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(54) Title: SYSTEMS AND METHODS FOR CONDUCTING SMOKE EVACUATION DURING LAPAROSCOPIC SURGICAL PROCEDURES

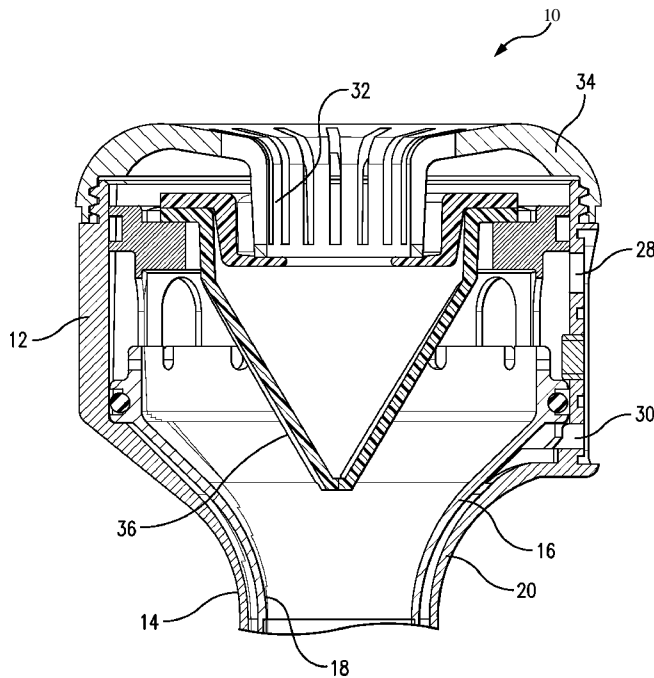


FIG. 1

(57) Abstract: An insufflation and smoke evacuation system for use during laparoscopic surgical procedures in an abdominal cavity of a patient is disclosed that includes a pump for circulating pressurized gas within the system, and a dual lumen cannula configured to provide access to the abdominal cavity of a patient, which includes a first lumen communicating with a source of insufflation fluid and a second lumen communicating with the pump.

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**SYSTEMS AND METHODS FOR CONDUCTING SMOKE EVACUATION  
DURING LAPAROSCOPIC SURGICAL PROCEDURES**

**CROSS-REFERENCE TO RELATED APPLICATIONS**

This application claims priority to U.S. Provisional Patent Application No. 61/826,088 filed May 22, 2013 and to U.S. Provisional Patent Application No. 61/728,608 filed November 20, 2012, each of which is incorporated by reference herein in its entirety.

**BACKGROUND OF THE INVENTION**

**1. Field of the Invention**

The subject invention is directed to laparoscopic surgery, and more particularly, to systems and methods for conducting smoke removal and evacuation from the abdominal cavity of a patient during a laparoscopic surgical procedure utilizing a dual lumen cannula.

**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 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 what is referred to as a pneumoperitoneum. The insufflation can be carried out by a surgical access device, e.g., 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 incisions, usually no larger than about twelve millimeters each, which are typically made with the surgical access devices themselves, typically using a separate inserter or obturator placed therein. Following insertion, the inserter is removed, and the trocar allows access for instruments to be inserted into the abdominal cavity. Typical trocars often provide means to insufflate the abdominal cavity, so that the surgeon has an open interior space in which to work.

The trocar must provide a means 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 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. Sealing elements or mechanisms typically include a duckbill-type valve made of a relatively pliable material, to seal around an outer surface of surgical instruments passing through the trocar.

Further, in laparoscopic surgery, electrocautery and other techniques (e.g. harmonic scalpels) create smoke and other debris in the surgical cavity, reducing visibility by fogging the view from, and coating surfaces of endoscopes and the like. A variety of surgical insufflation systems and smoke evacuation systems are known in the art.

Additionally, SurgiQuest, Inc., Milford, Conn. USA has developed surgical access devices that permit access to an insufflated surgical cavity without conventional

mechanical seals, and has developed related systems for providing sufficient pressure and flow rates to such access devices, as described in whole or in part in U.S. Patent No. 7,854,724.

While the systems and methods described above have generally been considered satisfactory for their intended purpose, there is an ongoing need for improved functionality in insufflation systems and related techniques.

### **SUMMARY OF THE INVENTION**

The subject disclosure is directed to a new and useful surgical gas delivery system for use during laparoscopic surgical procedures, e.g., in an abdominal cavity of a patient, and more particularly, to an insufflation and smoke evacuation system that includes a pump for circulating pressurized gas within the system and a dual lumen cannula configured to provide access to the abdominal cavity of a patient, which includes a first lumen communicating with the source of insufflation fluid and a second lumen communicating with the pump.

In one embodiment of the subject invention, the dual lumen cannula includes a first lumen communicating with the source of insufflation fluid and a pressure side of the pump for delivering pressurized gas and insufflation fluid to the abdominal cavity, and a second lumen communicating with a suction side of the pump for removing gas from the abdominal cavity.

In another embodiment of the subject invention, the dual lumen cannula includes a first lumen communicating with the source of insufflation fluid and a second lumen communicating with a pressure side of the pump for delivering pressurized gas to the abdominal cavity. In addition, the system includes a second cannula which has a

single lumen communicating with a suction side of the pump for removing gas from the abdominal cavity.

In certain embodiments of the subject invention, a bypass valve is operatively associated with the pump for controlling a gas circulation rate within the system. In addition, a mechanical seal is operatively associated with the second lumen to maintain abdominal pressure, and the first lumen serves as a sense line for sensing abdominal pressure. A filter device is also provided for filtering gas circulating through the system to remove smoke and debris therefrom.

These and other features of the system of the subject invention and the manner in which it is manufactured and employed will become more readily apparent to those having ordinary skill in the art from the following enabling description of the preferred embodiments of the subject invention taken in conjunction with the several drawings described below.

#### **BRIEF DESCRIPTION OF THE DRAWINGS**

So that those skilled in the art to which the subject invention appertains will readily understand how to make and use the subject invention without undue experimentation, preferred embodiments thereof will be described in detail herein below with reference to certain figures, wherein:

Fig. 1 is cross-sectional view of the upper portion of a dual lumen cannula constructed in accordance with a preferred embodiment of the subject invention, which includes, among other things a mechanical duckbill seal;

Fig. 2 is a schematic drawing of an embodiment of the insufflation and smoke evacuation system of the subject invention, which employs the dual lumen cannula shown in Fig. 1, as well as an additional single lumen cannula;

Fig. 3 is a schematic drawing of an embodiment of the insufflation and smoke evacuation system of the subject invention, which employs the dual lumen cannula shown in Fig. 1; and

Fig. 4 is a schematic drawing of yet another embodiment of the insufflation and smoke evacuation system of the subject invention, which employs a tri-lumen cannula, as well as an additional single lumen cannula.

### **DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS**

Reference will now be made to the drawings wherein like reference numerals identify similar structural features or aspects of the subject disclosure. For purposes of explanation and illustration, and not limitation, a partial view of an exemplary embodiment of an insufflation and smoke evacuation system in accordance with the disclosure is shown in Fig. 1 and is designated generally by reference character 10. Other embodiments of insufflation and smoke evacuation systems in accordance with the disclosure, or aspects thereof, are provided in Figs. 2-4, as will be described. It is to be appreciated that the systems, devices and methods presented herein may be used for surgical gas delivery, including insufflation, smoke evacuation, and/or recirculation in connection with suitable surgical devices, and in applicable surgical procedures.

The present invention relates to multimodal systems, and related devices and methods, capable of performing multiple surgical gas delivery functions, including insufflation to standard or specialized surgical access devices or other instruments, such as Veress needles and the like, smoke evacuation through standard or specialized surgical access devices, and specialized functions, such as recirculation and filtration of insufflation fluids, such as with the above-mentioned surgical access devices described for example in U.S. Patent No. 7,854,724; as well as those in U.S. Pat. Nos. 7,182,752;

7,285,112; 7,413,559 or 7,338,473; each of which is incorporated by reference herein in its entirety.

Use of a single multimodal system such as those described herein reduces costs by requiring purchase of only one system while achieving multiple functions, and also thereby reduces the amount of equipment needed in an operating room, thus reducing clutter and allowing space for other necessary equipment.

The present invention is particularly suited for minimizing the amount of equipment needed in a surgical operating room, in that the subject systems are capable of performing multiple functions, and therefore also allow flexibility of surgical technique. It is envisioned that the gas delivery system disclosed herein can be used in general laparoscopic procedures including but not limited to laparoscopic cholecystectomy, laparoscopic appendectomy, laparoscopic hernia repair, Nissen-Y and Lap Nephrectomy.

Those skilled in the art will readily appreciate that systems described in U.S. Patent No. 7,854,724, for example, provide pressurized gas to and remove depressurized gas from specialized surgical access devices, which penetrate into a surgical cavity, such as a patient's abdominal cavity. These access devices are adapted and configured to form a pressure barrier to inhibit the loss of insufflation gas to the atmosphere.

An example of an access device constructed in accordance with a preferred embodiment of the subject invention is illustrated in Fig. 1 and is designated generally by reference numeral 10. Access device 10 is configured as a dual lumen cannula. That is, it includes a proximal housing 12, an outer cannula 14 and an inner cannula 16. The inner cannula 16 defines a central or inner lumen 18 and an annular or outer lumen 20 is formed between the outer cannula 14 and the inner cannula 16.

The housing 12 includes a first flow port 28 communicating with the central lumen of the inner cannula 16 and a second flow port 30 communicating with the annular passage 20. A main access port 32 is provided in the end cap 34 of the housing 12, and a duckbill seal 36 is supported within the housing 12 to prevent the egress of pressurized gas from the device through the access port 32.

As discussed in more detail below with reference to Fig. 2, during use gas from the abdomen, e.g., pneumoperitoneum 116, interchanges with gas coming from the access device 10, a portion of which is collected and recycled through the system, and is re-pressurized along the way, passing through one or more filters, e.g., filter 123 described below. During this recycling process, smoke and/or other circulating debris, such as atomized fluids, are removed by the filters, improving visibility within the surgical cavity, thus aiding in the surgical procedure. An example of a filter that can be utilized with the subject invention is disclosed in U.S. Patent No. 8,088,189, the disclosure of which is herein incorporated by reference in its entirety.

Referring now to Fig. 2, there is illustrated an insufflation and smoke evacuation system constructed in accordance with the subject invention and designated generally by reference numeral 100 that includes a recirculation pump 112 for circulating pressurized gas within the system. The system 100 includes a dual lumen cannula 10 as illustrated in Fig. 1. In this embodiment of the invention, the dual lumen cannula 10 includes a first or outer lumen 20 communicating with a source of insufflation fluid 114 through a conduit 115 connected to the flow port 30 in housing 12. The source of insufflation fluid 114 maintains pressure within pneumoperitoneum 116. The outer lumen 20 of dual lumen cannula 10 also serves as a sense line for sensing and controlling abdominal pressure within the system 100.

The dual lumen cannula 10 of system 100 further includes a second or central lumen 18 communicating with a pressure or supply side of the recirculation pump 112 through a conduit 117 connected to the flow port 28 in housing 12 for delivering pressurized gas to the abdominal cavity, e.g., for recirculation as described below.

In addition, the system 100 includes a second cannula 150 which has a single lumen that communicates with a suction side of the recirculation pump 112 through a conduit 119, e.g., by way of a luer connection, for removing gas from the abdominal cavity. System 100 further includes a bypass valve 125 that is operatively associated with the recirculation pump 112 through a conduit 121 connecting conduit 117 to conduit 119 to control the gas circulation rate within the system 100. When bypass valve 125 is closed, pump 112 recirculates gas through connecting conduit 117, central lumen 18, pneumoperitoneum 116, second cannula 150, and conduit 119, which includes a filter 123. Filter 123 can remove smoke, particles, moisture, and the like from the insufflation gas circulating through pneumoperitoneum 116. Bypass valve 112 can be opened and adjusted as needed to reduce the flow of recirculation through pneumoperitoneum 116.

Referring now to Fig. 3, there is illustrated another insufflation and smoke evacuation system constructed in accordance with the subject invention and designated generally by reference numeral 200 that includes a recirculation pump 212 for circulating pressurized gas within the system. The system 200 further includes a dual lumen cannula 10 as illustrated in Fig. 1.

In this embodiment of the invention, the dual lumen cannula 10 includes a first annular lumen 20 communicating with a source of insufflation fluid 214 and a high pressure side (or supply side) of the pump 212 through a conduit 217 connected to the

flow port 30 in housing 12. The annular lumen 20 of dual lumen cannula 10 also serves as a sense line for sensing abdominal pressure within the system 200.

In system 200, the dual lumen cannula 10 further includes a second lumen 18 communicating with the suction side of the recirculation pump 212 through a conduit 219 connected to the flow port 28 of housing 12 for removing gas from the abdominal cavity, e.g. pneumoperitoneum 116 of Fig. 1. In this embodiment, second lumen 18 has only one line, namely conduit 219, which is a suction line, i.e., there is no sense/insufflation line for second lumen 18. System 200 further includes a bypass valve 225 that is operatively associated with the recirculation pump 212 through a conduit 221 connecting conduit 217 to conduit 219 to control the rate of gas circulation within the system 200. Bypass valve 225 can be used to control the amount of recirculation flow through dual lumen cannula 10 as described above. Filter 223 operates as described above with respect to filter 123.

Referring to Fig. 4, there is there is illustrated yet another insufflation and smoke evacuation system designated generally by reference numeral 300. System 300 includes a source of insufflation gas 314, pump 312, bypass valve 325, second cannula 350, and filter 323, and is substantially identical to the system 100 shown in Fig. 2, except that system 300 includes a tri-lumen cannula 320 and a communication line 360 that extends between the inner bowl area of the cannula 320 and the vacuum line 319. As a result, if the tri-lumen cannula 320 is used as an access port for a laparoscope, smoke will exit the abdominal cavity in an area that is located away from the distal end of the scope so as not to adversely impact visibility through the scope.

While shown and described in the exemplary context of insufflation of a peritoneum space, those skilled in the art will readily appreciate that any suitable space

can be insufflated with the systems and methods described herein without departing from the scope of this disclosure.

While the subject invention has been shown and described with reference to preferred embodiments, those skilled in the art will readily appreciate that various changes and/or modifications may be made thereto without departing from the spirit and scope of the subject invention as defined by the appended claims.

**What is claimed is:**

1. An insufflation and smoke evacuation system for use during laparoscopic surgical procedures, comprising:
  - a) a pump for circulating pressurized gas within the system; and
  - b) a dual lumen cannula configured to provide access to the abdominal cavity of a patient, which includes a first lumen for fluid communication with a source of insufflation fluid and a second lumen in fluid communication with the pump.
  
2. A system as recited in Claim 1, further comprising a second cannula for introduction into the abdominal cavity of the patient, which includes a single lumen in fluid communication with a suction side of the pump for removing gas from the abdominal cavity.
  
3. A system as recited in Claim 2, wherein the second lumen is in fluid communication with a pressure side of the pump for delivering pressurized gas to the abdominal cavity.
  
4. A system as recited in Claim 1, wherein the second lumen is in fluid communication with a suction side of the pump for removing gas from the abdominal cavity.
  
5. A system as recited in Claim 4, wherein the first lumen is in fluid communication with the source of insufflation fluid and a pressure side of the pump for delivering pressurized gas and insufflation fluid to the abdominal cavity.

6. A system as recited in Claim 1, wherein a bypass valve is operatively associated with the pump for controlling a gas circulation rate within the system.
7. A system as recited in Claim 1, wherein a mechanical seal is operatively associated with the second lumen to maintain abdominal pressure.
8. A system as recited in Claim 1, wherein the first lumen is configured to serve as a sense line for sensing abdominal pressure.
9. A system as recited in Claim 1, further comprising a filter device operatively connected for filtering gas circulating through the system to remove smoke and debris therefrom.
10. An insufflation and smoke evacuation system for use during laparoscopic surgical procedures, comprising:
  - a) a source of insufflation fluid;
  - b) a pump for circulating pressurized gas within the system; and
  - c) a dual lumen cannula configured to provide access to the abdominal cavity of a patient, which includes a first lumen in fluid communication with the source of insufflation fluid and a pressure side of the pump for delivering pressurized gas and insufflation fluid to the abdominal cavity, and a second lumen in fluid communication with a suction side of the pump for removing gas from the abdominal cavity.

11. A system as recited in Claim 10, wherein a bypass valve is operatively associated with the pump for controlling a gas circulation rate within the system.
12. A system as recited in Claim 10, wherein a mechanical seal is operatively associated with the second lumen to maintain abdominal pressure.
13. A system as recited in Claim 10, wherein the first lumen is configured to serve as a sense line for sensing abdominal pressure.
14. A system as recited in Claim 10, further comprising a filter device for filtering gas circulating through the system to remove smoke and debris therefrom.
15. An insufflation and smoke evacuation system for use during laparoscopic surgical procedures, comprising:
  - a) a source of insufflation fluid;
  - b) a pump for circulating pressurized gas within the system;
  - c) a dual lumen cannula including a first lumen in fluid communication with the source of insufflation fluid and a second lumen in fluid communication with a pressure side of the pump for delivering pressurized gas to the abdominal cavity; and
  - d) a second cannula having a single lumen in fluid communication with a suction side of the pump for removing gas from the abdominal cavity.
16. A system as recited in Claim 15, wherein a bypass valve is operatively associated with the pump for controlling a gas circulation rate within the system.

17. A system as recited in Claim 15, wherein a mechanical seal is operatively associated with the second lumen to maintain abdominal pressure.
  
18. A system as recited in Claim 15, wherein the first lumen is configured to serve as a sense line for sensing abdominal pressure.
  
19. A system as recited in Claim 15, further comprising a filter device for filtering gas circulating through the system to remove smoke and debris therefrom.

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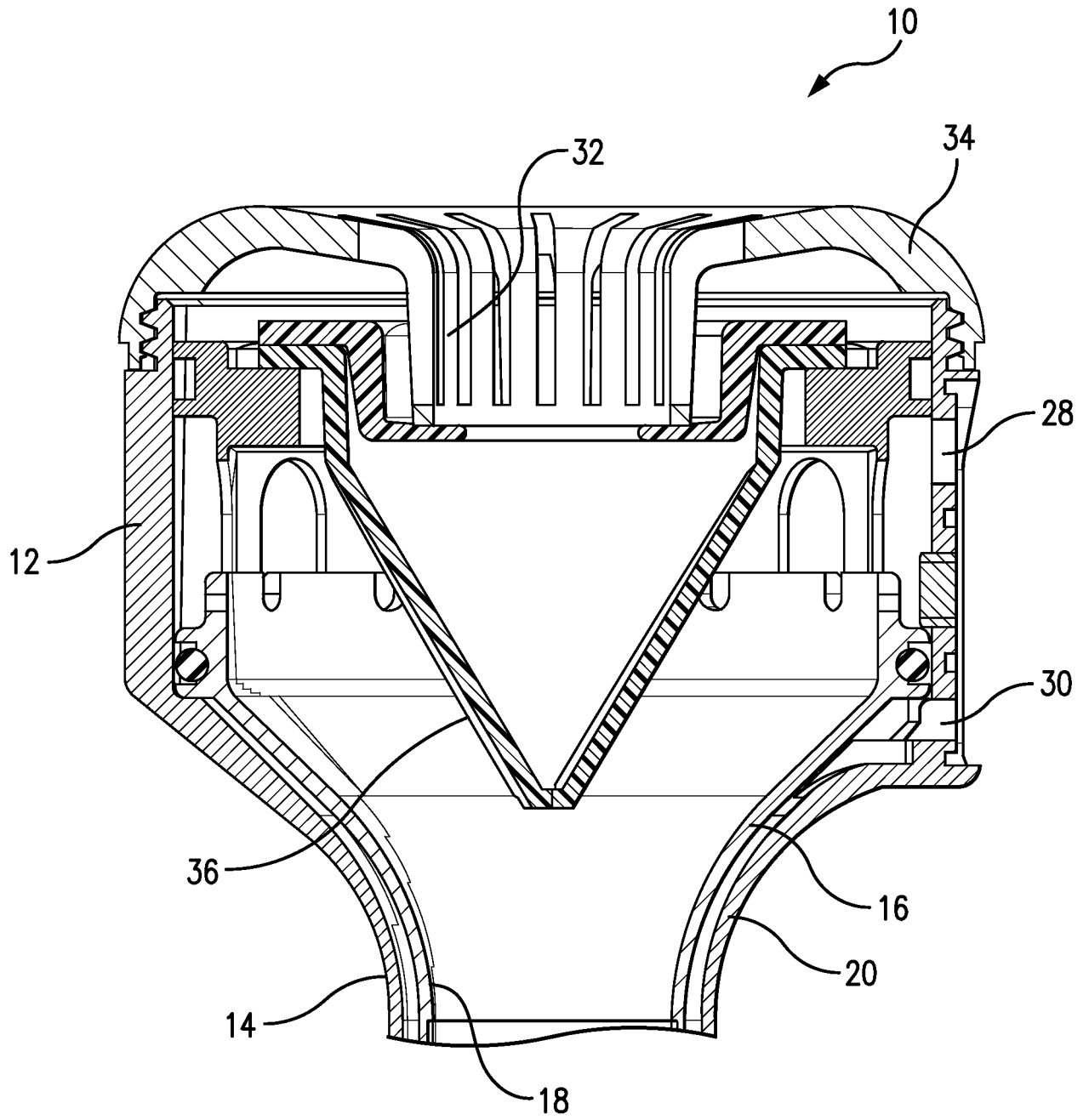


FIG. 1

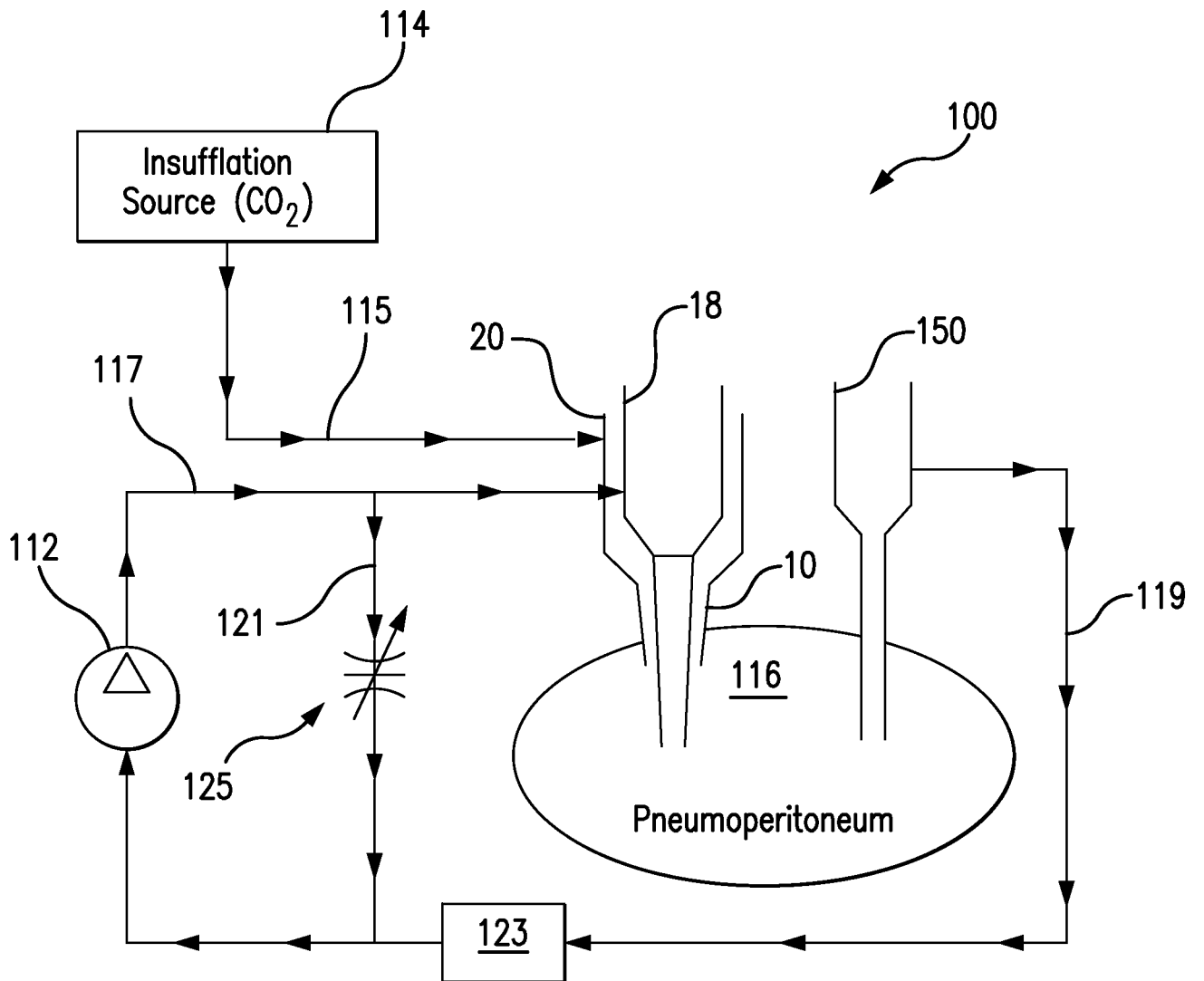


FIG. 2

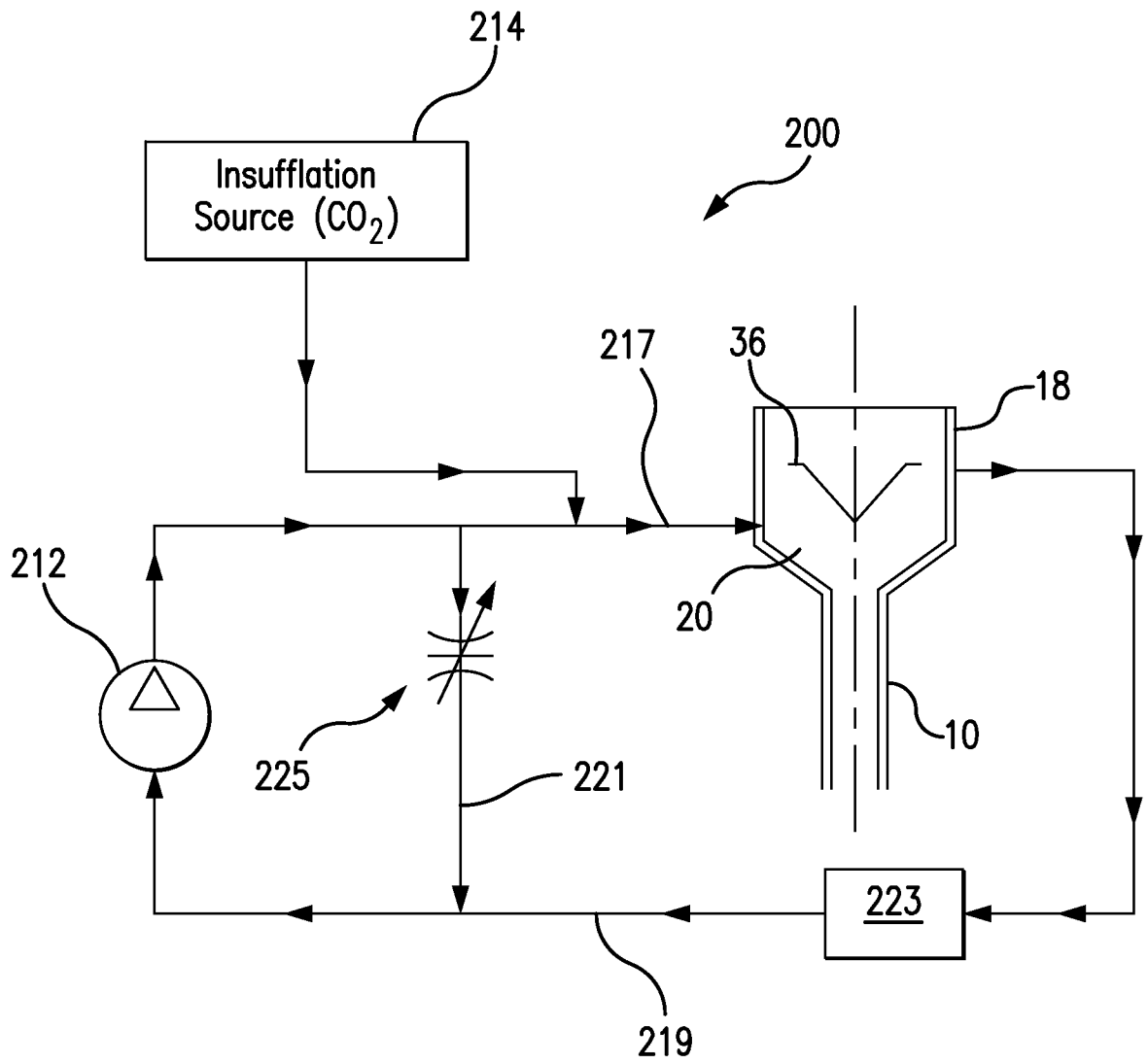


FIG. 3

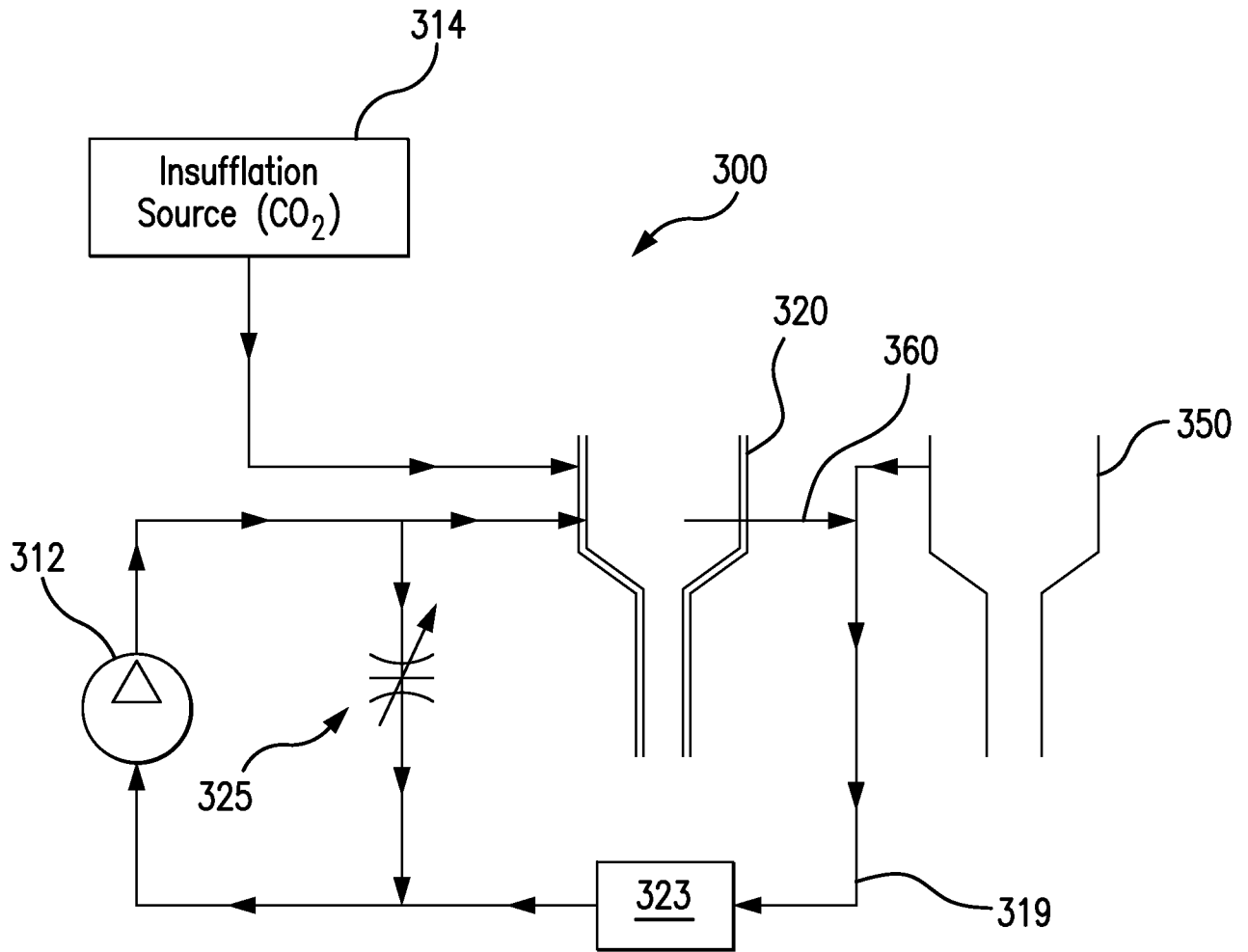


FIG. 4

## INTERNATIONAL SEARCH REPORT

International application No.  
**PCT/US2013/070933****A. CLASSIFICATION OF SUBJECT MATTER****A61M 1/00(2006.01)i, A61M 27/00(2006.01)i, A61B 17/94(2006.01)i, A61B 17/50(2006.01)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)

A61M 1/00; A61M 39/06; A61B 17/34; A61M 37/00; A61M 5/178; A61M 27/00; A61B 17/94; A61B 17/50

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) & Keywords: laparoscopic, pneumoperitoneum, insufflation gas, abdominal, evacuation, suction, dual lumen, cannula, bypass valve, pump****C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	W0 2010-042204 A2 (SURGIQUEST, INCORPORATED, et al.) 15 April 2010 See abstract; claims 1, 3; page 18, lines 18-19; page 20, lines 9-12; page 28, lines 2-4; page 35, lines 3-5; page 37, lines 22-24; figures 2, 14, 16, 24c, 28.	1,6-9
Y		2-5,10-19
Y	US 6544210 B1 (TRUDEL, G. J. et al.) 8 April 2003 See abstract; claim V, column 4, lines 12-16; figure 1.	2-5,10-19
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A	US 6592543 B1 (WORTRICH, T. S. et al.) 15 July 2003 See abstract; claim 1; figure 1.	1-19
A	US 5779662 A (BERMAN, P. J.) 14 July 1998 See abstract; claim 1; figure 1.	1-19



Further documents are listed in the continuation of Box C.



See patent family annex.

\* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

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

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"O" document referring to an oral disclosure, use, exhibition or other means

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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

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&amp;" document member of the same patent family

Date of the actual completion of the international search

27 February 2014 (27.02.2014)

Date of mailing of the international search report

**27 February 2014 (27.02.2014)**

Name and mailing address of the ISA/KR

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## INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

**PCT/US2013/070933**

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专利名称(译)	用于在腹腔镜外科手术过程中进行排烟的系统和方法		
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申请号	EP2013856218	申请日	2013-11-20
[标]申请(专利权)人(译)	瑟吉奎斯特公司		
申请(专利权)人(译)	SURGIQUEST INC.		
当前申请(专利权)人(译)	SURGIQUEST INC.		
[标]发明人	TANG RAYMOND YUE SING BLIER KENNETH STEARNS RALPH AZARBARZIN HURT MASTRI DOMINICK		
发明人	TANG, RAYMOND, YUE-SING BLIER, KENNETH STEARNS, RALPH AZARBARZIN, HURT MASTRI, DOMINICK		
IPC分类号	A61M1/00 A61M27/00 A61B17/94 A61B17/50 A61B17/34 A61M13/00		
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外部链接	<a href="#">Espacenet</a>		

#### 摘要(译)

公开了一种在患者腹腔内的腹腔镜外科手术过程中使用的注气和排烟系统，其包括用于在系统内循环加压气体的泵，以及配置成提供进入患者腹腔的双腔套管，其包括与吹入流体源连通的第一腔和与泵连通的第二腔。