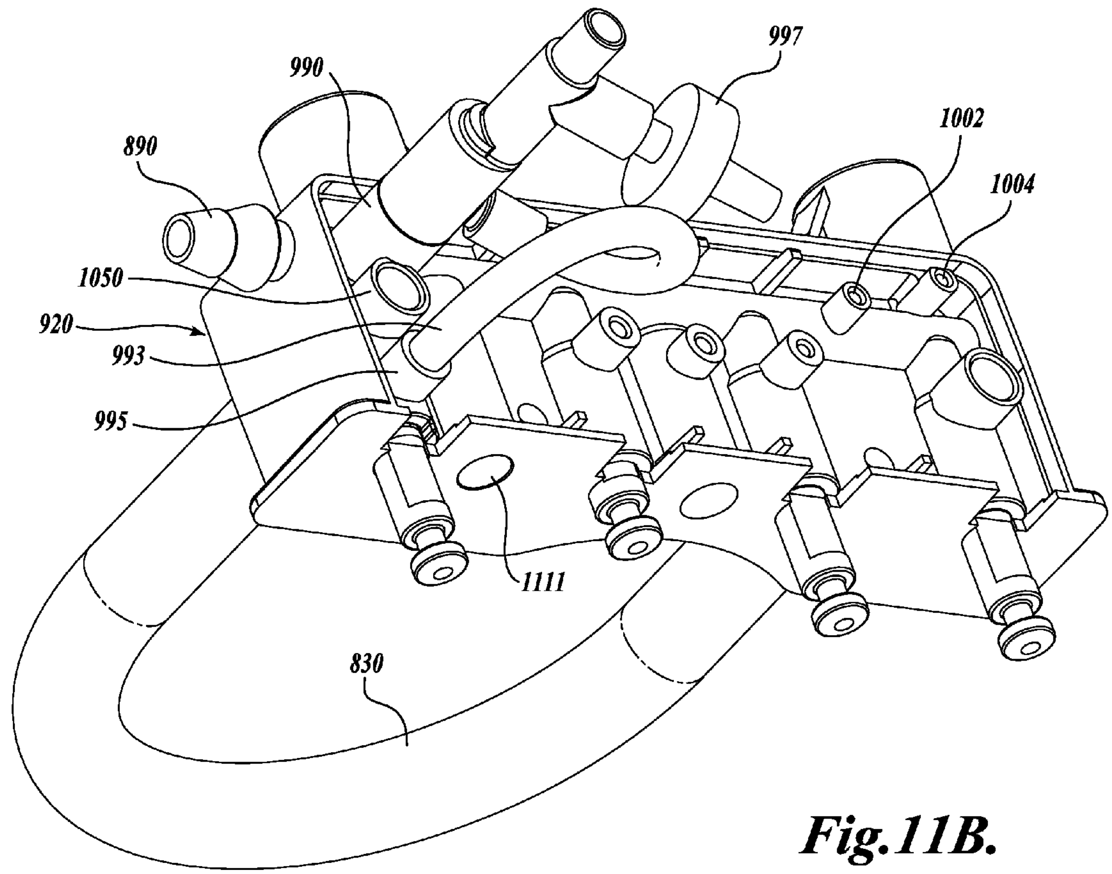


Fig.11B.

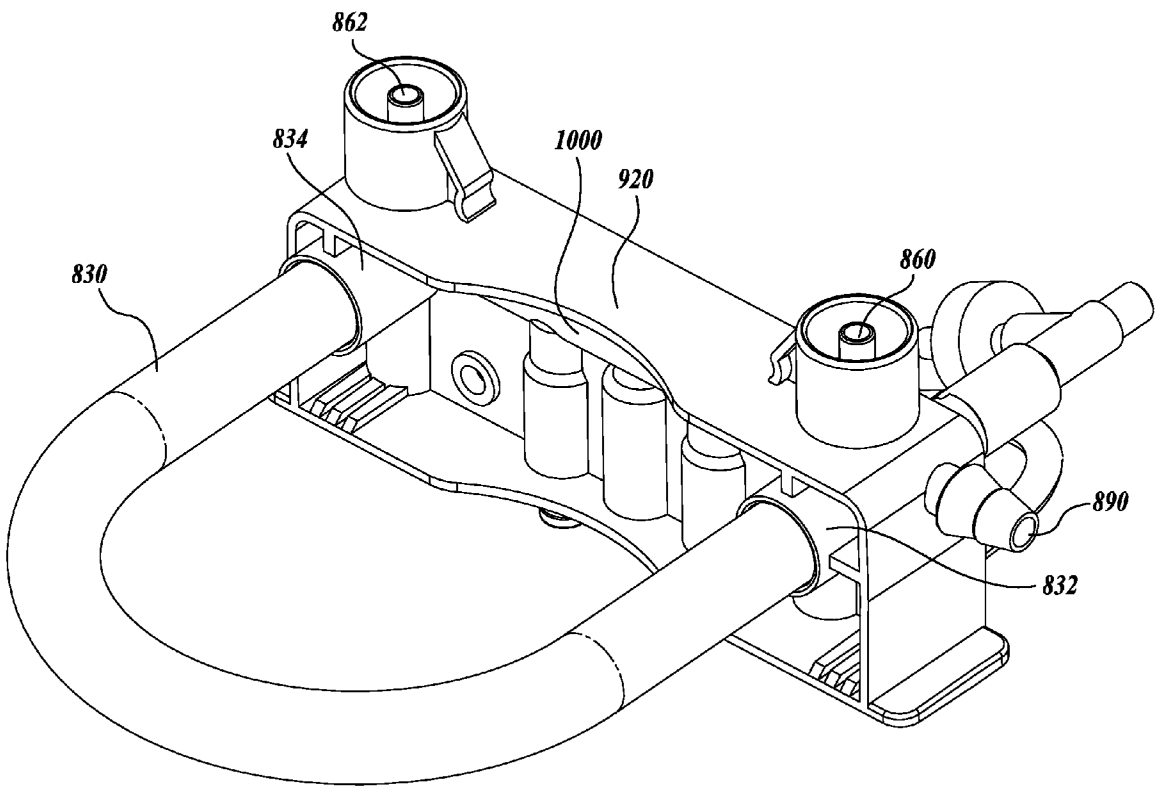
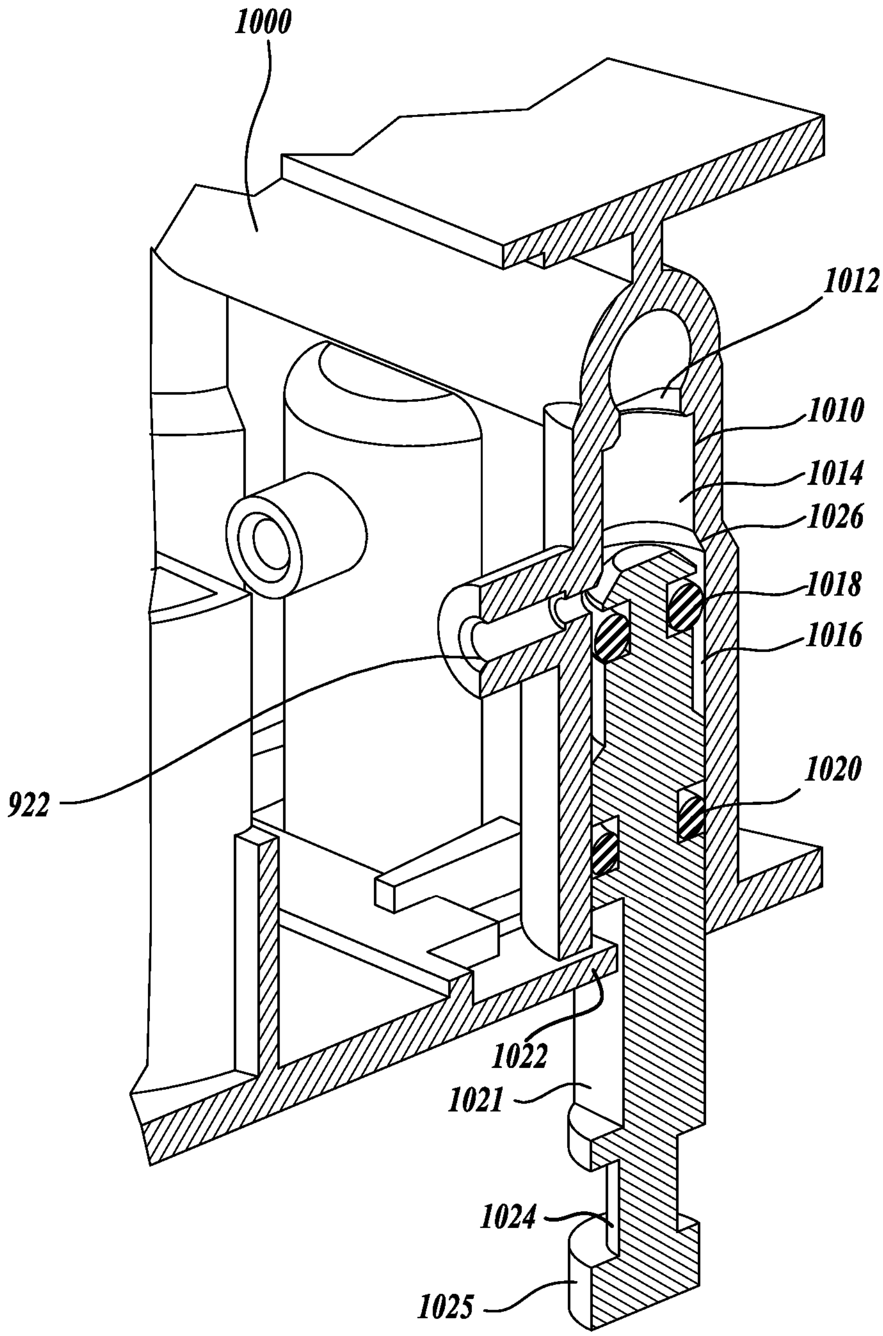


Fig.11C.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1024
1025

Fig.12.

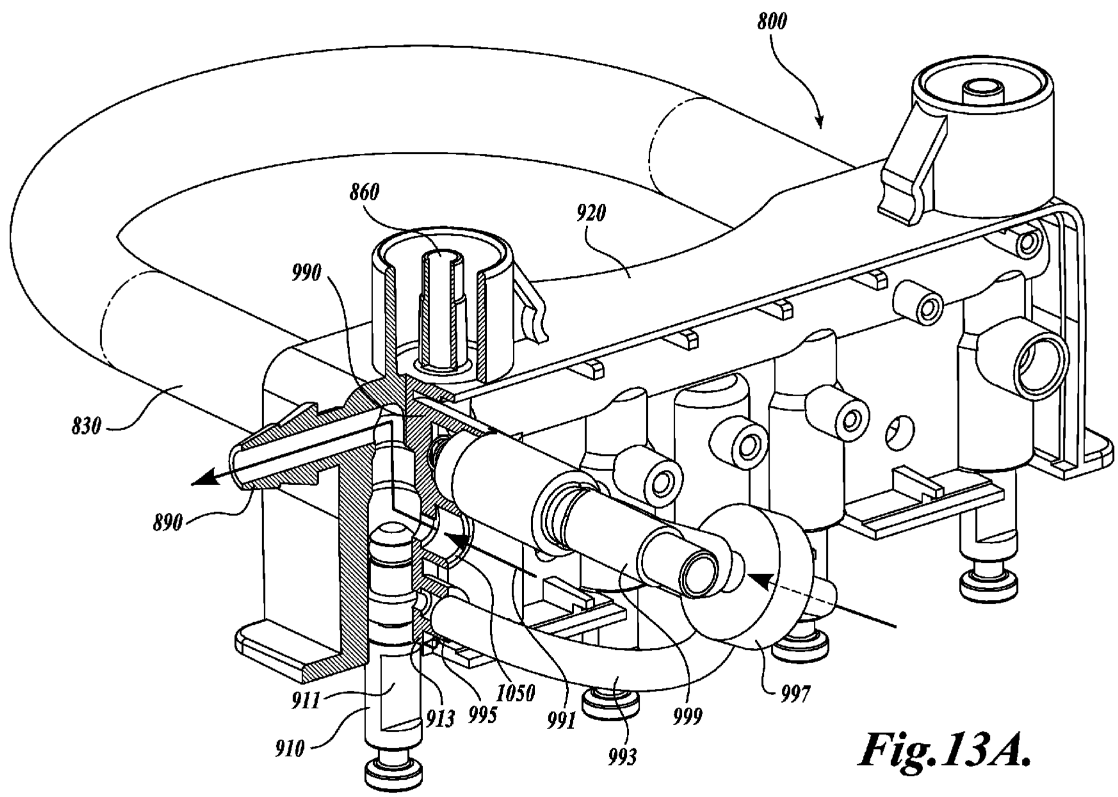


Fig.13A.

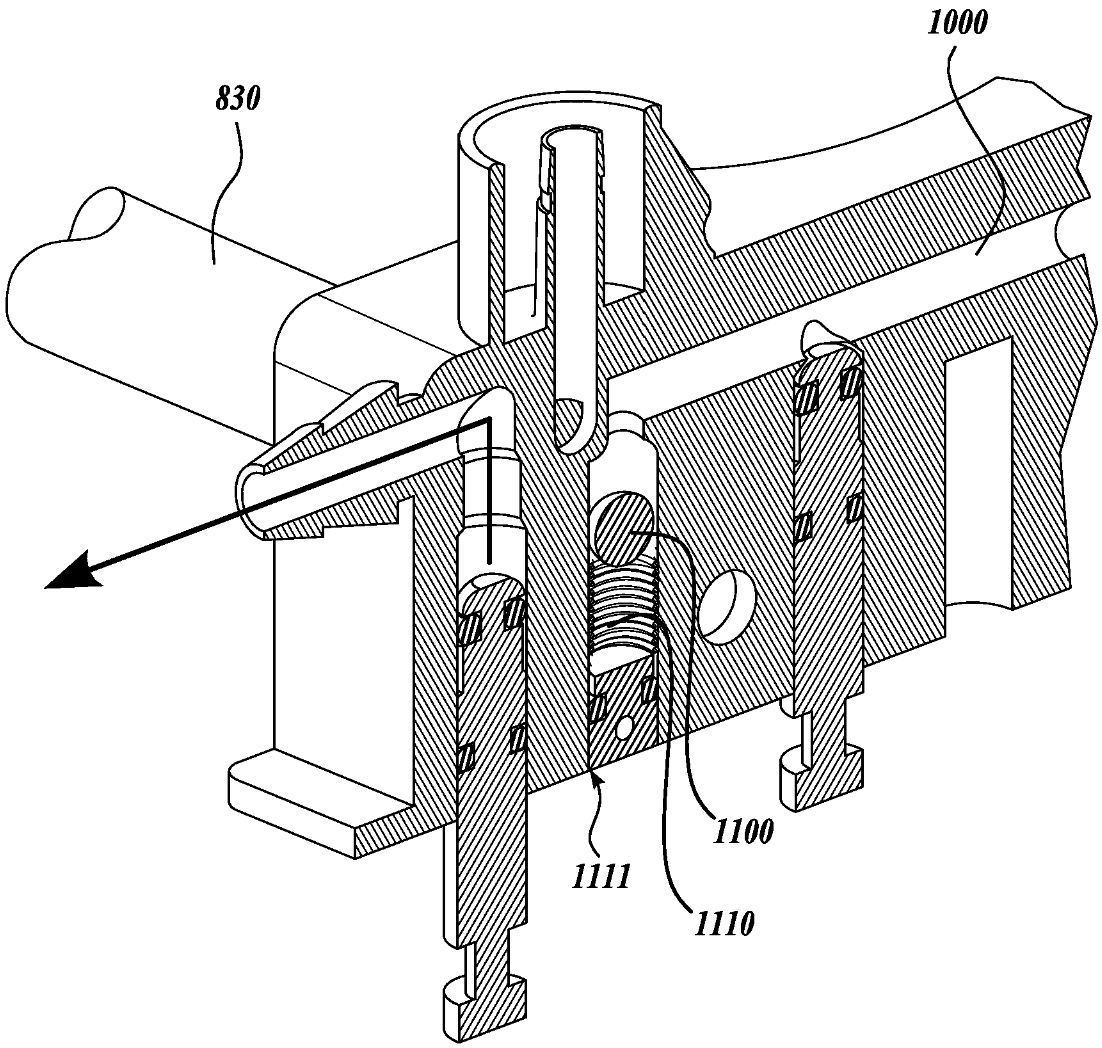


Fig.13B.

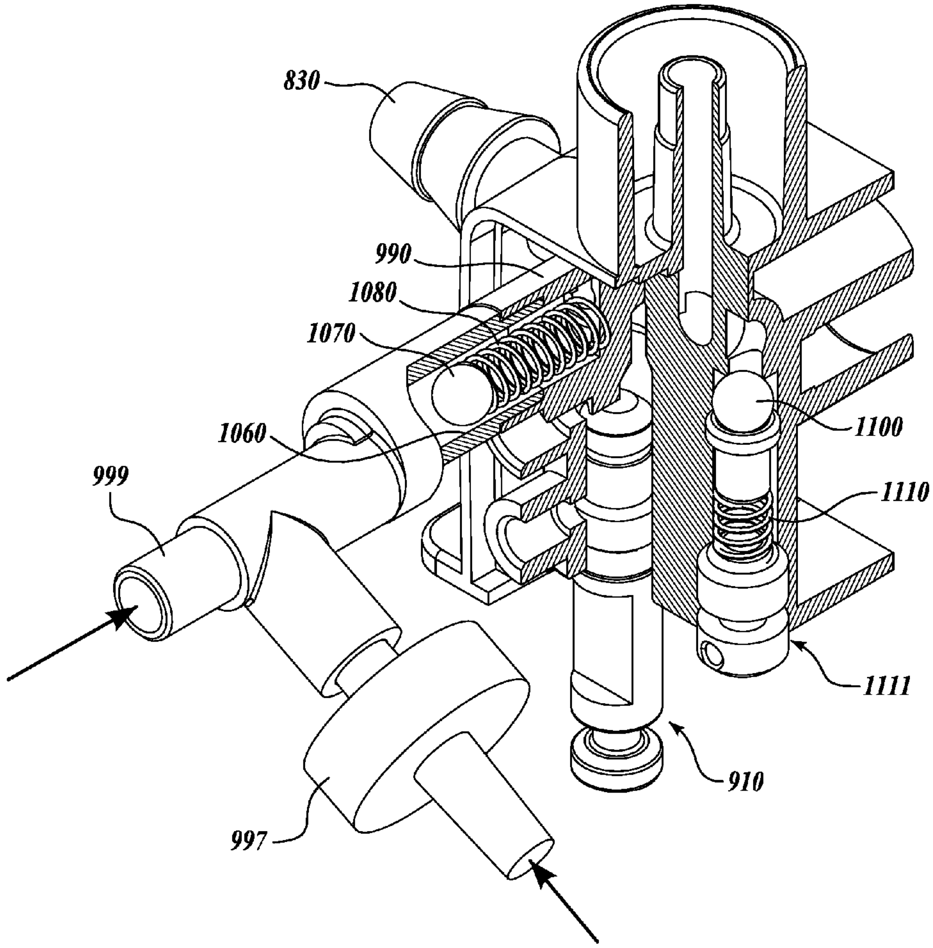
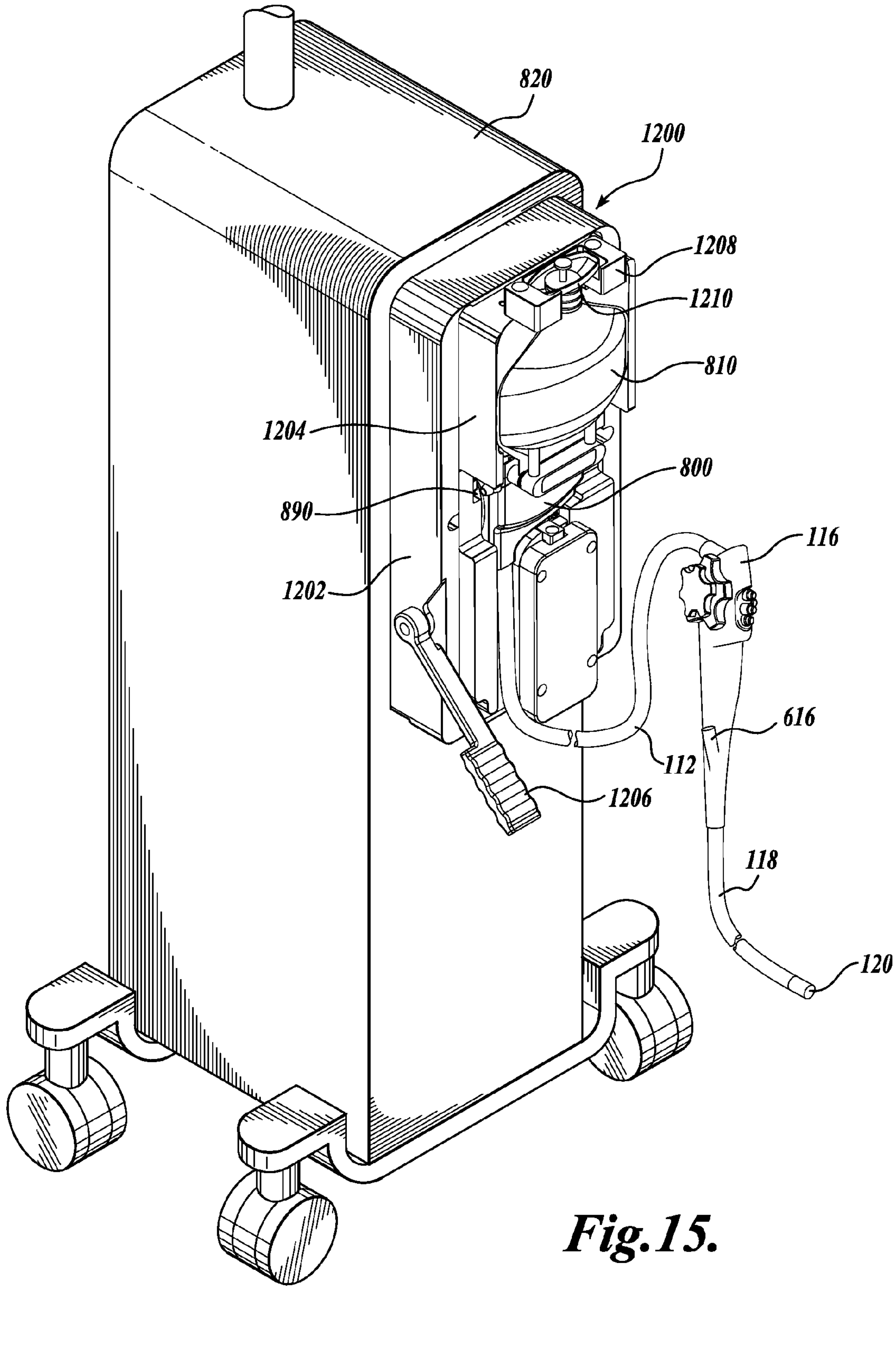


Fig.14.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116
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616
112
1206
118
120

Fig.15.

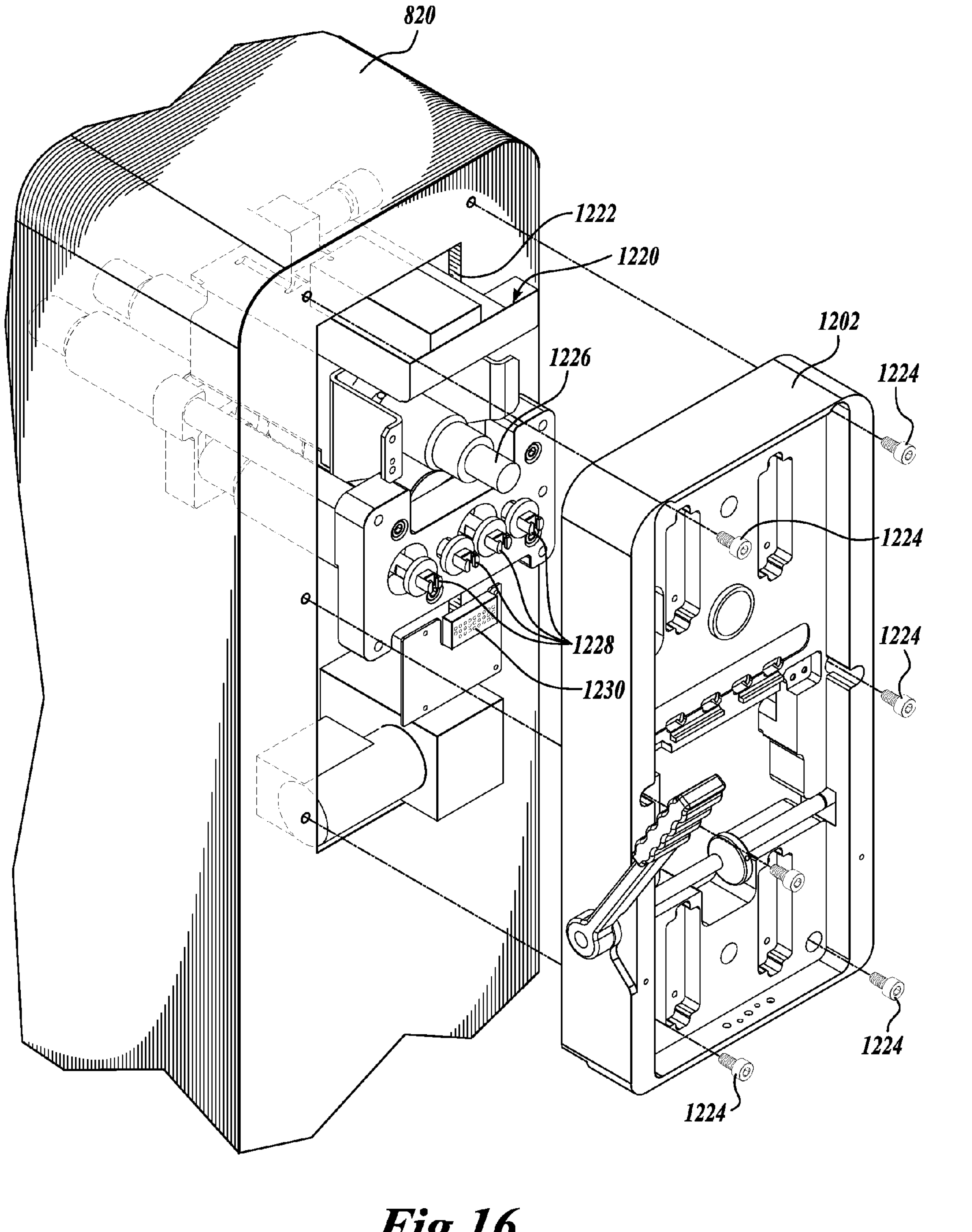

Fig.16.

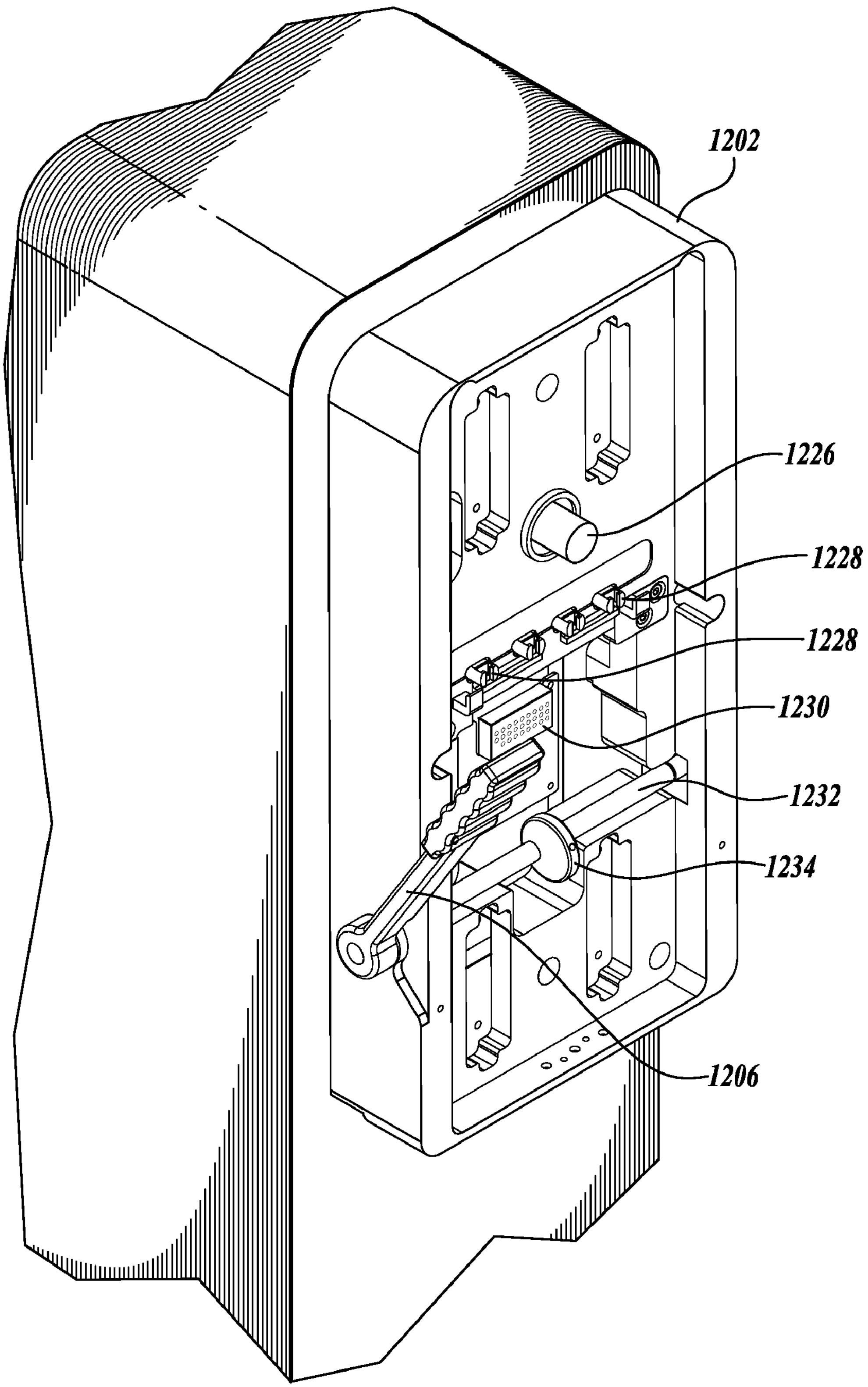

Fig.17.

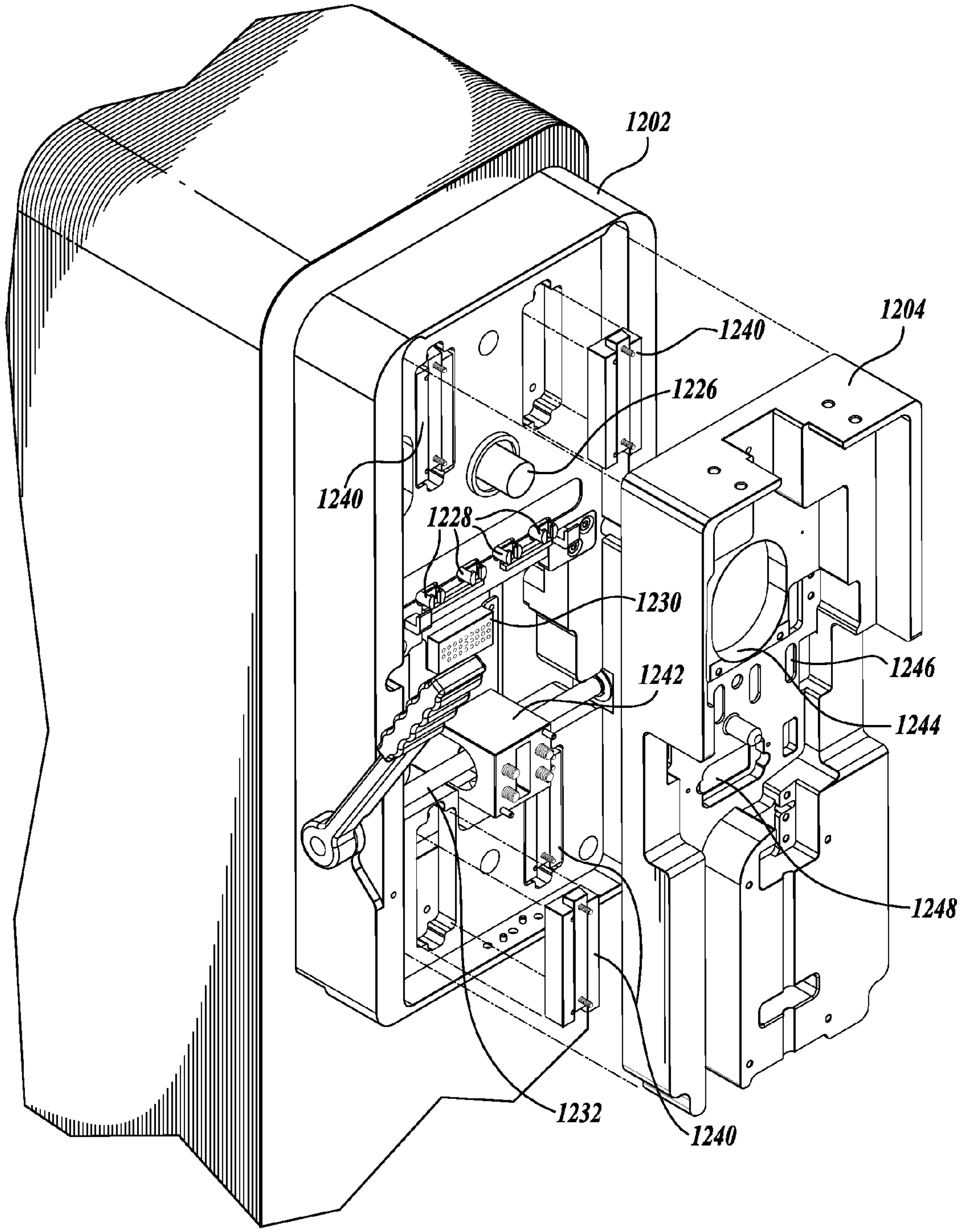
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Fig.18.

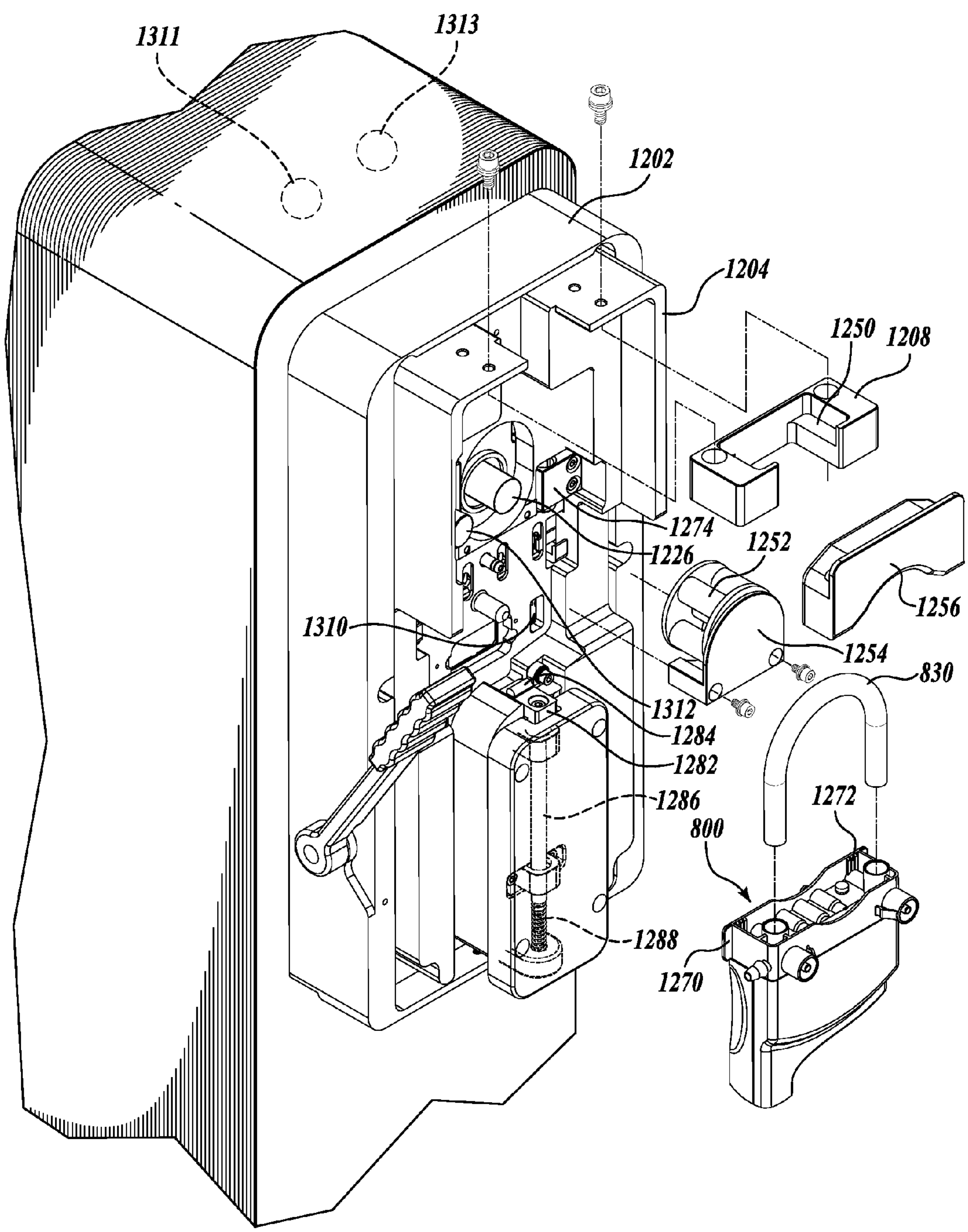
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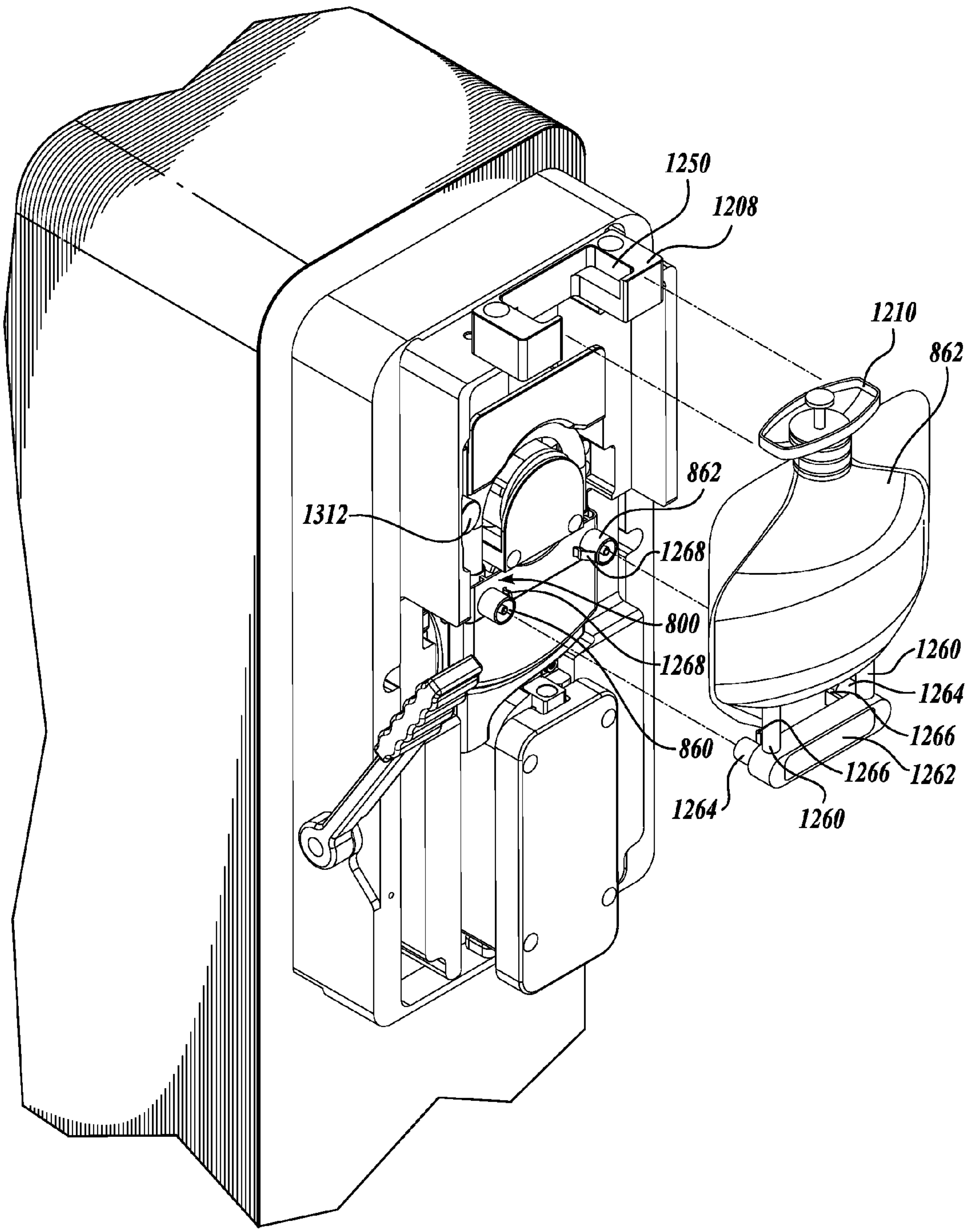
Fig.19.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860
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Fig.20.

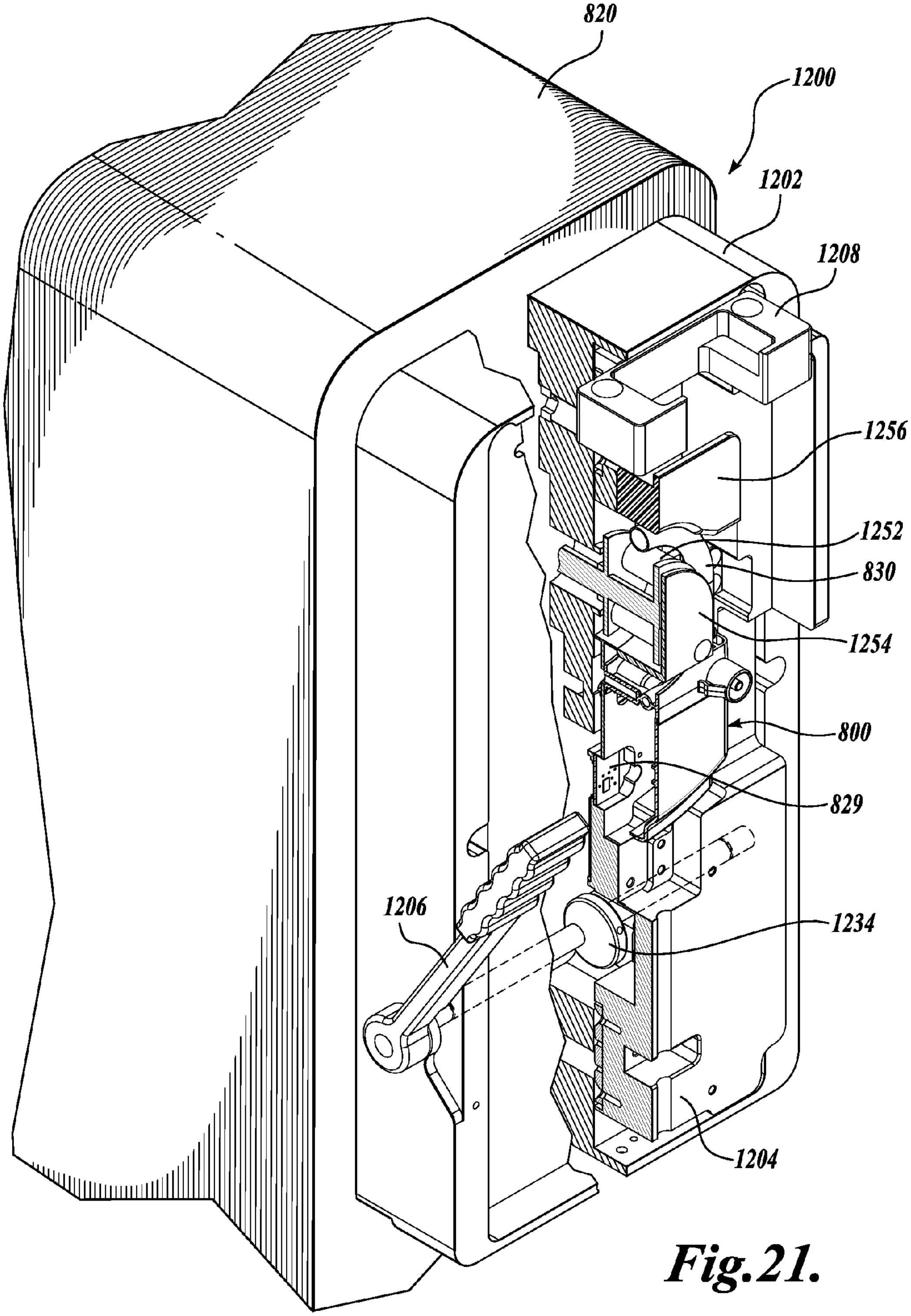
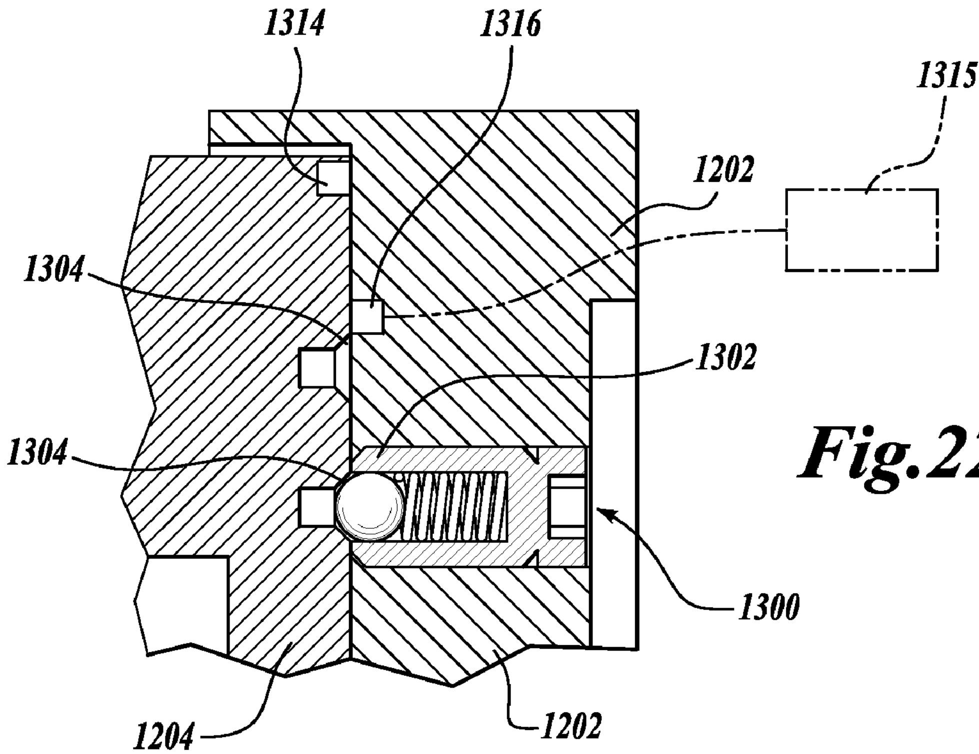


Fig.21.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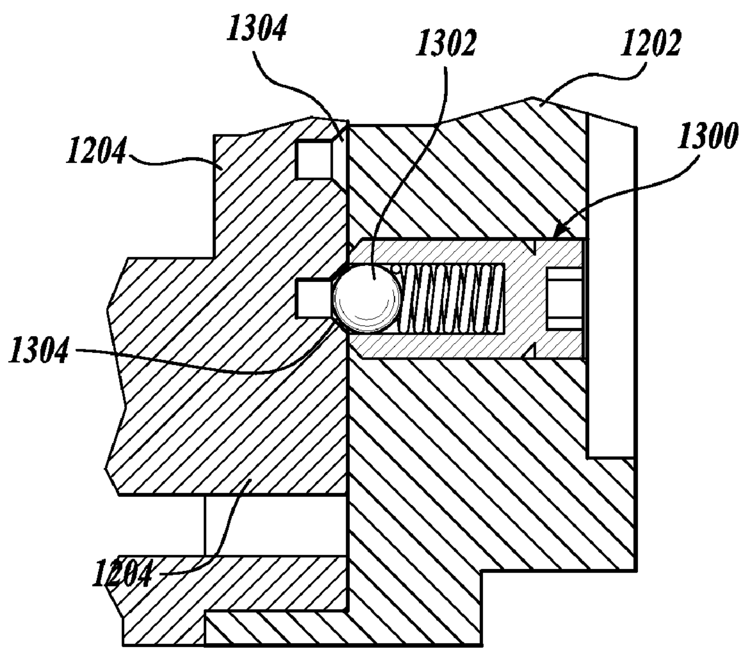
1202

Fig.22.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1204

Fig.23.

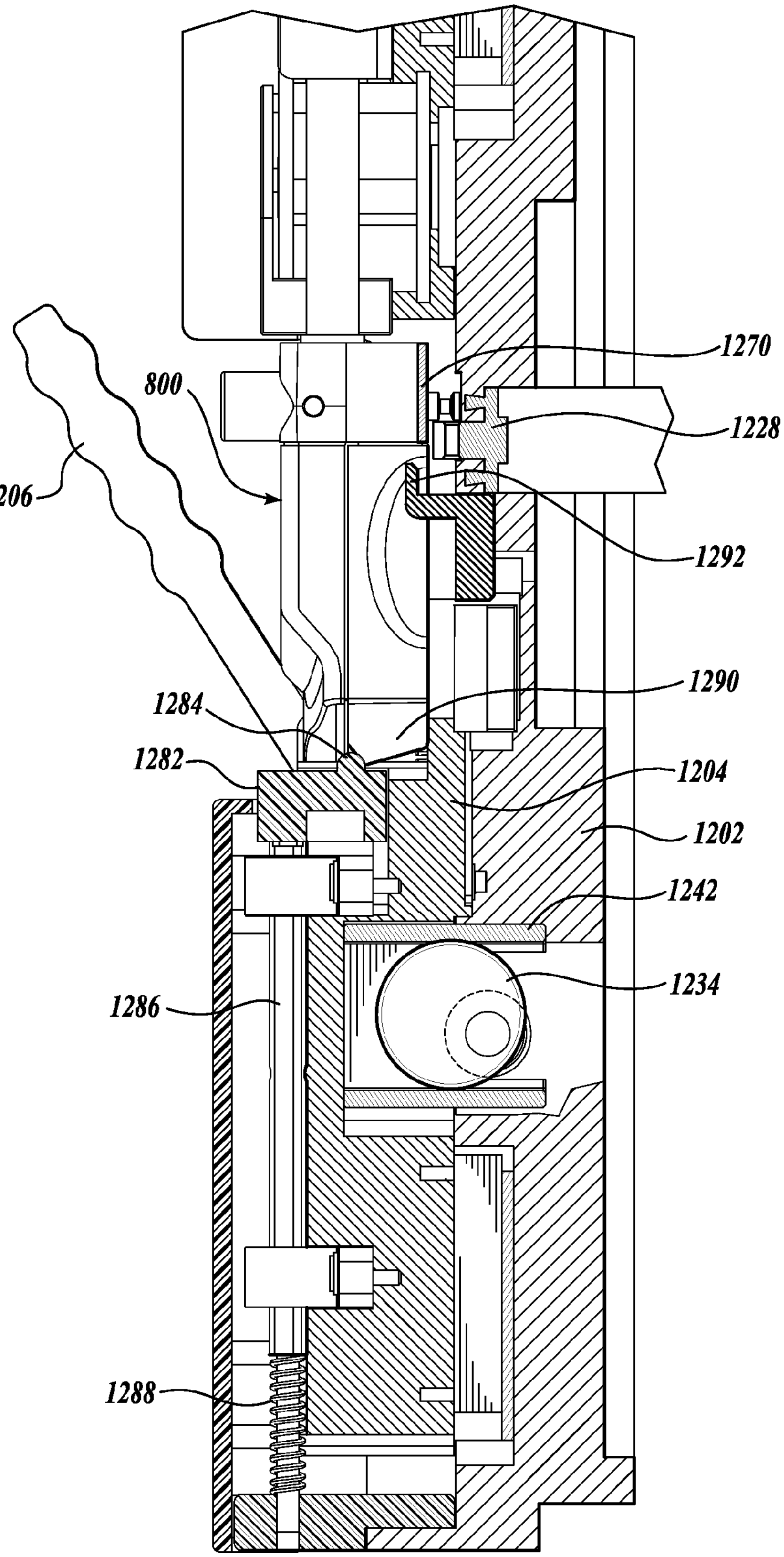
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Fig.24.

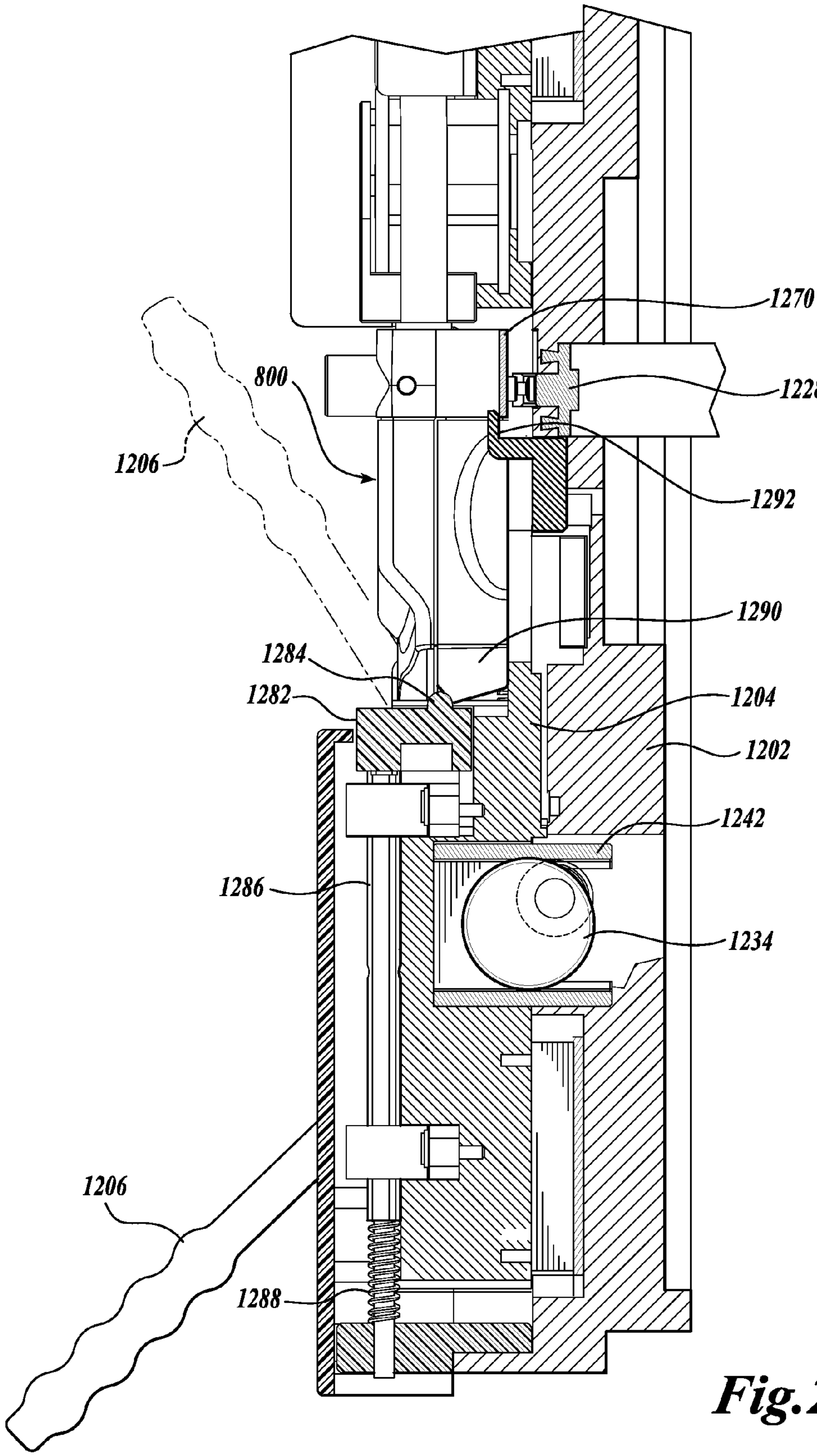
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Fig.25.

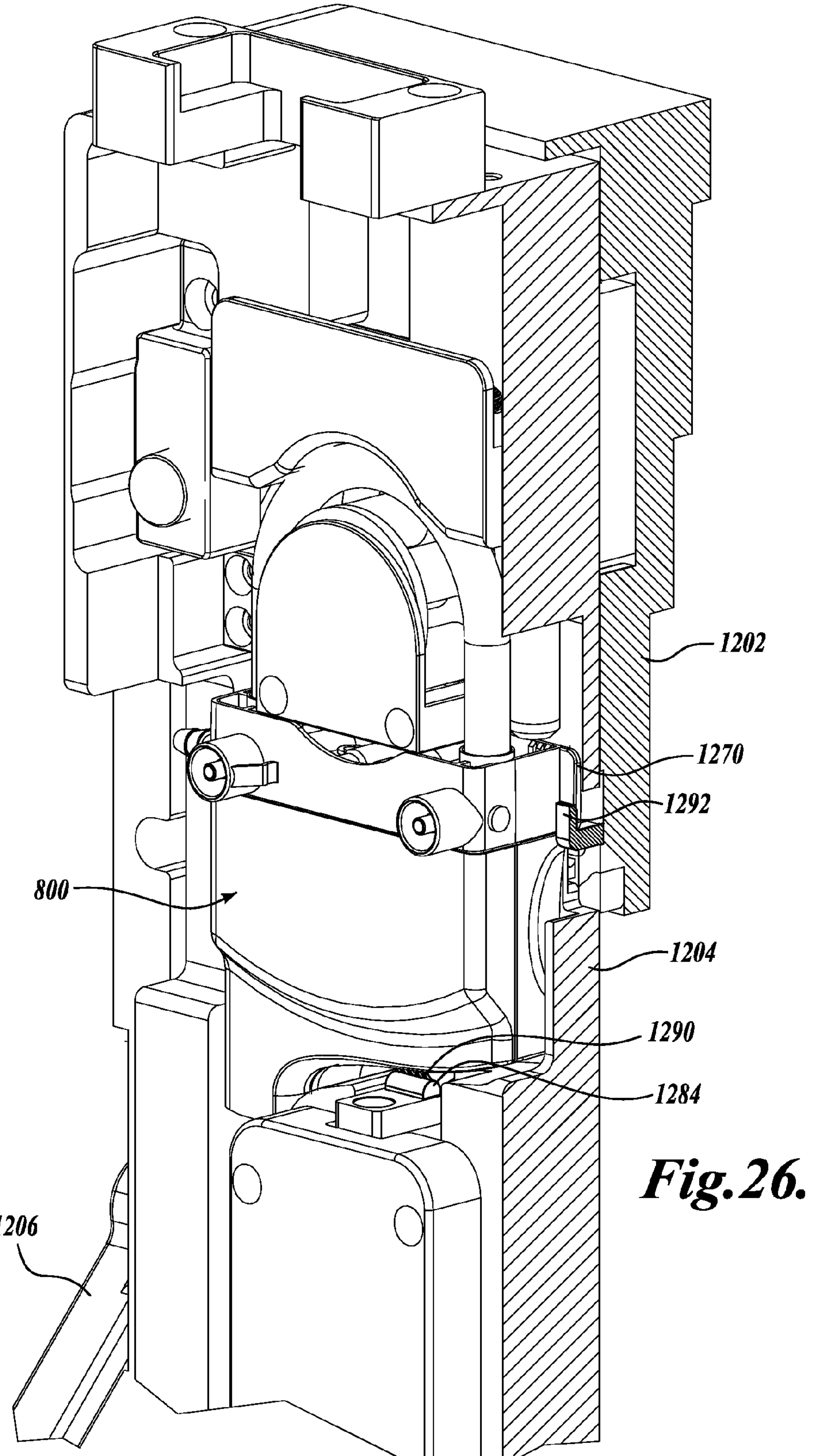

Fig.26.

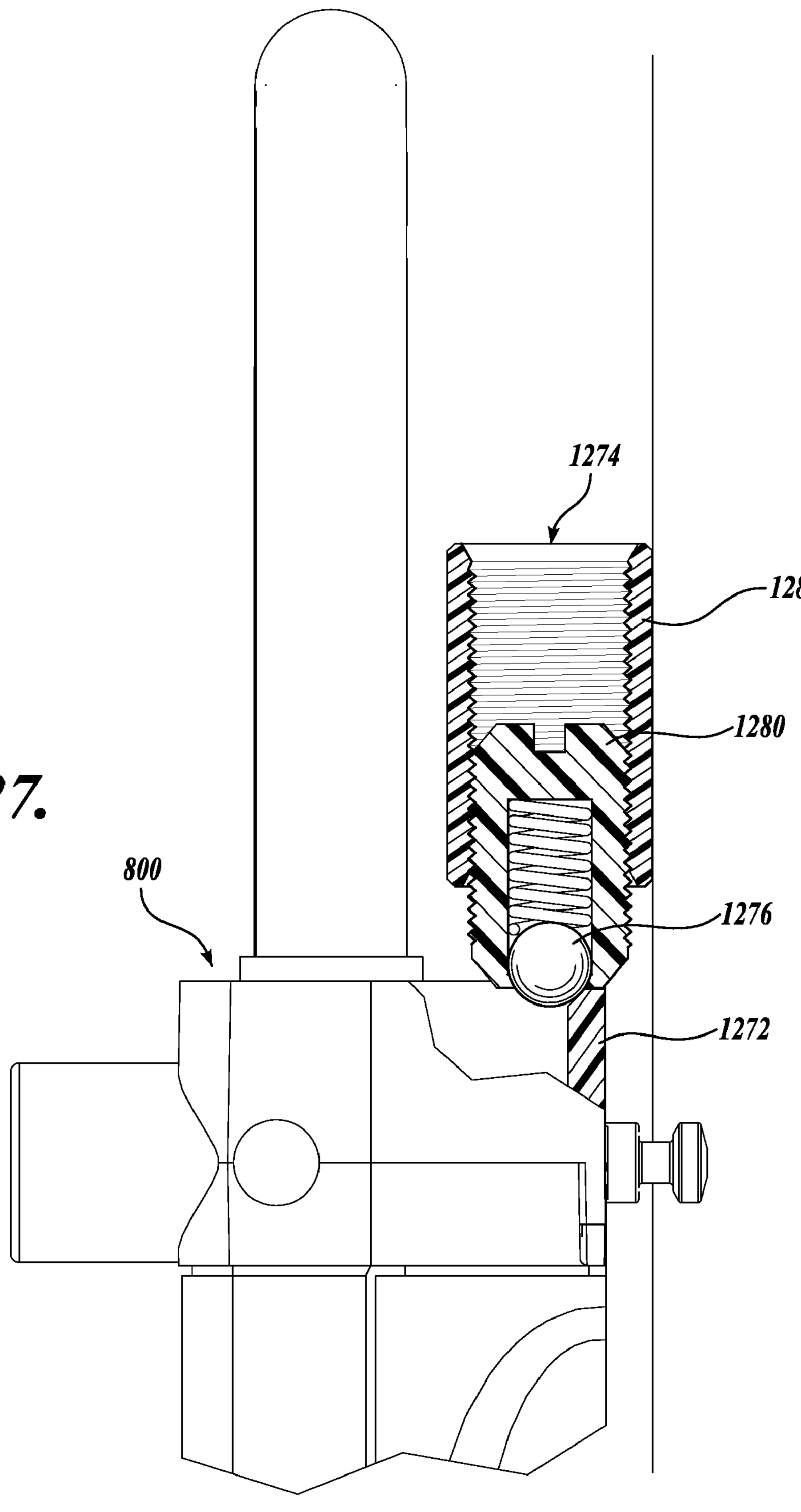

Fig.27.

MULTI-FLUID DELIVERY SYSTEM

CROSS-REFERENCES TO RELATED APPLICATIONS

[0001] This application is a continuation of application Ser. No. 11/430,518, filed May 8, 2006, which is a continuation-in-part of application Ser. No. 11/239,644, filed Sep. 29, 2005, which claims the benefit of Provisional Application No. 60/614,868, filed Sep. 30, 2004, the entire disclosures of which are hereby incorporated by reference herein.

BACKGROUND

[0002] As an aid to the early detection of disease, it has become well established that there are major public health benefits that result from regular endoscopic examination of internal structures, such as the alimentary canals and airways, e.g., the esophagus, stomach, lungs, colon, uterus, ureter, kidney, and other organ systems. A conventional imaging endoscope used for such procedures is formed of a flexible shaft that has a fiber optic light guide that directs illuminating light from an external light source to the distal tip, where it exits the endoscope and illuminates the tissue to be examined. Frequently, additional optical components are incorporated, in order to adjust the spread of light exiting the fiber bundle at the distal tip. An objective lens and fiber optic imaging light guide communicating with a camera at the proximal end of the endoscope or an imaging camera chip installed at the distal tip produces an image that is displayed to the examiner. In addition, most endoscopes include one or more working channels, through which medical devices, such as biopsy forceps, snares, fulguration probes, and other tools, may be passed.

[0003] Navigating the endoscope shaft through complex and tortuous paths in a way that produces minimum pain, side effects, risk, or sedation to the patient is critical to the success of the examination. To this end, modern endoscopes include means for deflecting the distal tip of the endoscope to follow the pathway of the structure under examination, with minimum deflection or friction force upon the surrounding tissue. By manipulating a set of control knobs, the examiner is able to steer the endoscope during insertion and direct it to a region of interest, in spite of the limitations of such traditional control systems, which may be clumsy, non-intuitive, and friction-limited.

[0004] In any endoscopic procedure, there is almost always a need for the introduction and evacuation of different types of fluids, such as water, saline, drugs, contrast material, dyes, or emulsifiers. For example, one endoscopic procedure is a colonoscopy, which is an internal examination of the colon by means of an instrument called a colonoscope. In colonoscopy procedures, typically 5-10% of patients who arrive for the procedure are inadequately prepared (i.e., the colon is not properly cleared and flushed) and are, therefore, turned away. Some patients who are only marginally unprepared can be fully prepared by a physician or their assistant administering doses of liquid and aspirating the colon. However, these procedures are made more difficult and time consuming because it requires the physician to flush and evacuate stool or other debris, which represents a loss of productivity.

[0005] Another endoscopic procedure is an esophagogastroduodenoscopy (EGD), which is an examination of the lining of the esophagus, stomach, and upper duodenum by means of an endoscope that is inserted down the throat. During an EGD procedure, the mixing of bile and water creates a lot of captivating bubbles. These bubbles hinder the physician's visibility during the procedure. As a result, a liquid is often introduced to help reduce the bubbles and, thus, improve visibility.

[0006] Yet another endoscopic procedure is an endoscopic retrograde cholangiopancreatography (ERCP), which is an endoscopic procedure used to identify stones, tumors, or narrowing in the bile ducts. In an ERCP procedure, fluids are used to flush away bleeding from sites. In addition, it is sometimes helpful to introduce dyes for providing contrast to the site. Contrast material, or contrast dye, is a substance used to make specific organs, blood vessels, or types of tissue (such as tumors) more visible on X-rays. Common contrast material substances include iodine, barium, and gadolinium.

[0007] Conventional endoscopes allow the introduction of liquids via a separate delivery device, such as a syringe or injection catheter that is passed through its working channel, in order to deliver the liquid to the distal tip of the endoscope to the target site within a patient's body. This liquid delivery method involves several steps that include, for example, the user selecting a large capacity syringe (e.g., up to 100 cc), the user pouring a desired liquid into a bowl, the user drawing the liquid into the syringe, the user attaching the syringe to the working channel of the endoscope, and the user squeezing the liquid out of the syringe. This cumbersome and time-consuming process is repeated for any and all types of liquids required in any given endoscopic procedure.

[0008] To overcome these and other problems, there is a need for an endoscope having a simplified way to introduce one or more liquids, such as water, saline, drugs, contrast material, dyes, or emulsifiers, that are used in endoscopic procedures, such as a colonoscopy procedure, an EGD procedure, or an ERCP procedure, etc. The endoscopic system should have improved simplicity and ease of use, increased efficiency, and greater clinical productivity and patient throughput. Furthermore, there is a need for improved control of the delivery rate of a liquid and improved mechanisms for mixing two or more fluids. Finally, there is a need for an endoscope that can deliver one or more liquids during a procedure and be inexpensive enough to manufacture that the device can be disposable.

SUMMARY

[0009] This summary is provided to introduce a selection of concepts in a simplified form that are further described below in the Detailed Description. This summary is not intended to identify key features of the claimed subject matter, nor is it intended to be used as an aid in determining the scope of the claimed subject matter.

[0010] The present invention provides a fluid delivery system for use with an endoscope. The fluid delivery system includes an imaging endoscope that may be used in combination with multiple fluid delivery mechanisms. In one embodiment, the imaging endoscope may be designed such that it is sufficiently inexpensive to manufacture that it may be considered a single-use, disposable item.

[0011] Certain embodiments of the invention include a single, large fluid source and pump installed upon a reusable operator console in combination with a small, fluid reservoir and pump installed within a proximal connector of the imaging endoscope. Other embodiments of the invention include multiple fluid sources that feed a common fluid channel and that are pressurized by a common pump. Yet other embodi-

ments of the invention include multiple fluid sources that feed dedicated fluid channels that are pressurized by dedicated pumps, respectively. Yet other embodiments of the invention include a small, fluid reservoir and pump installed within a handheld manual controller of the imaging endoscope or on the proximal connector itself. The multi-fluid endoscopic systems of the present invention provide the user with the flexibility of changing fluids either in advance of a procedure or on-the-fly as needed, instead of relying on fixed fluid sources only. Furthermore, the arrangement of fluid sources, pumps and valves within the multi-fluid endoscopic systems of the present invention provide a controlled fluid delivery rate and a controlled way of mixing fluids.

[0012] In yet another embodiment of the invention, the endoscope includes a proximal connector, including a manifold that delivers a fluid to one or more lumens in the endoscope. Valve pistons or spools are selectively actuated to deliver a pressurized liquid to one or more of its lumens. The proximal connector can be attached to and detached from an interface assembly between the console and the proximal endoscopic shaft leading to the control handle.

DESCRIPTION OF THE DRAWINGS

[0013] The foregoing aspects and many of the attendant advantages of this invention will become more readily appreciated as the same become better understood by reference to the following detailed description, when taken in conjunction with the accompanying drawings, wherein:

[0014] FIG. **1** illustrates a perspective view of a multi-fluid endoscopic system in accordance with an embodiment of the invention;

[0015] FIG. **2** illustrates a side view of an endoscope proximal connector in accordance with an embodiment of the invention;

[0016] FIG. **3** illustrates a flow diagram of an exemplary method of using a multi-fluid endoscopic system of the present invention during a colonoscopy procedure;

[0017] FIG. **4** illustrates a perspective view of a multi-fluid endoscopic system in accordance with another embodiment of the invention;

[0018] FIG. **5** illustrates a perspective view of a multi-fluid endoscopic system in accordance with another embodiment of the invention;

[0019] FIG. **6** illustrates a perspective view of a handheld manual controller that includes a local fluid reservoir in accordance with an embodiment of the invention;

[0020] FIG. **7** illustrates a top view of the integrated fluid reservoir that is installed, optionally, within the handheld manual controller of FIG. **6** in accordance with an embodiment of the invention;

[0021] FIG. **8** illustrates a single use endoscope having a proximal connector positioned on a reusable control unit in accordance with one embodiment of the present invention;

[0022] FIGS. **9**A and **9**B illustrate further details of a proximal connector;

[0023] FIG. **9**C illustrates a rear surface of a proximal connector in accordance with an embodiment of the present invention;

[0024] FIG. **10**A is a cutaway view of the proximal connector in accordance with an embodiment of the present invention;

[0025] FIG. **10**B illustrates a circuit board retaining feature of the proximal connector in accordance with an embodiment of the present invention;

[0026] FIG. **10**C illustrates a cutaway view similar to FIG. **10**A but with additional parts shown;

[0027] FIGS. **11**A, **11**B, and **11**C illustrate a manifold within the proximal connector in accordance with an embodiment of the present invention;

[0028] FIG. **12** illustrates a valve spool within a manifold in accordance with an embodiment of the present invention;

[0029] FIGS. **13**A and **13**B illustrate a vacuum line and valve within a manifold in accordance with an embodiment of the present invention;

[0030] FIG. **14** illustrates a pressure relief valve within a manifold in accordance with an embodiment of the present invention;

[0031] FIG. **15** is a top perspective illustrating attachment of a proximal connector of the type shown in FIGS. **9**-**14** to a console of an endoscope;

[0032] FIG. **16** is a fragmentary top perspective of a portion of the console of FIG. **15** with parts shown in exploded relationship, and FIG. **17** is a corresponding top perspective with parts assembled;

[0033] FIG. **18** and FIG. **19** are corresponding fragmentary top perspectives of the console showing some parts in exploded relationship in each instance;

[0034] FIG. **20** is a corresponding fragmentary top perspective of the console showing most parts assembled, but with a fluid reservoir detached;

[0035] FIG. **21** is a top perspective of the console with parts broken away;

[0036] FIG. **22** and FIG. **23** are enlarged detail vertical sections illustrating detents for relatively moveable parts of the console;

[0037] FIG. **24** and FIG. **25** are corresponding diagrammatic, vertical sections showing parts in different positions;

[0038] FIG. **26** is a diagrammatic, top perspective showing detents on console-mounted interface units for the proximal connector; and

[0039] FIG. **27** is an enlarged, diagrammatic detail of part of the detent mechanism for the proximal connector.

DETAILED DESCRIPTION

[0040] FIG. **1** illustrates a perspective view of an endoscopic system **100** in accordance with a first embodiment of the invention. The endoscopic system **100** includes an imaging endoscope **110** that further includes an endoscope proximal shaft **112** that is electrically, mechanically, and fluidly connected, at one end, to an endoscope proximal connector **114** and, at an opposite end, to an inlet port of a handheld manual controller **116**, and an endoscope distal shaft **118** that is electrically, mechanically, and fluidly connected, at one end, to an output port of handheld manual controller **116**. The endoscope distal tip **120** is located at the opposite end for advancing into a patient's body.

[0041] Imaging endoscope **110** is an instrument that allows for the examination of the interior of a tract, lumen or vessel or hollow organ of a patient. Imaging endoscope **110** further includes an illumination mechanism, an image sensor, and an elongated shaft that has one or more lumens located therein. Imaging endoscope **110** may be sufficiently inexpensive to manufacture, such that it is considered a single-use, disposable item, such as is described in reference to U.S. patent application Ser. No. 10/406,149 filed Apr. 1, 2003, No. 10/811,781, filed Mar. 29, 2004, and No. 10/956,007, filed Sep. 30, 2004, and International Application No. PCT/US2005/035479, filed Sep. 30, 2005, published Apr. 13, 2006, under No. WO2006/039646A2, all assigned to Scimed Life Systems, Inc./Boston Scientific Scimed, Inc., which are incorporated herein by reference. The referenced patent applications describe an endoscope imaging system that includes a reusable control cabinet that has a number of actuators or a manually operated handle on the endoscope that controls the orientation of an endoscope that is connectable thereto. The endoscope is used with a single patient and is then disposed. This assures a sterile instrument for each use. The endoscope includes an illumination mechanism, an image sensor, and an elongated shaft that has one or more lumens located therein. An articulation joint at the distal end of the endoscope allows the distal end to be oriented by the actuators in the control cabinet or by manual control.

[0042] The endoscopic system **100** further includes an operator console **122** that is electrically connected to standard I/O devices, such as a video display and a keyboard. A fluid source **124** is fluidly connected to the endoscope proximal connector **114** of imaging endoscope **110** via a length of tubing **126** that passes through a pump **128** or in another way to achieve the desired flow, such as gravity feed. Fluid source **124** serves as a reservoir that contains a supply of liquid, such as water or saline, for use during a medical procedure. Fluid source **124** may take the form of a rigid vessel or a bladder with a capacity of, for example, up to one liter of fluid. Fluid source **124** may be a refillable vessel, or alternatively, fluid source **124** is sufficiently inexpensive to manufacture that it is considered a single-use, disposable item. Tubing **126** is a length of any standard flexible tubing, for example, ¼-inch tubing, which is also sufficiently inexpensive to manufacture, such that it is considered a single-use, disposable item. Pump **128** is, for example, a standard peristaltic pump that is used to withdraw liquid from fluid source **124** on demand. A peristaltic pump works by means of rollers on rotating arms that pinch the flexible tubing against an arc and, thus, move the fluid along. Pump **128** is capable of delivering, for example, up to 65 pounds/square inch (PSI) of pressure for a flow rate of, for example, 600 ml/min.

[0043] In one embodiment, the endoscope proximal connector **114** of imaging endo scope **110** is electrically and mechanically connected to the exterior of operator console **122**, as shown in FIG. **1**, via a quick-release mechanism for making and breaking all electrical, mechanical, and fluid/air/vacuum connections. The quick-release mechanism allows endoscope proximal connector **114** to be secured easily to the exterior of operator console **122**. Endoscope proximal connector **114** includes wires and tubes that pass through endo scope proximal shaft **112**, then through a handheld manual controller **116**, then through endoscope distal shaft **118**, and then to endoscope distal tip **120**. Additionally, mounted within endoscope proximal connector **114** can be another fluid reservoir that has an associated pump mounted within operator console **122** or controller **116**. Endoscope proximal connector **114** and the additional fluid reservoir are described in more detail below with reference to FIG. **2**.

[0044] Endoscope proximal shaft **112** and endoscope distal shaft **118** are formed of a suitably lightweight, flexible material, such as polyurethane or other biocompatible materials. Endoscope proximal shaft **112** and endoscope distal shaft **118** are elongated shafts that have one or more lumens located therein and wiring located therein to support, for example, a working channel, a jet wash mechanism, an illumination mechanism, and an image sensor located at endoscope distal tip **120**. Also included within handheld manual controller **116** and endo scope distal shaft **118** are the electrical and mechanical mechanisms for articulating endoscope distal tip **120** for manually advancing into a patient.

[0045] Handheld manual controller **116** of imaging endo scope **110** is a handheld device that is electrically and mechanically connected to operator console **122**. Handheld manual controller **116** accepts inputs from a human operator via standard push buttons, rotary knobs, joysticks, or other activation devices, either singularly or in combination, to control the operation of imaging endoscope **110**, which includes the delivery of pressurized liquid from fluid source **124**. Alternatively, a user input device such as a keyboard or other user interface located remotely from the endoscope may accept inputs from a human operator to control the operation of the imaging endo scope **110**, including the delivery of pressurized liquid from fluid source **124**.

[0046] Operator console **122** is a special-purpose electronic and electromechanical apparatus that facilitates, processes, and manages all functions of multi-fluid endoscopic system **100**. Operator console **122** is loaded with software for managing, for example, the operation of imaging endoscope **110** and its associated imaging electronics in order to create and/or transfer images received from an image sensor within imaging endoscope **110** to the video display for viewing by a user, and/or video capture. Operator console **122** further manages the operation of all pumps, such as pump **128**.

[0047] FIG. **2** illustrates a side view of an exemplary endoscope proximal connector **114** in accordance with an embodiment of the present invention. Endoscope proximal connector **114** includes a proximal connector housing **210** that is formed of a suitably lightweight, rigid material, such as molded plastic. An end of tubing **126**, which is a single fluid channel, is split into an arrangement of multiple fluid channels **212**, for example, fluid channels **212***a*, **212***b*, **212***c*, and **212***d*. Fluid channels **212***a*, **212***b*, **212***c*, and **212***d* are fed separately into and along the full length of endoscope proximal shaft **112** to endoscope distal tip **120**.

[0048] Fluid channels **212***a*, **212***b*, **212***c*, and **212***d* are used, for example, for supplying fluid, such as water, from fluid source **124** via pump **128** for (1) cooling light-emitting diodes (LEDs) (i.e., the illumination mechanism), (2) supplying a low pressure bolus wash, (3) supplying a high pressure jet wash, and (4) supplying a lens wash, all of which are located at endoscope distal tip **120**. Multiple fluid channels **212** are controlled via multiple respective pinch valves **214**. More specifically, fluid channels **212***a*, **212***b*, **212***c*, and **212***d* are controlled via pinch valves **214***a*, **214***b*, **214***c*, and **214***d*, respectively. Pinch valves **214** are standard valves, within which the flexible tubing of fluid channels **212** is pinched between one or more moving external elements, in order to regulate the flow of fluid.

[0049] FIG. **2** also shows a fluid reservoir **130** fitted into a recessed cavity **216** within endo scope proximal connector **114**. Fluid reservoir **130** is fluidly connected to a fluid channel **218** that is fed into and along the full length of endoscope proximal shaft **112** and delivers the fluid from fluid reservoir **130** to endoscope distal tip **120**. The flow of fluid is controlled by a pinch valve **220** that is identical to pinch valves **214**. Fluid reservoir **130** is in the form of, for example, a disposable, soft, flexible bag or bladder that is easily detachable from fluid channel **218**. The capacity of liquid held within fluid reservoir **130** is relatively small, compared with the capacity of fluid source **124**. Fluid reservoir **130** may be sized, for example, to hold a small quantity of irrigation liquids, contrast media, medication, or dyes for marking tissue. An access door may be included within proximal connector housing **210** for installing or removing fluid reservoir **130** as needed before, after, or during a medical procedure. The liquid within fluid reservoir **130** may be pressurized with any well-known mechanisms, such as a piston that pushes against the bladder that forms fluid reservoir **130**. Additionally, electrical wires pass through endoscope proximal connector **114** between handheld manual controller **116** and operator console **122** for controlling the flow of fluids via the combined functions of pinch valves **214***a*, **214***b*, **214***c*, or **214***d* and pump **128** and/or pinch valve **220** and the pressurizing mechanism of fluid reservoir **130**.

[0050] In operation, and with continuing reference to FIGS. **1** and **2**, pressurized fluids from fluid source **124** and/or fluid reservoir **130** are delivered along the full length of endoscope proximal and distal shafts **112**, **118** to endoscope distal tip **120**, on demand, under the control of electronics located within operator console **122**. More specifically, pump **128** and the pressurizing mechanism of fluid reservoir **130** are activated, and the user controls the on-demand delivery of fluid, for example, to supply a low pressure bolus wash via the working channel of imaging endoscope **110**, to supply a high pressure jet wash at endoscope distal tip **120**, or to supply a lens wash at endoscope distal tip **120**, all via push buttons on handheld manual controller **116** that control pinch valves **214***a*, **214***b*, **214***c*, or **214***d*. Additionally, the user controls the on-demand delivery of fluid from fluid reservoir **130** via a push button on handheld manual controller **116** that controls pinch valve **220** and the pressurizing mechanism of fluid reservoir **130**, for example, to deliver medication or dye through endoscope distal shaft **118** of imaging endoscope **110** and out of endoscope distal tip **120** to a tissue site within the patient. Pressurized fluids from fluid source **124** and/or fluid reservoir **130** may be delivered continuously to the endoscope distal tip **120** to supply cooling to the LEDs.

[0051] FIG. **3** is a flow diagram of an exemplary method **300** of using multi-fluid endoscopic system **100** to handle a poorly prepared patient during a colonoscopy procedure in accordance with the invention. Method **300** and multi-fluid endoscopic system **100** are not limited to a colonoscopy procedure. Those skilled in the art will recognize that the method steps of method **300** may be adapted easily to apply to any of the various medical procedures that use various types of fluid sources, respectively. Method **300** includes the steps of:

[0052] Step **310**: Preparing the Patient

[0053] In this step, in a predetermined time period prior to the time of the colonoscopy procedure, a patient consumes a quantity of, for example, a phosphosoda solution or a colyte solution, which serves as a laxative to flush stool out of the patient's colon. Alternatively, the patient arrives with no or insufficient preparation and the physician manually clears the patient's colon with a colon preparation endoscope. Method **300** proceeds to step **312**.

[0054] Step **312**: Connecting Imaging Endoscope to Operator Console

[0055] In this step, a user, which may be a physician, nurse, or other assistant, attaches endoscope proximal connector **114** of imaging endoscope **110** to the side of operator console **122** and thereby makes all electrical and fluid connections to operator console **122**. The user activates operator console **122**. Method **300** proceeds to step **314**.

[0056] Step **314**: Mounting Fluid Source and Activating Operator Console

[0057] In this step, a user mounts fluid source **124** to operator console **122** and, subsequently, connects tubing **126**, at one end, to the outlet of fluid source **124** and, at the opposite end, to a port of endoscope proximal connector **114**, while, at the same time, passing a portion of tubing **126** within pump **128**. The user then activates operator console **122**. Method **300** proceeds to step **316**.

[0058] Step **316**: Selecting and Mounting Fluid Reservoir

[0059] In this step, a user selects a fluid reservoir **130** that contains the type of liquid required for the medical procedure, such as a bowel softener in the case of a colonoscopy procedure and, subsequently, mounts fluid reservoir **130** within cavity **216** of endoscope proximal connector **114**. Method **300** proceeds to step **318**.

[0060] Step **318**: Intubating the Patient

[0061] In this step, under the control of operator console **122** and by using the controls of handheld manual controller **116**, the physician intubates the patient, by introducing and advancing endoscope distal tip **120** of imaging endoscope **110** into a body cavity of the patient, until such time that the area of the colon to be cleared may be visualized upon video display of operator console **22**. Method **300** proceeds to step **320**.

[0062] Step **320**: Flushing the Colon

[0063] In this step, under the control of operator console **122** and by using the controls of handheld manual controller **116**, the user alternately flushes and aspirates the patient's colon, by alternately activating the bolus wash and/or jet wash function and a suction function of multi-fluid endoscopic system **100**. Aspiration can be through the working channel, back to a vacuum source (typically a house source) with an appropriate trap for solid matter. In doing so, the user controls the activation of pump **128**, one or more pinch valves **214**, and the connection to the suction/vacuum source via the controls of handheld manual controller **116**. Method **300** proceeds to step **322**.

[0064] Step **322**: Is Colon Clear?

[0065] In this decision step, the user visualizes the colon by using the imaging electronics at endoscope distal tip **120**, in combination with the video display of operator console **122**, to determine whether the bolus wash and/or jet wash of step **320** is effective in breaking down the stool in the patient's colon and, thus, renders the colon clear. If yes, method **300** proceeds to step **326**. If no, method **300** proceeds to step **324**.

[0066] Step **324**: Injecting Bowel Softener

[0067] In this step, under the control of operator console **122** and by using the controls of handheld manual controller **116**, the user injects a bowel softener to help emulsify the stool by controlling pinch valve **220**, such that the bowel softener within fluid reservoir **130** that is mounted within endoscope proximal connector **114** is released and, thus, passes into the patient's colon via fluid channel **218** of endoscope proximal shaft **112**. Method **300** returns to step **320**.

[0068] Step **326**: Completing the Colonoscopy Procedure

[0069] In this step, under the control of operator console **122** and by using the controls of handheld manual controller **116**, the user completes the colonoscopy procedure which may include such steps as selecting another type of liquid for installing into fluid reservoir **130** within cavity **216** of endoscope proximal connector **114**. Such fluids include, for example, an India ink for marking a tissue site. Method **300** then ends.

[0070] FIG. **4** illustrates a perspective view of a multi-fluid endoscopic system **400** in accordance with a second embodiment of the invention. Multi-fluid endoscopic system **400** includes imaging endoscope **110** that is connected to operator console **122** via endoscope proximal connector **114**, as described in reference to FIGS. **1** and **2**. Multi-fluid endoscopic system **400** includes pump **128**, as described in reference to FIG. **1**. Multi-fluid endoscopic system **400** further includes a plurality of fluid sources **410**, e.g., a fluid source **410***a*, **410***b*, and **410***c*, that feed tubing **126** via a tubing subassembly **412** that brings together the tubing from the separate fluid sources **410** to a common line, i.e., tubing **126**, and wherein each fluid source **410** has an associated pinch valve that allows liquid to reach the pump **128**. Each fluid source **410** may take the form of a rigid vessel or a bladder with a capacity of, for example, up to one liter of fluid. Each fluid source **410** may be a refillable vessel, or alternatively, each fluid source **410** is sufficiently inexpensive to manufacture, such that it is considered a single-use, disposable item.

[0071] In operation and with reference to FIG. **4**, pressurized fluids are delivered along the full length of endoscope proximal shaft **112** to endoscope distal tip **120** on demand, under the control of electronics located within operator console **122**, in similar fashion as described in reference to the endoscopic system **100** of FIG. **1**. However, the inclusion of multiple fluid sources **410** in the endoscopic system **100** allows multiple fluid types, such as saline, irrigation liquids, medication, or dyes, to be delivered, singly or mixed with one another, to imaging endoscope **110**, under the control of operator console **122** and in combination with handheld manual controller **116** for controlling pump **128** and the pinch valves of tubing sub-assembly **412**. Furthermore, endoscope proximal connector **114** may include multiple fluid channels **212** and fluid reservoir **130**, as described in reference to FIG. **2** or, optionally, may include a greater or lesser number of fluid channels **212** and not include fluid reservoir **130** of the type illustrated in FIG. **2**.

[0072] FIG. **5** illustrates a perspective view of a multi-fluid endoscopic system **500** in accordance with a third embodiment of the invention. Multi-fluid endoscopic system **500** includes imaging endoscope **110** that is connected to operator console **122** via endoscope proximal connector **114**, as described in reference to FIGS. **1** and **2**. Multi-fluid endoscopic system **400** also includes multiple fluid sources **410**, e.g., fluid source **410***a*, **410***b*, and **410***c*, as described in reference to FIG. **4**. However, instead of including tubing subassembly **412**, each fluid source **410** has its own dedicated length of tubing **126** and dedicated pump **128** that feed endoscope proximal connector **114** of imaging endoscope **110**. For example, fluid source **410***a* is fluidly connected to endoscope proximal connector **114** via a length of tubing **126***a* that passes through pump **128***a*, fluid source **410***b* is fluidly connected to endoscope proximal connector **114** via a length of tubing **126***b* that passes through pump **128***b*, and fluid source **410***c* is fluidly connected to endoscope proximal connector **114** via a length of tubing **126***c* that passes through pump **128***b*, as shown in FIG. **5**. Each fluid source **410**, therefore, has its own dedicated fluid channel **212** and pinch valve **214** within endoscope proximal connector **114**. The dedicated fluid channels **212** pass along the full length of endoscope proximal shaft **112** to endoscope distal tip **120**.

[0073] In operation and with reference to FIG. **5**, pressurized fluids are delivered along the full length of endoscope proximal shaft **112** to endoscope distal tip **120** on demand, under the control of electronics located within operator console **122**, in similar fashion as described in reference to multi-fluid endoscopic system **100** of FIG. **1**. However, the inclusion of multiple fluid sources **410** in multi-fluid endoscopic system **100** allows multiple fluid types, such saline, irrigation liquids, medication, or dyes, to be delivered via a dedicated fluid channel **212** to imaging endoscope **110**, under the control of operator console **122**, in combination with handheld manual controller **116**, for controlling pumps **128***a*, **128***b*, and **128***c* and associated pinch valves **214***a*, **214***b*, and **214***c* within endoscope proximal connector **114**. Optionally, endoscope proximal connector **114** may not include fluid reservoir **130**.

[0074] FIG. **6** illustrates a perspective view of handheld manual controller **116** that includes a local fluid reservoir in accordance with another embodiment of the invention.

[0075] FIG. **6** shows that handheld manual controller **116** includes a controller housing **610** formed of a suitably lightweight, rigid material, such as molded plastic. Controller housing **610** is electrically, mechanically, and fluidly connected, at one end, to endoscope proximal shaft **112** and, at an opposite end, to endoscope distal shaft **118**. Mounted within controller housing **610** of handheld manual controller **116** are a plurality of control buttons **612** that allow the physician to manipulate the functions of the endoscope, such as taking a picture, activating light, activating water, activating air, or activating suction at endoscope distal tip **120**. A plurality of rotary knobs **614** control the articulation of endoscope distal tip **120** for manually advancing into the patient, and a working channel access port **616** allows the insertion of a therapeutic or diagnostic instrument into the working channel of endoscope distal shaft **118**.

[0076] In the example shown in FIG. **6**, handheld manual controller **116** provides an alternative to having a fluid reservoir located within endoscope proximal connector **114**, such as fluid reservoir **130**, as described in reference to FIGS. **1** and **2**. In this example, handheld manual controller **116** further includes an integrated fluid reservoir **618** that has an associated fluid activation button **620**, which provides a conveniently located mechanism for activating the delivery of fluid from integrated fluid reservoir **618**. Integrated fluid reservoir **618** is described in more detail in reference to FIG. **7**.

[0077] FIG. **7** illustrates a top view of an exemplary integrated fluid reservoir **618** that is installed, optionally, within handheld manual controller **116**. Integrated fluid reservoir **618** includes a fluid bladder **710** surrounded on at least two opposite sides by a water bladder **712**. The contacting surfaces between fluid bladder **710** and water bladder **712** are represented by a pressure interface **714**. The combination of fluid bladder **710** and water bladder **712** that form integrated fluid reservoir **618** is installed into a recessed cavity within controller housing **610** of handheld manual controller **116**.

[0078] Fluid bladder **710** is fluidly connected to a fluid channel that is fed into and along the full length of endoscope distal shaft **118** to endoscope distal tip **120**. Fluid bladder **710** is in the form of a disposable, soft, flexible bladder that is easily detachable from within controller housing **610**. Integrated fluid reservoir **618** includes a pinch valve **716** at the outlet of fluid bladder **710** to control the flow of fluid therefrom. Water bladder **712** is also in the form of a soft, flexible bladder; however, water bladder **712** is permanently installed within controller housing **610**. Integrated fluid reservoir **618** includes a pinch valve **718** at the inlet/outlet of water bladder **712** to control the flow of fluid therethrough.

[0079] The capacity of liquid held within fluid bladder **710** is relatively small, compared with the capacity of fluid source **124** or fluid sources **410**. Fluid bladder **710** may be sized, for example, to hold a small quantity of irrigation liquids, contrast media, medication, or dyes for marking tissue. An access door may be included within controller housing **610** of handheld manual controller **116** for installing or removing fluid bladder **710** as needed before, after, or during a medical procedure.

[0080] Integrated fluid reservoir **618** takes advantage of the supply of, for example, water passing through handheld manual controller **116** from, for example, fluid source **124** of the endoscopic system **100** or fluid sources **410** of the endoscopic systems **400** and **500**. More specifically, the flow of water is able to pass in or out of water bladder **712** and, therefore, cause water bladder **712** to expand or contract. When water bladder **712** is expanded, pressure is created against fluid bladder **710** at the pressure interface **714**. As a result, a pressure mechanism is created, and pressurized fluid is forced out of fluid bladder **710** and down the fluid channel of endoscope distal shaft **118** and delivered to endoscope distal tip **120**. In operation, the user activates the pressure mechanism created by the combination of fluid bladder **710** and water bladder **712** via fluid activation button **620**, which activates any associated pump and controls pinch valves **716** and **718** that enable the flow of, for example, water into water bladder **712** and fluid from fluid bladder **710**.

[0081] Those skilled in the art will recognize that the method steps of method **300** may be adapted easily to apply to any of the various medical procedures that use various types of fluid sources, such as shown in FIGS. **1** through **7**. For example, fluid source **124**, fluid reservoir **130**, fluid sources **410**, and integrated fluid reservoir **618**, as described in reference to the endoscopic systems **100**, **400**, and **500** of the present invention, provide the user with the flexibility of changing fluids either in advance of a procedure or on-the-fly as needed, instead of relying on fixed fluid sources only. Furthermore, the arrangement of fluid sources, pumps, and valves within the endoscopic systems **100**, **400**, and **500** of the present invention provide a controlled fluid delivery rate and a controlled way of mixing fluids.

[0082] FIG. **8** shows yet another alternative embodiment of a fluid delivery system for an endoscope. An endoscopic system **100** includes an imaging endoscope **110** having a handheld manual controller **116** that is used by the physician to operate the endoscope and to steer the endoscope distal tip **120**. The proximal end of the endoscope includes a connector **800** that is releasably secured to a reusable console **820**. As will be described in further detail below, the connector **800** supplies liquids to various lumens in the endoscope in order to perform such functions as bolus wash, jet wash, lens wash, as well as providing vacuum and insufflation. The connector **800** is fluidly coupled to a reservoir **810** including a liquid such as water or saline for delivery to the patient. The connector **800** also includes a U-shaped loop of tubing **830** which engages the rollers of a peristaltic pump **840** for providing fluid pressure to the liquid in the reservoir **810** such that it can be selectively delivered to the lumens of endoscope to perform the desired tasks. The connector **800** is also connected via a tube to a vacuum collection jar **850** that captures retrieved aspirated liquids, debris, tissue samples, etc., from the endoscope.

[0083] FIGS. **9**A, **9**B and **9**C illustrate further detail of one embodiment of the proximal connector **800**. In the example shown, the connector **800** is made from a molded housing having front and rear halves **919** that are joined to a molded fluid manifold **920**. The connector **800** is sufficiently inexpensive to manufacture that it can be a disposable item. However, the connector design could also be made to withstand repeated disinfection procedures that are performed with reusable endoscopes.

[0084] As shown in FIG. **9**A, the proximal connector **800** includes a pair of ports **860**, **862** that receive water from and return water to the fluid reservoir **810** shown diagrammatically in FIG. **8** and in much greater detail below. The reservoir is secured to the ports **860**, **862** with a pair of retaining detents **870**, **872** that engage cooperating elements on the reservoir. The proximal connector **800** also includes one or more ergonomic hand grip depressions **880** that facilitate the manual insertion and removal of the proximal connector **800** from the console **820**. As shown in FIG. **9**B, the proximal connector **800** includes a vacuum port **890** that is connected by a tubing to the vacuum collection jar or trap (**850**, shown diagrammatically in FIG. **8**). The U-shaped tubing section **830** receives fluid from the fluid input port **860** and delivers it under pressure to a fluid manifold tube within the connector.

[0085] The rear surface of the connector **800** is shown in FIG. **9**C. This view shows the countersunk fasteners **904** that hold the halves **919** together. The rear surface includes one or more sockets and/or fluid connections **900**, **902** that are received on corresponding guide pegs and/or cooperating fittings on the console (or the interface between proximal connector and console described below) in order to aid in the placement of the proximal connector on the console. In addition, the proximal connector **800** also includes a number of reciprocating valve pistons or spools **910**, **912**, **914**, **916** that are selectively actuated by electromagnetic, hydraulic, pneumatic, or other console-mounted actuator types in order to direct fluids within the manifold **920** to various lumens in the endoscope. An electrical connector **929** is seated within an outwardly extending rim **932** on the rear surface of the proximal connector **800**. The connector **929** serves to connect electrical components within the endoscope to a mating electrical connector on the console.

[0086] FIG. **10**A illustrates some of the internal components of the proximal connector **800**. The proximal connector includes the manifold member **920** which can have a number of ports **922**, **924**, **926** that are activated by movement of the valve spools to selectively deliver pressurized liquid from the reservoir, through the manifold, to various lumens of the endoscope. In the embodiment shown, port **922** delivers liquid for the bolus wash in the endoscope, port **924** delivers liquid for a lens wash and a port **926** delivers liquid for a jet wash.

[0087] The proximal end of the endoscope intermediate shaft **112** (FIG. **8**) fits within a receiving portion **940** of the proximal connector **800**. The receiving portion **940** includes a number of ribs **950** that retain the proximal end of the shaft such that it cannot be easily pulled from the connector **800**. In one embodiment, the receiving portion includes an anti-rotation boss **952** that extends through a hole in the endoscope shaft such that the shaft cannot be rotated within the connector.

[0088] With reference to FIG. **10**B, a cover **960** is placed over the inner surface of electrical connector **929** to secure it in the rear surface of the proximal connector. Cover **960** also acts as a splash guard. The circuit board **929** is held to the rear surface of the connector **800** behind a lip of the outwardly extending rim **932** on the rear surface of the connector **800**. The rim has an opening that exposes the contacts on the connector and a lip that is sized to be smaller than the connector **929**. The cover **960** has an outwardly extending rim **962** that fits within the rim **932** in order to compress the circuit board against the inside surface of the outer rim **932** when the cover **960** is secured to the rear surface of the proximal connector **800**.

[0089] Returning to FIG. **10**A, a series of molded channels **970** operate to guide the various tubes or lumens in the endoscope to the ports **922**, **924**, and **926** that provide fluids to the endoscope as well as a tube that it is connected to. A port **930** provides insufflation gas to the endoscope (with reference to FIG. **9**C, socket **902** receives the insufflation fitting, as compared to socket **900** which receives a larger locating boss).

[0090] Again referring to FIG. **10**A, the proximal connector **800** also includes a four-way fitting **980**. Fitting **980** can direct fluids and air/vacuum to the working channel lumen within the endoscope shaft. Fitting **980** includes a port **982** that is oriented generally in line with the endoscope shaft and is connected to a working channel lumen of the endoscope. A port **984** extends in a direction perpendicular to the port **982** and in the embodiment shown is connected via a tube to the port **922** that supplies water for a bolus wash.

[0091] A port **986** is generally in line with the port **982** and is fluidly coupled by a tube to a bolus wash overpressure valve **990** and an air bleed assembly as will be explained in further detail below. In addition, the fitting **980** includes a fourth port positioned in line with the working channel and beneath the port **986** that is coupled by a tube to a vacuum port below valve **990**. The arrangement of these lines is shown in FIG. **10**C. Port **922** (at the right) for the bolus wash is connected to fitting port **984** (at the left) by a tube **923**. Port **924** (lens wash) connects to and through the endoscope proximal shaft by a tube **925**. Similarly, a tube **927** leads from the port **926** (jet wash) and a tube **931** leads from the port **930** (insufflation) into and through the endoscope proximal shaft. Ports **922**, **924** and **926** communicate with the common manifold whereas port **930** does not. Ports **1002**, **1004** and corresponding tubes **1003**, **1005** can be configured to supply a cooling flow of liquid to the endoscope LEDs or other heat generating components. A wiring harness (represented by broken line **934**) also extends along or through the endoscope shaft and connects to the electrical connector below the cover **960**.

[0092] FIGS. **11**A, **11**B and **11**C illustrate further detail of the manifold **920** within the proximal connector. In the embodiment shown, the manifold is molded as a separate piece and is joined to the front and rear halves of the proximal connector **800**. The manifold **920** includes a common tube or channel **1000** which is fluidly connected to each of the ports **922**, **924** and **926**. In addition, the tube **1000** includes the port **1002** that continually delivers a cooling liquid through a lumen to a heat exchanger within the distal tip of the endoscope in order to cool the illumination devices. In addition, the manifold **920** includes a port **1004** which receives the cooling liquid back from the heat exchanger and supplies it to the port **862** for return to the liquid reservoir. The corresponding tubes **1003** and **1005** are seen in FIG. **10**C.

[0093] Other aspects of the tube routing through the manifold component are best seen in FIG. **11**B. Vacuum port **1050** connects to the bottom port of the four-way fitting **980** (fitting **980** is seen, for example, in FIGS. **10**A and **10**C) below port **986**. A pressure control loop tube **993** connects between a bottom manifold vacuum port **995** and the upper valve **990**. An upper bleed control check valve **997** connects to the vacuum tube on the distal side of valve **990**. Operation of the vacuum system is described in more detail below.

[0094] FIG. **11**C illustrates how the U-shaped flexible tubing **830** is secured within two ports **832**, **834** on the top of the manifold. The port **832** is fluidly coupled to the port **860** that receives liquid from the fluid reservoir. The port **834** is fluidly coupled to the tube **1000** in the manifold **920**. The tubing **830** is preferably made of propylene or other flexible material that can be pressurized by the rollers of the pump wheel for the peristaltic pump on the console.

[0095] FIG. **12** illustrates further detail of the valve pistons or spools within the ports connected to the manifold. As indicated above, the manifold includes a tube **1000** that contains a pressurized liquid to deliver to each of various liquid ports. In each of the liquid ports, for example, port **922**, liquid within the tube **1000** flows through a cylindrical chamber **1010** having an opening **1012** that fluidly connects the chamber **1010** with the tube **1000**. Chamber **1010** has a first diameter in the space between the port **922** and the tube **1000** and a larger diameter in a region **1016** occupying the remainder of the chamber. A generally cylindrical valve piston or spool, such as valve spool **916**, is slidably received within the valve chamber **1010**. The valve spool includes a pair of longitudinal spaced O-rings **1018**, **1020**. O-ring **1018** has a smaller diameter that is for reception within the smaller diameter section **1014** of the chamber **1010**. Moving the O-ring **1018** into the smaller diameter section **1014** seals the port **922** from receiving fluids from the tube **1000**. Conversely, retracting the valve spool in the chamber **1010** creates a fluid path between the tube **1000** and the port **922** when the O-ring **1018** is below the port **922** (the position shown in FIG. **12**). At the transition of the larger and smaller diameters of the valve chamber, the chamber is chamfered at an area **1026** to prevent the O-ring **1018** from becoming sheared as the valve spool assembly is moved back and forth. In one embodiment of the invention, the chamfer is set at approximately 30 degrees.

[0096] The valve spool also includes a notched section **1021** in which a corresponding tab **1022** from the rear half of the proximal connector is fitted thereby retaining the valve spool in the manifold **920** and limiting the range of motion of the spool. Finally, the valve spool includes a stepped neck portion **1024** of a smaller diameter that allows the spool to be grasped at the enlarged head **1025** by a console-mounted actuator to move the valve spool in and out to close and open the valve.

[0097] FIGS. **13**A and **13**B illustrate the vacuum valve assembly within the manifold. The vacuum assembly includes a vacuum port **1050** that is connected by a tube to a port on the four-way fitting **980** that is generally in line with the working channel lumen of the endoscope. The valve assembly includes a valve piston or spool **910** having a construction similar to that described above, which is selectively moved by an actuator to provide fluid communication between the vacuum port **1050** and the port **890** that is coupled to the vacuum collection jar or trap and house vacuum source or another vacuum source. FIG. **13**A also shows the low pressure bolus wash bypass port **990** that is fluidly connected to the vacuum port **890**. If a bolus wash is applied while the physician has a tool in the working channel or while the working channel is blocked, liquid supplied from the manifold will open a valve in the low pressure bolus wash bypass port **990**. By entering the bypass port **990**, the working channel is prevented from becoming pressurized with a liquid that may splash onto a physician or assistant.

[0098] Further detail of the low pressure bolus wash bypass valve is shown in FIG. **14**. The bypass port **990** includes an insert **1060** that secures a ball valve **1070** and biasing spring **1080** in the port **990**. The insert **1060** has a lip that mates with the surface of the ball valve **1070** in the port **990** by virtue of pressure from the spring **1080**. Once the pressure of the bolus wash liquid in the port **990** overcomes the spring force of the spring **1080**, the ball valve **1070** is opened thereby allowing passage of liquid through the insert **1060** and port **990** to the vacuum port **890**. Also shown in FIGS. **13**B and **14**, the manifold also includes a high pressure bypass valve **1111** including a ball valve **1100** and spring **1110** that operate to relieve pressure in the manifold tube **1000**. If pressure within the tube **1000** exceeds the spring force of the spring **1110**, ball valve **1100** is forced open thereby opening a fluid channel between the manifold tube **1000** and the low pressure side of the tubing **830**. In some embodiments of the invention, it may be necessary to employ a metal seating ring within the cylinder of the high pressure bypass valve in order to provide proper mating seal between the cylinder and the ball valve **1100**.

[0099] The vacuum system allows liquids and solid material, including polyps, to be aspirated through the endoscope and the manifold piece **920** of the proximal connector **800**. In FIG. **13**A, valve piston or spool **910** is shown in the "open" position in which maximum aspiration is provided through the port **1050** in the direction of the arrow **991**, up through the manifold piece to the suction outlet **890**. The aspiration (vacuum) system provides two additional features. Check valve **997** provides for a small bleeding air flow from the atmosphere into the upper tube **999** which, in turn, is connected back to the vacuum port by way of the four-way connector described above. In some scenarios, the distal tip of the endoscope will stick to the lining of the large intestine sufficiently that vacuum is maintained when the vacuum valve **910** is closed. Check valve **997** allows the aspiration channel to return to atmospheric pressure for easy removal of the distal tip of the endoscope from the lining. The bleed bypass tube **993** provides another feature. In the open condition, for maximum aspiration, shown in FIG. **13**A, the bleed tube **993** and port **995** are sealed from the aspiration channel which leads to the vacuum port **890**. However, the notched portion **911** of the vacuum valve and the inner face **913** of port **995** are configured such that, when the valve is closed, there is some small air communication from outside the valve to the bleed tube **993**, and from there into the endoscope working channel. This prevents the full force of the house vacuum from being instantaneously drawn upon opening of the valve. Rather, the vacuum ramps up when the valve is opened, based on the bleed permitted when the valve is closed.

[0100] FIGS. **15**-**27** show more detailed aspects of the attachment of the proximal connector **800** to the console **820**, although these views are still somewhat diagrammatic and have part sizes exaggerated for ease of description. With reference to FIG. **15**, to orient the parts, the endoscope distal end **120** is connected by a distal shaft section **118** to the hand controller **116**. Controller **116** is connected to the proximal connector **800**, of the type described with reference to FIGS. **9**-**14**, by the proximate endoscope shaft section **112**. Knobs and buttons on the controller **116** provide for articulation of the endoscope distal end portion and control of illumination, bolus wash, high pressure wash, and so on. The handheld controller **116** also has the working channel access port **16**, shown diagrammatically, by means of which probes, tools, and so on, may be introduced into the working channel of the endoscope. The proximal connector **800** attaches to the console **820** by way of an interface **1200** which includes a first interface plate **1202** and a sliding plate **1204** that moves up and down relative to plate **1202** by manipulation of a swinging handle **1206**. The sliding plate **1204** has a top mount **1208** for the cap portion **1210** of a liquid reservoir **810**. Such reservoir hangs from the mount **1208** and is attached at the bottom to the proximal connector **800**. In general, with the handle **1206** swung upward to a first receiving position such that the sliding plate **1204** is in a vertically raised position, the proximal connector **800** is manually fitted onto the sliding plate, and the reservoir **1212** is connected. The sliding plate forms a recess or socket of the approximate size and shape of the periphery of the body of the proximal connector **800**. As described in detail below, swinging of the handle **1206** downward shifts the sliding plate **1204** downward to a second operating position and secures the various valve pistons or spools to console-mounted actuators.

[0101] With reference to FIG. **16** (parts shown exploded) and FIG. **17** (parts shown assembled), the stationary interface plate **1202** is secured to a pump and valve actuator assembly **1220**. Plate **1202** and assembly **1220** are slid rearward into a cavity **1222** of the console **820** and secured by fasteners **1224**. Assembly **1220** includes the rotary shaft **1226** for the peristaltic pump, as well as end effectors **1228** (from solenoids, for example) for the proximal connector valves. In the assembled condition shown in FIG. **17**, the pump shaft **1226** is exposed and protrudes from the interface plate **1202**. Similarly, the reciprocating end effectors **1228** extend through holes or slots of the plate **1202** so that there is no interference with reciprocating movement that ultimately controls opening and closing of the valves. Plate **1202** also has an opening for the electrical connector **1230**.

[0102] The swinging lever **1206** connects to a transverse shaft **1232** having a projecting cam lobe **1234** at about its center. Up and down swinging movement of the lever **1206** rotates the horizontal shaft and the cam lobe such that the cam moves down when the lever moves down and up when the lever moves up.

[0103] FIG. **18** shows parts of the sliding plate **1204** broken away from the interface plate **1202**. The sliding plate connects to the interface plate by linear bearings **1240** which include slide blocks secured to the sliding plate and vertical channels secured to the interface plate. A follower **1242** fits over the cam of shaft **1232** and is secured to the rear of the sliding plate **1204**. The sliding plate has a vertically elongated opening **1244** for the pump shaft **1226** and vertically elongated openings **1246** for the end effectors **1228**. The console electrical connector **1230** is carried by the sliding plate and projectors through a hole **1248**.

[0104] FIG. **19** shows most of the components of the sliding plate **1204** connected to the interface plate **1202**. The reservoir mount **1208** connects to the sliding plate at the top and has a stepped opening **1250** that the cap of the reservoir fits in. The pump wheel **1252** is keyed to the pump shaft **1226**. A guard plate **1254** covers the outer end and bottom part of the pump wheel **1252**. The pump wheel cooperates with an occlusion plate **1256** which is secured to the sliding plate above the pump wheel. When the sliding plate is lowered, the occlusion plate holds the tube **830** of the proximal connector **800** in working relationship with the pump wheel.

[0105] With reference to FIG. **20**, showing the parts assembled except for the reservoir **810**, the cap **1210** of the reservoir is rigid or substantially rigid and sized to fit in the stepped opening **1250** of the mount **1208**. The central bag of the reservoir can be flexible, with bottom fittings **1260** that mate with corresponding fittings of a rigid horizontal connector **1262**. Connector **1262** has rear ports **1264** that fit snugly in the ports **860**, **862** of the proximal connector **800**. Latch fingers **1266** adjacent to the ports **1264** interfit with the detents **1268** adjacent to the ports **860**, **862** for reliably maintaining a fluid-tight connection between the reservoir and the manifold piece of the proximal connector **800**. It should be noted that the reservoir can be connected to the sliding plate and proximal connector, and detached therefrom, with one hand. During assembly, the reservoir is hung from the mount **1208** by its cap **1210**, followed by pressing the horizontal connector **1262** inward until the firm snap fit of the latch fingers **1266** in the detents **1268** is detected. Similarly, only one hand is required to detach or change the reservoir, by pulling outward on the connector **1262** sufficiently to release the detents, followed by lifting the cap **1210** from the mount **1208**.

[0106] Similarly, the proximal connector itself can be secured to the sliding plate **1204** with one hand. Adjustable detents can be provided to reliably hold the proximal connector in position against the sliding plate, but not so tight that they cannot be overcome with one hand when the operating lever is in its up position. Preferably, spring loaded detents are provided toward the top and bottom of the proximal connector where it fits in the sliding plate **1204**.

[0107] With reference to FIG. **19**, in one embodiment the top manifold piece of the proximal connector **800** has thin tabs or wings **1270** at opposite sides, and closely adjacent ribs **1272** in recessed portions or sockets inward of the tabs. Still referring to FIG. **19**, spring loaded detents **1274** are provided at each side of the sliding plate, only one such detent being shown in FIG. **19**. The general construction of each detent is shown in more detail in FIG. **27**. Each detent **1274** has a spring loaded ball **1276** positioned to overlie the detent ribs **1272** on the proximal connector **800**. The force required to push the upper portion of the proximal connector into position can be adjusted (e.g., lessened from the position shown in FIG. **27**) by mounting the spring loaded ball in an externally threaded stud **1280** which itself is threaded within a sleeve **1282** secured to the sliding plate.

[0108] Another spring loaded detent is provided toward the bottom portion of the proximal connector. FIG. **19** shows the detent plate **1282** with a transverse projection **1284**. Plate **1282** and its projection **1284** are carried on a spring loaded rod **1286** biased upward by the bottom spring **1288**. This construction is also seen in, for example, FIG. **24**. The corresponding detent piece on the proximal connector can be seen in various views, including, for example, FIGS. **10**A and **10**C where it is labeled **1290**. Detent piece **1290** has opposite sloping surfaces which cooperate with the projection **1284** by wedging it downward, against the biasing force of spring **1288**, as the proximal connector is inserted. FIG. **24** shows the position after the proximal connector **800** has been inserted into the sliding plate and the front angled or ramped portion of the detent piece **1290** fits behind the projection **1284**. From this position, preferably after connection of the reservoir, the operating handle **1206** can be swung downward to the position shown in FIG. **25**. The cam **1234** cooperates with the follower to move the slide plate **1204** downward and compress the bottom spring **1288**. At the same time, the wings **1270** toward the top of the proximal connector fit behind stationary hooks **1292** carried by the interface plate **1202** (see also FIG. **26**). Substantially greater force holds the projection **1284** up behind the recess formed by the back of the ramp **1290** when the lever **1206** has been swung down to the position of FIG. **25** than when it is in its up position with the spring **1208** less compressed as shown in FIG. **24**. As the plate shifts downward, the valve spool ends or caps fit into the effectors **1228**. Preferably, the electrical connection is made when the proximal connector is first attached (lever raised) and is maintained as the sliding plate is lowered. For example, the electrical connector **1230** of the console can include spring-loaded pins ("pogo pins") that mate with corresponding contacts on the electrical board **829** of the proximal connector. Alternatively, a different electrical connection could be used such that the electrical contacts on the separate parts are connected as the sliding plate moves down to the operating position.

[0109] Additional precautions can be provided to assure that a secure and correct connection is made between the proximal connector and the console. FIGS. **22** and **23** show detent mechanism **1300** providing tactile feedback for the operator when the lever is in the full up or full down position. The interface plate **1202** carries spring-loaded balls **1302** which fit in tapered recesses **1304** of the sliding plate **1204** when the sliding plate is in the full up or full down position. It also is preferred that sensors and indicators be provided so that the operator can easily distinguish whether or not proper connections have been made. With reference to FIG. **19**, an optical sensor **1310** can be mounted on the interface plate **1202** in line with an opening of the sliding plate, to detect when the proximal connector **800** has been seated in the sliding plate. An operator may detect this by an indicator on the graphical user interface, represented diagrammatically at **1311** in FIG. **19**. As seen in FIGS. **19** and **20**, a capacitive sensor **1312** can be provided adjacent to the pump wheel to detect the presence of the reservoir **810** if filled with liquid to a height at least as high as the capacitive sensor. A corresponding indicator **1313** (FIG. **19**) can be provided on the graphical user interface. In a representative embodiment, the reservoir may hold 500 ml of liquid, and the capacitive sensor may detect when the liquid bevel has fallen below 200 ml or so. With reference to FIG. **22**, another sensing mechanism can detect the position of the sliding plate **1204** relative to the stationary interface plate **1202**. In the illustrated embodiment, a small magnet **1314** is carried on the rear of the sliding plate, in line with a Hall effect sensor **1316** carried on the stationary plate. An indicator **1315** can be provided on the graphical user interface so that the operator can easily tell when the sliding plate has been moved down to the operating position in which the magnet will overly the Hall effect sensor.

[0110] As will be appreciated by those of ordinary skill in the art, the present invention is not limited to the configurations of endoscopic systems as described and shown in reference to FIGS. **1** through **27**. For example, the present invention may be used with an endoscope that is steered by actuators in the console in response to commands received from a user input device such as a joystick or other mechanism. Furthermore, the manifold in the connector **800** may also be used to deliver liquid from alternate fluid sources either in the proximal connector or the endoscope such as is shown in FIGS. **1** and **6**.

[0111] While illustrative embodiments have been illustrated and described, it will be appreciated that various changes can be made therein without departing from the spirit and scope of the invention.

1. An interface between an endoscope shaft proximal end connector and a console, the console and proximal end connector having a first set of separate mating connectors that mate for control of the endoscope, said interface comprising:

a member mounted on the console adjacent to the mating connector of the console, the member being moveable relative to the console between a first receiving position and a second operating position, the member being adapted to receive the proximal end connector of the endoscope shaft when in the first position, the mating connectors of the console and proximal end connector being in non-mating relationship when the plate member is in the first position after receiving the proximal end connector and being in mating relationship when the member is moved to the second position.

2-**29**. (canceled)

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