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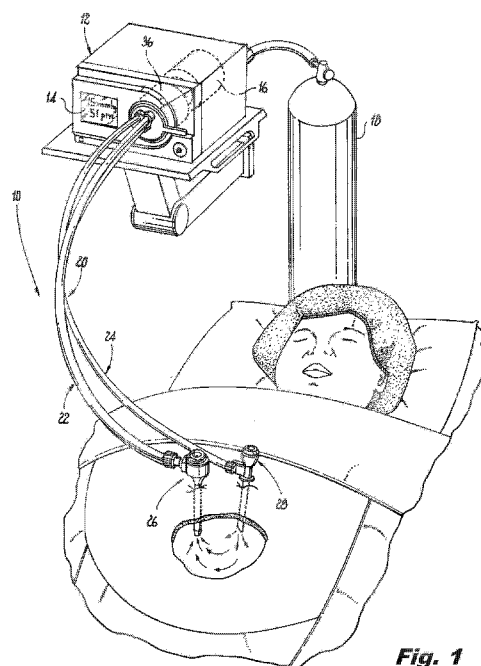


Fig. 1

(57) Abstract: A system for performing a laparoscopic surgical procedure that includes a bifurcated multi-lumen tube set including a dual lumen portion having a pressurized gas line and a return gas line, and a single lumen portion having a gas supply and sensing line for delivering insufflation gas to the abdominal cavity of the patient and for periodically sensing pressure within the abdominal cavity of the patient, a first abdominal port for communicating with the dual lumen portion of the tube set a second abdominal port for communicating with the gas supply and sensing line of the tube set.



**GAS CIRCULATION SYSTEM  
WITH A SINGLE LUMEN GAS SEALED ACCESS PORT  
FOR USE DURING LAPAROSCOPIC SURGICAL PROCEDURES**

5    **CROSS-REFERENCE TO RELATED APPLICATION**

This application claims the benefit of priority to U.S. Provisional Patent Application Serial No. 62/468,417 filed March 8, 2017 and U.S. Patent Application No.: 15/896,272 filed February 14, 2018, the disclosure of which is herein incorporated by reference in its entirety.

10   **BACKGROUND OF THE INVENTION**

1.    **Field of the Invention**

The subject invention is directed to laparoscopic surgery, and more particularly, to a surgical gas circulation system with a single lumen gas sealed access port for use during a laparoscopic surgical procedure.

15   2.   **Description of Related Art**

Laparoscopic or "minimally invasive" surgical techniques are becoming commonplace in the performance of procedures such as cholecystectomies, appendectomies, hernia repair and nephrectomies. Benefits of such procedures include reduced trauma to the patient, reduced opportunity for infection, and decreased  
20   recovery time. Such procedures within the abdominal (peritoneal) cavity are typically performed through a device known as a trocar or cannula, which facilitates the introduction of laparoscopic instruments into the abdominal cavity of a patient.

Additionally, such procedures commonly involve filling or "insufflating" the abdominal (peritoneal) cavity with a pressurized fluid, such as carbon dioxide, to create  
25   what is referred to as a pneumoperitoneum. The insufflation can be carried out by a surgical access device (sometimes referred to as a "cannula" or "trocar") equipped to deliver insufflation fluid, or by a separate insufflation device, such as an insufflation

(veress) needle. Introduction of surgical instruments into the pneumoperitoneum without a substantial loss of insufflation gas is desirable, in order to maintain the pneumoperitoneum.

During typical laparoscopic procedures, a surgeon makes three to four small  
5 incisions, usually no larger than about twelve millimeters each, which are typically made with the surgical access devices themselves, often using a separate inserter or obturator placed therein. Following insertion, the obturator is removed, and the trocar allows access for instruments to be inserted into the abdominal cavity. Typical trocars often provide a pathway to insufflate the abdominal cavity, so that the surgeon has an  
10 open interior space in which to work.

The trocar must also provide a way to maintain the pressure within the cavity by sealing between the trocar and the surgical instrument being used, while still allowing at least a minimum freedom of movement of the surgical instruments. Such instruments can include, for example, scissors, grasping instruments, and occluding  
15 instruments, cauterizing units, cameras, light sources and other surgical instruments. Sealing elements or mechanisms are typically provided on trocars to prevent the escape of insufflation gas. These sealing mechanisms often comprise a duckbill-type valve made of a relatively pliable material, to seal around an outer surface of surgical instruments passing through the trocar.

20 SurgiQuest, Inc., a wholly owned subsidiary of ConMed Corporation has developed unique gas sealed surgical access devices that permit ready access to an insufflated surgical cavity without the need for conventional mechanical valve seals, as described, for example, in U.S. Patent No. 7,854,724. These devices are constructed from several nested components including an inner tubular body portion and a coaxial  
25 outer tubular body portion. The inner tubular body portion defines a central lumen for

introducing conventional laparoscopic surgical instruments to the abdominal cavity of a patient and the outer tubular body portion defines an annular lumen surrounding the inner tubular body portion for delivering insufflation gas to the abdominal cavity of the patient and for facilitating periodic sensing of abdominal pressure.

5           While these earlier developed dual lumen gas sealed access devices provide significant benefits and improvements over conventional single lumen valve sealed access devices, they do present certain disadvantages in the performance of a laparoscopic surgical procedure. In particular, because these earlier developed access devices are constructed with two coaxial tubular body portions, the effective outer  
10   diameter of the tubular body of the access device is significantly greater than the effective outer diameter of the tubular body of a conventional valve sealed access device.

For example, the outer diameter of the dual lumen gas sealed access device may be at least 2.0 mm greater than the outer diameter of a conventional single lumen valve  
15   sealed access device. Consequently, the length of the incision that is required to introduce the dual lumen access device into the abdominal cavity will be greater than the typical incision that is made for introducing a conventional single lumen valve sealed access device. This larger incision can increase the degree of patient trauma, cause larger and more visible scars for the patient, more pain or pain medication, and  
20   more difficult wound closure for the surgeon.

It would be beneficial therefore to provide a gas sealed surgical access device that overcomes the disadvantages associated with earlier developed dual lumen gas sealed access devices, such as those disclosed in U.S. Patent No. 7,854,724, while maintaining the substantial benefits they provide over conventional single lumen valve

sealed access devices. The subject invention provides such a novel abdominal access device and a filtered tube set for the device, which is described in detail herein below.

### **SUMMARY OF THE DISCLOSURE**

5           The subject invention is directed to a new and useful system for performing a laparoscopic surgical procedure in the abdominal cavity of a patient. The system includes a bifurcated multi-lumen tube set including a dual lumen portion and a single lumen portion. The dual lumen portion of the tube set has a pressurized gas line and a return gas line. The single lumen portion of the tube set has a gas supply and sensing  
10   line for delivering insufflation gas to the abdominal cavity of the patient and for periodically sensing pressure within the abdominal cavity of the patient. Preferably, the tube set is operatively associated with a multi-path filter cartridge assembly.

          The system further includes a first abdominal port having a proximal housing and an elongated tubular body portion extending distally from the proximal housing  
15   and defining a central cannula or bore. The proximal housing of the first abdominal access port has an inlet path for communicating with the pressurized gas line of the tube set and an outlet path for communicating with the return gas line of the tube set. The proximal housing accommodates an annular jet assembly for receiving pressurized gas from the inlet path and for generating a gaseous sealing zone within the central  
20   cannula of the body portion to maintain a pressure stable pneumoperitoneum within the abdominal cavity of the patient.

          The system also includes a second abdominal port having a proximal housing and a tubular body portion extending from the proximal housing. The proximal housing of the second abdominal port accommodates a mechanical valve for sealing the

tubular body portion and an inlet path for communicating with the gas supply and sensing line of the tube set.

Preferably, the first abdominal port is adapted and configured to perform smoke evacuation from the abdominal cavity of the patient. In one embodiment of the invention, the first abdominal port is adapted and configured to permit air entrainment, emergency relief of abdominal pressure and instrument access into the central cannula during a laparoscopic surgical procedure. In another embodiment of the invention, the first abdominal port is adapted and configured to permit air entrainment and emergency relief of abdominal pressure, but without permitting instrument access into the central cannula. In this regard, the central bore of the cannula may be louvered or screened to prevent instrument access thereby.

In another embodiment, the first abdominal port includes a proximal housing portion that is adapted to be selectively coupled with the tubular body portion thereof, and wherein the tubular body portion is configured for manipulation by a robotic surgical system, such as, for example, Da Vinci robotic system manufactured by Intuitive Surgical, Inc. For example, the proximal housing portion may be selectively coupled to the tubular body portion by a pair of diametrically opposed cantilevered or spring loaded locking tabs or the like. The tubular body portion would include a grasping flange for enabling a robotic manipulator to grasp and move the abdominal port during a surgical procedure.

In accordance with a preferred embodiment of the subject invention, the proximal housing portion includes a manifold defining the gas inlet path and the gas outlet path for the access port. Preferably, the inlet and outlet paths are concentrically arranged within the manifold, and the dual lumen portion of the tube set includes a coaxial connector for coupling with the manifold. In comparison, the single lumen

portion of the tube set can include a luer type connector for coupling with a conventional luer type fitting associated with the inlet path of the second abdominal port.

The system further includes a gas recirculation apparatus including a pump  
5 having an outlet for delivering pressurized gas to the tube set and an inlet for receiving depressurized gas from the return line of the tube set through the filter cartridge assembly. The apparatus is also configured to deliver insufflation gas to the gas supply and sensing line of the tube set from a gas source. In accordance with a preferred embodiment of the subject invention, the gas recirculation apparatus includes a  
10 programmable controller with software that is adapted and configured to detect the presence of the bifurcated multi-lumen tube set and is able to differentiate it from a different type tube set.

The subject invention is also directed to a new and useful surgical access port for performing a laparoscopic surgical procedure in the abdominal cavity of a patient,  
15 which includes a proximal housing and an elongated tubular body portion extending distally from the proximal housing and defining a central cannula or bore. The proximal housing has an inlet path for communicating with a pressurized gas line of a tube set and an outlet path for communicating with a return gas line of the tube set. The housing accommodates an annular jet assembly for receiving pressurized gas from  
20 the inlet path and for generating a gaseous sealing zone within the central cannula of the body portion to maintain a pressure stable pneumoperitoneum within the abdominal cavity of the patient.

The subject invention is also directed to new and useful bifurcated multi-lumen tube set for performing a laparoscopic surgical procedure in the abdominal cavity of a  
25 patient, which includes a multi-path filter cartridge, a dual lumen portion

communicating with the filter cartridge and having a pressurized gas line and a return gas line, and a single lumen portion communicating with the filter cartridge and having a gas supply and sensing line for delivering insufflation gas to the abdominal cavity of the patient and for periodically sensing pressure within the abdominal cavity of the

5 patient. Preferably, the dual lumen portion of the tube set includes a unique coaxial connector, and the single lumen portion of the tube set can include a conventional luer type connector.

These and other features of the gas circulation system and the single lumen gas sealed access device of the subject invention will become more readily apparent to

10 those having ordinary skill in the art to which the subject invention appertains from the detailed description of the preferred embodiments taken in conjunction with the following brief description of the drawings.

**BRIEF DESCRIPTION OF THE DRAWINGS**

So that those skilled in the art will readily understand how to make and use the gas circulation system and gas sealed abdominal access devices of the subject invention without undue experimentation, preferred embodiments thereof will be described in

5 detail herein below with reference to the figures wherein:

Fig. 1 is a perspective view of a gas circulation system for performing laparoscopic surgical procedures that includes a bifurcated filtered tube set having a dual lumen portion connected to a gas sealed access port for maintaining a stable pneumoperitoneum and facilitating smoke evacuation, and a single lumen portion

10 connected to a valve sealed access port configured for insulation and sensing;

Fig. 2 is a perspective view of a single lumen gas sealed access port constructed in accordance with a preferred embodiment of the subject invention;

Fig. 3 is a cross-sectional view of the single lumen gas sealed access port of Fig. 2, illustrating the interior of the proximal housing portion that accommodates an annular jet assembly that generates a gaseous sealing zone within the central bore of the cannula to maintain stable pneumoperitoneum within the abdominal cavity of a patient;

Fig. 4 is a top plan view of the gas sealed access port of Fig. 2, illustrating the central bore of the cannula through which a surgical instrument can be introduced into the abdominal cavity of a patient through the gaseous sealing zone;

20

Figs. 5 and 6 are elevational and perspective views, respectively, of the fluid management manifold of the proximal housing of the single lumen access port shown in Figs. 2 through 4, which includes concentric inlet and outlet ports, wherein the inlet port receives pressurized gas from the pressurized gas line of the bifurcated tube set and  
5 the outlet port sends spent gas to the return line of the bifurcated tube set;

Figs. 7A-7C shows the configuration and relative size of the three abdominal access ports that are currently utilized for gas sealed laparoscopic surgical procedures, including a dual lumen gas sealed access port and two conventional valve sealed access ports;

10 Figs. 8A-8C shows the configuration and relative size of the three abdominal access ports that are utilized with the gas circulation system of the subject invention including a single lumen gas sealed access port and two conventional valve sealed access ports;

Fig. 9 is a top plan view of a gas sealed gas access port constructed in  
15 accordance with a preferred embodiment of the subject invention which is configured for gas entrainment and emergency relief, without permitting instrument access to the central bore of the cannula;

Fig. 10 is a perspective view of a gas circulation system for performing robotically assisted laparoscopic surgical procedures that includes a bifurcated filtered  
20 tube set having a dual lumen portion connected to a two-part, single lumen gas sealed access port for maintaining a stable pneumoperitoneum and facilitating smoke evacuation, and a single lumen portion connected to a conventional valve sealed access port configured for insulation and sensing;

Fig. 11 is a perspective view of the two-part, single lumen gas sealed access  
25 port shown in Fig. 10, which includes a distal cannula portion configured for robotic

manipulation and a detachable housing portion configured for gaseous sealing, recirculation and smoke evacuation;

Fig. 12 is an exploded perspective view of the two-part, single lumen gas sealed access port of Fig. 11, with the two parts separated from one another for ease of  
5 illustration;

Fig. 13 is a side elevational view of the separable housing portion of the two-part, single lumen gas sealed access port of Fig. 11;

Fig. 14 is a cross-sectional view of the separable housing portion of the two-part, single lumen gas sealed access port taken along of Fig. 13; and

10 Fig. 15 is an exploded perspective view of the separable housing portion of the of the two-part, single lumen gas sealed access port of Fig. 11, with the component parts thereof separated for ease of illustration.

**DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS**

Referring now to the drawings wherein like reference numerals identify similar structural elements and features of the subject invention, there is illustrated in Fig. 1 a gas circulation system for performing a laparoscopic surgical procedure in the abdominal cavity of a patient that is constructed in accordance with a preferred embodiment of the subject disclosure and is designated generally by reference numeral 10.

Referring to Fig. 1, the gas circulation system 10 includes a bifurcated multi-lumen tube set 12 that includes a dual lumen portion 14 and a single lumen portion 16. The dual lumen portion 14 has a pressurized gas line 20 and a return gas line 18. The single lumen portion 16 has a gas supply and sensing line 22 for delivering insufflation gas to the abdominal cavity of the patient and for periodically sensing pressure within the abdominal cavity of the patient. The tube set 12 is operatively associated with a multi-path filter cartridge assembly 24. A filter cartridge assembly of this type is disclosed for example in commonly assigned U.S. Patent No. 9,067,030 the disclosure of which is herein incorporated by reference in its entirety.

The bifurcated multi-lumen tube set 12 and the multi-path filter cartridge assembly 24 are preferably designed for a single use and are thereafter disposable, and they are specifically designed to cooperate with a multi-modal gas delivery system of the type which is described in commonly assigned U.S. Patent No. 9,375,539, the disclosure of which is herein incorporated by reference in its entirety.

With continuing reference to Fig. 1, the system 10 further includes a first abdominal port 30 that is adapted and configured to provide gas sealed access to the abdominal cavity of a patient. In this regard, abdominal port 30 functions similar to the dual-lumen trocar assembly that is disclosed, for example, in commonly assigned

U.S. Patent Nos. 7,854,724, the disclosure of which is herein incorporated by reference in its entirety. However, abdominal port 30 differs significantly from the trocar assembly disclosed in U.S. Patent No. 7,854,724 in that it has only one central lumen. The abdominal port 30 of the subject invention does not have a second annular lumen surrounding the central lumen. Thus, this abdominal port 30 is not capable of delivering insufflation gas to the abdominal cavity of a patient or sensing abdominal pressure. Rather, abdominal port 30 is configured to provide gas sealed instrument access while facilitating a stable pneumoperitoneum and smoke evacuation from the abdominal cavity. The abdominal port 30 will be described in greater detail below with regard to Figs. 2 through 6.

In the meantime, with continuing reference to Fig. 1, the system 10 further includes a second abdominal port 50 having a proximal housing 52 and a tubular body portion 54 extending from the proximal housing. The proximal housing 52 of the second abdominal port 50 is a conventional mechanically sealed access device that has a mechanical valve (not shown) for sealing the tubular body portion 54. The abdominal port 50 includes an inlet path 56 for communicating with the gas supply and sensing line 22 of the tube set 12.

More particularly, the gas supply and sensing line 22 of tube set 12 includes a conventional luer type connector 60 for coupling with a conventional luer type fitting 58 associated with the inlet path 56 of the second abdominal port 50. Alternatively, the conventional luer type connector 60 can be replaced with a larger fitting for increased flow.

While a convention valve sealed access port or trocar is illustrated and described herein, those skilled in the art will readily appreciate that other types of valve

sealed access ports can also be connected to the supply and sensing line 22 of tube set 12, such as, for example, the elastically deformable anchored access ports described in commonly assigned U.S. Patent No. 7,806,870, the disclosure of which is herein incorporated by reference in its entirety.

5           Referring now to Figs. 2 through 4, there is illustrated in more detail the abdominal port 30 of the subject invention, which includes a proximal housing 32 and an elongated tubular body portion 34 extending distally from the proximal housing 32 and defining a central cannula or bore 36. The proximal housing 32 of the first abdominal access port 30 has an inlet path 40 for communicating with the pressurized  
10 gas line 20 of the tube set 12 and an outlet path 38 for communicating with the return gas line 18 of the tube set 12.

More particularly, as best seen in Figs. 5 and 6, to manage gas flow in the access port 30, the proximal housing 32 includes a manifold 42 defining the inlet path 40 and the outlet path 38 which are concentrically arranged within the manifold 42. The  
15 dual lumen portion 14 of the tube set 12 includes a coaxial connector 60 for coupling with the manifold 42 of the proximal housing. A coupled connection of this type is disclosed, for example, in commonly assigned U.S. Patent Application Publication 2017/0050011, the disclosure of which is incorporated herein by reference in its entirety.

20           Referring to Fig. 3, the proximal housing 32 of abdominal port 30 defines an interior chamber 44 to accommodate a two-part annular jet assembly 46. The annular jet assembly 46 is adapted and configured to receive pressurized gas from the inlet path 40 and for generating a gaseous or pneumatic sealing zone within the central cannula bore 36 of the tubular body portion 34 to maintain a pressure stable pneumoperitoneum  
25 within the abdominal cavity of the patient. The annular jet assembly 46 is disclosed in

great detail in commonly assigned U.S. Patent No. 8,795,223 and U.S. Patent Application Publication 2015/0025323, the disclosures of which are herein incorporated by reference in their entireties.

There are several advantages to employing the gas circulation system of the subject invention as compared to a system that utilizes the gas sealed access port disclosed for example in U.S. Patent No. 8,795,223. In particular, with respect to the access port, by removing the need for both an inner and outer cannula, because of the use of a separate conventional cannula for insufflation and sensing, there is a significant reduction in the effective outer diameter of the tubular body of the access port. Figs. 7A-7C and 8A-8C, illustrate this comparison, wherein Fig. 7A shows a 5 mm dual lumen gas sealed access device 80 constructed in accordance with the disclosure of U.S. Patent No. 8,795,223, which has a tubular body portion 84 with an effective outer diameter of about 11.05 mm, whereas Fig. 8A shows a 5 mm version of the single lumen gas sealed access device 30 of the subject invention, which has a tubular body portion 34 with an effective outer diameter, for example, of about 8.97 mm. In other example embodiments, the effective outer diameter can be less than 8.97mm, depending on the contemplated application and desired gas seal functionality. The four access ports that are illustrated in Figs. 7B, 7C, 8B and 8C are all conventional valve sealed access ports used in a gas sealed surgical procedure.

This significant difference in the effective outer diameter of the single lumen gas sealed access port 30 of the subject invention enables surgery with a smaller patient incision, while maintaining similar functionality (i.e., gaseous sealing for instrumentation, stable pneumoperitoneum and smoke evacuation). A smaller incision size can also lead to smaller or invisible scars for the patient, less pain or pain medication, easier wound closure for the surgeon, etc. In addition, the single lumen gas

sealed access port 30 of the subject invention uses less plastic and has fewer components than the gaseous sealed access port disclosed for example in U.S. Patent No. 8,795,223, and the single lumen design eliminates several mating features. This could allow for lower component and assembly costs, as well as more efficient product qualification.

Those skilled in the art will readily appreciate that the tubular body portion 34 of the first abdominal access port 30 can be introduced into the abdominal cavity of a patient through the abdominal wall using an inserter or obturator. In this regard, Figs. 2 and 4 illustrate an end cap 45 of the proximal housing 32 that includes diametrically opposed flanges 48a and 48b for cooperating with an obturator of the type described and illustrated in commonly assigned U.S. Patent No. 9,545,264, the disclosure of which is herein incorporated by reference in its entirety. Other types of obturators or inserters could also be utilized.

As noted above, the gas circulation system 10 of the subject invention, including the bifurcated multi-lumen tube set 12, the multi-path filter cartridge assembly 24, the first (single lumen gas sealed) access port 30 and the second (conventional valve sealed) access port 50 are all specifically designed to cooperate with a multi-modal gas delivery system of the type which is described in commonly assigned U.S. Patent No. 9,526,849, the disclosure of which is herein incorporated by reference in its entirety.

In accordance with a preferred embodiment of the subject invention, the software-based controller of the multi-modal gas delivery system would require detection features and sensors that are adapted and configured to detect the presence or absence of the bifurcated multi-lumen tube set 12 and be able to differentiate that tube set from a different type of tube set, such as, for example, a tube set such as that which

is disclosed in commonly assigned U.S. Patent Application Publication No. 2015/0196722, which is incorporated herein by reference in its entirety, or a tube set such as that which is disclosed in commonly assigned U.S. Patent Application Publication No. 2016/0106952, which is also incorporated herein by reference in its entirety. Those skilled in the art will readily appreciate that such a software design feature would promote the safe and efficacious operation of the gas circulation system of the subject invention.

Single-Lumen Gas Sealed Port Without Instrument Passage

Referring now to Fig. 9, while the first abdominal port 30 described above is adapted and configured to perform gaseous sealing for surgical instrumentation passing therethrough, stable pneumoperitoneum and smoke evacuation of the abdominal cavity, as well as being constructed to permit air entrainment and emergency relief of abdominal pressure, it is also envisioned and well within the scope of the subject disclosure that an embodiment of the subject invention does not necessarily have to provide instrument access to the abdominal cavity.

Rather, as shown in Fig. 9, an embodiment of the abdominal port of the subject invention that is designated generally by reference numeral 130 is adapted and configured to maintain a stable pneumoperitoneum and smoke evacuation of the abdominal cavity, as well as permit air entrainment and emergency pressure relief, without permitting instrument access through the central cannula bore of the port. In this regard, the central bore 136 of the port 130 is covered by a louvered or screened end cap 145 that physically prevents or otherwise blocks instrument access through the central bore 136 of the device.

Because surgical instruments are not inserted into this device 130, the inside diameter (and therefore the outside diameter of the device) can be reduced significantly without sacrificing gaseous sealing functionality. This can further increase the potential size-based advantages of the port of the subject invention. This version of the

5 port can have many alternative embodiments. For example, it could include a thinner and flatter channel or an oblong channel, since the conduit does not have to be cylindrical in order to provide a gaseous seal around cylindrical surgical instruments. It also does not have to include a straight or longitudinal pathway. For example, the port could be configured to bend 90 degrees from its axis, allowing for improvements

10 such as anchoring to the patient's abdominal wall, providing enhanced smoke evacuation, and eliminating clutter within the working space both inside and outside of the abdominal cavity.

#### Single-Lumen Gas Sealed Port for Robotic Surgery

15 Referring to Figs. 10 through 15, there is illustrated another embodiment of the gas circulation system of the subject invention which is designated generally by reference numeral 210 that is particularly configured for use in robotically assisted minimally invasive surgical procedures, and more particularly, it is adapted for use in conjunction with a Da Vinci Xi type robotic system that is manufactured and sold by

20 Intuitive Surgical, Inc.

The system 210 includes a bifurcated tube set 212 having a dual lumen portion 214, a single lumen portion 216 and a multi-path filter cartridge assembly 224. The dual lumen portion 214 is adapted and configured to communicate with a two-part single lumen gas sealed access port designated generally by reference numeral 230.

25 The single lumen portion 216 is adapted and configured to communicate with a two-

part single lumen valve sealed access port designated generally by reference numeral 250.

Access port 230 is particularly configured for use in robotic surgery. It includes a proximal housing portion 232 that is adapted to be selectively coupled with a separate tubular body portion 234, as best seen in Fig. 11. The tubular body portion 234 is configured for manipulation by a robotic surgical system. More particularly, the proximal reception portion 235 of the tubular body portion 234 includes a radially outwardly extending grasping flange 237 for enabling a Da Vinci Xi type robotic manipulator (not shown) to grasp and move the abdominal port 230 during a minimally invasive surgical procedure.

As best seen in Fig. 12, the proximal housing portion 232 of the abdominal port 230 is configured to be selectively coupled to the tubular body portion 234 by a pair of diametrically opposed spring-loaded locking tabs 239a, 239b, secured beneath the end cap 245. The proximal housing portion 232 is otherwise substantially similar in most respects to the proximal housing portion 32 of access port 30, described hereinabove with reference to Figs. 2 through 4.

More particularly, the separable housing portion 232 includes a bi-lumen manifold 242 to manage the flow of the pressure and return lines. It also has an interior chamber 244 to accommodate an annular jet assembly 246 which is configured to receive pressurized gas from the inlet path 240 and generate a gaseous or pneumatic sealing zone within the central cannula bore 236 of the separable tubular body portion 234. This acts to maintain a pressure stable pneumoperitoneum and provide smoke evacuation in the abdominal cavity of the patient.

While the gas circulation system, bifurcated tube set and gas sealed access ports of the subject disclosure has been shown and described with reference to preferred

embodiments, those skilled in the art will readily appreciate that changes and/or modifications may be made thereto without departing from the scope of the subject disclosure.

**WHAT IS CLAIMED IS:**

1. A system for performing a laparoscopic surgical procedure in the abdominal cavity of a patient, comprising:
  - a) a bifurcated multi-lumen tube set including a dual lumen portion  
5 having a pressurized gas line and a return gas line, and a single lumen portion having a gas supply and sensing line for delivering insufflation gas to the abdominal cavity of the patient and for periodically sensing pressure within the abdominal cavity of the patient;
  - b) a first abdominal port having a proximal housing and an  
10 elongated tubular body portion extending distally from the proximal housing and defining a central cannula, the proximal housing of the first abdominal access port having an inlet path for communicating with the pressurized gas line of the tube set and an outlet path for communicating with the return gas line of the tube set, the housing accommodating an annular jet assembly for receiving pressurized gas from the inlet  
15 path and for generating a gaseous sealing zone within the central cannula of the body portion to maintain a pressure stable pneumoperitoneum within the abdominal cavity of the patient; and
  - c) a second abdominal port having a proximal housing and a  
tubular body portion extending from the proximal housing, the proximal housing of the  
20 second abdominal port having a mechanical valve for sealing the tubular body portion and an inlet path for communicating with the gas supply and sensing line of the tube set.
2. A system as recited in Claim 1, wherein the tube set is operatively  
25 associated with a filter cartridge assembly.

3. A system as recited in Claim 1, wherein the first abdominal port is adapted and configured to perform smoke evacuation from the abdominal cavity of the patient.

5

4. A system as recited in Claim 1, wherein the first abdominal port is adapted and configured to permit air entrainment and instrument access into the central cannula.

10

5. A system as recited in Claim 1, wherein the first abdominal port is adapted and configured to permit air entrainment without permitting instrument access into the central cannula.

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6. A system as recited in Claim 1, wherein the first abdominal port includes a proximal housing portion that is adapted to be selectively coupled with the tubular body portion thereof, and wherein the tubular body portion is configured for manipulation by a robotic surgical system.

20

7. A system as recited in Claim 1, wherein the proximal housing portion includes a manifold defining the inlet path and the outlet path.

8. A system as recited in Claim 7, wherein the inlet and outlet paths are concentrically arranged within the manifold.

9. A system as recited in Claim 7, wherein the dual lumen portion of the tube set includes a coaxial connector for coupling with the manifold.

10. A system as recited in Claim 1, wherein the single lumen portion of the tube set includes a luer type connector for coupling with a luer type fitting associated with the inlet path of the second abdominal port.

11. A system as recited in Claim 1, further comprising a gas recirculation apparatus including a pump having an outlet for delivering pressurized gas to the tube set and an inlet for receiving depressurized gas from the return line of the tube set, and configured to deliver insufflation gas to the gas supply and sensing line of the tube set, wherein the gas recirculation apparatus includes a programmable controller that is adapted and configured to detect the presence of the bifurcated multi-lumen tube set and differentiating it from a different type tube set.

15

12. A surgical access port for performing a laparoscopic surgical procedure in the abdominal cavity of a patient, comprising:

a proximal housing and an elongated tubular body portion extending distally from the proximal housing and defining a central cannula, the proximal housing having an inlet path for communicating with a pressurized gas line of a tube set and an outlet path for communicating with a return gas line of the tube set, the housing accommodating an annular jet assembly for receiving pressurized gas from the inlet path and for generating a gaseous sealing zone within the central cannula of the body portion to maintain a pressure stable pneumoperitoneum within the abdominal cavity of the patient.

13. A surgical access port as recited in Claim 12, which is adapted and configured to perform smoke evacuation from the abdominal cavity of the patient.

5 14. A surgical access port as recited in Claim 12, which is adapted and configured to permit air entrainment and instrument access into the central cannula.

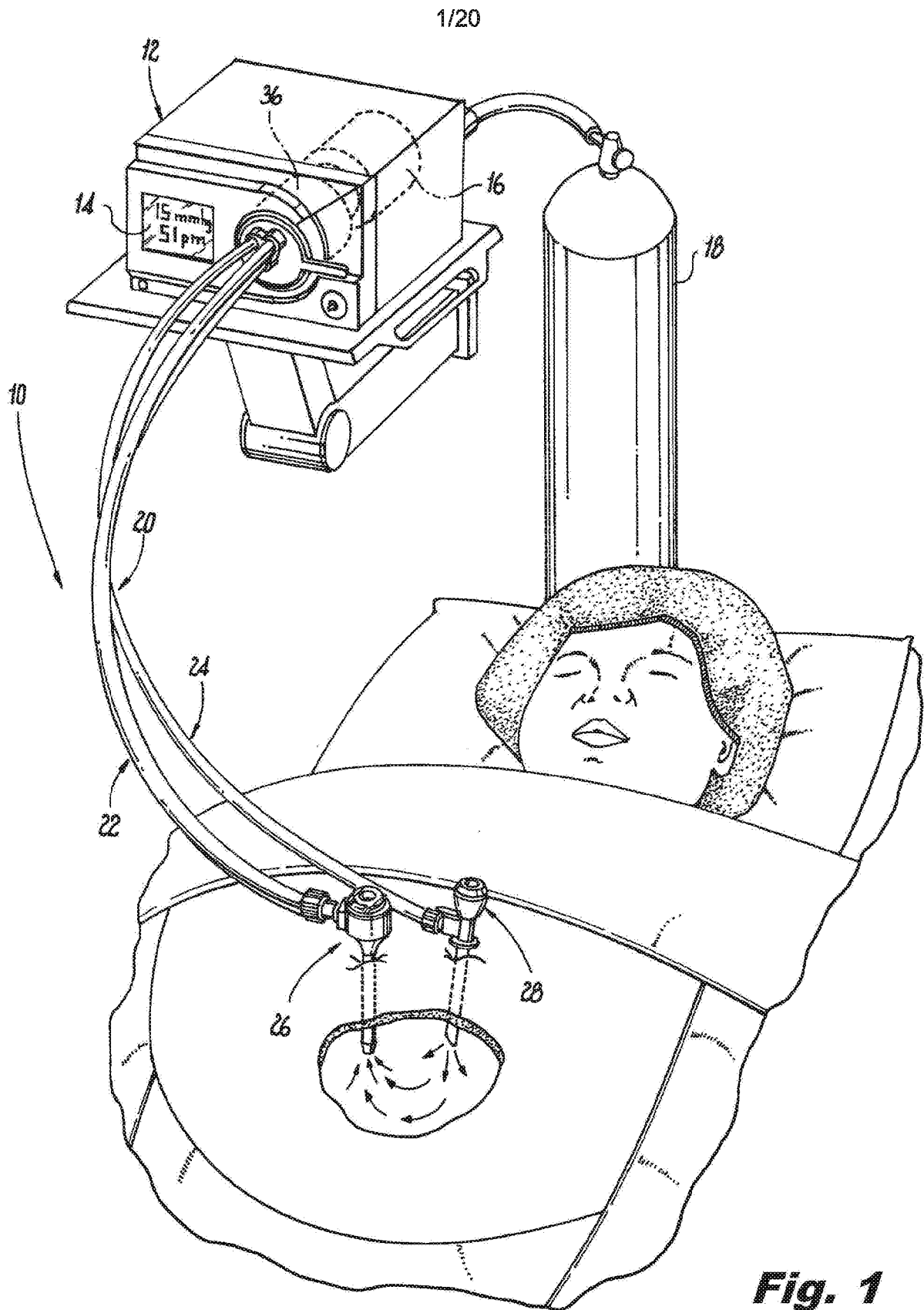
15 15. A surgical access port as recited in Claim 12, which is adapted and configured to permit air entrainment without permitting instrument access into the central cannula.

16. A surgical access port as recited in Claim 12, wherein the proximal housing portion is adapted to be selectively coupled with the tubular body portion, and wherein the tubular body portion is configured for manipulation by a robotic surgical system.

17. A surgical access port as recited in Claim 12, wherein the proximal housing portion includes a manifold defining the inlet path and the outlet path.

20 18. A surgical access port as recited in Claim 17, wherein the inlet and outlet paths are concentrically arranged within the manifold.

19. A bifurcated multi-lumen tube set for performing a laparoscopic surgical procedure in the abdominal cavity of a patient, comprising:
- a) a dual lumen portion having a pressurized gas line and a return gas line; and
  - 5 b) a single lumen portion having a gas supply and sensing line for delivering insufflation gas to the abdominal cavity of the patient and for periodically sensing pressure within the abdominal cavity of the patient.
20. A multi-lumen tube set as recited in Claim 19, wherein the dual lumen
- 10 portion of the tube set includes a coaxial connector, and the single lumen portion of the tube set includes a luer type connector.



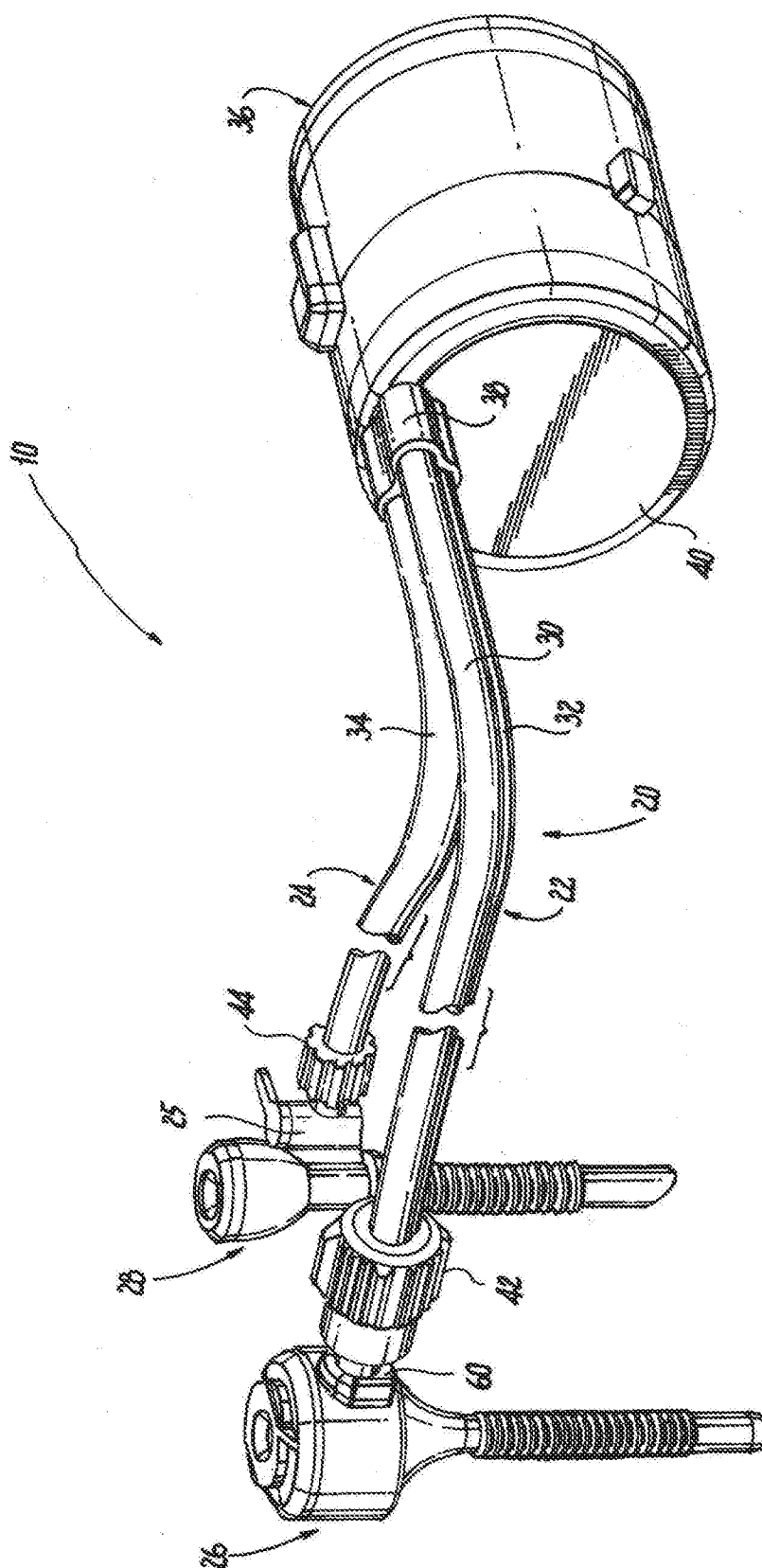


**Fig. 2**

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**Fig. 3**

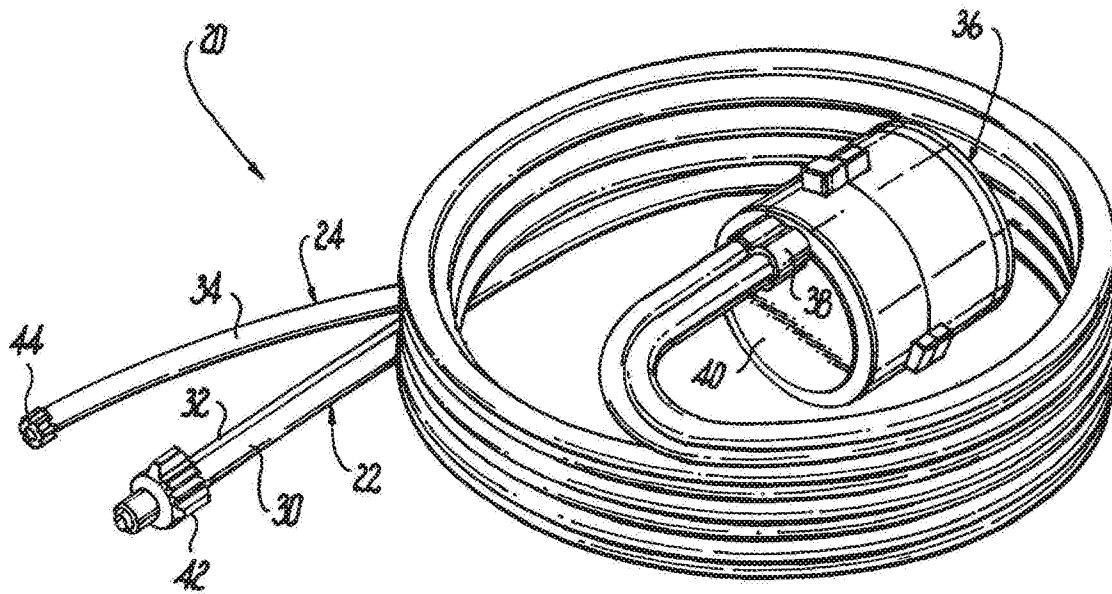
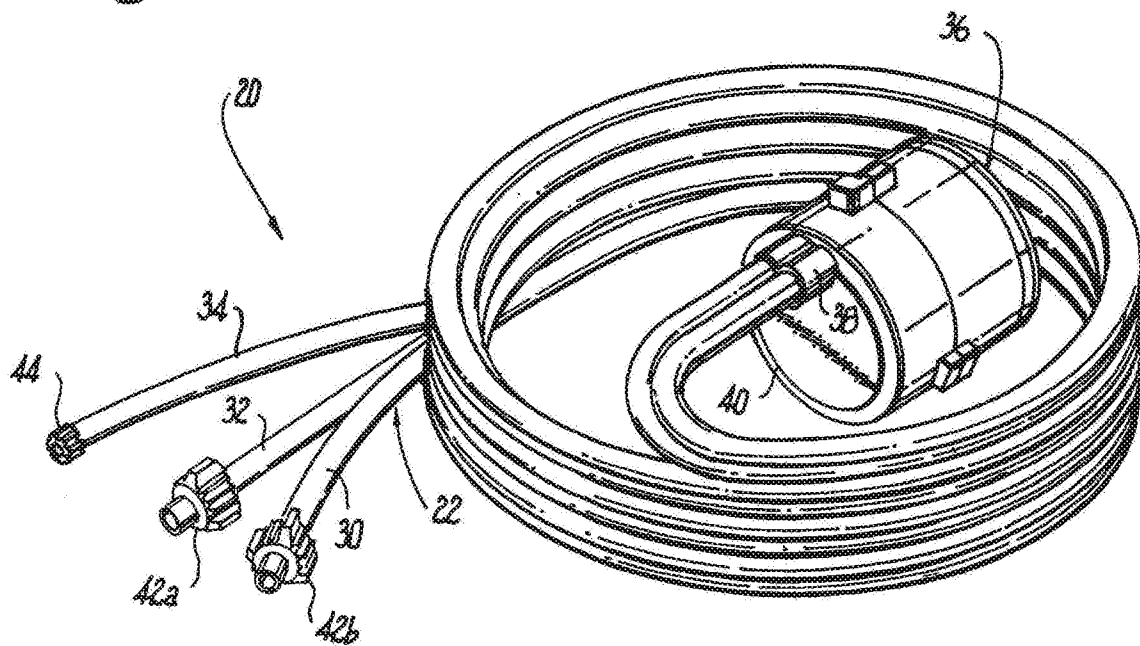


**Fig. 3A**



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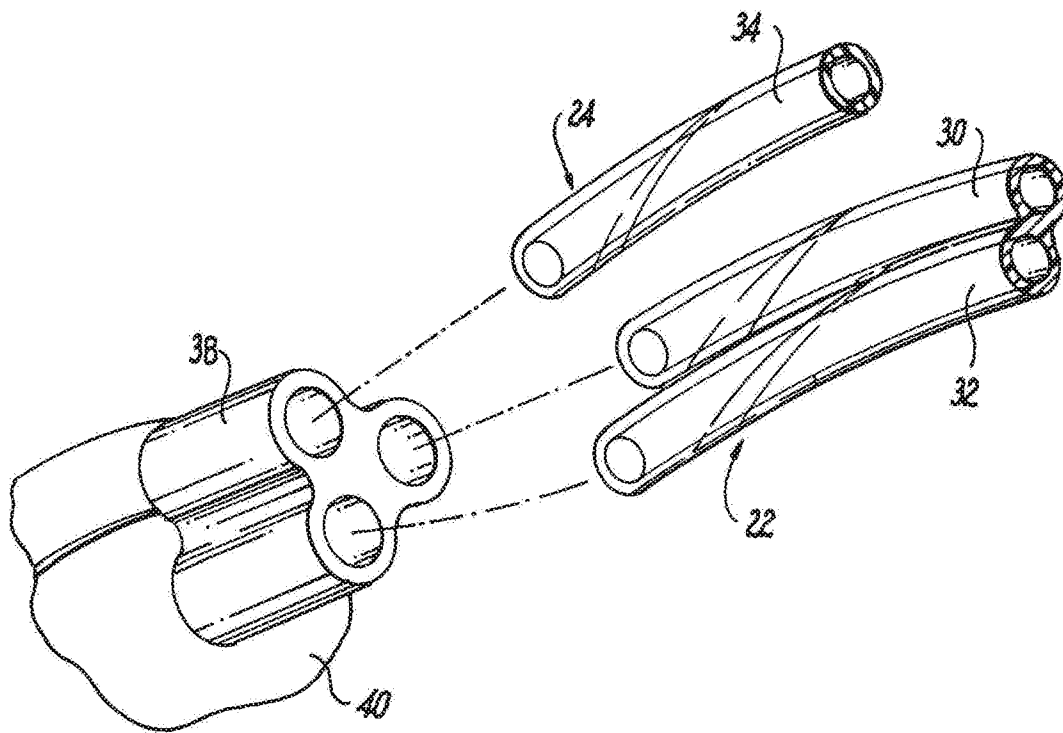


**Fig. 4**

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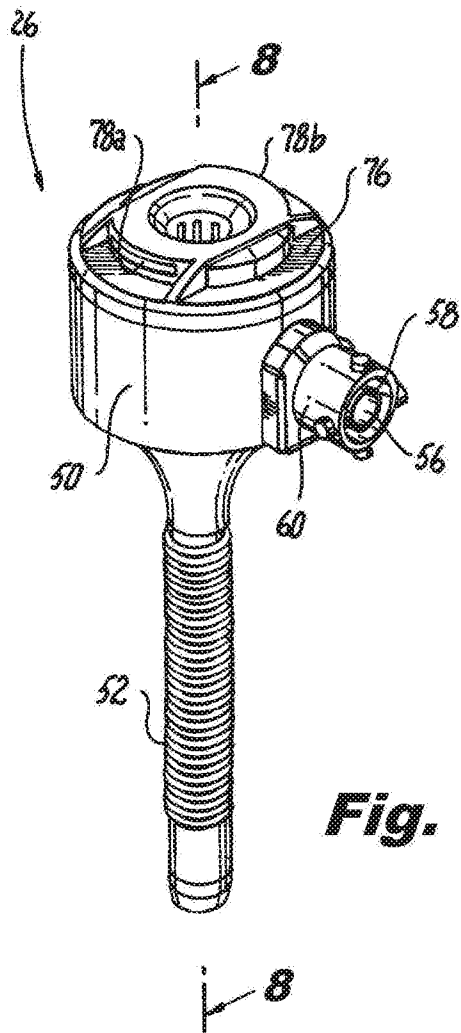


**Fig. 5**

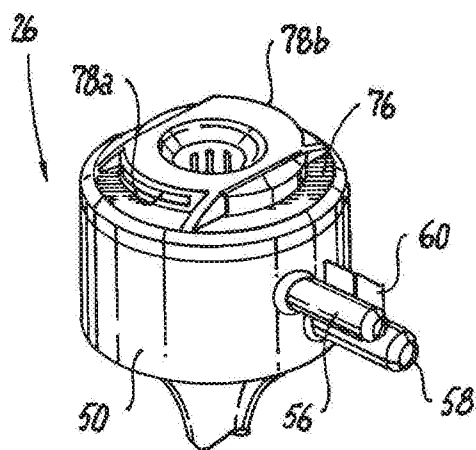


**Fig. 5A**

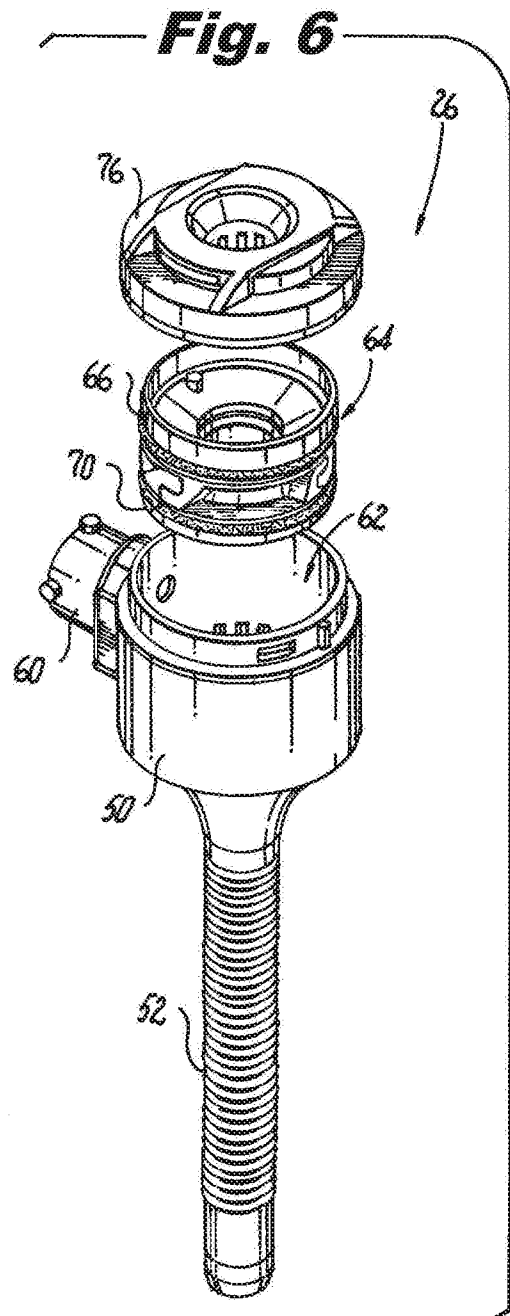


**Fig. 6**

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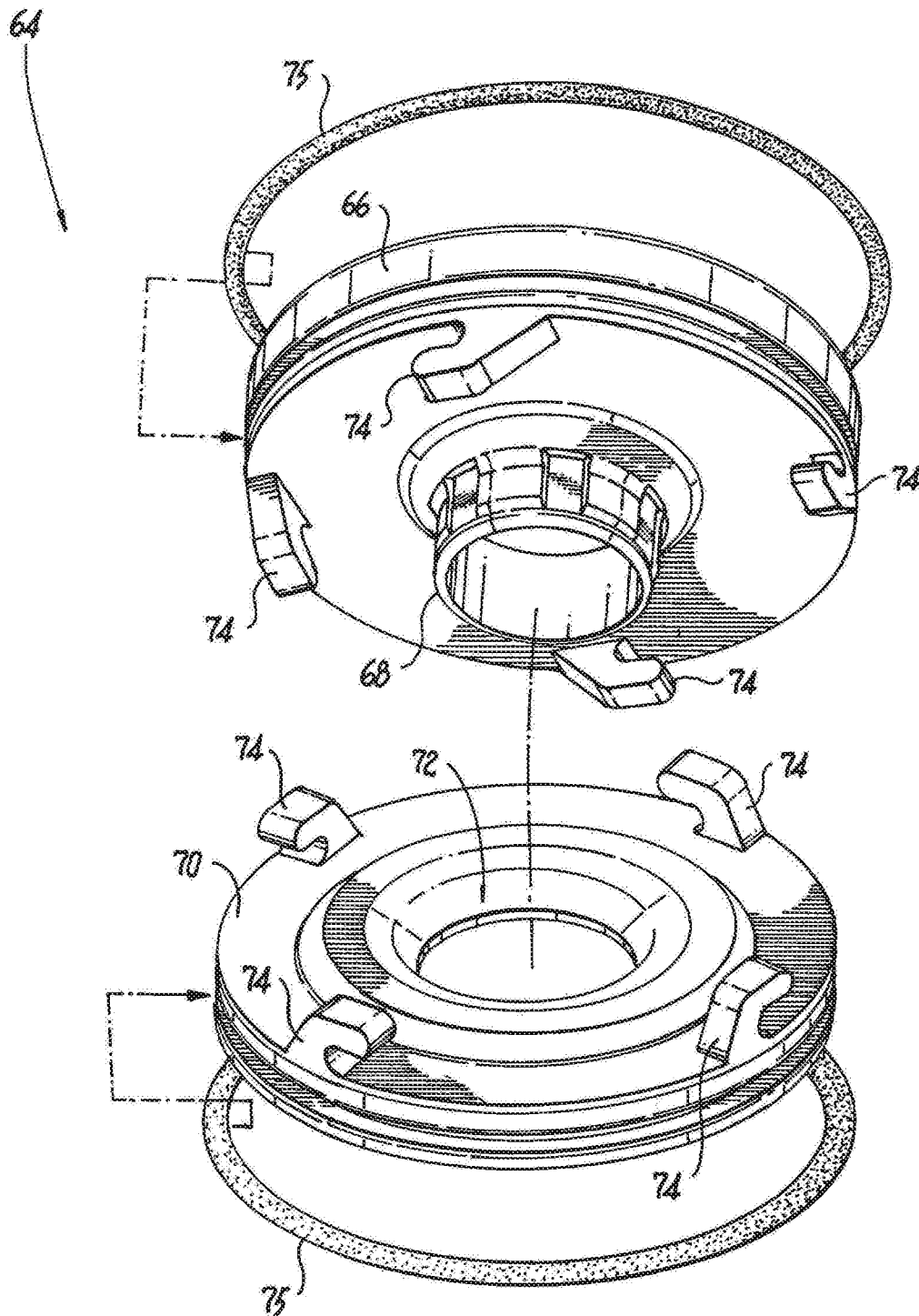


**Fig. 7**

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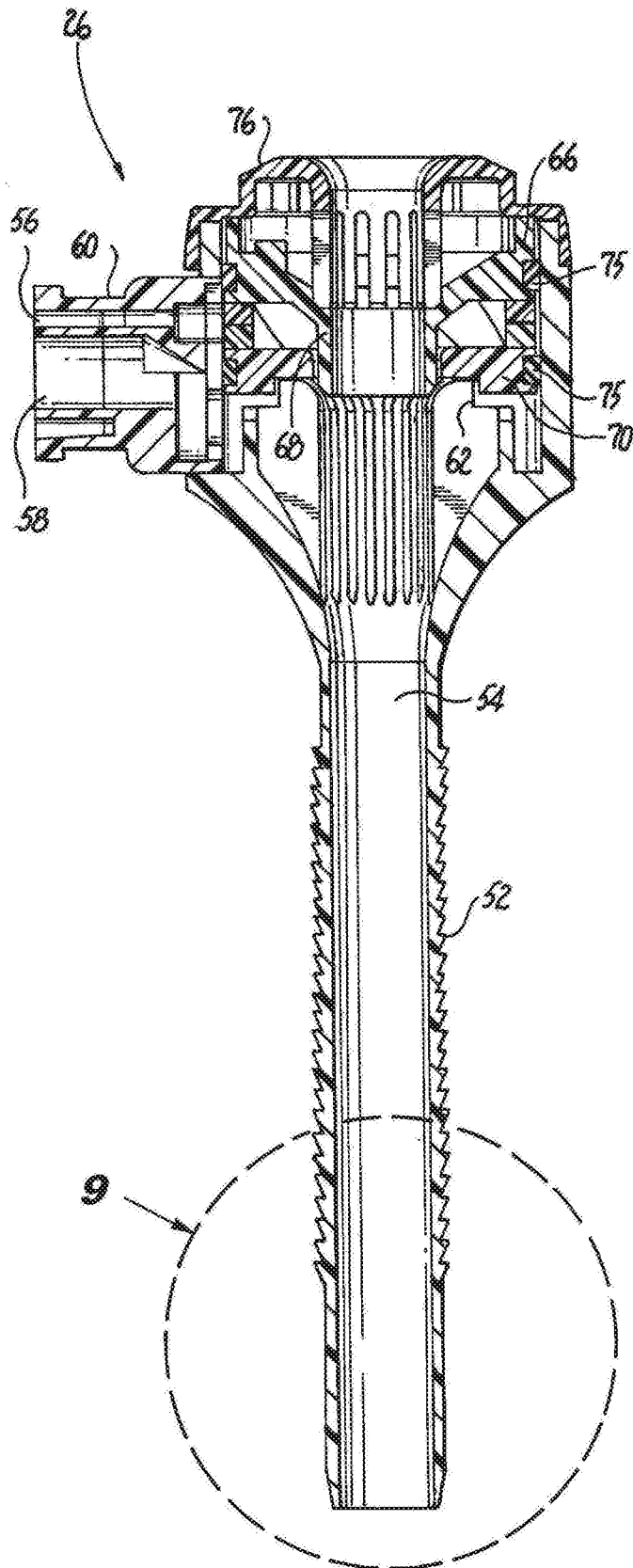


**Fig. 8**

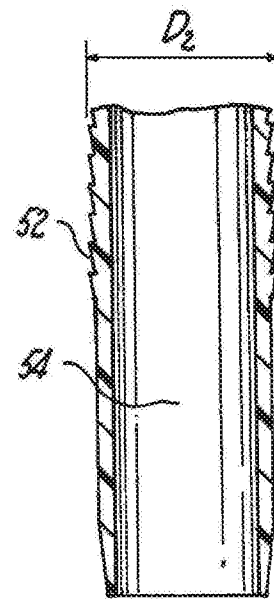


**Fig. 9**

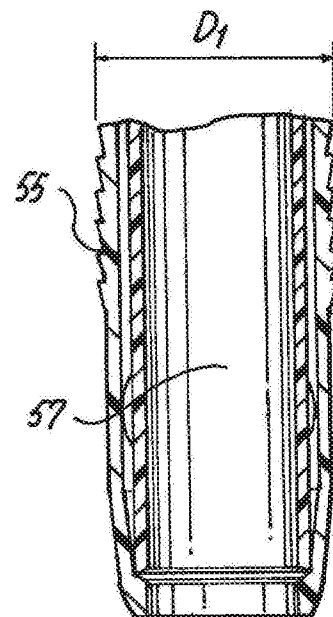


**Fig. 10**  
**(Prior Art)**

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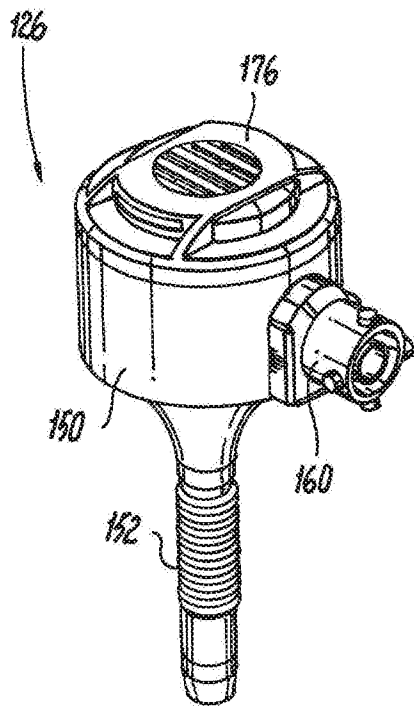


**Fig. 11**

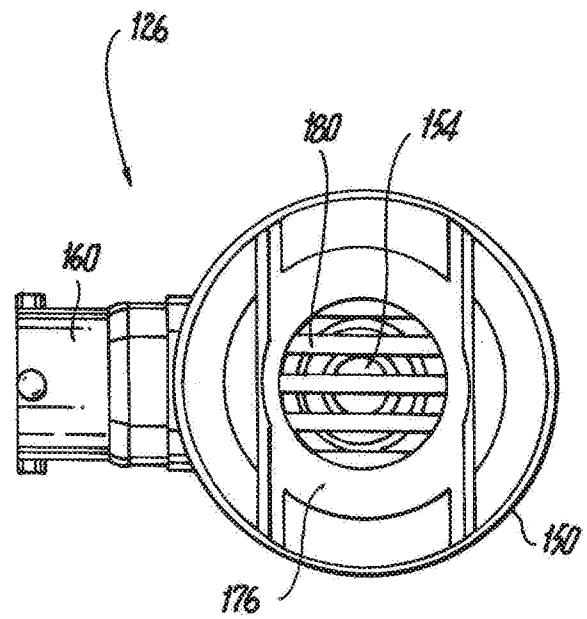


**Fig. 12**

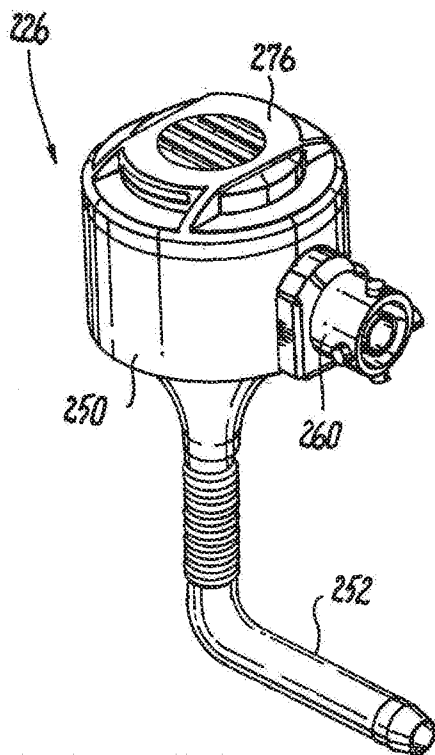


**Fig. 13**

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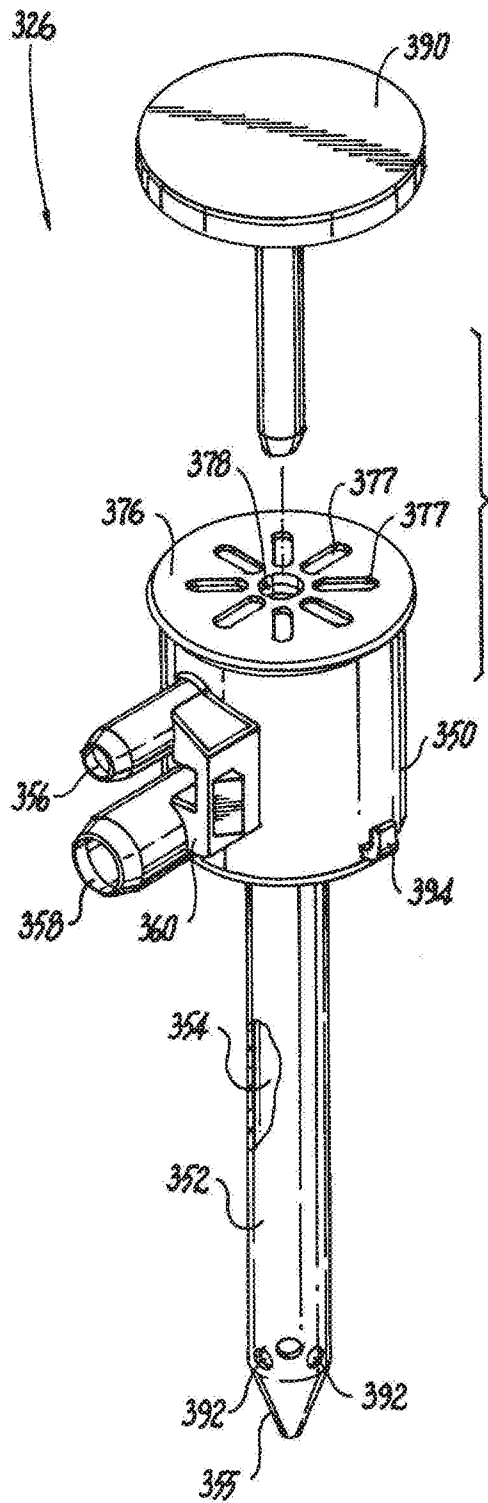


**Fig. 14**

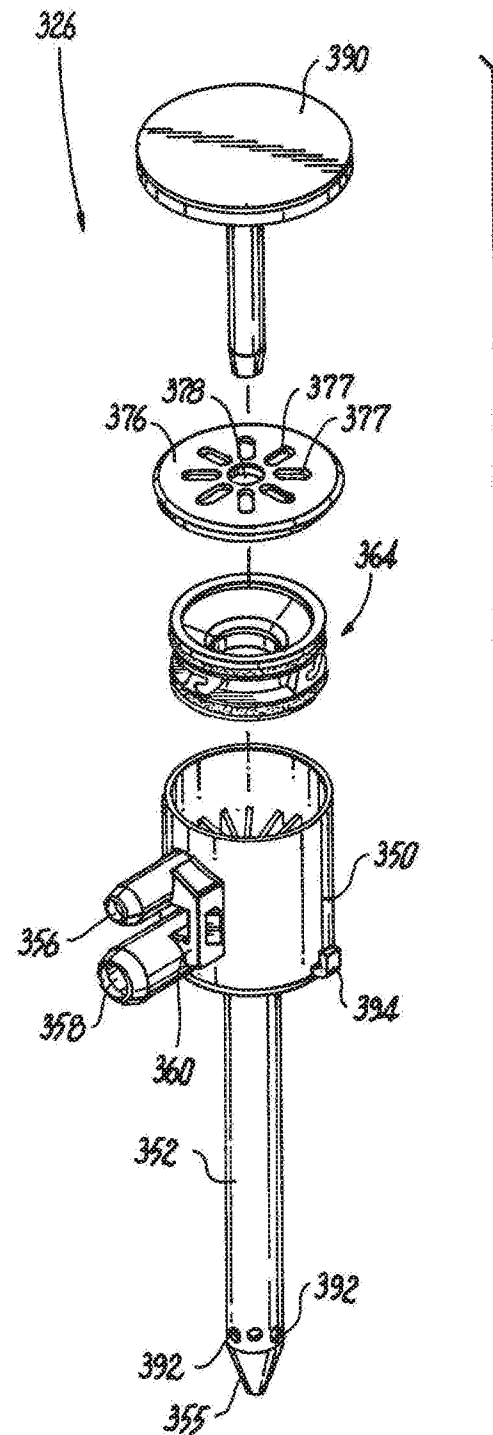


**Fig. 15**

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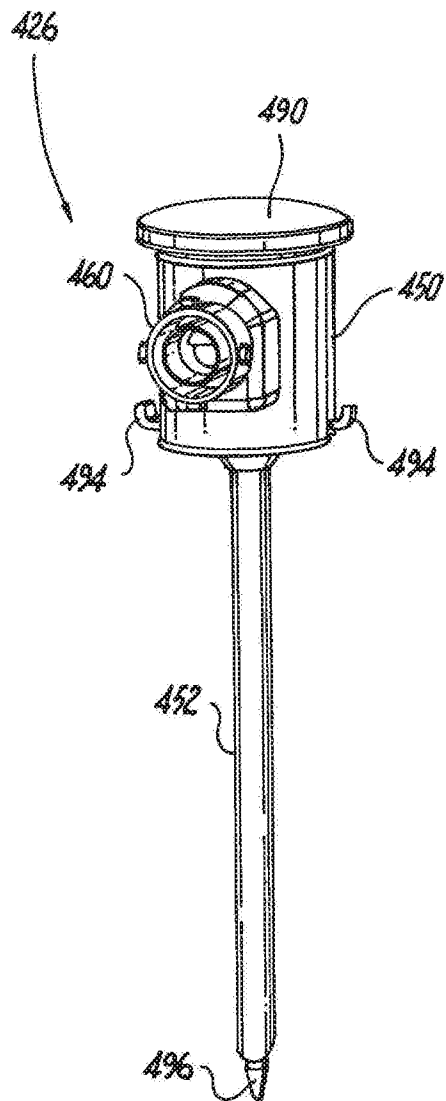


**Fig. 16**

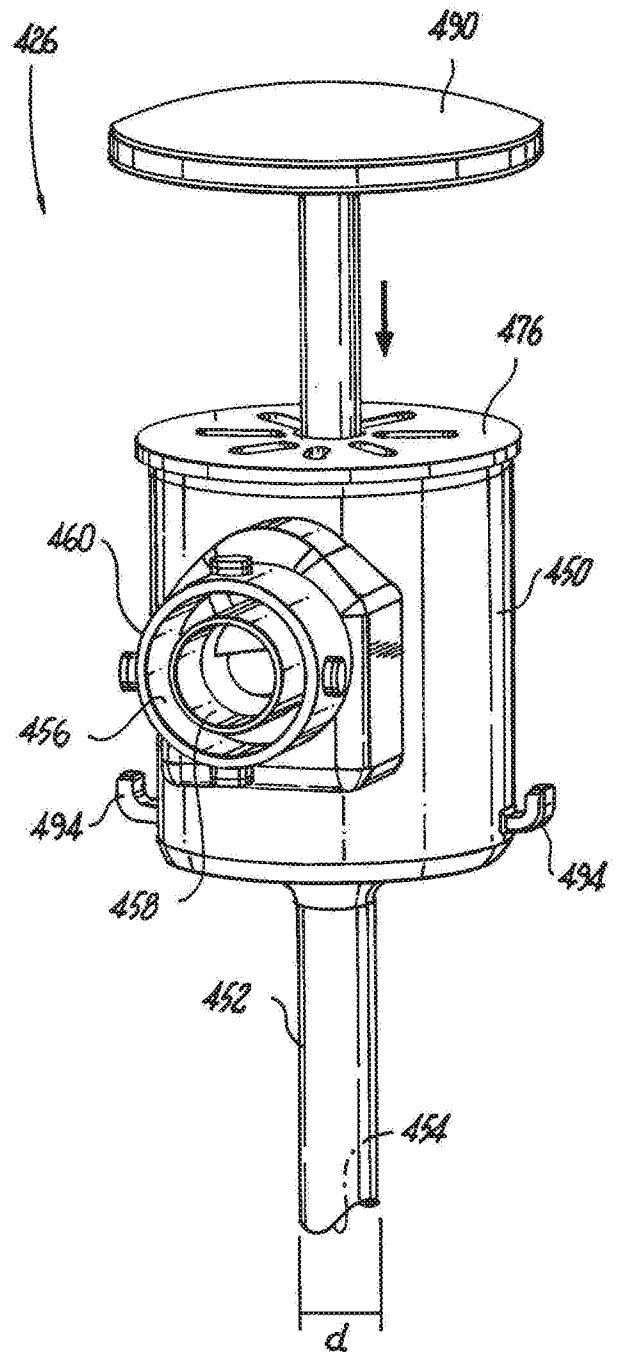


**Fig. 17**

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**Fig. 19**

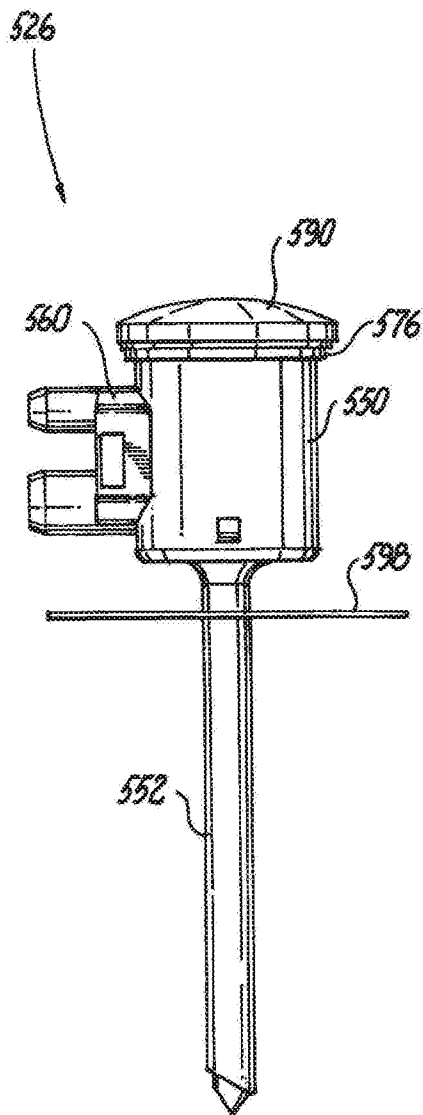


**Fig. 18**

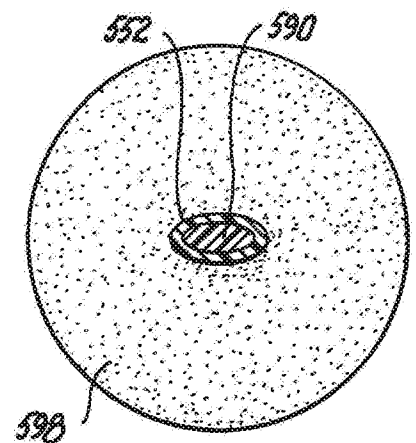
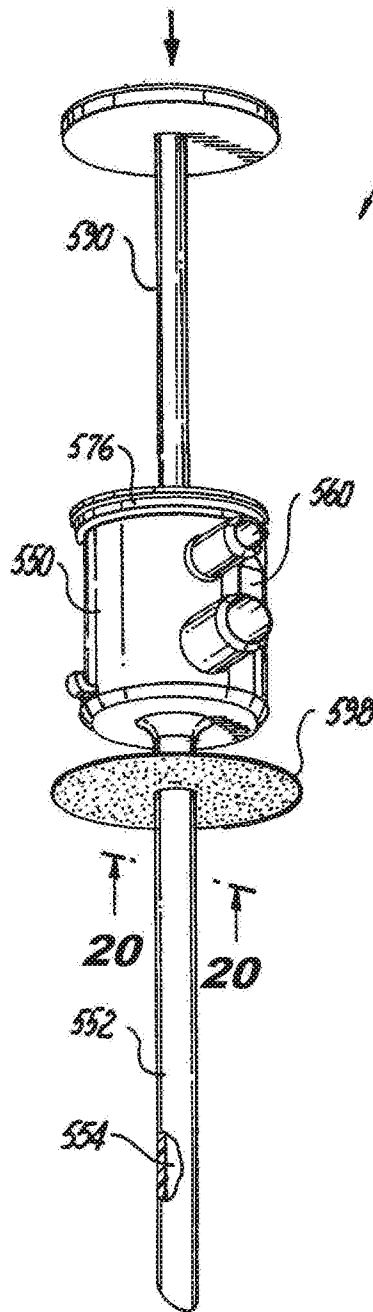


**Fig. 20**

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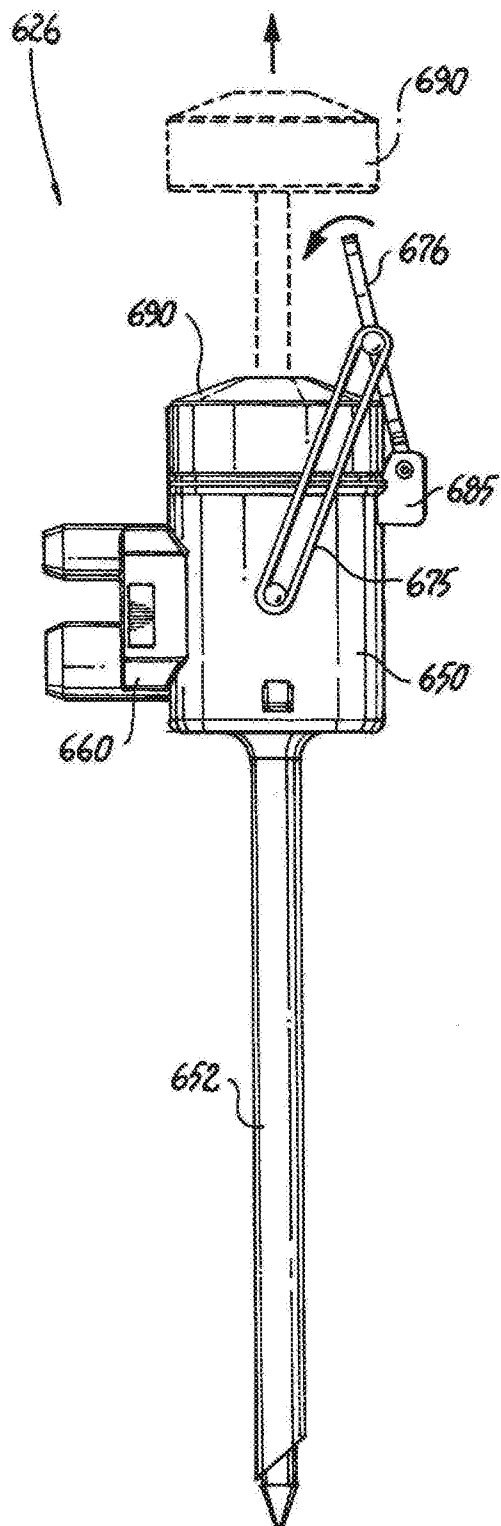


**Fig. 21**

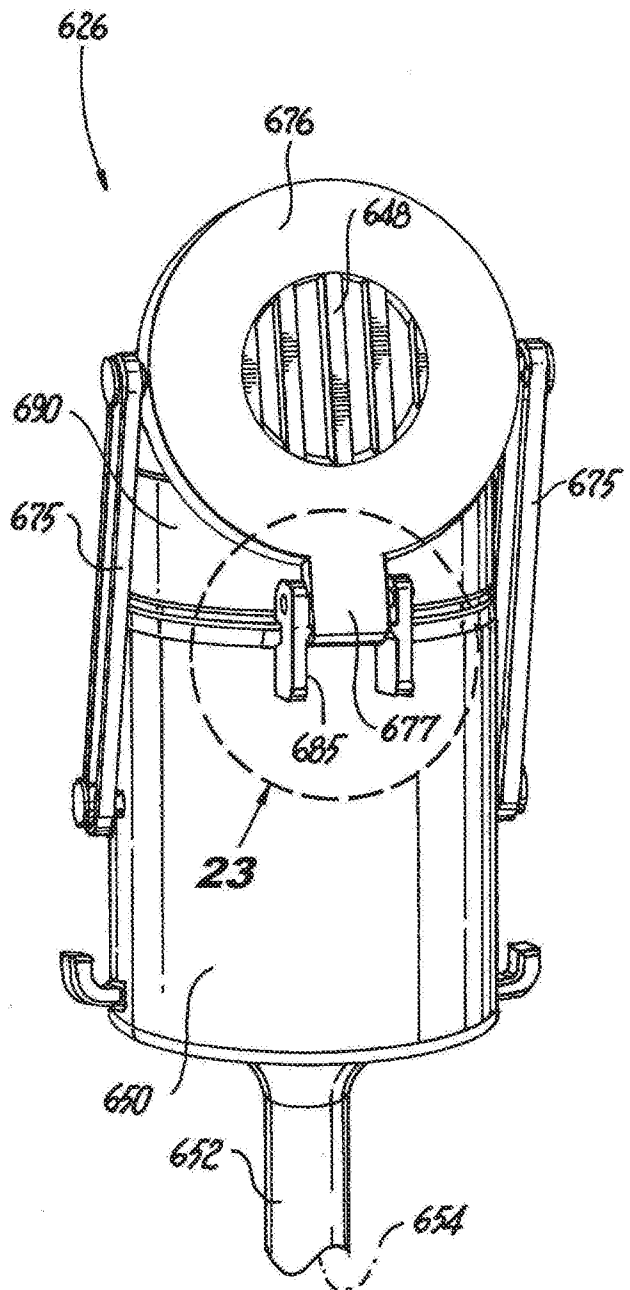


**Fig. 22**

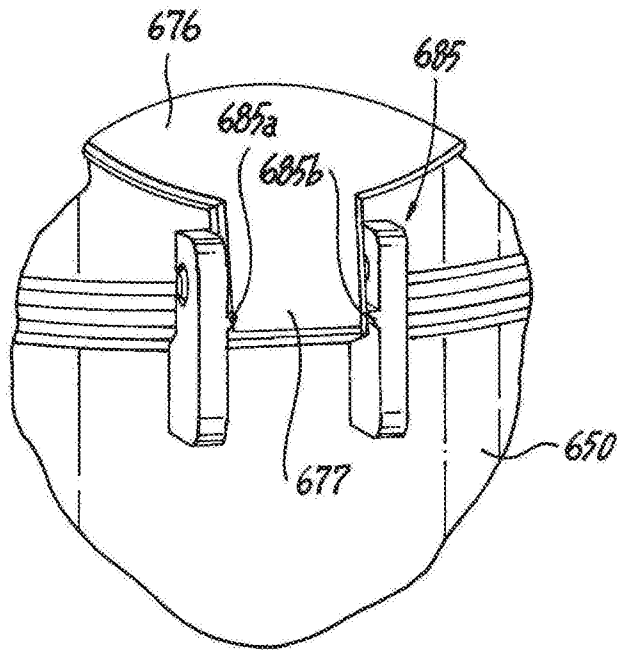


**Fig. 23**

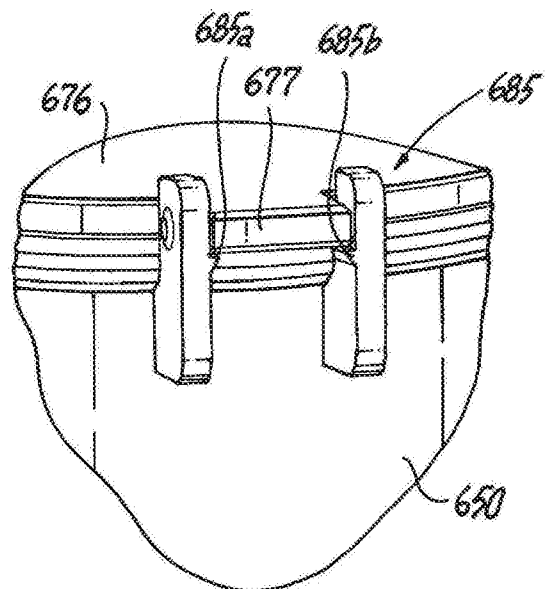


**Fig. 24**

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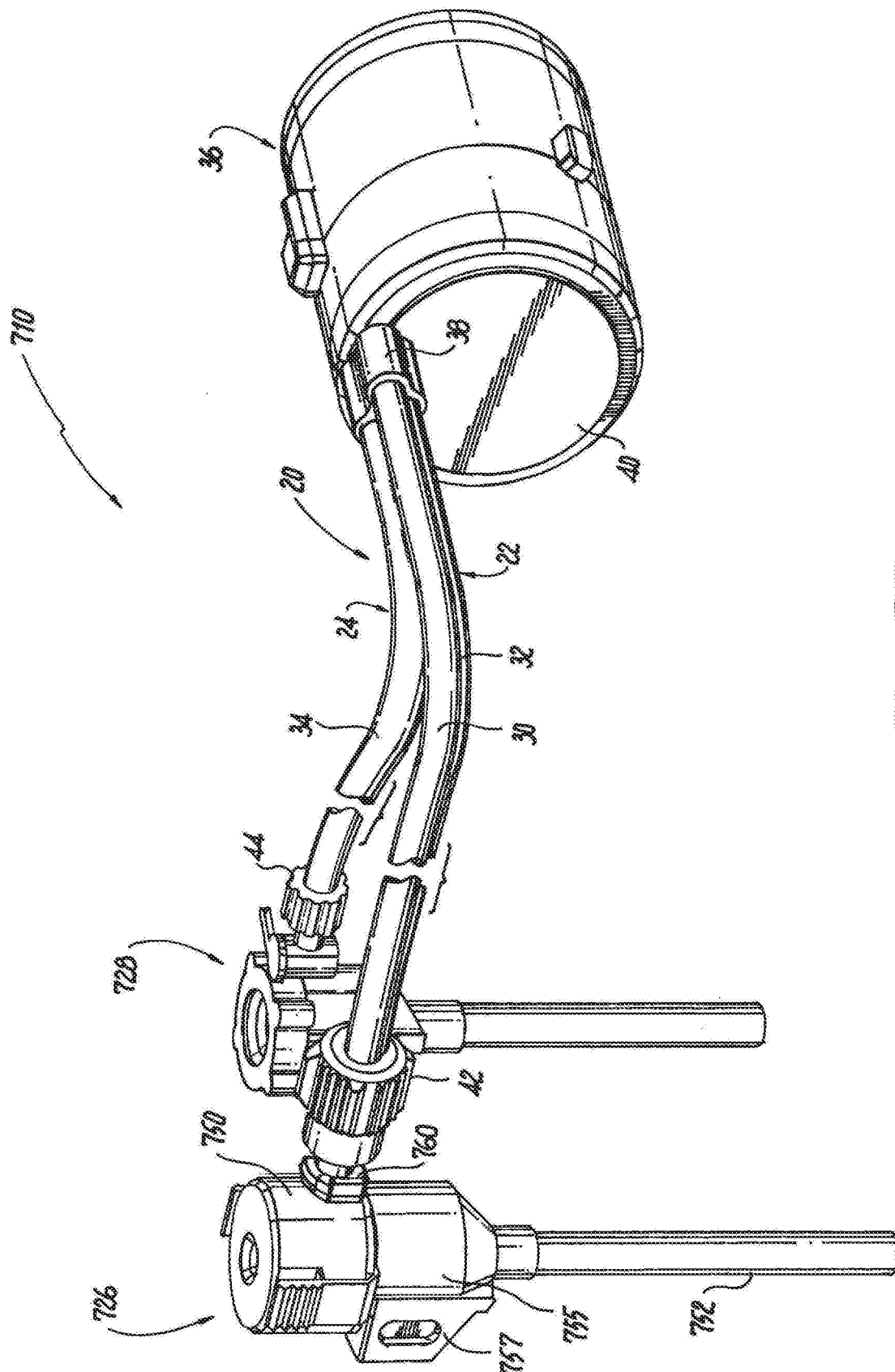


**Fig. 25**

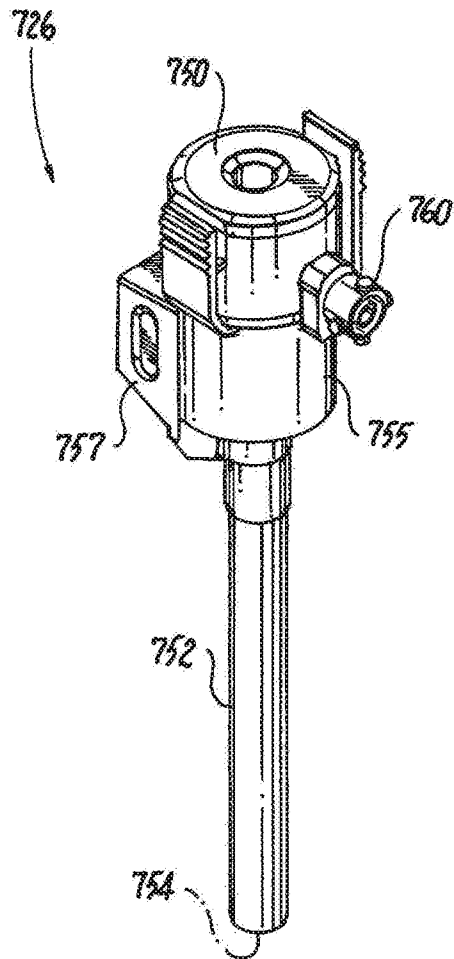


**Fig. 26**

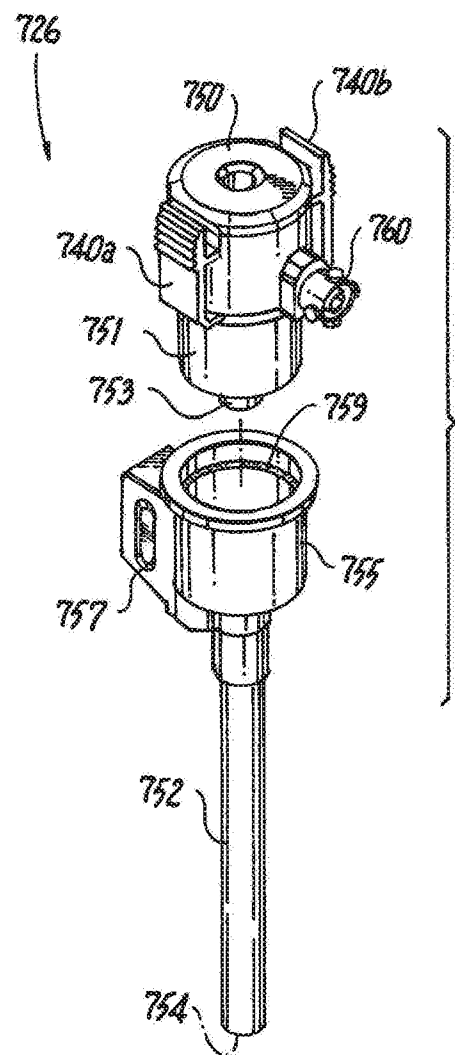


**Fig. 27**

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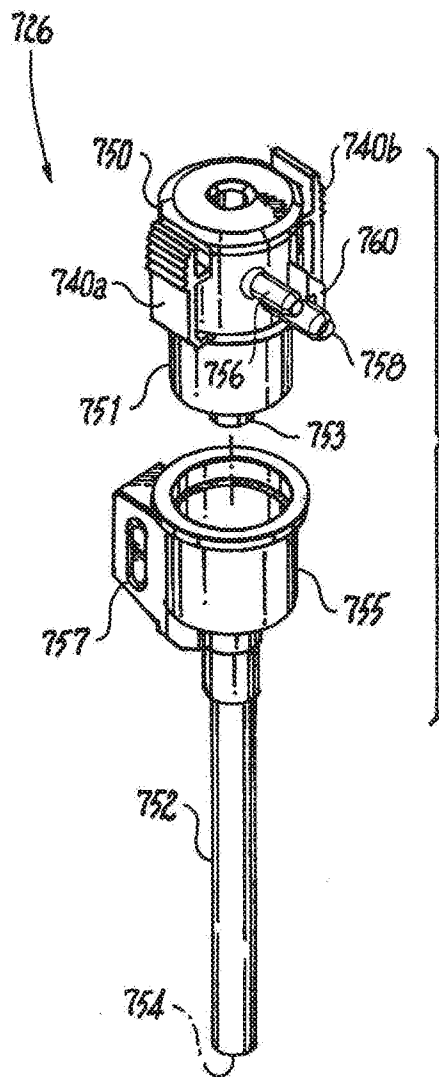


**Fig. 27a**

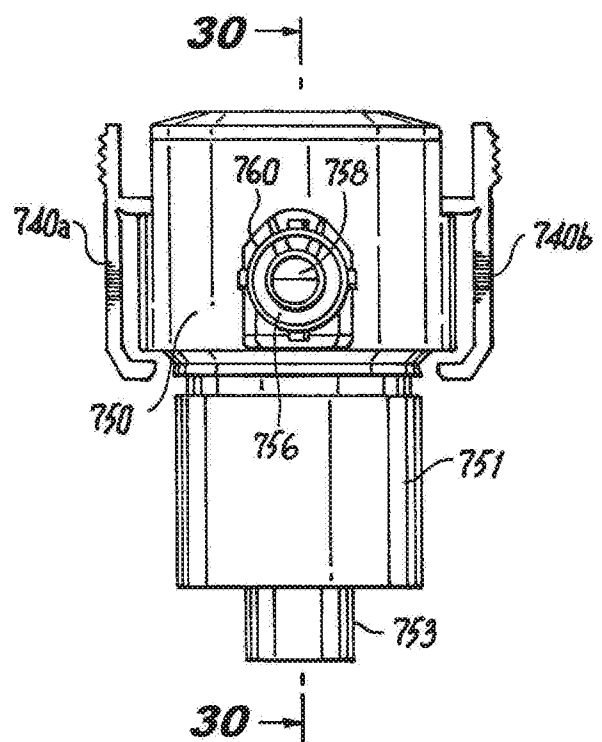
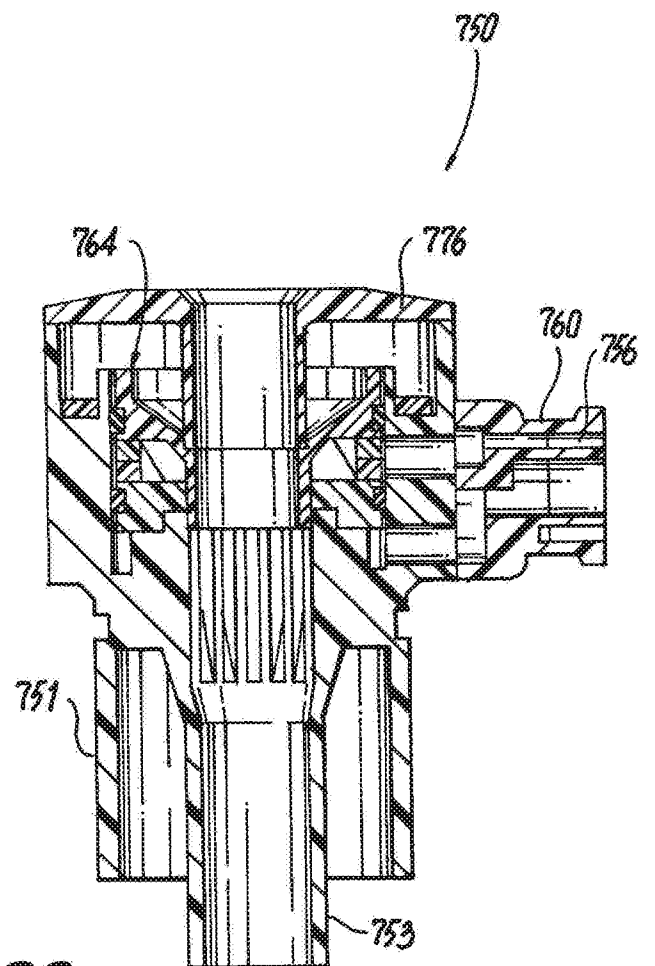
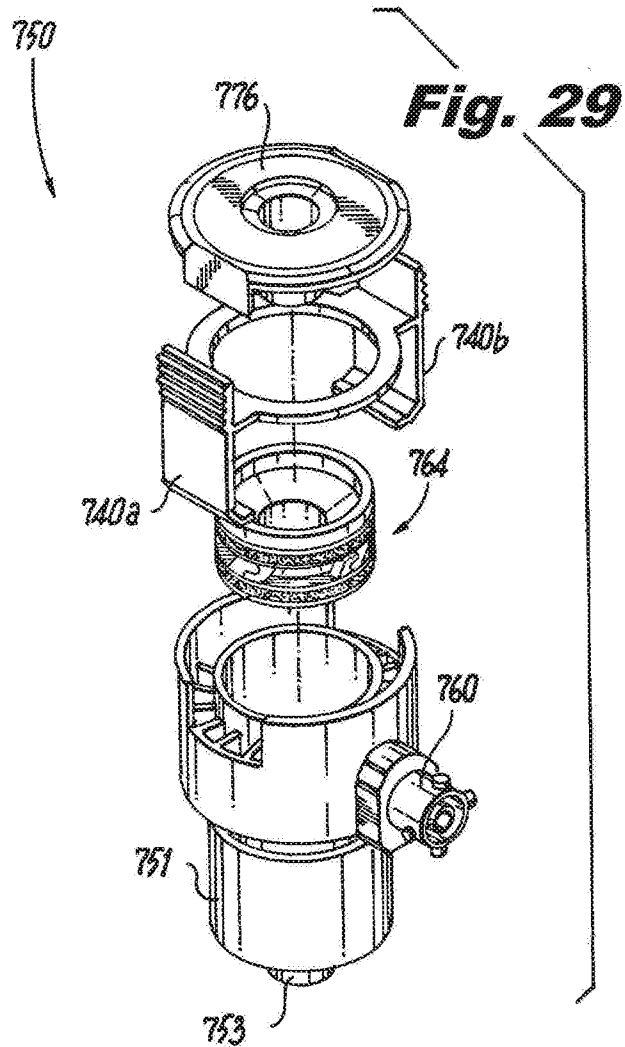


**Fig. 28**

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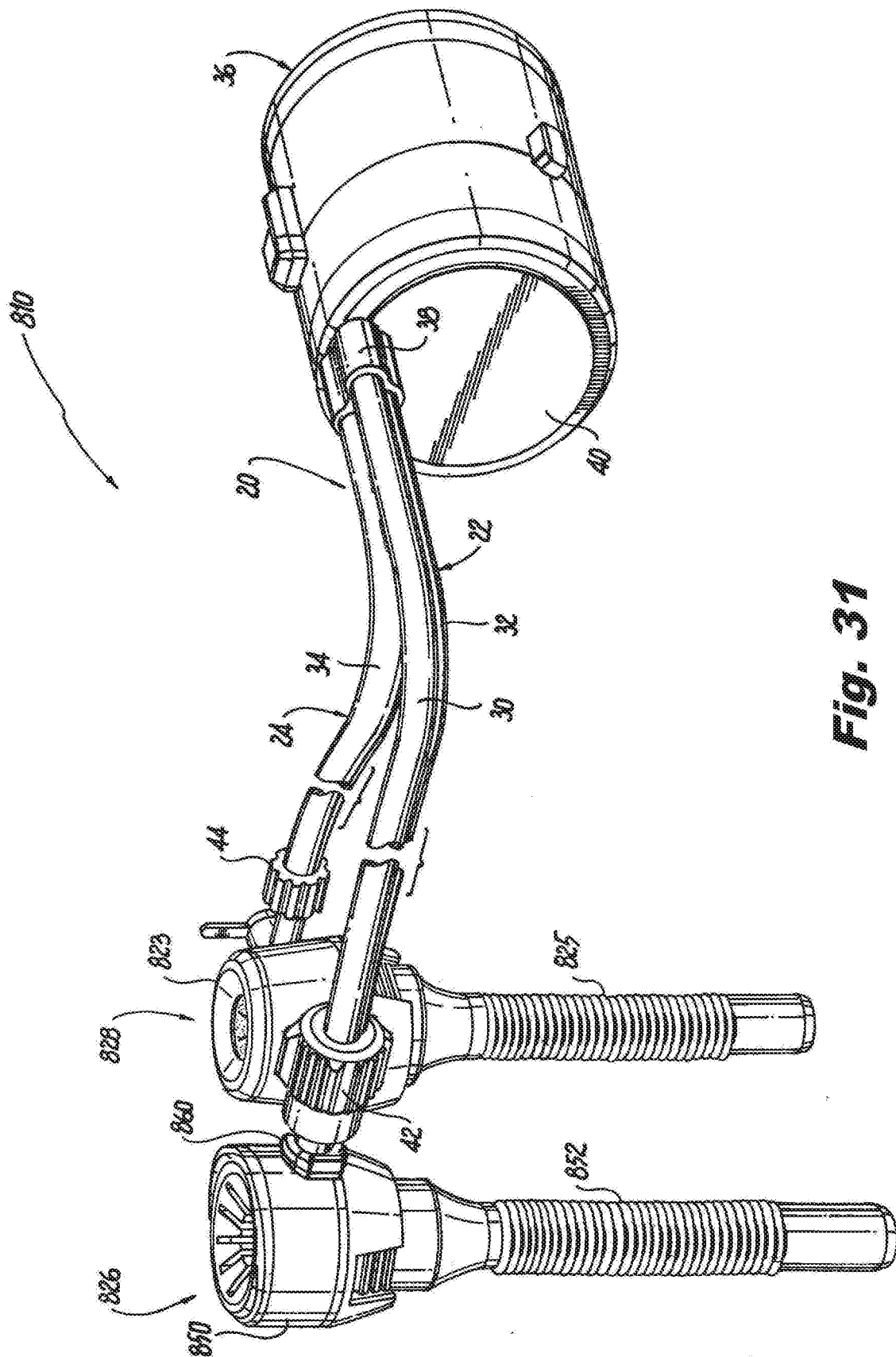


**Fig. 31**

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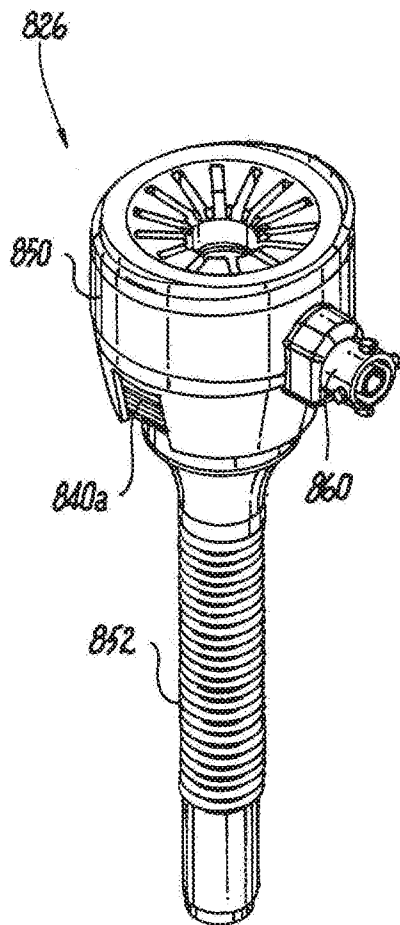


**Fig. 32**

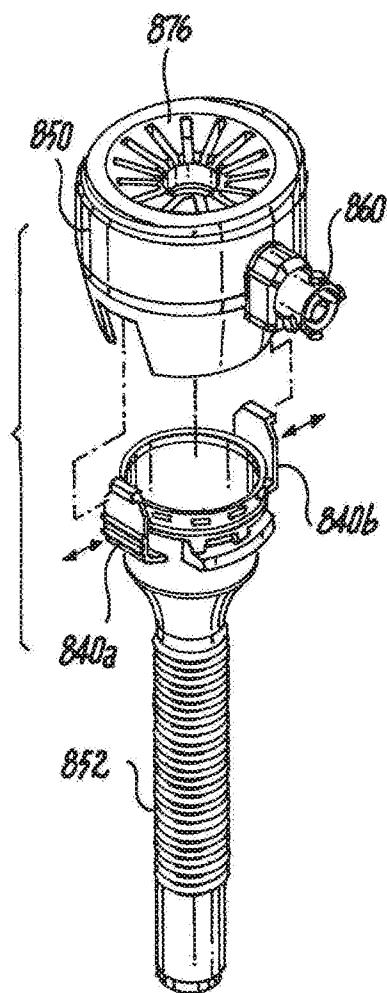


**Fig. 33**

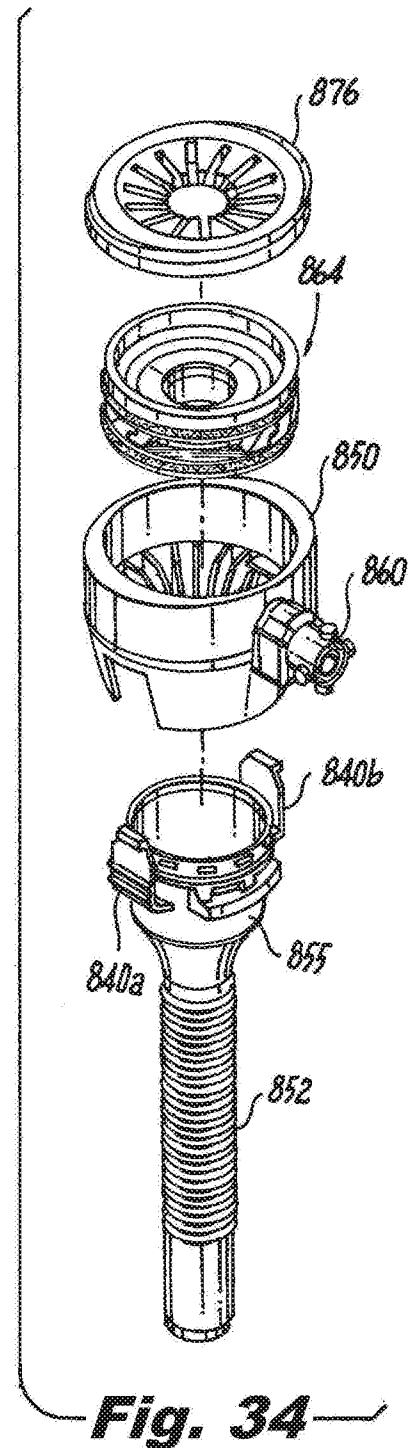
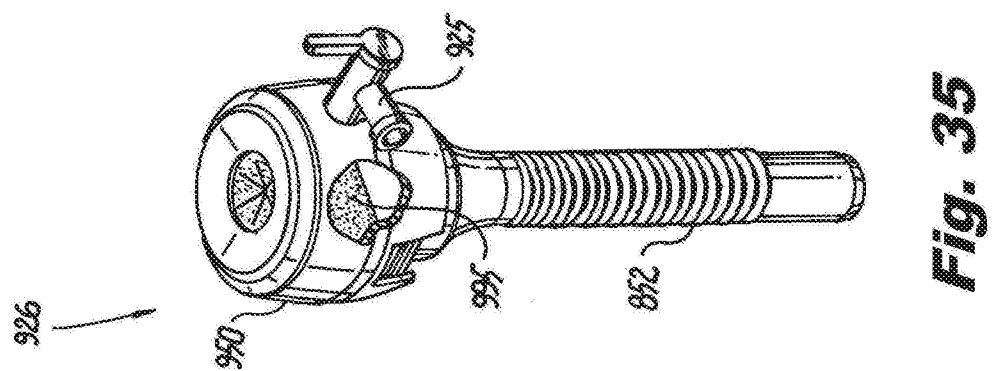
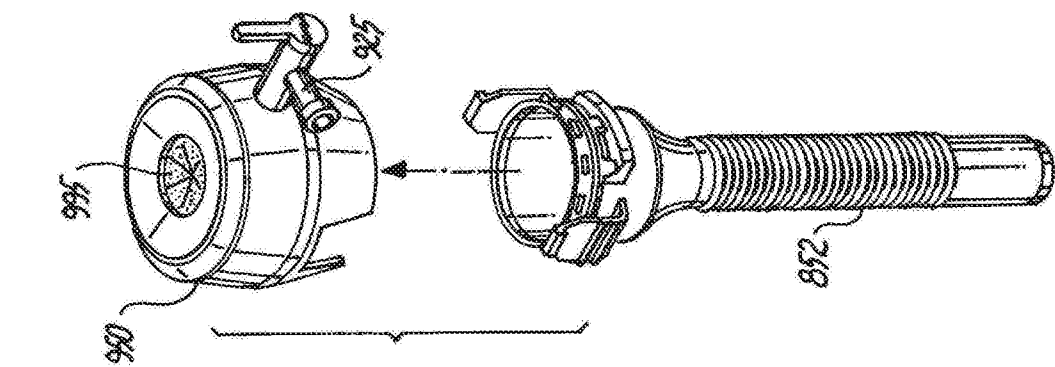
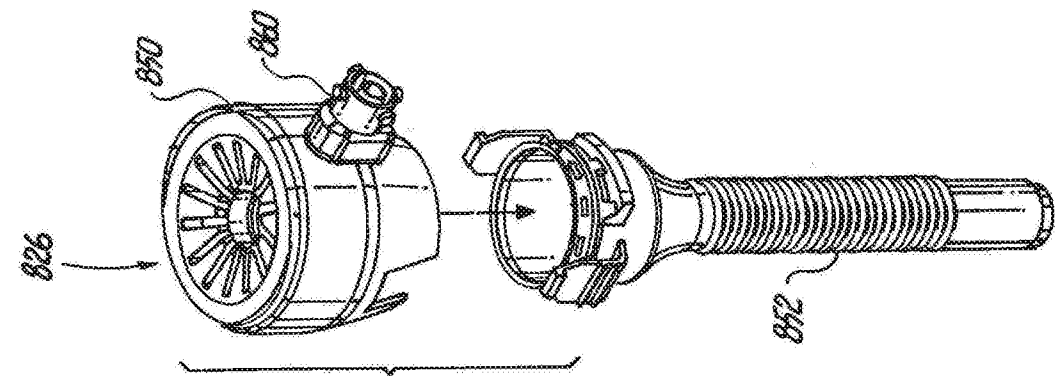
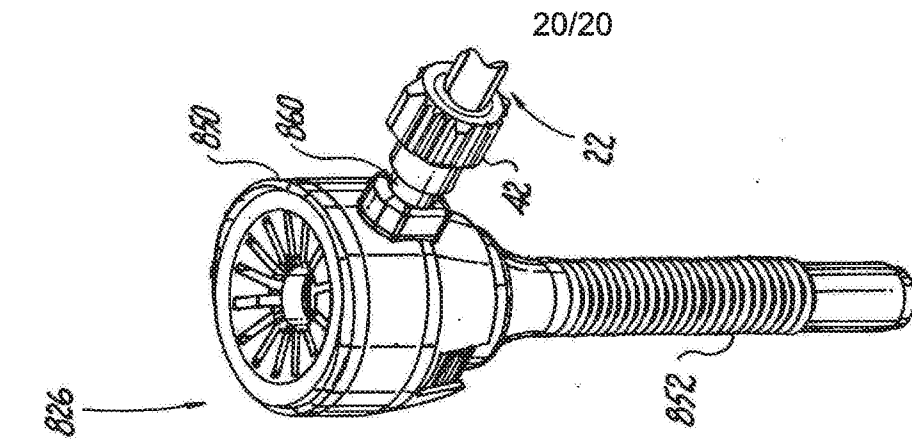


**Fig. 34**



## INTERNATIONAL SEARCH REPORT

International application No.  
**PCT/US2018/019445****A. CLASSIFICATION OF SUBJECT MATTER****A61B 17/34(2006.01)i, A61M 13/00(2006.01)i, A61M 39/06(2006.01)i, A61B 34/30(2016.01)i**

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)

A61B 17/34; A61B 17/02; A61B 1/015; A61M 13/00; A61B 19/00; A61M 39/10; A61M 39/06; A61B 34/30

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

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKOMPASS(KIPO internal) &amp; Keywords: laparoscopic surgical procedure, multi-lumen tube set, dual lumen, single lumen, gas line, sensing line, access port, inlet, outlet, cannula

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                                 | Relevant to claim No. |
|-----------|--------------------------------------------------------------------------------------------------------------------|-----------------------|
| X         | US 2014-0358070 A1 (SURGIQUEST, INC.) 04 December 2014<br>See paragraphs [0094]-[0218]; claims 1-14; figures 1-63. | 1-7, 9-17, 19, 20     |
| Y         |                                                                                                                    | 8, 18                 |
| Y         | US 2014-0171855 A1 (SURGIQUEST, INC.) 19 June 2014<br>See paragraphs [0042]-[0059]; claims 1-23; figures 1-19.     | 8, 18                 |
| A         | US 2015-0173792 A1 (APPLIED MEDICAL RESOURCES CORPORATION) 25 June 2015<br>See the whole document.                 | 1-20                  |
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Further documents are listed in the continuation of Box C.



See patent family annex.

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"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

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Date of the actual completion of the international search

08 June 2018 (08.06.2018)

Date of mailing of the international search report

**08 June 2018 (08.06.2018)**

Name and mailing address of the ISA/KR

International Application Division

Korean Intellectual Property Office

189 Cheongsa-ro, Seo-gu, Daejeon, 35208, Republic of Korea



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CHOI, Sang Won

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**INTERNATIONAL SEARCH REPORT**

Information on patent family members

International application No.

**PCT/US2018/019445**

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International application No.

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