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(54) SYSTEMS AND METHODS FOR OPTIMIZING AND MAINTAINING VISUALIZATION OF A SURGICAL FIELD DURING THE USE OF SURGICAL SCOPES

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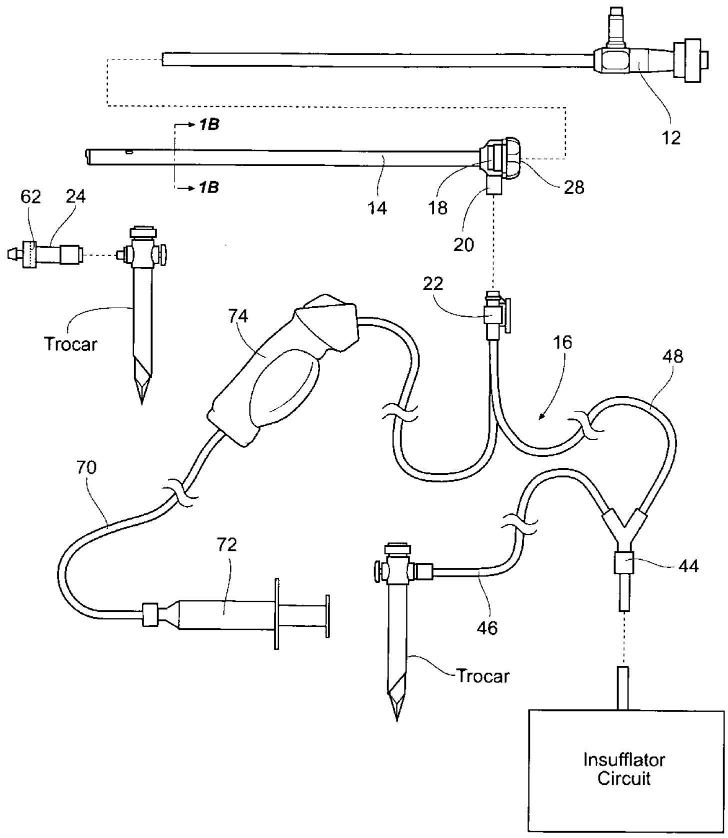
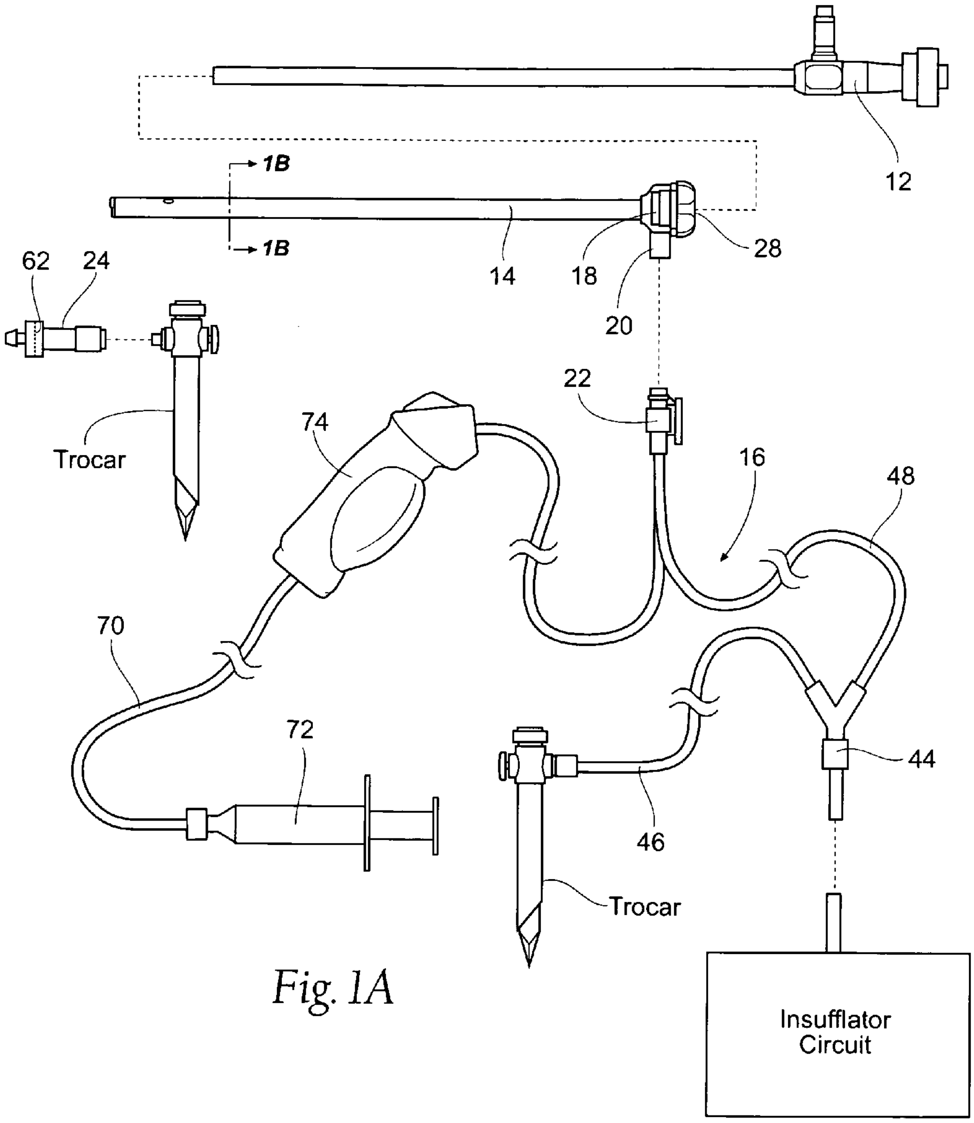
(57) **ABSTRACT**

Systems and methods make use of a view optimizing assembly having a deflector assembly with critical physical, pneumatic, and optical characteristics that make possible intraoperative defogging, surgical debris deflection, and cleaning of a laparoscope lens during minimally invasive surgery, while also maintaining visualization of the surgical site. The view optimizing assembly can incorporate a quick exchange feature, which makes possible a surgical method for maintaining clear visualization that includes the ability to make a quick exchange of laparoscopes having different operating characteristics (e.g., laparoscopes with different tip angles, lengths, or diameters) entirely on the sterile operating field and without interference with the preexisting surgical set-up on the sterile operating field. The view optimizing assembly integrates with the existing suite of minimally invasive instrumentation. It does not interfere with the surgical set-up, and it requires minimal change in the process or practice of a surgical operating room (OR) team.

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1B
1B
14
18
28
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74
Trocar
16
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72
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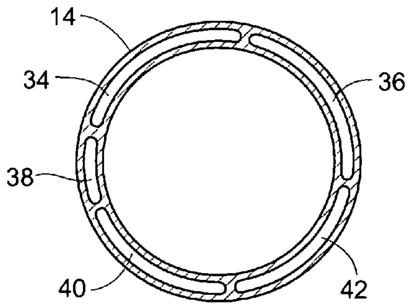
Trocar
Insufflator Circuit

Fig. 1A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36
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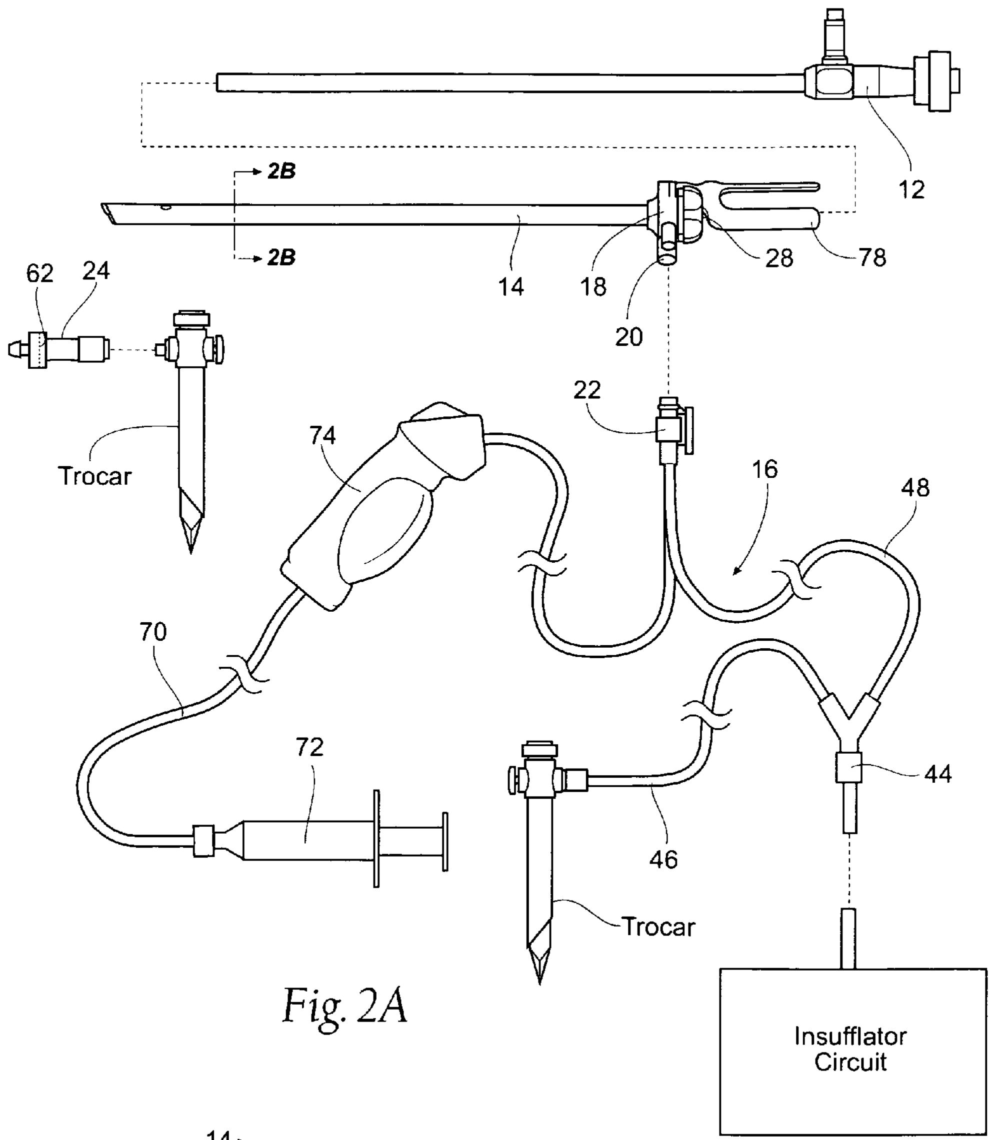
40
42

Fig. 1B


2B
2B
12
14
18
28
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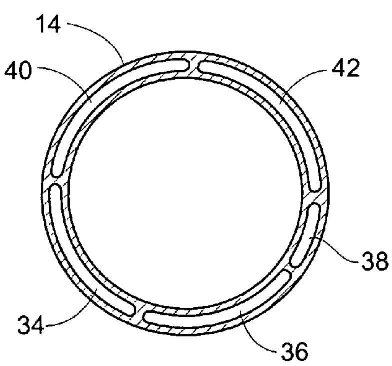
Trocar
Insufflator Circuit

Fig. 2A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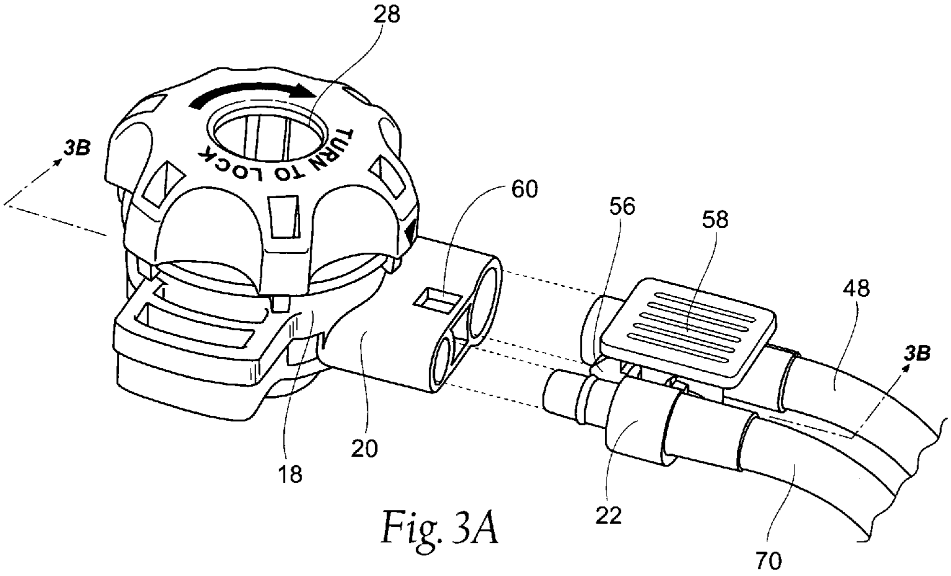
36

Fig. 2B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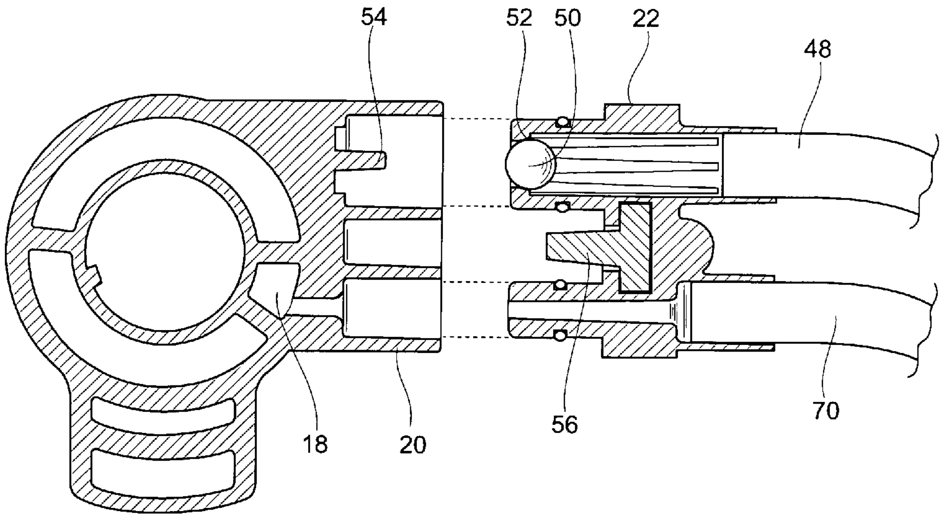
TURN TO LOCK
3B
60
56
58
48
3B
20
18
22
70

Fig. 3A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18
20
56
70

Fig. 3B

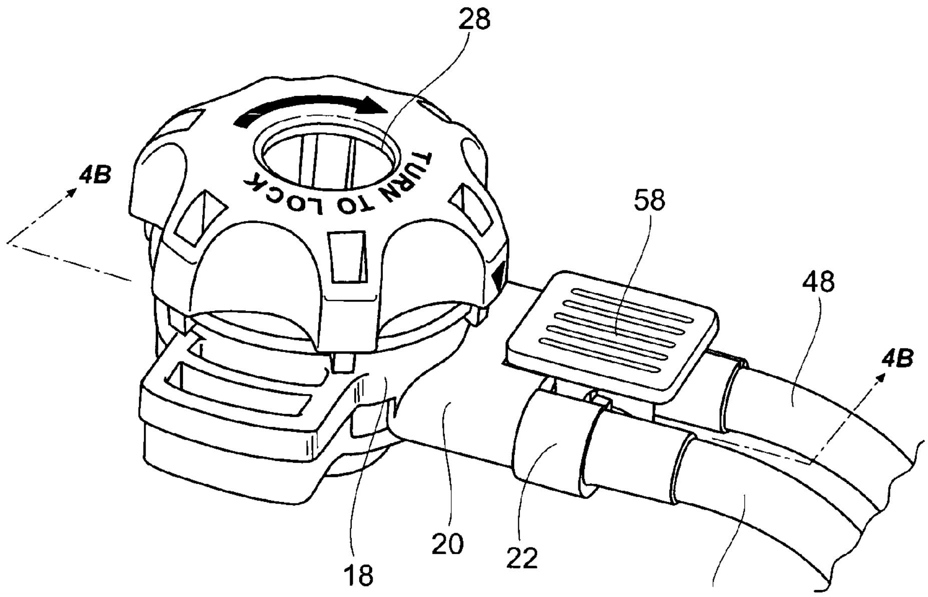


Fig. 4A

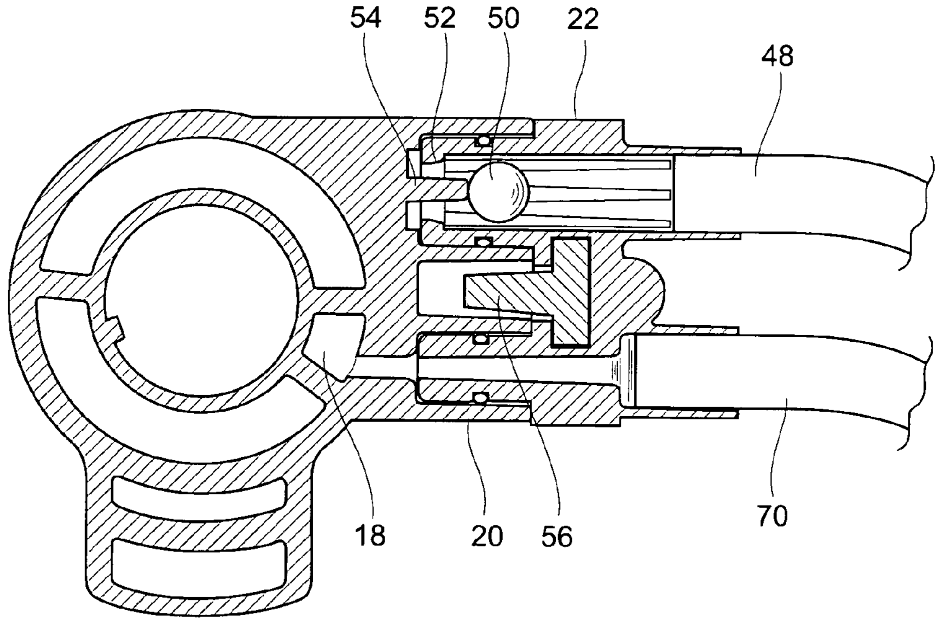


Fig. 4B

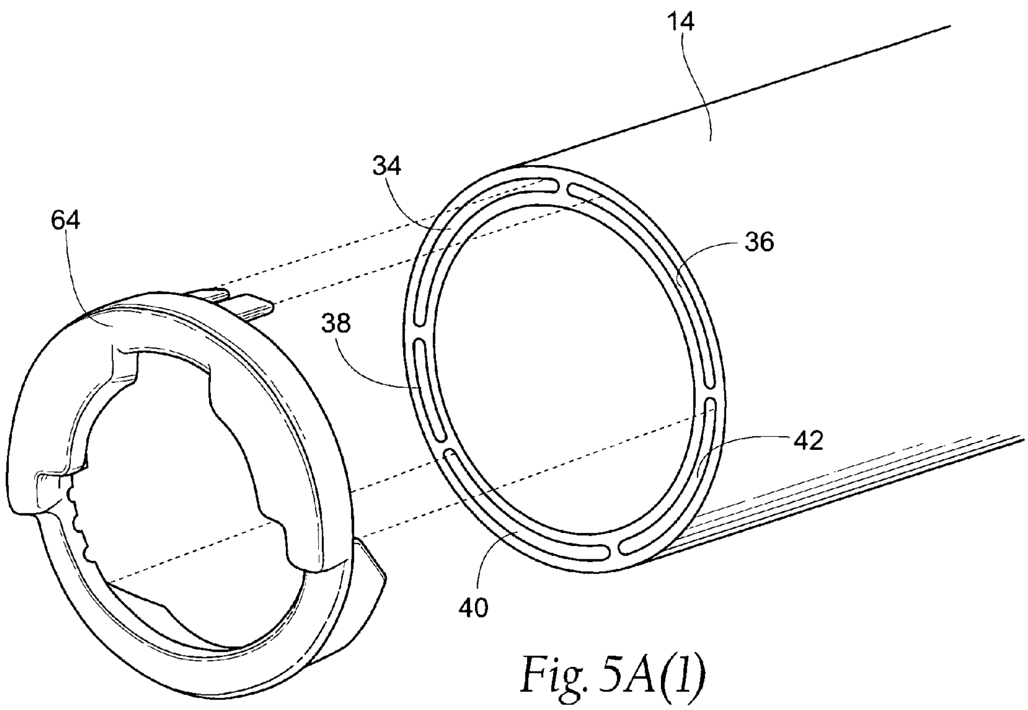


Fig. 5A(1)

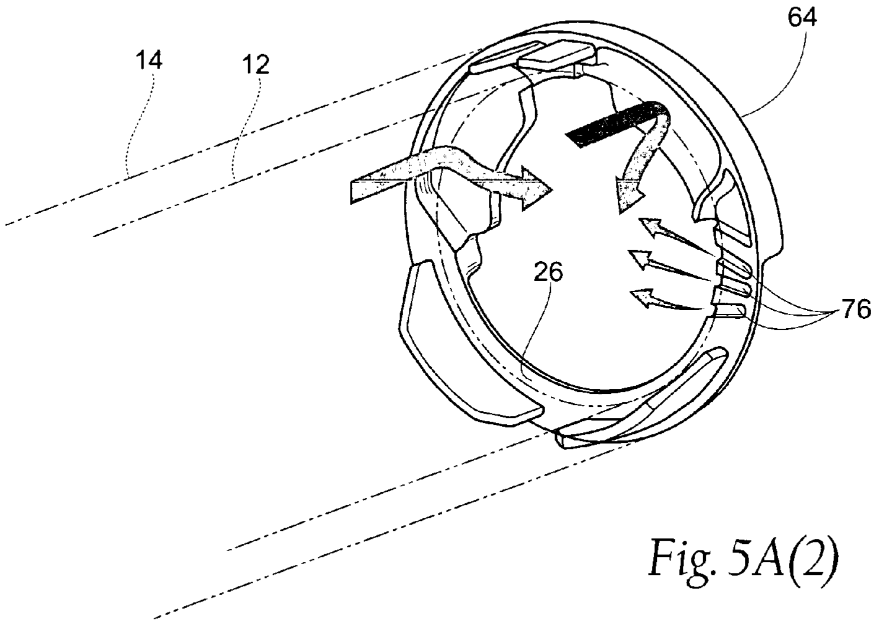


Fig. 5A(2)

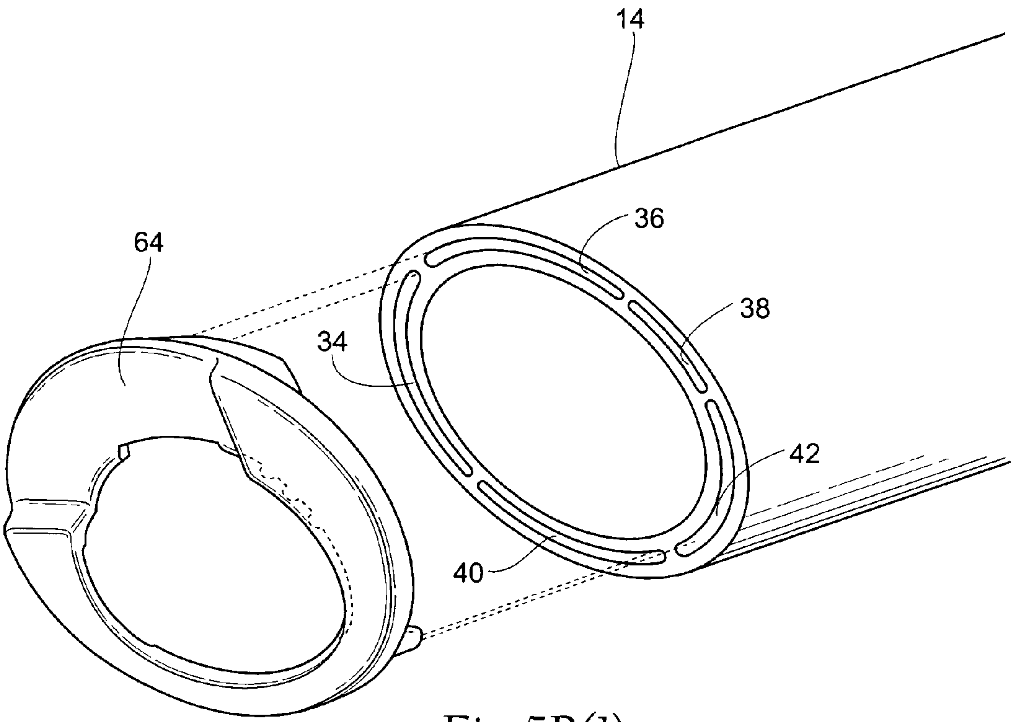


Fig. 5B(1)

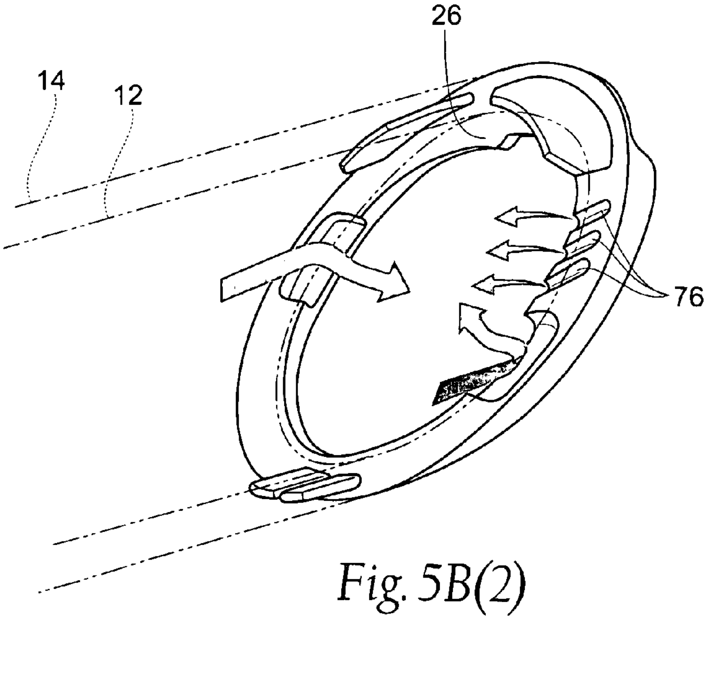
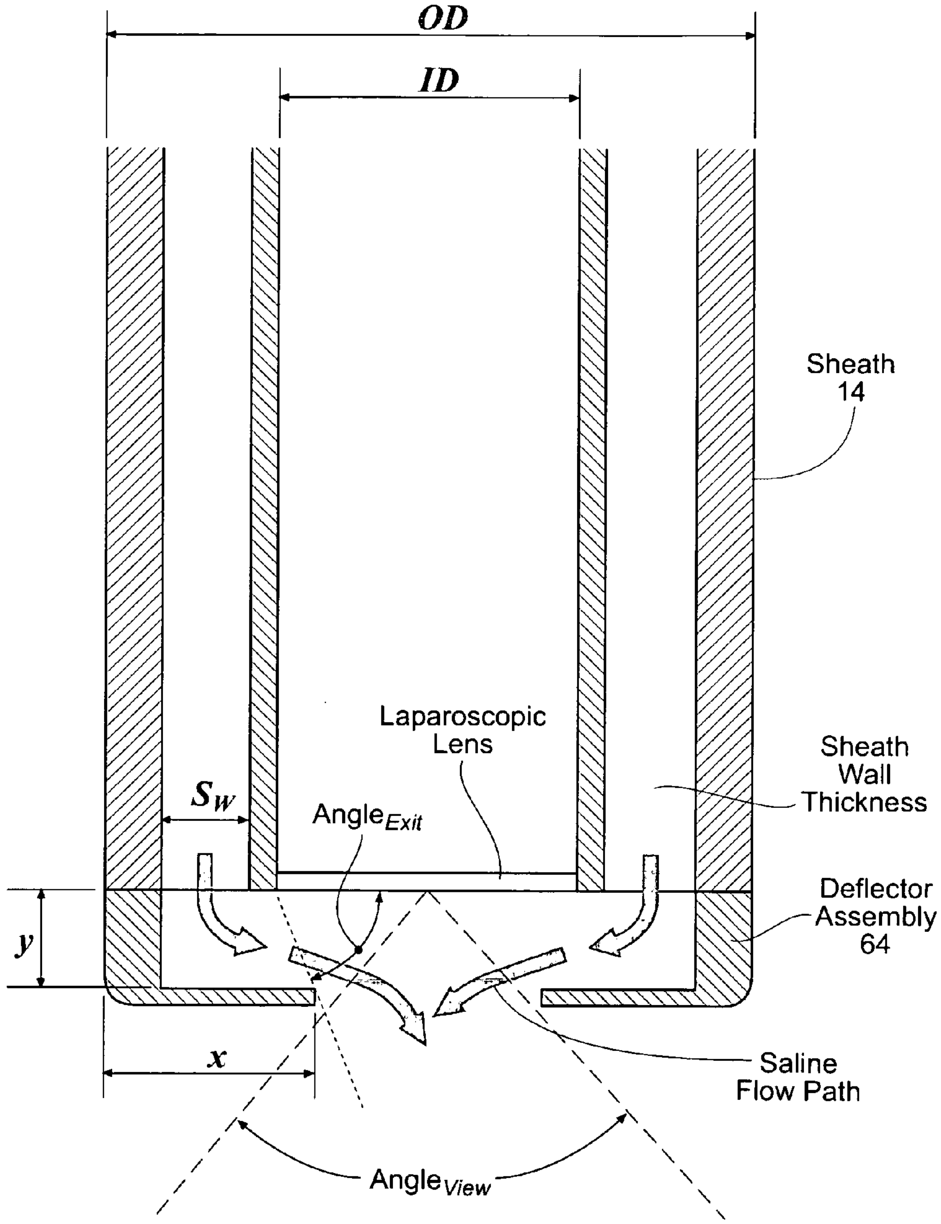


Fig. 5B(2)



OD
ID
Sheath
14
Laparoscopic
Lens
Sheath
Wall
Thickness
S_W
$Angle_{Exit}$
Deflector
Assembly
64
y
x
Saline
Flow Path
$Angle_{View}$

Fig. 6

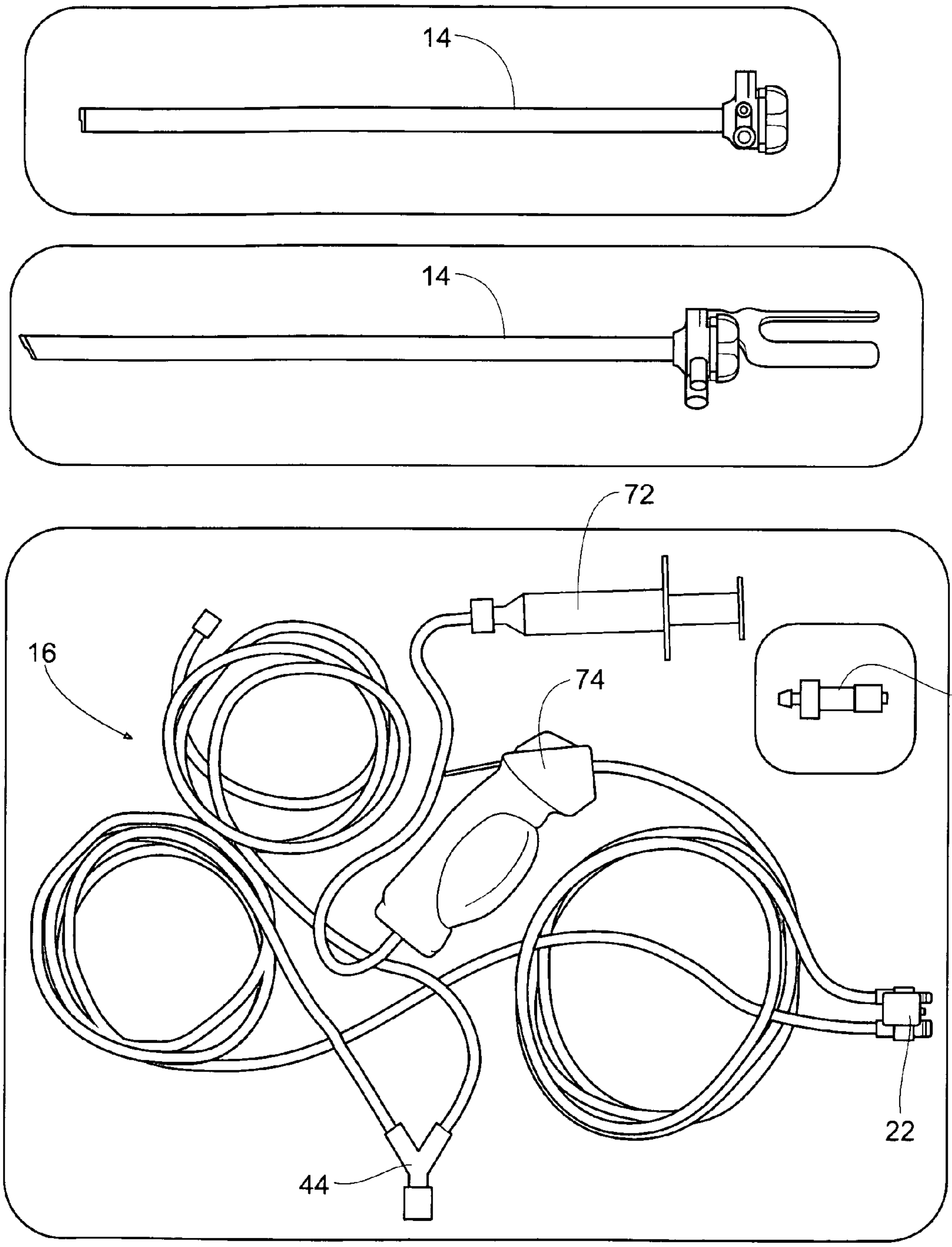


Fig. 7

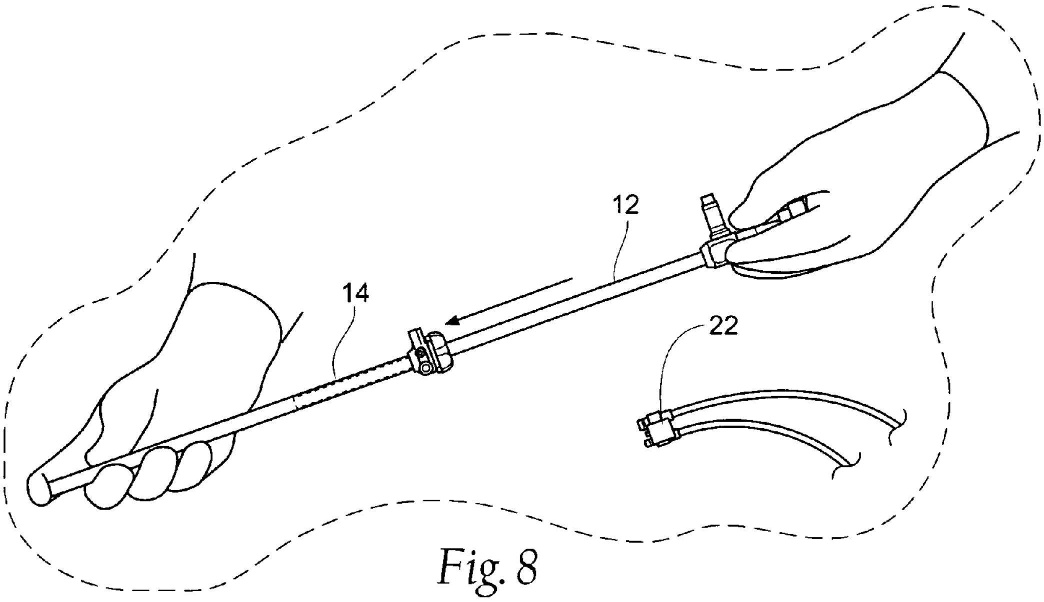


Fig. 8

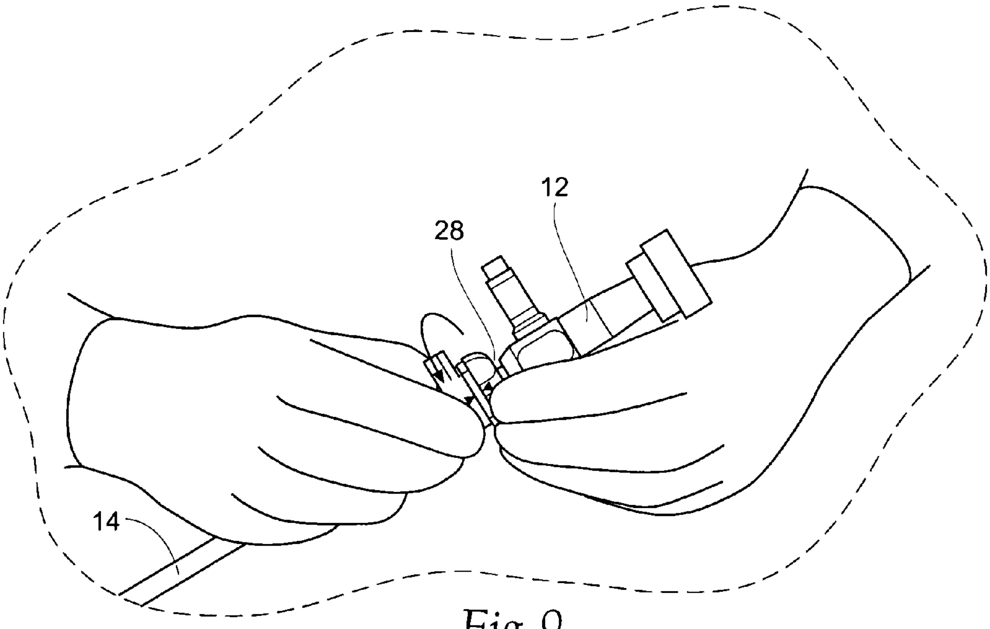


Fig. 9

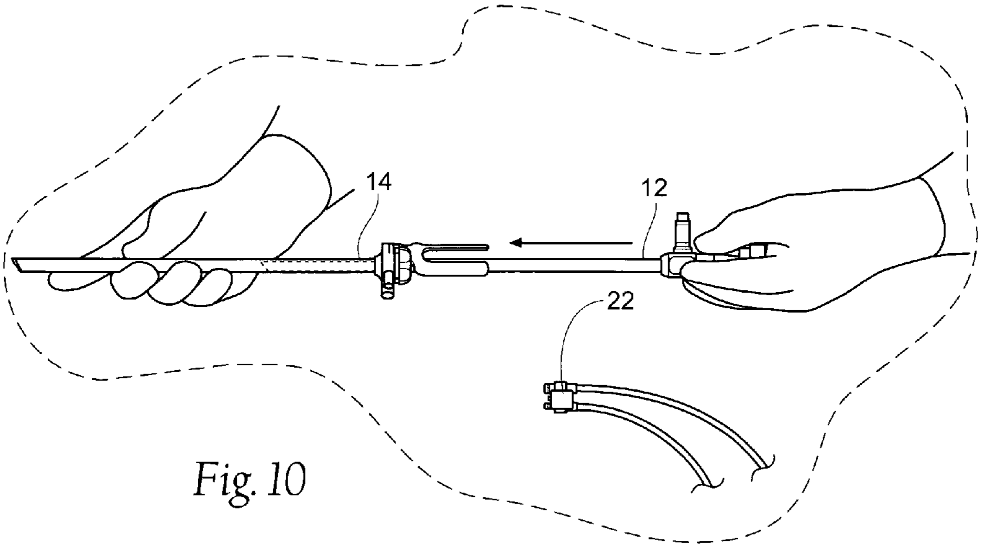


Fig. 10

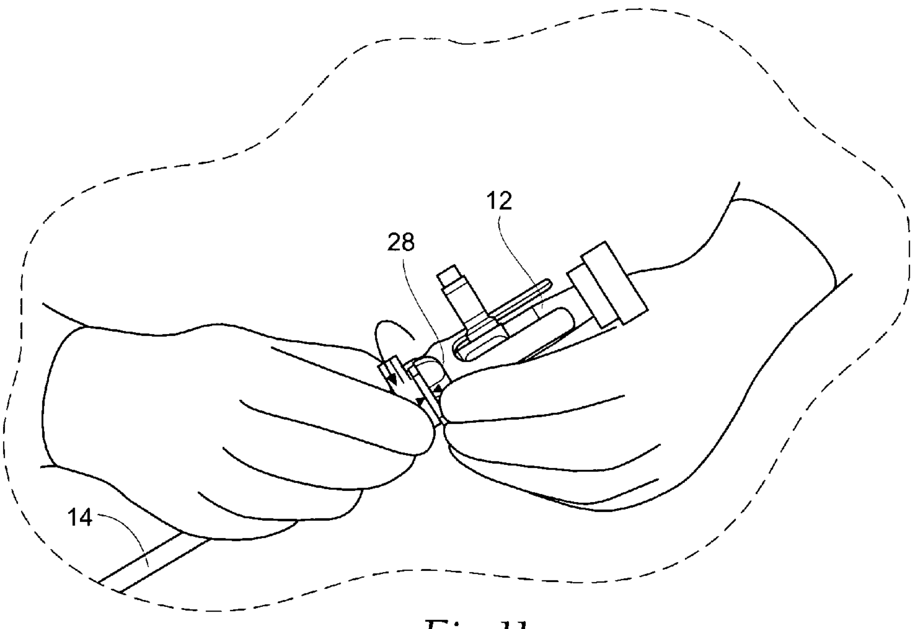


Fig. 11

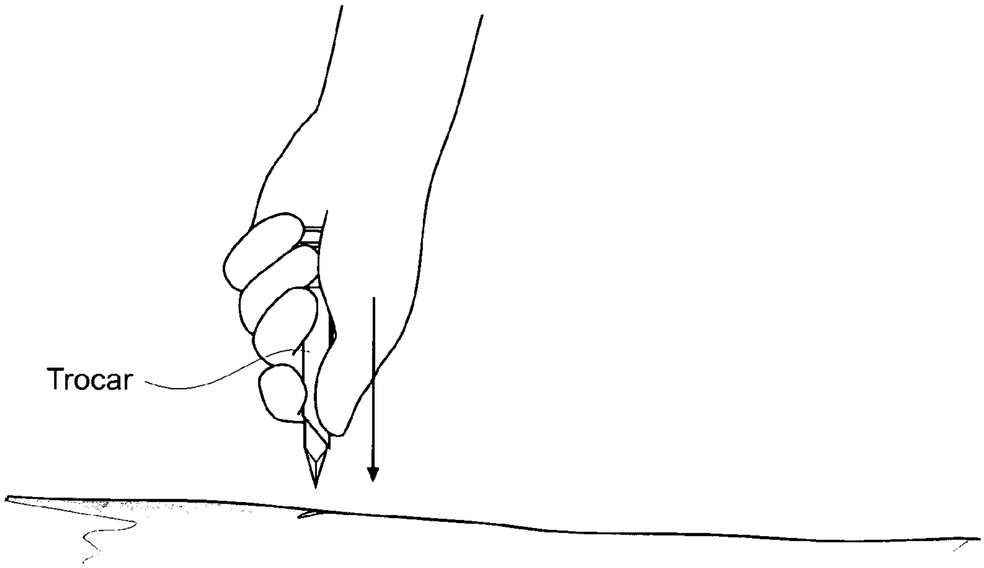


Fig. 12

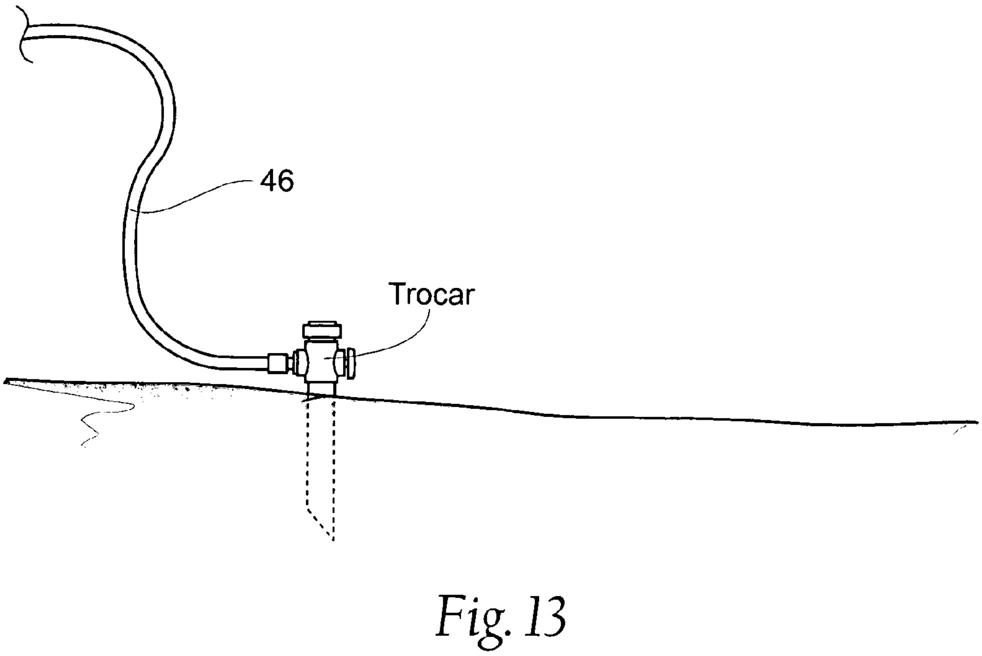


Fig. 13

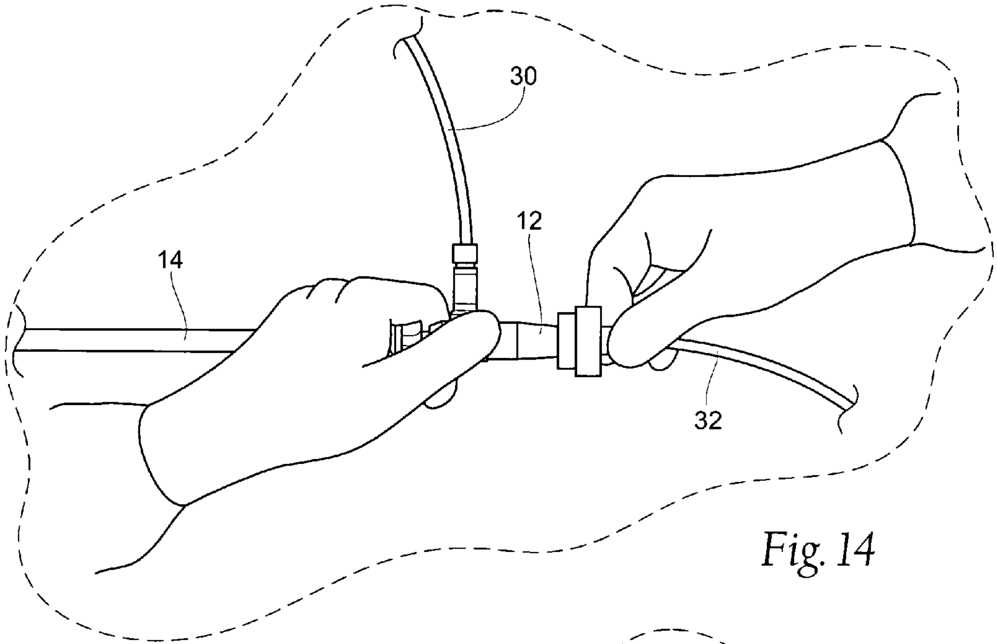


Fig. 14

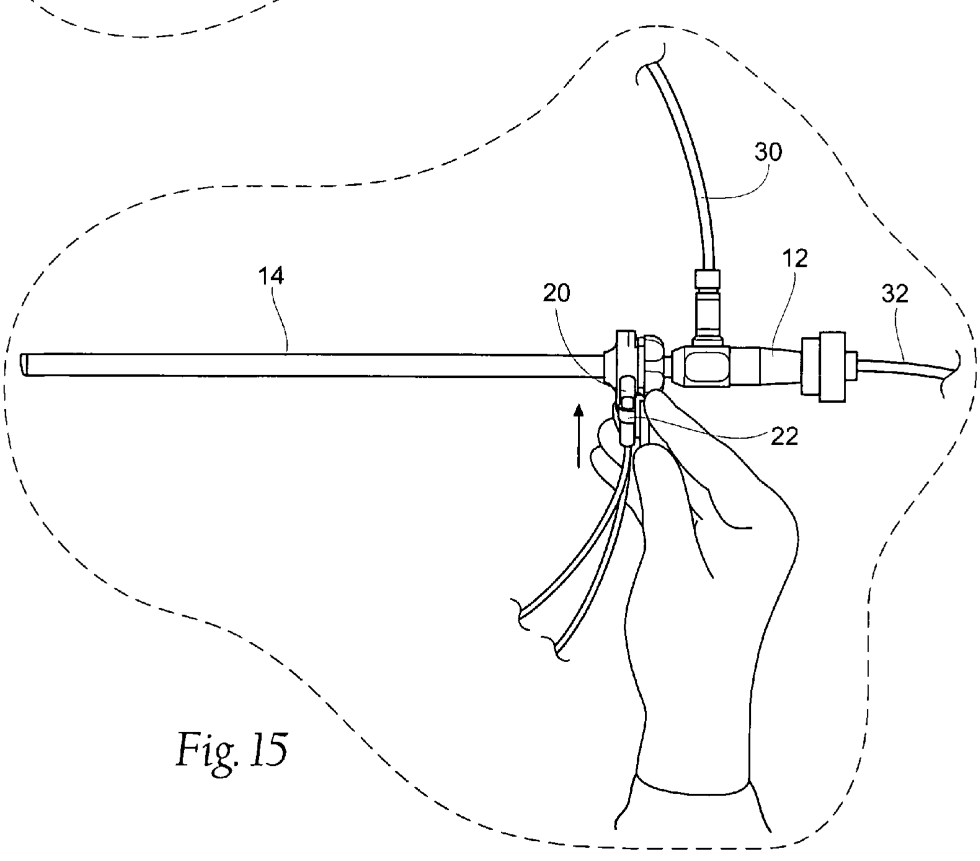


Fig. 15

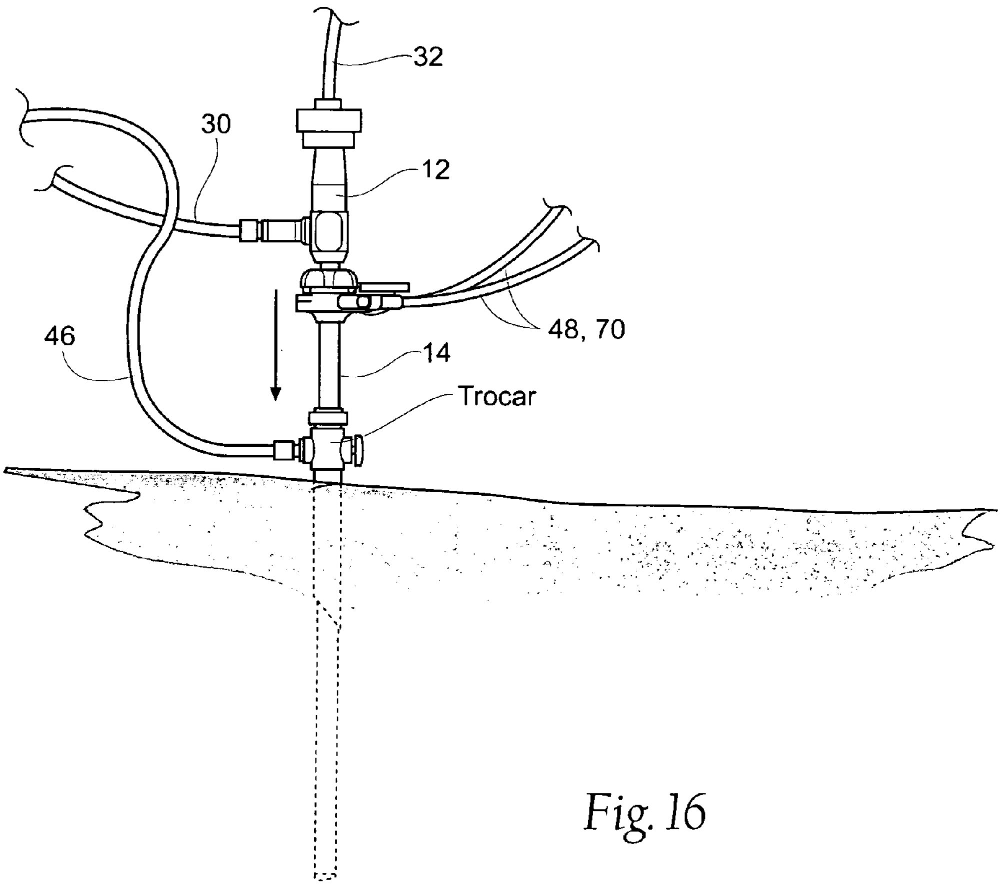


Fig. 16

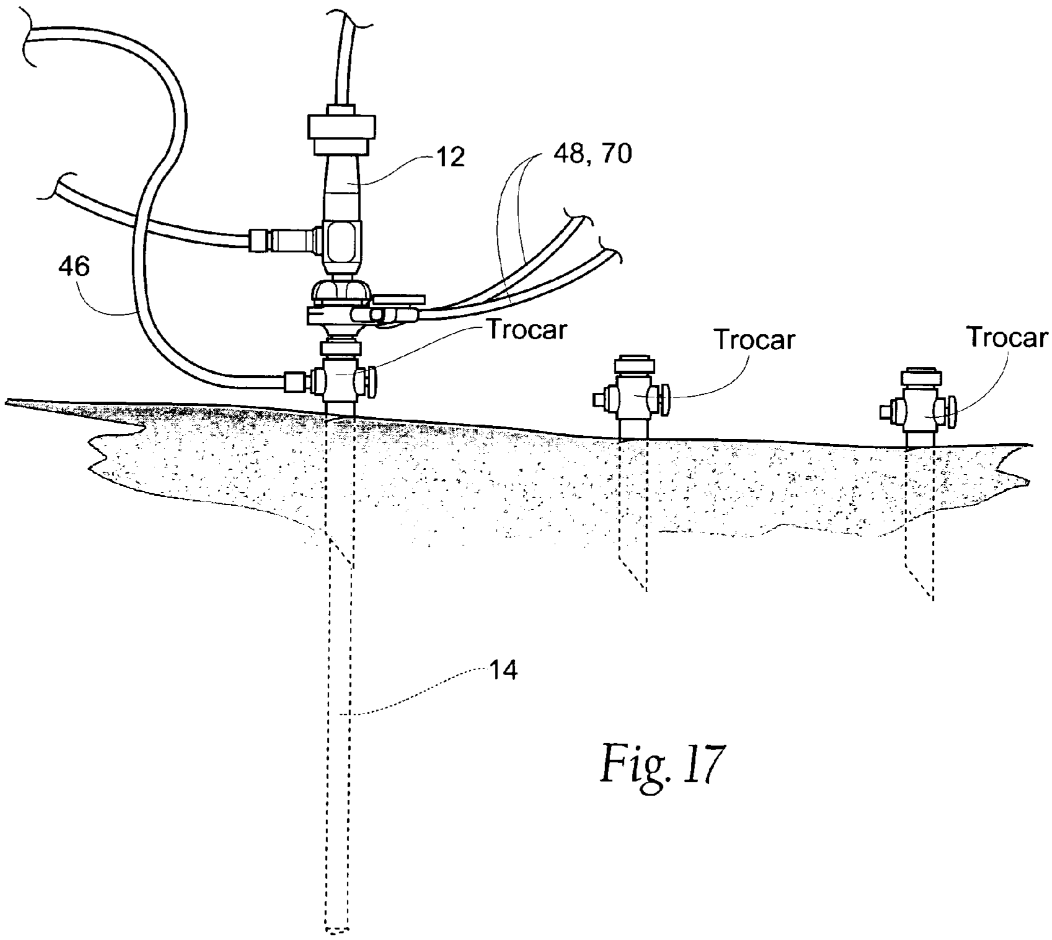


Fig. 17

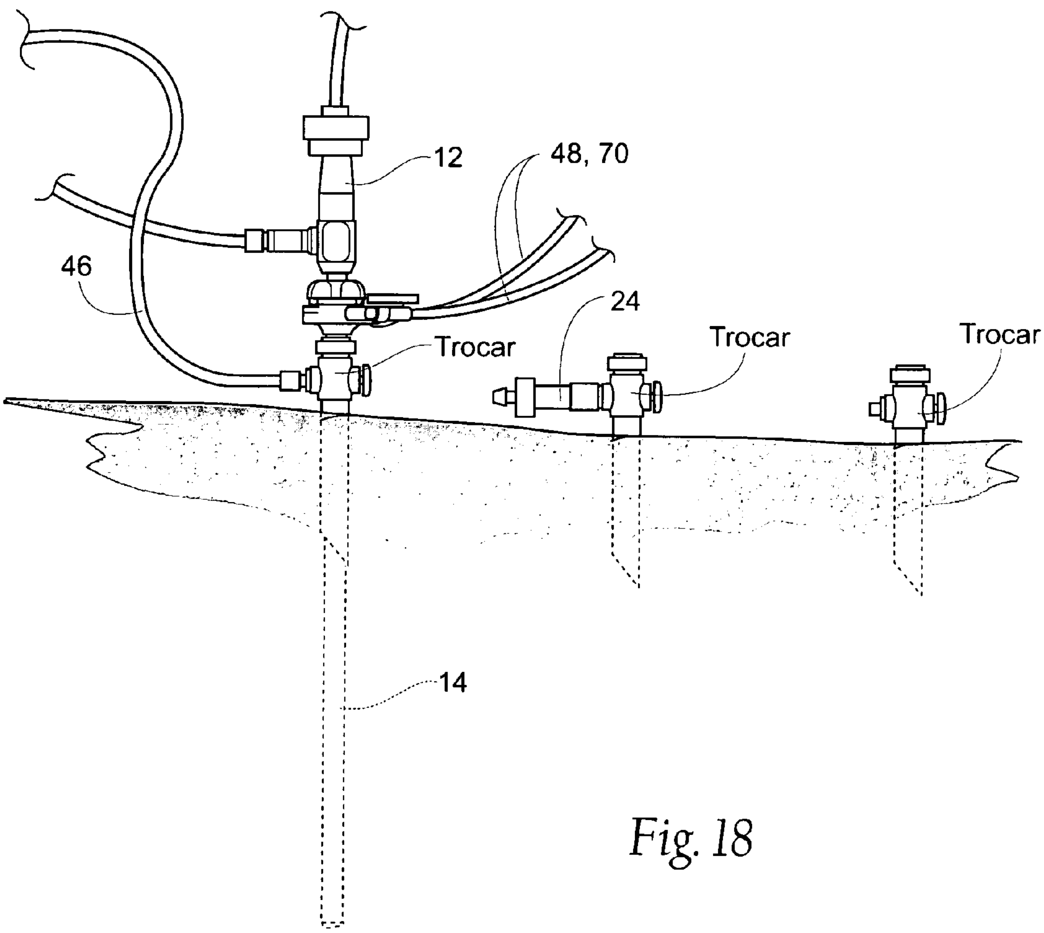


Fig. 18

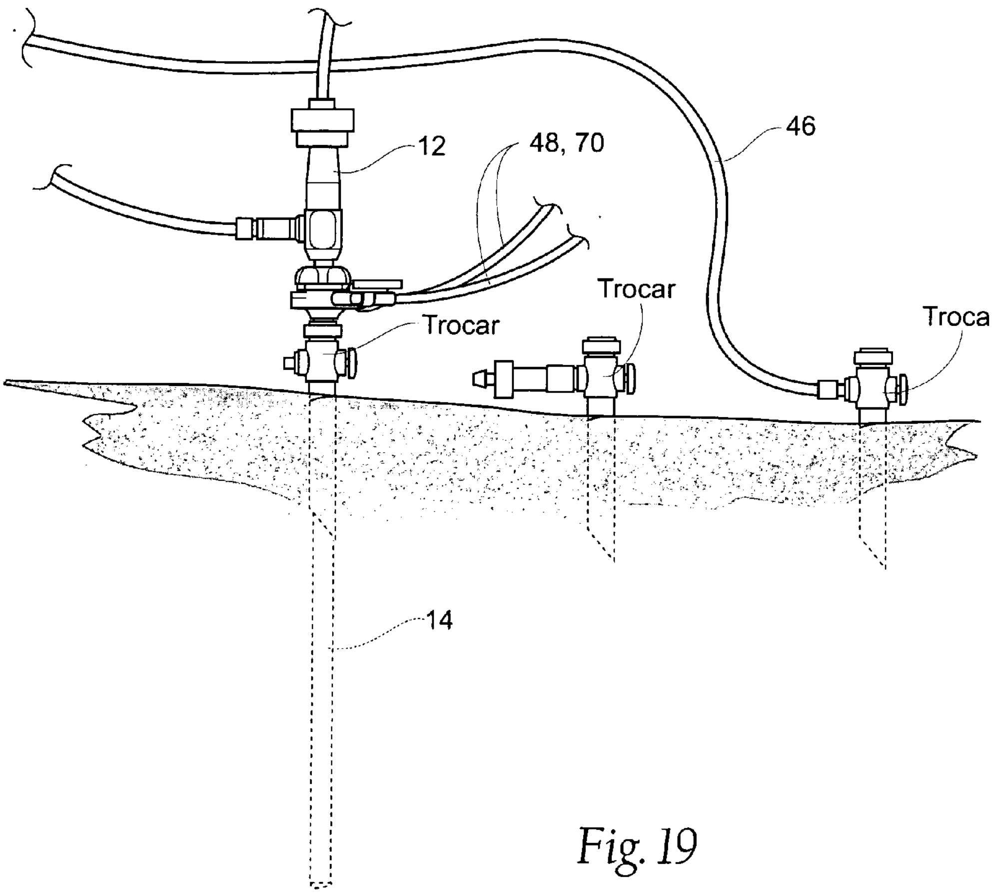


Fig. 19

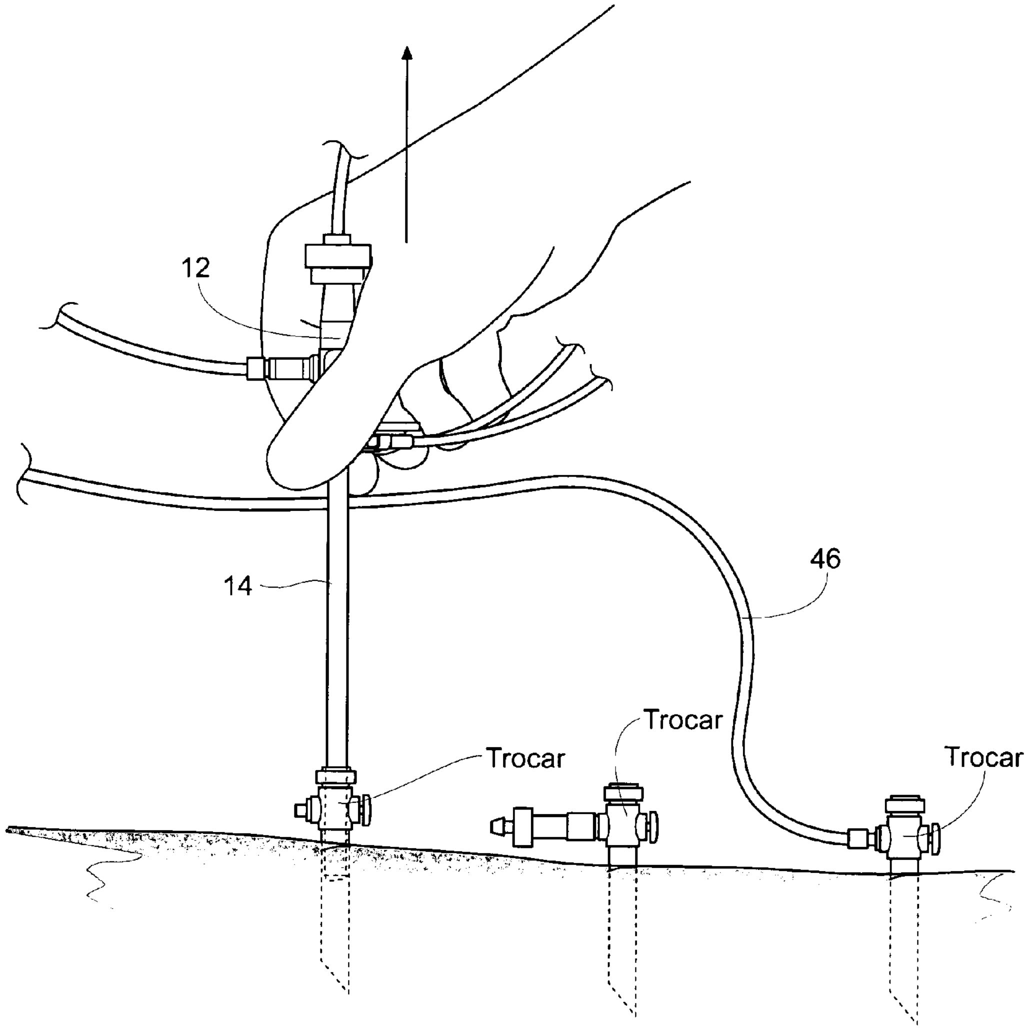


Fig. 20

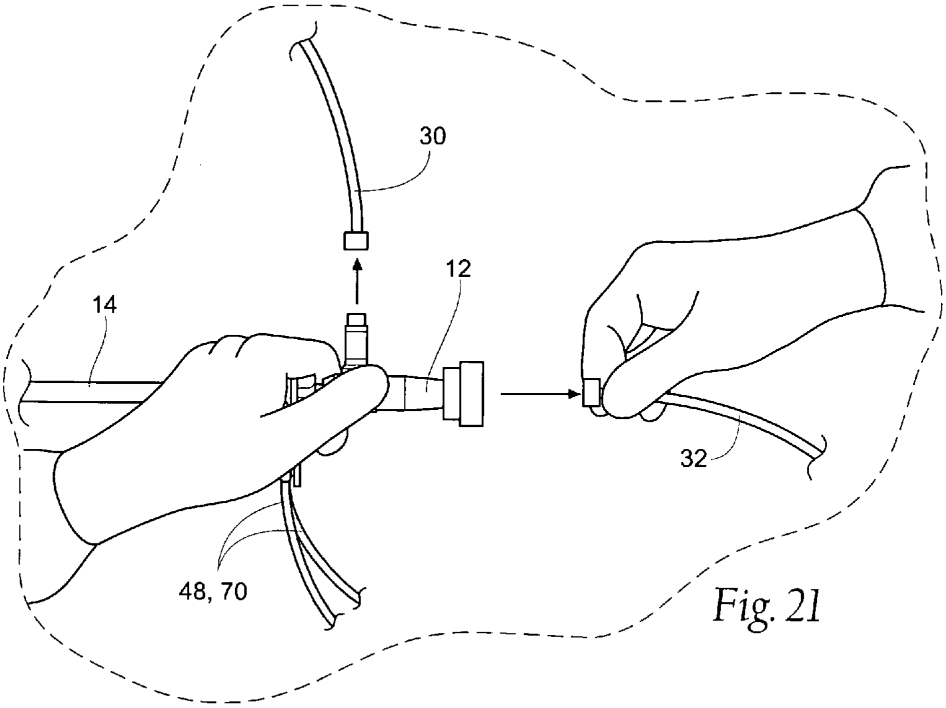


Fig. 21

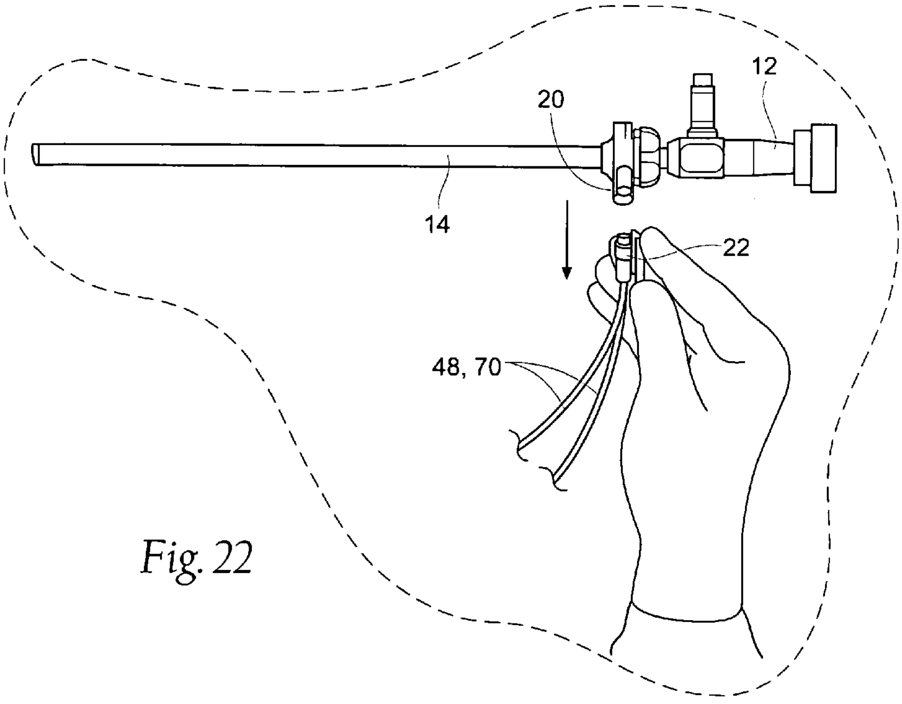


Fig. 22

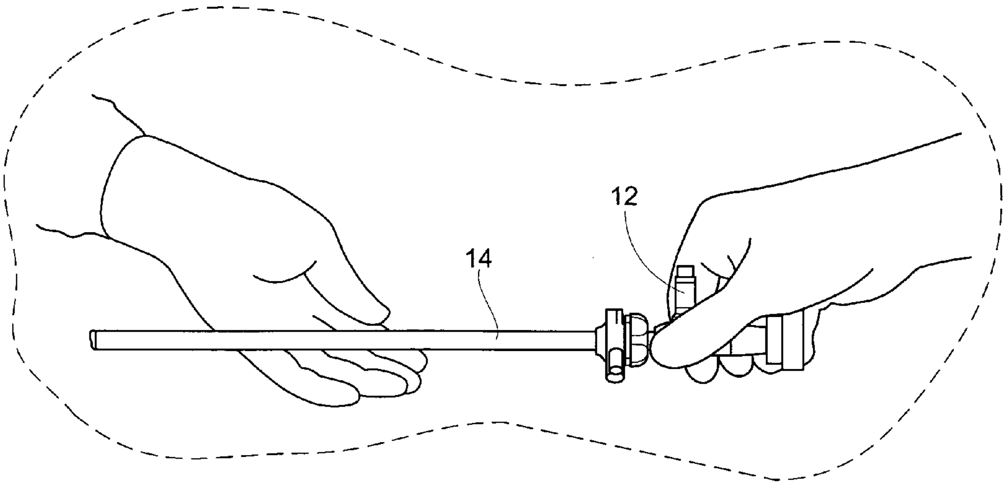


Fig. 23

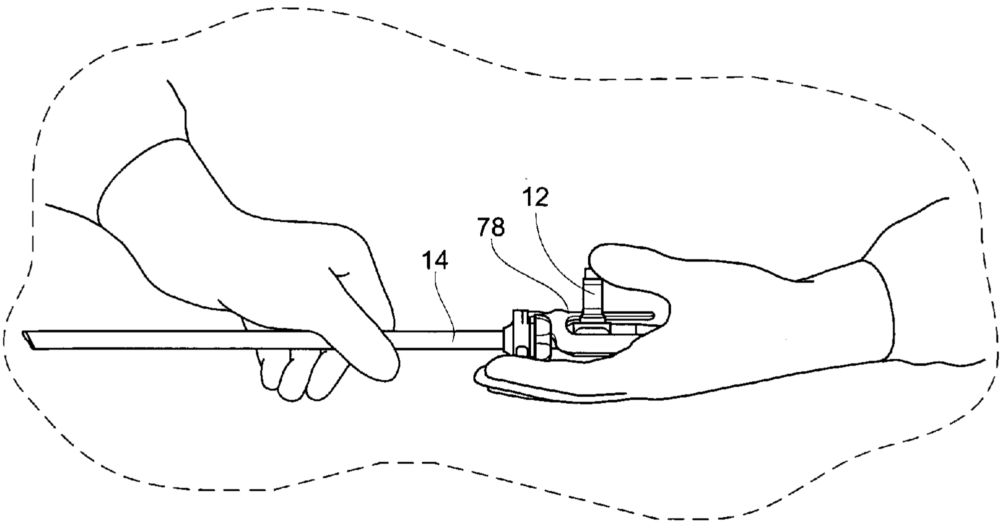


Fig. 24

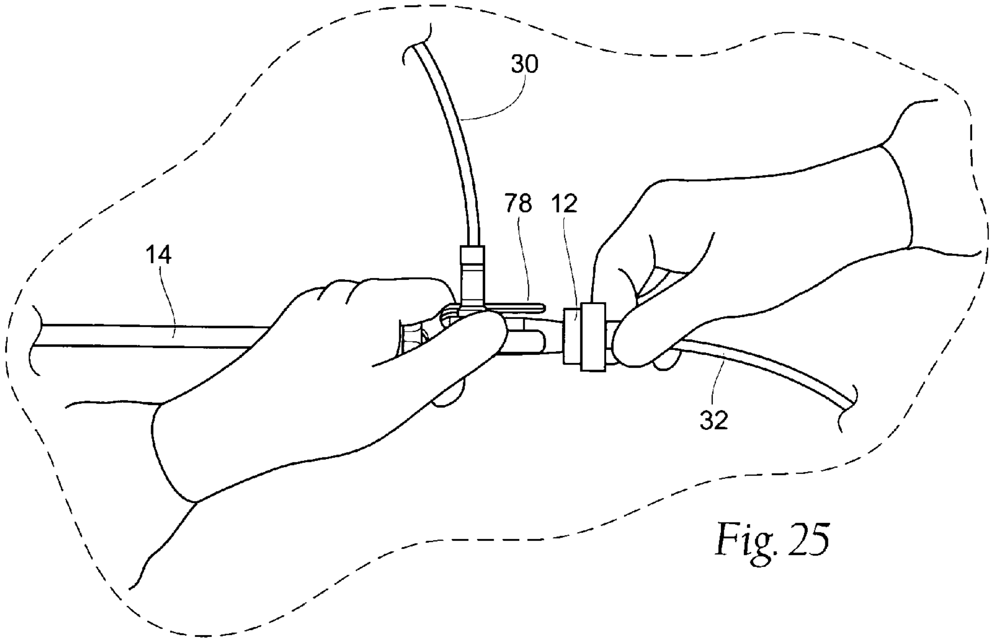


Fig. 25

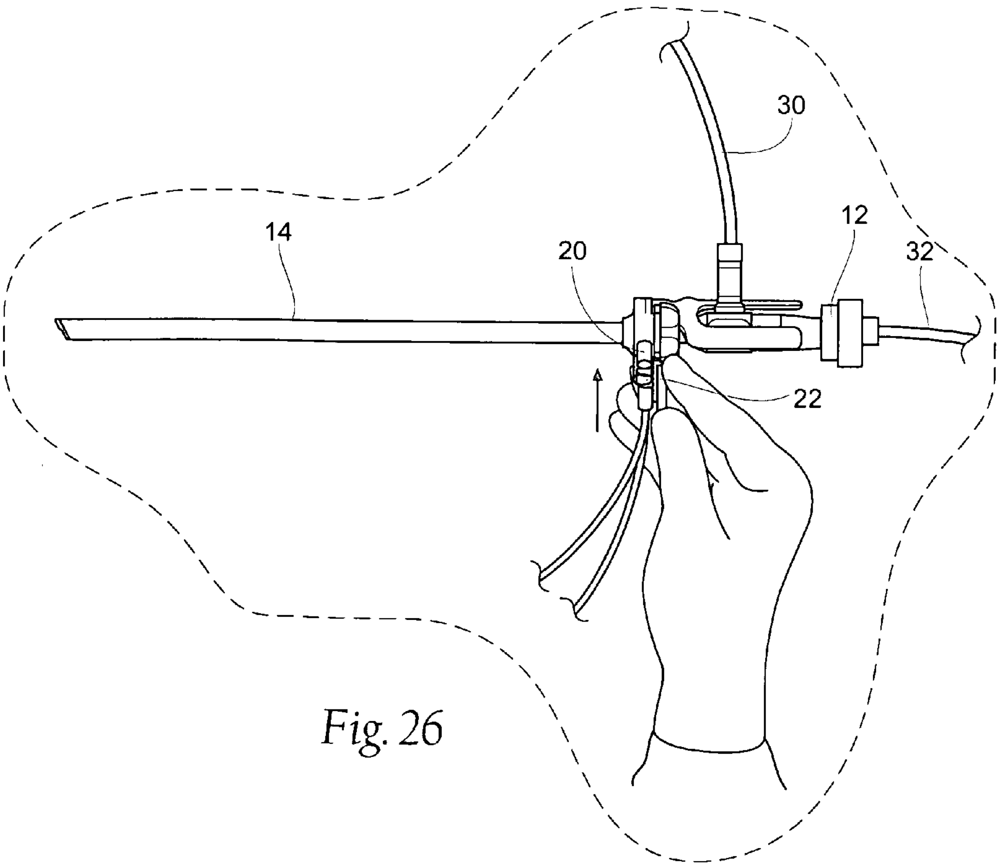


Fig. 26

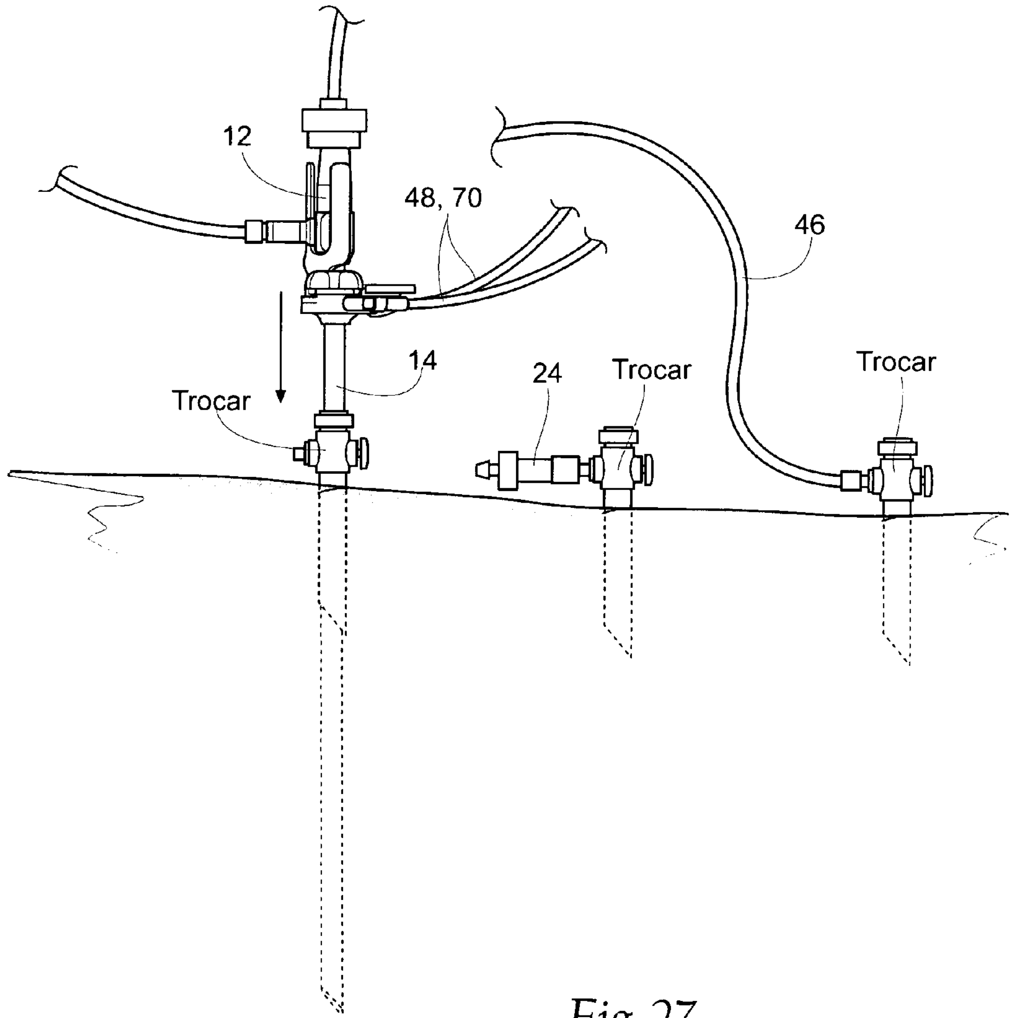


Fig. 27

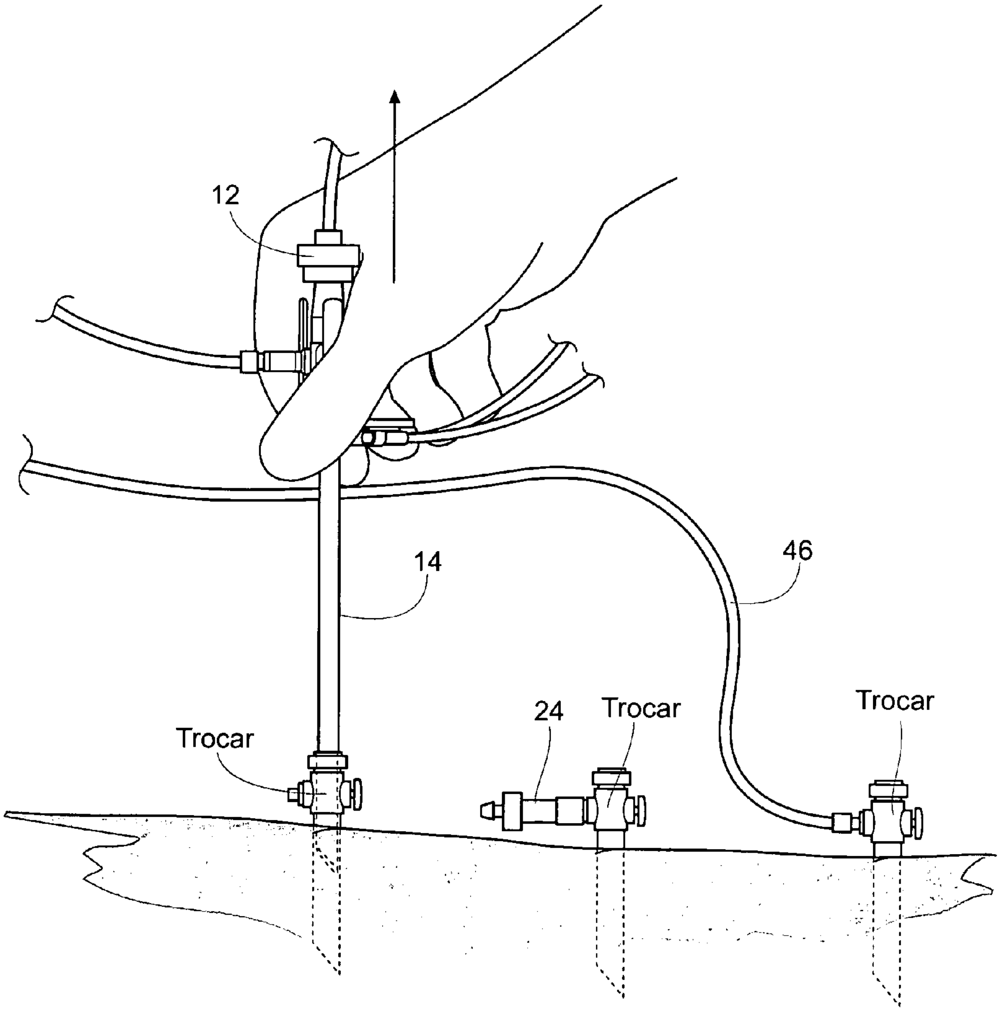


Fig. 28

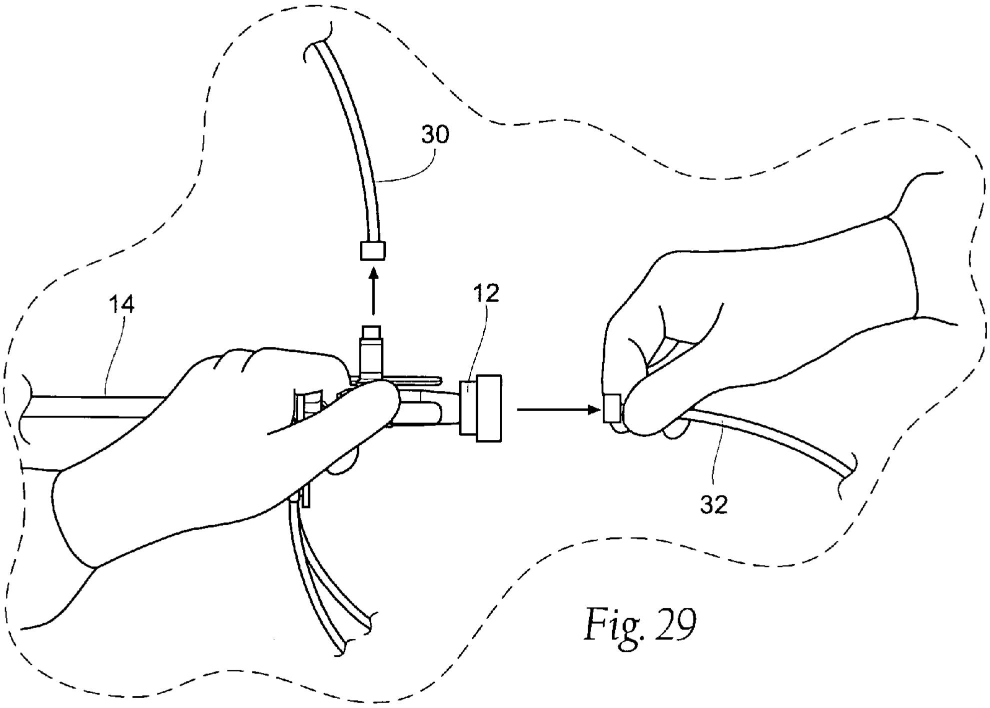


Fig. 29

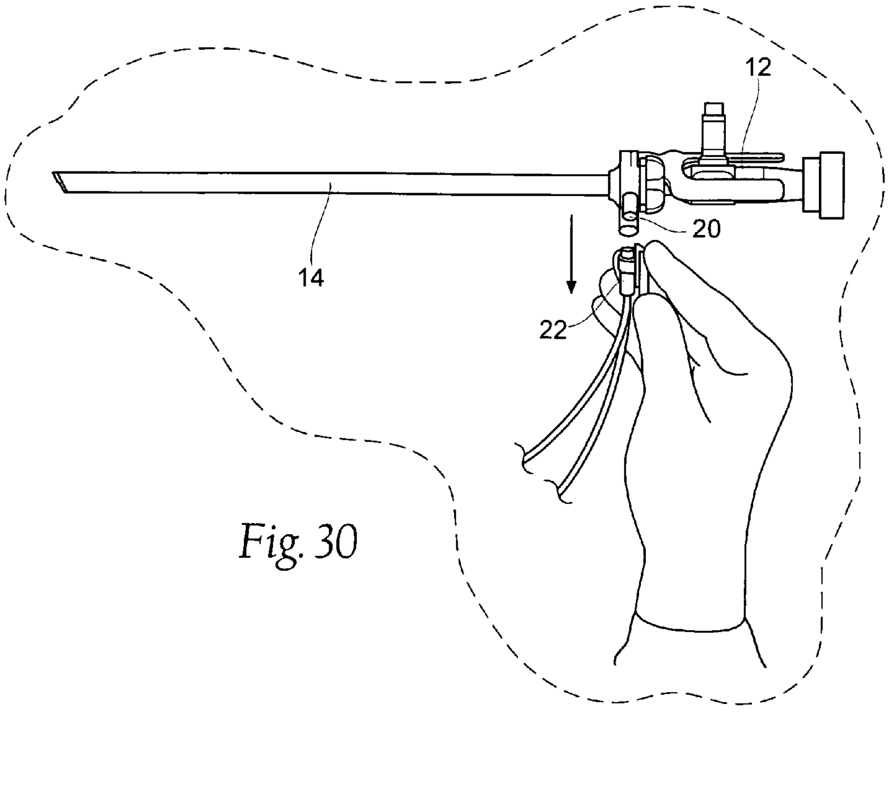


Fig. 30

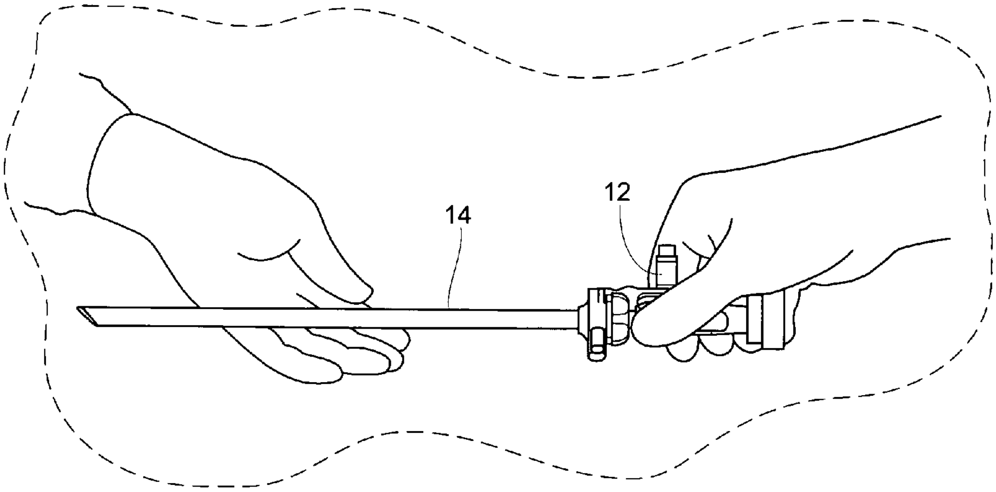


Fig. 31

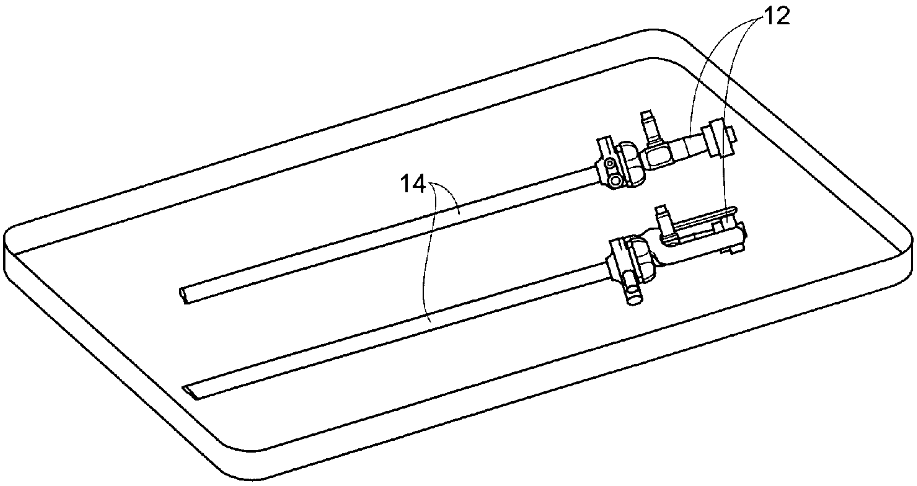


Fig. 32

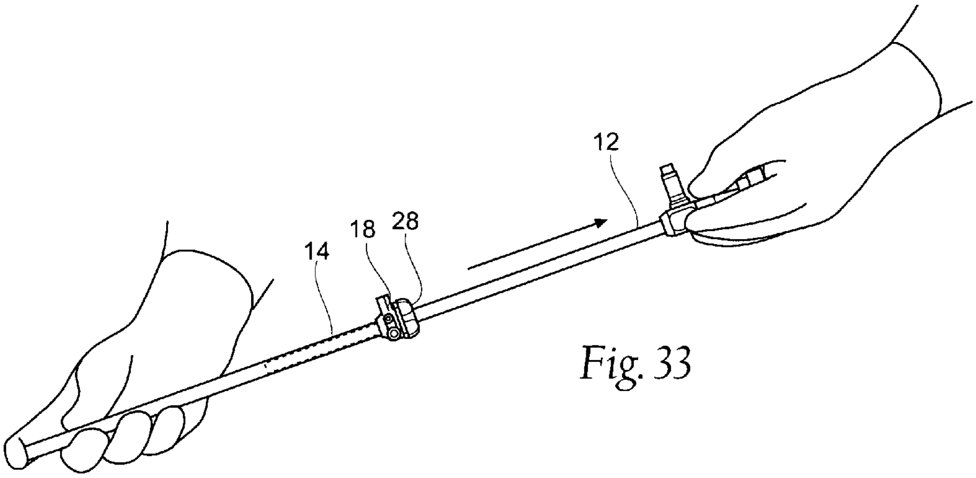


Fig. 33

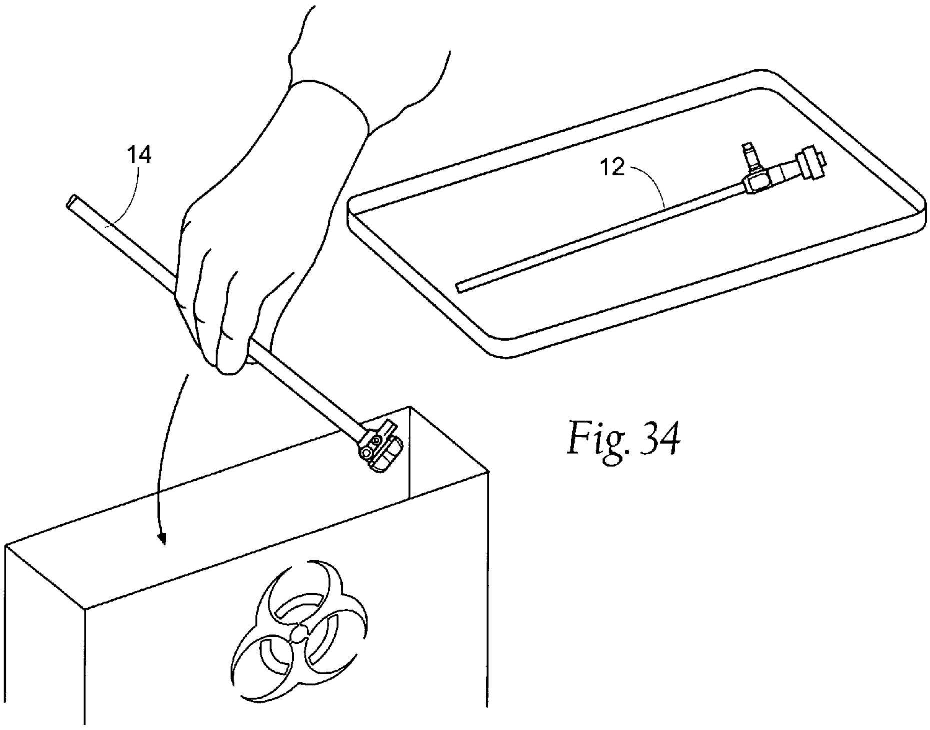


Fig. 34

SYSTEMS AND METHODS FOR OPTIMIZING AND MAINTAINING VISUALIZATION OF A SURGICAL FIELD DURING THE USE OF SURGICAL SCOPES

RELATED APPLICATION

[0001] This application claims the benefit of U.S. Provisional Patent Application Ser. No. 61/121,514 filed 10 Dec. 2008, and entitled "Device for Maintaining Visualization with Surgical Scopes," which is incorporated herein by reference. This application also claims the benefit of U.S. Provisional Patent Application Ser. No. 61/170,864 filed 20 Apr. 2009, and entitled "Surgical Scope Stabilizer for Use with Device for Maintaining Visualization with Surgical Scopes" which is also incorporated herein by reference. This application is also a continuation-in-part of U.S. Utility application Ser. No. 11/765,340, filed 19 Jun. 2007, which corresponds to PCT Application Serial No. PCT/US2008/067426, filed 19 Jun. 2008, the entirety of which applications are incorporated herein by reference.

FIELD OF THE INVENTION

[0002] The invention generally relates to surgical scopes, and, more particularly, for optimizing and maintaining visualization of a surgical field when using a surgical scope, such as, e.g., a laparoscope.

BACKGROUND OF THE INVENTION

[0003] Minimally invasive surgical procedures utilizing surgical scopes are desirable because they often provide one or more of the following advantages: reduced blood loss; reduced post-operative patient discomfort; shortened recovery and hospitalization time; smaller incisions; and reduced exposure of internal organs to possible contaminants.

[0004] Generally, minimally invasive surgeries utilize scopes, such as laparoscopes, that permit remote visualization of a surgical site within a patient's body while the surgical procedure is being performed. During a laparoscopic procedure, the patient's abdominal or pelvic cavity is accessed through two or more relatively small incisions rather than through a single large incision that is typical in a conventional surgery. Surgical scopes, such as laparoscopes, usually consist in part of a rigid or relatively rigid rod or shaft having an objective lens at one end and an eyepiece and/or integrated visual display at the other. The scope may also be connected to a remote visual display device or a video camera to record surgical procedures.

[0005] In laparoscopic surgeries, the abdomen is typically inflated with a gas through the use of an insufflator, to distend the abdominal space by elevating the abdominal wall above the internal organs and thereby create a sufficient working and viewing space for the surgeon. Carbon dioxide is usually used for insufflation, though other suitable gases may also be used. Conventional insufflators are adapted to cycle on and off to maintain a preset and suitable pressure within the patient's body cavity.

[0006] The local environment within a patient's abdominal space is generally rather warm and humid, and the use of devices such as harmonic scalpels and other cutting and coagulating devices generate mist, smoke, and other debris that is released into the surgical field and often becomes suspended throughout the expanded abdominal space. Additionally, blood, bodily fluids, pieces of tissue, fat or other bodily material may come in contact with or even attach to the lens. As a result of these conditions, visualization through the scope can be significantly diminished. Typically, the only solution to fogging and debris collection on the lens is removal of the scope from the body cavity and defogging or cleaning the lens by wiping it with a cloth, warming the scope tip, or utilizing another defogging method. The need to remove the scope to defog and remove debris from the lens is inconvenient for the scope operator and the surgeon and can interrupt and undesirably prolong surgical procedures.

SUMMARY OF THE INVENTION

[0007] One aspect of the invention provides a view optimizing assembly having a deflector assembly with critical physical, pneumatic, and optical characteristics that make possible intra-operative defogging, surgical debris deflection, and cleaning of a laparoscope lens during minimally invasive surgery, while also maintaining visualization of the surgical site. In use, the view optimizing assembly makes possible the practice of a surgical method for maintaining clear visualization of the surgical site without removing the laparoscope **12** from the abdominal cavity for the purpose of cleaning or de-fogging its lens.

[0008] Another aspect of the invention provides a view optimizing assembly having a quick exchange feature. In use, the quick exchange feature makes possible a surgical method for maintaining clear visualization that includes the ability to make a quick exchange of laparoscopes having different operating characteristics (e.g., laparoscopes with different tip angles, lengths, or diameters) entirely on the sterile operating field and without interference with the preexisting surgical set-up on the sterile operating field. The view optimizing assembly integrates with the existing suite of minimally invasive instrumentation. It does not interfere with the surgical set-up, and it requires minimal change in the process or practice of a surgical operating room (OR) team.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] FIG. **1**A is a somewhat schematic views of a view optimizing assembly for use with a laparoscope having a 0° shaft tip.

[0010] FIG. **1**B is a section view of the sheath, showing internal fluid flow lumens, taken generally along line **1**B-**1**B in FIG. **1**A.

[0011] FIG. **2**A is a somewhat schematic of a view optimizing assembly for use with a laparoscope having an angled shaft tip.

[0012] FIG. **2**B is a section view of the sheath, showing internal fluid flow lumens, taken generally along line **2**B-**2**B in FIG. **2**A.

[0013] FIG. **3**A is an enlarged perspective view of a manifold that the view optimizing assembly shown in FIG. **1**A or FIG. **2**A incorporates, including a quick exchange coupling, and a quick exchange coupler that the tubing set shown in FIG. **1**A or FIG. **2**A incorporates, the coupling and the coupler being disconnected.

[0014] FIG. **3**B is a sectional view taken generally along line **3**B-**3**B in FIG. **3**A, showing a one way check valve that is normally closed.

[0015] FIG. **4**A is an enlarged perspective view of the manifold including a quick exchange coupling and the quick exchange coupler of the tubing set, as shown in FIG. **3**A, but now connected.

[0016] FIG. 4B is a sectional view taken generally along line 4B-4B in FIG. 4A, showing the one way check valve that is opened by the connection of the quick exchange coupling and connectors.

[0017] FIGS. 5A(1) and 5A(2) are enlarged, exploded views of the deflector assembly for use with a laparoscope having a 0° shaft tip.

[0018] FIGS. 5B(1) and 5B(2) are enlarged, exploded views of the deflector assembly for use with a laparoscope having an angled shaft tip.

[0019] FIG. 6 is a schematic view of the critical physical, pneumatic, and optical characteristics of the deflector assembly shown in FIGS. 5A and 5B.

[0020] FIGS. 7 to 34 illustrate a representative method including the set up and use of the view optimizing assembly using sterile technique by technicians/operating room personnel.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0021] Although the disclosure hereof is detailed and exact to enable those skilled in the art to practice the invention, the physical embodiments herein disclosed merely exemplify the invention, which may be embodied in other specific structure. While the preferred embodiment has been described, the details may be changed without departing from the invention, which is defined by the claims.

I. View Optimizing Assembly

[0022] A. Overview

[0023] FIGS. 1A/1B and FIG. 2A/2B show a view optimizing assembly 10 for use in association with a state of the art laparoscope 12. In FIGS. 1A/1B, the laparoscope 12 possesses at 0° (blunt) shaft tip In FIGS. 2A/2B, the laparoscope possess an angle shaft tip (e.g., a 30° shaft tip or 45° shaft tip). The components of the view optimizing assembly 10 may be made from plastic materials (extruded and/or molded), but other suitable materials, such as metal or a composite material, or combinations thereof could be used.

[0024] As will be described in greater detail, the view optimizing assembly 10 facilitates intra-operative defogging, surgical debris deflection, and cleaning of a laparoscope lens during minimally invasive surgery, while also maintaining visualization of the surgical site. The view optimizing assembly 10 is intended to be a single-use, disposable laparoscopic accessory. The view optimizing assembly 10 is desirably a sterile accessory for immediate set up and use on a sterile operating field.

[0025] As shown in FIGS. 1A and 2A, the view optimizing assembly 10 comprises a multi-lumen sheath assembly 14, which mounts over the shaft of the laparoscope 12. The end of the shaft is sized and configured to match the size and configuration of the corresponding laparoscope 12, having a blunt tip in FIG. 1A and angled tip in FIG. 2A. The assembly 10 includes a tubing set 16 to connect the sheath 14 to an existing anhydrous carbon dioxide (CO2) insufflation circuit.

[0026] In use, the view optimizing assembly 10 makes possible the practice of a surgical method for maintaining clear visualization of the surgical site without removing the laparoscope 12 from the abdominal cavity for the purpose of cleaning or de-fogging its lens. Furthermore, the view optimizing assembly 10 also makes possible a surgical method for maintaining clear visualization that includes the ability to make a quick exchange of laparoscopes having different operating characteristics (e.g., laparoscopes with different tip angles, lengths, or diameters) entirely on the sterile operating field and without interference with the preexisting surgical set-up on the sterile operating field. The view optimizing assembly 10 integrates with the existing suite of minimally invasive instrumentation. It does not interfere with the surgical set-up, and it requires minimal change in the process or practice of a surgical operating room (OR) team.

[0027] The view optimization assembly 10 desirably comes packaged for use in sterile peel away pouches (see FIG. 7). As also shown in FIGS. 1A and 2A, the pouches contain the components of the view optimization assembly 10, including the sheath 14 and a manifold 18 that is assembled to the sheath 14 and that includes a quick exchange coupling 20; the tubing set 16 which includes a quick exchange coupler 22 that mates with the quick exchange coupling 20 on the manifold 18; and (optionally) a vent device 24.

[0028] B. The Sheath/Manifold Assembly

[0029] As shown in FIGS. 1A and 2A, the sheath 14/manifold 18 assembly includes a sheath 14 that is sized and configured to receive a laparoscope 12 having a prescribed tip angle, length, and diameter. The sheath 14 includes a stop 26 (see FIGS. 5A(2) and 5B(2) formed adjacent the distal end of the sheath 14. The stop 26 prevents advancement of the laparoscope 12 beyond the distal end of the sheath 14, so that lens at the distal end of the laparoscope 12 rests in a desired, generally coterminous alignment with the distal end of the sheath 14. The sheath 14 also includes a locking collar 28 at its proximal end to frictionally engage the laparoscope 12 and resist axial withdrawal of the laparoscope 12 from the sheath 14.

[0030] In use, it is expected that the laparoscope 12 will be inserted into the sheath 14 by a scrub nurse during set-up for the operation (see FIGS. 8 to 11). The assembled laparoscopic and sheath 14 will then be handed as a unit to personnel at the operating room (OR) table at the desired time). The laparoscope 12 is then connected by personnel at the OR table in conventional fashion to a light cable 30 (which directs light to illuminate the operative field) and the camera cable 32 (which takes the image from the scope and displays it on monitors in the OR) (see FIG. 14). The sheath 14 is sized and configured not to interfere with this normal set-up of the laparoscope 12.

[0031] In use, the assembled laparoscopic and sheath 14 are placed as a unit through a trocar into the body cavity (e.g., the abdominal cavity), for viewing the surgical procedure as it is performed (see FIG. 16).

[0032] As shown in FIGS. 1A and 2A, and as further shown in FIGS. 3A, the sheath 14/manifold 18 assembly also includes the manifold 18 at the proximal end of the sheath 14. The manifold 18 communicates with multiple lumens (five 34 to 42) are shown in the illustrated embodiment) formed within the wall of the sheath 14 (see FIGS. 1B and 2B. In use, the lumens 34 to 42 convey anhydrous CO2 to the distal end of the sheath 14; vent or exhaust air from the distal end of the sheath 14 through the manifold 18; and, if desired, convey sterile fluid and bursts of air to the distal end of the sheath 14. In a representative embodiment (see FIGS. 1B and 2B), two lumens 34 and 36 are dedicated to the transport of CO2; two lumens 40 and 42 are dedicated to venting; and one lumen 38 is dedicated to the transports of sterile fluid or air.

[0033] C. The Tubing Set

[0034] As previously described, the tubing set **16** includes a quick exchange coupler **22** that mates with the quick exchange coupling **20** on the manifold **18** (see FIGS. **3**A/**3**B and **4**A/**4**B). The tubing set **16** includes lengths of flexible medical grade tubing with individual end couplers (best shown in FIGS. **1**A and **2**A) that connect to an existing CO2 insufflation circuit and, if desired, a source of sterile fluid (saline or sterile water, preferably with a "surface active agent") on the sterile operating field (e.g., a bag or a syringe). The tubing set **16** includes a Y-connector **44** that divides the anhydrous CO2 output of the insufflation circuit in a first branch **46** for coupling to an insufflation trocar inserted in the body cavity (as will be described later), and a second branch **48** coupled to the quick exchange coupler **22**.

[0035] The second branch **48** diverts a small portion of the CO2 output (e.g., 20% or less) to the quick exchange coupler **22**.

[0036] As shown in FIGS. **3**B and **4**B, the quick exchange coupler **22** includes a one way check valve **50** that communicates with the second branch **48** of the tubing set **16**. In the illustrated embodiment, the check valve **50** comprises a ball valve. Insufflation pressure normally presses the ball valve **50** against a ball valve seat **52** (as shown in FIG. **3**B). A projection **54** in the manifold **18** displaces the ball valve **50** from the valve seat **52** when the quick exchange coupler **22** mates with the quick exchange coupling **20** on the manifold **18** (as shown in FIG. **4**B). Unseating the ball valve **50** opens flow communication through the check valve **50**. In the absence of coupling the quick exchange coupler **22** on the tubing set **16** to the quick exchange coupling **20** on the manifold **18**, the check valve **50** remains closed, normally blocking flow of CO2 through the second branch **48**.

[0037] Thus, the tubing set **16** accommodates the set-up of the supply of the entire CO2 output to a insufflation trocar through the tubing set **16**, separate and independent of the connection of the tubing set **16** to the manifold **18** of the sheath **14**.

[0038] As FIGS. **3**A and **4**A further show, a latch **56** carried on a spring-biased button **58** on the quick exchange coupler **22** "clicks" into a detent **60** on the quick exchange coupling **20** on the manifold **18** to reliably lock the coupler **22** and coupling **20** together for use, opening the check valve to flow CO2 through the second branch **48** (shown in FIGS. **4**A/**4**B). Depressing the button **58** allows the quick exchange coupler **22** and coupling **20** to be separated, and the check valve **50** will close in response to insufflation pressure in the second branch **48** (as shown in FIGS. **3**A/**3**B).

[0039] Connection of the quick exchange coupling **20** on the manifold **18** to the quick exchange coupler **22** on the tubing set **16** is intended to occur at the OR table in the normal course, after the laparoscope **12** is connected to the light cable **30** and the camera cable **32** (see FIG. **15**). Upon coupling, the one way check valve **50** is opened, and the manifold **18** directs the small portion of CO2 from the CO2 insufflation circuit. Disconnection of the of the quick exchange coupling **20** on the manifold **18** to the quick exchange coupler **22** on the tubing set **16** is also intended to occur at the OR table in the normal course, after a removal and/or exchange of a laparoscope **12** (see FIG. **22**).

[0040] D. The Vent Device

[0041] The vent device **24** (see FIGS. **1**A and **2**A) comprises a tube with an inline membrane **62** that restricts air flow through the tube. A proximal end of the tube is sized and configured to couple to a stopcock valve of a conventional trocar, as will be described later. In use, the vent device **24** provides a controlled leak of CO2 from the operating cavity, as will also be described in greater detail later.

[0042] E. The Deflector Assembly

[0043] 1. CO2

[0044] The sheath **14** includes at its distal end a deflector assembly **64** (see FIGS. **5**A(**1**) and **5**A(**2**) for a blunt shaft tip and FIGS. **5**B(**1**) and **5**B(**2**) for an angled shaft tip). The deflector assembly **64** projects a predetermined distance beyond the distal end of the sheath **14**, and thus also a predetermined distance beyond the lens at the distal end of the laparoscope **12**. The deflector assembly **64** communicates with the lumens in the sheath **14**. The deflector assembly **64** is sized and configured to direct the small portion of the CO2 from the insufflation circuit in a prescribed flow path and flow velocity continuously across the laparoscopic lens.

[0045] The desired flow path and flow velocity of CO2 established by the deflector assembly **64** continuously across the laparoscopic lens creates a "wind shear." The wind shear path of anhydrous CO2 prevents fogging. The desired flow path and flow velocity of CO2 established by the deflector assembly **64** continuously across the laparoscopic lens also desirably serves to deflect smoke and surgical debris away from the laparoscopic lens during surgery.

[0046] 2. Physical, Pneumatic, and Optical Characteristics of the Deflector Assembly

[0047] The size and configuration of the deflector assembly are defined and constrained by several, sometime overlapping considerations including (i) prescribed physical characteristics, which are imposed due to the need to access the operating environment in as minimally invasive manner as possible and to be compatible with state of the art laparoscopes and other laparoscopic surgical instruments and techniques; (ii) prescribed pneumatic characteristics, which are imposed due to the need to create a particular "wind shear" effect in terms of the flow path and flow velocity of CO2 across the laparoscopic lens; and (iii) prescribed optical characteristics, which are imposed due to the need to prevent interference with the field of view and the visualization of the operating field by the laparoscope **12**.

[0048] 3. Physical Characteristics

[0049] The size and configuration requirements for minimally invasive access compatible with state of the art laparoscopic instrumentation and techniques are paramount. These requirements impose constrains upon the minimum inside diameter of the sheath **14** as well as the maximum outside diameter of the sheath **14**. Because state of the art laparoscopes are provided with different shaft diameters, lengths, and lens configurations, the sheath dimensions and configuration change for compatibility with them. The view optimizing assembly **10** actually includes a family of sheath **14**/manifold **18** assemblies differently sized and configured to accommodate different classes of laparoscopes, to make possible compatibility with the families of state of the art laparoscopes that are in use.

[0050] For example, state of the art laparoscopes include 10 mm laparoscopes, 5 mm laparoscopes, and, within these sizes, 0° shaft tips, 30° shaft tips, and 45° shaft tips. Further, within these classes of laparoscopes, manufacturing tolerances typically vary from scope to scope, as well as from manufacturer to manufacturer. A given sheath **14**/manifold **18** assembly for a given laparoscope class (e.g., 10 mm or 5 mm) desirably takes these typical manufacturing and manufacturer variances into account, and is desirably sized and configured to fit the largest scope variance encountered within a given laparoscope class.

[0051] To maximize the fluid flow lumen area within the sheath **14**, the minimum inside diameter of a given sheath **14** must closely conform to the maximum outside diameter of the shaft of the particular state of the class of laparoscope **12** selected for use, which the sheath **14** must accommodate in a smooth, sliding fit. Further, a gap between the outside diameter of the laparoscope shaft and the inside diameter of the sheath **14** must be minimized to avoid the transport and leakage of blood and fluids from the operating field. Still further, minimizing the gap also assures that the laparoscope **12** self-centers in the sheath **14**, thereby assuring faithful and accurate visualization through the laparoscope lens.

[0052] For example, for a typical laparoscope **12** in the 10 mm class, which measures 0.392 inch, the inside diameter of the sheath **14** is manufactured to 0.405 inch, providing a gap thickness of 0.0064 inch. For a 5 mm laparoscope **12** in the 5 mm class, which measures 0.196 inch, the inside diameter of the sheath **14** is manufactured to 0.218 inch, providing gap thickness of 0.011 inch.

[0053] The maximum outside diameter of the sheath **14** for minimally invasive access must take into account the minimum inside diameter of the trocar, which the maximum outside diameter cannot exceed.

[0054] For example, for a typical 10 mm trocar that measures 0.509 inch, the outside diameter of the sheath **14** is manufactured to 0.486 inch, providing a gap thickness of 0.0115 inch. For a typical 5 mm trocar that measures 0.324 inch, the outside diameter of the sheath **14** is manufactured to 0.300 inch, providing a gap thickness of 0.012 inch.

[0055] It is desirable, given the particular size and configuration constraints of the laparoscopic instrumentation and techniques used, to maximize the outside diameter to the extent possible. This is because, together the inside and outside diameters of the sheath **14** define the wall thickness for the sheath S_W. The wall thickness S_W, together with the length of the sheath **14**, in turn, define the maximum area available for the transport of the CO2 and fluids by the sheath **14**. The area of the fluid flow lumen or lumens dedicated to the supply of CO2, in turn, defines the maximum flow rate of the CO2 directed by the deflector assembly **64**. The flow rate should be sufficient at a minimum, given the output of the insufflator selected for use, to supply anhydrous CO2 across the lens of the laparoscope **12** sufficient to prevent fogging. Also affecting the effectiveness of the CO2 to defog the lens, is the water content of the anhydrous CO2. Given the same flow rate, the less water that is present in the anhydrous CO2, the greater is the defogging capacity of the assembly. Further, the flow rate desirable should also be sufficient to deflect smoke and surgical debris away from the viewing field of the laparoscopic lens during surgery, so that the anhydrous CO2 directed by the deflector assembly **64** both defogs and deflects debris.

[0056] Medical grade CO2 for use with conventional insufflators is typically 99% pure, that is, no more than 1% of the gas is other than CO2, and such medical grade anhydrous CO2 generally has a maximum moisture content of 25 parts per million by volume. Typically, a state of the art insufflator circuit delivers anhydrous CO2 at a max flow rate of about 20 liters per hour. Typically, the insufflator circuit will sense pressure in the circuit and cycle off when the sensed pressure is at or above 15 mmHg and cycle on when the sensed pressure is below 15 mmHg.

[0057] Given the above sheath dimensions, and given the supply of typical medical grade anhydrous CO2, a flow rate of at least about 1.0 liters per minute is critical to achieving this objective. Given the above dimensions, and the supply of typical medical grade anhydrous CO2, a flow rate less than 0.8 liters per minute is not sufficient to prevent significant accumulation of moisture on the laparoscope lens.

[0058] In a representative embodiment, for a sheath **14** having an inside diameter of 0.405 inch and an outside diameter of 0.486 inch, and a length of 11.25 inch (which accommodates passage of a typical 10 mm laparoscope and its own passage through a conventional trocar) (i.e., S_W=0.081 inch), the total area available in the sheath wall is 0.056 square inches. Based upon required structural support within the wall (inside, outside, and radial) the total available area for lumens to transport fluids is 0.027 square inch.

[0059] In a representative embodiment, the total lumen area is occupied by five lumens **34** to **42**, two for transporting CO2 (**34** and **36**), one for sterile fluid (**38**), and two for passive exhaust air venting (**40** and **42**).

[0060] The area of each lumen can be maximized by selection of lumen geometry. In a representative embodiment, lumen geometry is generally triangular or pie shaped with rounded corners. The radial walls that separate the lumens within the sheath **14** are sized to minimize the spacing between the lumens.

[0061] In a representative embodiment, CO2 transport is accomplished by two lumens **34** and **36** that extend about 175 degrees about the outer circumference of the sheath **14** and comprising a flow area of 0.013 square inches. Sterile fluid transport is accomplished by one lumen **38** comprising a flow area of 0.003 square inches. Exhaust air venting is accomplished by two lumens **40** and **42** comprising a flow area of 0.011 square inches. The distal openings of the exhaust lumens **40** and **42** desirably are spaced from the distal end of the sheath, to prevent uptake of blood and fluids.

[0062] 4. Pneumatic Characteristics.

[0063] As diagrammatically shown in FIG. **6**, the deflector assembly **64** must overhang the laparoscopic lens by a prescribed transverse distance, defining a deflection width X, sufficient to change the direction of CO2 flowing axially through lumens of the sheath **14** (i.e., along the axis of the laparoscope shaft) into a non-axially, transverse path across the laparoscopic lens (i.e., at an angle relative to the axis of the laparoscope shaft). Still, the distance of the deflection width X should not extend to the point that is obstructs the field of the view of the laparoscopic lens. This is an example where a pneumatic characteristic of the deflector assembly **64** overlaps with an optical characteristic. Further optical characteristics will be described in greater detail below.

[0064] The deflector assembly **64** must also project axially beyond the distal terminus of the sheath **14** by a prescribed axial distance, defining an air channel distance Y, sufficient to maintain the CO2 flowing along the path bounded by the deflection width X at a distance sufficiently close (proximal) to the laparoscopic lens to achieve the desired shear flow effect, but without forming an abrupt flow bend that can lead to a reduction in the desired CO2 flow velocity.

[0065] Together, the deflection width X and the channel distance Y define the pneumatic characteristics of the deflection assembly. At the desired minimum flow rate, the pneumatic characteristics create a flow path that conveys CO2 continuously across the laparoscopic lens at the desired flow velocity, in shorthand called the "wind shear." The pneumatic characteristics of the $CO2$ "wind shear" across the laparoscopic lens prevent fogging, as well as desirably deflect smoke and surgical debris away from the viewing field of the laparoscopic lens during surgery.

[0066] Together, the pneumatic characteristics defined by the deflection width X and the channel distance Y create an exit angle A_{EXIT}, measured between the plane of the laparoscopic lens and the terminal edge of the deflector assembly **64**. The exit angle A_{EXIT} must be less than a maximum angle of 45 degrees, else the flow path of the CO2 will not pass sufficiently both across and proximal to the laparoscopic lens. To maintain a desired exit angle A_{EXIT}, the channel distance Y should be at least equal to the wall thickness of the sheath S_W and should not exceed 1.5 times the wall thickness of the sheath S_W. The deflection width X should be at least equally to two times the channel distance Y, but not extend into the field of view of the laparoscopic lens.

[0067] 5. Optical Characteristics

[0068] The optical characteristics of the deflector assembly **64** are selected (i) to not block or reduce the illuminated image of the operating field provided by the laparoscope **12**; (ii) not decrease the intensity of the illumination provided by the laparoscope **12** on the operating field; and (iii) prevent reflection of illumination light at the lens of the laparoscope **12**.

[0069] As discussed above, the maximum deflection width X takes into account one of the desirable optical characteristics; namely, the deflection width X should not obstruct the field of the view of the laparoscopic lens.

[0070] To prevent the decrease of the illumination, the deflector assembly **64** is desirably made from a material having high light transmission properties (i.e., transparency), to not interfere with the passage of light through the light cable **30** onto the operating field as well as the passage of the reflected image conveyed to the camera cable **32** of the laparoscope **12**.

[0071] Furthermore, the material and surface finish of the deflector assembly **64** must pose minimal reflectively to light. In a representative embodiment, the deflector assembly **64** is made from Bayer Makrolen Rx1805 with a surface finish defined as SPI/SPE A-3.

[0072] 6. Orientation

[0073] As before described, CO2 transport is accomplished by two lumens **34** and **36** that extend about 175 degrees about the outer circumference of the sheath **14**. For a 0° shaft tip (see FIG. **5**A), the orientation of the deflector assembly **64** relative to the laparoscopic lens is not critical. However, for angled shafts (e.g., 30° shaft tips and 45° shaft tips) (see FIG. **5**B), the orientation of the deflector assembly **64** relative to the laparoscopic lens is critical.

[0074] As FIG. **5**B shows, the angled tip of a typical laparoscope **12** has a high end **66** and a low end **68**. The lens slopes at the prescribed angle between the high end **66** and the low end **68**. In a laparoscope **12** having a angled tip, the illumination cable **30** (transmitting light onto the operating field) is located at the high end **66** of the angled tip, and the camera cable **32** (transmitting reflected light back to the camera) is located at the low end **68** of the angled tip. To provide the desired wind shear effect on an angled tip, it is critical that the deflector assembly **64** be oriented relative to the sloped laparoscopic lens such that the flow CO2 is directed across the sloped plane of the lens from the low end **68** of the tip toward the high end **66** of the tip. In this arrangement, the defogging and debris deflection flow path originates proximal to the camera cable **32**, which effectively comprises the eyes of the OR team. In this arrangement, the desired exit angle A_{EXIT} directs the flow path of the CO2 both sufficiently across and proximal to the sloped plane of the laparoscopic lens to achieve optimal defogging and debris deflection.

[0075] F. Sterile Fluid Flush

[0076] As previously explained, if desired, the tubing set **16** can also include, connected to the quick exchange coupler **22**, a length of tubing **70** sized and configured for connection to a source **72** of sterile fluid, such as saline or sterile water (as shown in FIGS. **1**A and **2**A). Preferably, the sterile fluid includes in solution a "surface-active agent" that stabilizes mixtures of oil and water (e.g., fat) by reducing the surface tension at the interface between the oil and water molecules.

[0077] The quick exchange coupling **20** on the manifold **18** (see FIGS. **3**A/**3**B and **4**B/**4**B) can also include a port to integrally connect the sterile fluid tubing **70** to direct the sterile fluid through the separate lumen **38** in the sheath **14** to the distal end of the sheath **14**. The deflector assembly **64** directs the sterile fluid across the laparoscopic lens.

[0078] As shown in FIGS. **1**A/**2**A, the sterile fluid tubing **70**, if present, desirably includes an in-line pumping device **72**. The in-line pumping device **72** is sized and configured to be operated on demand by a person at the OR table to convey bursts of sterile fluid through the manifold **18** through the lumen to the distal end of the sheath **14**. The in-line pumping device **72** and source can be integrated and comprise, e.g., a 20 cc syringe filled with sterile fluid and connected by a tubing luer-lock on the saline tubing. Alternatively, the in-line pumping device **72** and source can be separate and comprise, e.g., a bag of sterile fluid, a spike connection on the saline tubing of the tubing set **16** to open communication with the bag in conventional fashion, and an inline squeeze bulb or the like to pump burst of sterile fluid from the bag to the quick exchange coupler **22**.

[0079] In this arrangement, the deflector assembly **64** is also sized and configured to direct the burst of sterile fluid in a desired path across the laparoscopic lens. The bursts of sterile fluid serve to flush debris off the end of the lens that may eventually accumulate, thereby cleaning the lens. Thereafter, bursts of air supplied through the deflector assembly **64** by a squeeze pump **74** in the tubing set **16** (see FIGS. **1**A/**2**A) serve to clear residual fluid droplets off the lens and away from the deflector assembly **64** to maintain the desired flow path and flow velocity of CO2 established by the deflector assembly **64** continuously across the laparoscopic lens, to maintain an acceptable view.

[0080] In an illustrative embodiment (see FIGS. **5**A and **5**B), the deflector assembly **64** directs the bursts of sterile fluid or air along a plurality of individual diverging channels **76** (three are shown). The diverging channels **76** distribute the bursts of sterile fluid or air in a fanning pattern across the lens of the laparoscope **12**. In the illustrative embodiment, the diverging channels **76** discharge the bursts of sterile fluid or air in a path that is generally ninety-degrees to the path of CO2. This orientation of the sterile fluid path relative to the CO2 path across the lens, optimal for effective lens cleaning, applies to both 0° shaft tips and angled tips (e.g., 30° shaft tips and 45° shaft tips).

II. Use of the View Optimizing Assembly

[0081] The view optimizing assembly is well suited for use as a single-use disposable laparoscopic accessory device to facilitate intra-operative defogging and debris deflection (due to the flow of anhydrous CO2) and cleaning of the lens of a laparoscope **12** (due to burst of sterile fluid, preferably including a "surface-active agent") during minimally invasive surgery, while also maintaining visualization of the surgical site.

[0082] FIGS. **7** to **34** illustrate a representative method including the set up and use of the view optimizing assembly using sterile technique by qualified technicians/operating room personnel.

[0083] The procedure can be incorporated into written instructions for use that accompany the packaging. The instructions can also be supplied separately, e.g., embodied in separate instruction manuals, or in video or audio tapes, CD's, and DVD's. The instructions for use can also be available through an internet web page.

[0084] The instructions can direct the OR set-up to peel open the outer pouches in which the components of the view optimizing assembly (shown in FIG. **7**), and remove the sterile contents on the sterile field. The sheath **14**/manifold **18** assembly is removed, taking care to prevent damage to the walls of the sheath **14** or to its distal end, and also keeping the tubing set **16** and vent device **24** on the sterile field prior to making necessary connections.

[0085] During set up (see FIGS. **8** and **9**), the sheath **14** (with the manifold **18**, which is integrally connected to the sheath **14** during manufacture, called a sheath assembly) can be assembled to the corresponding laparoscope **12**. In this representative example, it is contemplated that the OR team plan to use a 0-degree laparoscope **12** (see FIGS. **8** and **9**) and at least one angled laparoscope **12** (see FIGS. **10** and **11**), e.g., a 30-degree and/or a 45-degree laparoscope **12**. Therefore, during set-up, a sheath assembly for each laparoscope **12** selected for use will be pre-assembled to the corresponding laparoscope **12**.

[0086] As FIGS. **8** and **10** show, while gently pressing the tip of the sheath assembly against one hand or finger-tip, the laparoscope **12** can be inserted down into the sheath **14**. The sheath **14** is sized and configured so that the laparoscope **12** will slide smoothly through the sheath **14**. Insertion continues until the lens and distal rim of the laparoscope **12** seat against the stop at the distal end of the sheath **14**. The laparoscope **12** will "bottom out" inside the sheath **14** against the stop **26**, assuring correct axial alignment of the lens with the deflector assembly **64**.

[0087] If the laparoscope **12** is angled (as shown in FIG. **10**), the corresponding sheath assembly will also include an alignment fork guide **78**. The light post of the scope seats within the alignment fork guide **78**, therefore assuring correct rotational alignment between the angled lens and the deflector assembly **64**.

[0088] The laparoscope **12** (now fully inserted into the sheath **14**) the manifold **18** are supported by hand, a member of the OR set-up team rotates the locking collar **28** on the sheath assembly in the desired direction, e.g., clockwise (see FIGS. **9** and **11**), indicated by an arrow on the locking collar **28**, until a firm stop is felt tactilely (e.g., after approximately one-third (⅓) of a turn). Registration of an alignment mark on the locking collar **28** and an alignment mark on the manifold **18** serves to visually confirm that the laparoscope **12** is secured against axial movement relative to the sheath **14**.

[0089] The insufflator is set up off the sterile field. Once the patient is draped on the sterile field, and it is expected that the end of the output tubing from the insufflator (originating from the insufflator off the sterile field) will brought onto the sterile field. It is also expected that the light cable **30** and the camera cable **32** for the laparoscope **12** will be brought onto the sterile field.

[0090] As FIGS. **12** and **13** generally show, the OR team makes an incision to gain access to the laparoscopic operating site within the body, e.g., into the abdominal cavity through the abdominal wall. A first trocar with a stopcock valve (which may take the form of an optical trocar) is inserted through the incision. Alternatively, according to physician preference, the first trocar can be pushed through abdominal wall with only a skin incision. The obturator (the sharp inner insert of the trocar) is removed from the first trocar once it is in position.

[0091] The insufflator line of the tubing set **16** on the sterile field is connected to the output tubing of the insufflator circuit on the sterile field. The first branch **46** of the tubing set **16** on the sterile field, originating at the Y-connector **44**, is coupled to the stopcock valve of the first trocar (see FIG. **13**). The stopcock valve is opened, and the insufflator is turned on. CO2 output of the insufflation circuit inflates the abdomen through the first trocar.

[0092] During this time (see FIGS. **8** and **10**), the second branch **48** of the tubing set **16** on the sterile field, also originating at the Y-connector **44**, and the quick exchange coupler **22** integrally attached to it can remain on the sterile field in a free, unconnected condition as the insufflator supplies CO2 through the first branch **46**. The one-way check valve in the quick exchange coupler **22** serves to block flow of CO2 through the second branch **48**, even as the insufflator supplies CO2 through the first branch **46**. The entire CO2 pressure of the insufflator circuit is, at the present, delivered to the first trocar through the first branch **46**.

[0093] The first laparoscope **12** selected for use, which has been pre-inserted into the sheath **14** by the OR set-up team as just described, is handed to personnel at the OR table at the appropriate time. On the sterile field, personnel at the OR table connect the light cable **30** and the camera cable **32** to the laparoscope **12** (see FIG. **14**). On the sterile field, personnel at the OR table now connect the quick exchange coupler **22** of the tubing set **16** to the quick exchange coupling **20** of the manifold **18** (see FIG. **15**). The one way valve opens, and a small portion of the output of the insufflator circuit is routed by the second branch **48** through the manifold **18** into to the sheath **14**.

[0094] The laparoscope/sheath assembly is then placed as an integrated unit through the first trocar to get an initial view of the abdominal cavity (see FIG. **16**). Due to the technical features of the deflector assembly **64**, CO2 flows over the lens, eliminating fogging and also deflecting away debris. If present, the pump (e.g., the 20 cc syringe) filled with sterile fluid (preferably with a "surface-actuve agent") and connected to the tubing luer-lock, can be operated by personnel at the OR table to flush sterile fluid through the deflector assembly **64** of the sheath **14**. The deflector assembly **64** directs the fluid bursts across the lens in a path generally 90-degrees offset from the CO2 path. Once this is done, the bulb on the tubing set **16** can be pumped several times introduce bursts of air to clear droplets off the lens and away from the tip deflector, to maintain to the continuous directed flow of CO2 across the laparoscopic lens.

[0095] Once a satisfactory view is achieved, additional ancillary trocars with stopcock valves, e.g. three to four, or more, are also placed through incisions to provide access for other instruments (see FIG. **17**). The trocar vent device **24**

provided with the view optimizing assembly is desirably placed in the stopcock of one of the ancillary trocars, and the stopcock valve is opened (see FIG. **18**).

[0096] As FIG. **19** shows, a member of the OR team preferable decouples the main insufflation line (the first branch **46** tubing of the Y-connector **44** of the tubing set **16**) from the first trocar to the stopcock valve of another available trocar on the sterile field (except the trocar to which the vent device **24** is coupled). This other trocar then serves as the main insufflation trocar, separate from the first trocar, which now serves as the main visualization trocar. In this way, the main CO2 insufflation provided for the duration of the surgery is provided by an insufflation trocar that is also not the visualization trocar. The controlled leak of insufflation pressure that the vent device **24** provides creates a pressure gradient within the pneumo-peritoneum that helps maintain a generally continuous flow of CO2 from the deflector assembly **64** across the lens, despite periodic cycling of the insufflator. Lumens **40** and **42** in the sheath **14** (previously described) can also serve as additional passive vents, to leak insufflation pressure out through the manifold **18**.

[0097] The surgery proceeds. The deflector assembly **64** provides intra-operative defogging and cleaning of the laparoscope lens during the minimally invasive surgery, while maintaining visualization of the surgical site. The sterile fluid flush mechanism can be used, as desired, if required to augment visualization by flushing the lens. If this is done, the bulb on the tubing set **16** should be pumped several times to clear droplets off the lens and away from the deflector assembly **64** to maintain the CO2 curtain across the lens.

[0098] During the surgery, the OR team can decide, e.g., that one portion of the procedure is better visualized with a different angle scope. The quick exchange features of the coupler of the tubing set **16** and the coupling of the manifold **18**, greatly facilitate the exchange of one laparoscope **12** for another with minimal interruption of the surgical procedure and without compromising the sterile field.

[0099] To exchange one laparoscope **12** for another, a member of the OR team withdraws the laparoscope/sheath assembly an integrated unit from the visualization trocar (see FIG. **20**).). A member of the OR team disconnects the laparoscope **12** from the light cable **30** and camera cable **32** (see FIG. **21**). A member of the OR team uncouples the quick exchange coupler **22** from the quick exchange coupling **20**, freeing the laparoscope/sheath assembly from the tubing set **16** (see FIG. **22**). The disconnected laparoscope/sheath assembly is handed as an integrated unit to a member of the OR team, e.g., a scrub nurse (see FIG. **23**). There is no reason to remove the sheath **14** from the matching laparoscope **12** at this time. This can be accomplished later, after the surgery is all done.

[0100] The laparoscope/sheath assembly that includes the second laparoscope **12** that is to be used, has already been assembled into an integrated unit, as previously described. This pre-assembled unit is handed to a member of the OR team (see FIG. **24**). A member of the OR team connects the second laparoscope **12** to the light cable **30** and camera cable **32** (see FIG. **25**). A member of the OR team couples the quick exchange coupler **22** of the tubing set **16** to the quick exchange coupling **20**, connecting the second laparoscope/sheath assembly in flow communication with the tubing set **16** (see FIG. **26**), completing the quick exchange. The second laparoscope/sheath assembly is inserted into the visualization trocar (see FIG. **27**).

[0101] The quick connect feature functions with a manifold **18** associated with every sheath **14**. The tubing set **16** on the sterile field can be rapidly disconnected, but need not, and desirably is not, exchanged with another tubing set **16**. During a given surgical procedure, the same tubing set **16** serves every laparoscope/sheath assembly used (unneeded tubing sets **16** that came with the additional sheaths can be simply discarded).

[0102] The surgery proceeds using the second laparoscope/sheath assembly.

[0103] Additional quick exchanges of laparoscopes can be accomplished as surgery proceeds in the manner just described.

[0104] Once surgery is completed, all instruments, including the laparoscope/sheath assembly in use are removed from the visualization trocar (see FIG. **28**). A member of the OR team disconnects the laparoscope **12** from the light cable **30** and camera cable **32** (see FIG. **29**). A member of the OR team uncouples the quick exchange coupler **22** from the quick exchange coupling **20**, freeing the laparoscope/sheath assembly from the tubing set **16**. The laparoscope/sheath assembly is handed to a member of the OR team (see FIG. **31**), and placed alongside previously used laparoscope/sheath assemblies (see FIG. **32**).

[0105] Access sites are closed. The insufflator is shut off. The tubing set **16** is disconnected from the insufflator circuit. The lock collars on the manifolds **18** are loosened, and laparoscopes are withdrawn from the sheaths for reuse (FIG. **33**). The sheaths and tubing set **16** are disposed of (FIG. **34**).

[0106] Some trocars are called "optical trocars" that have a lumen within the obturator, that is within the trocar. If the lens of a laparoscope **12** is first placed into the center of an optical trocar to guide the first trocar insertion, then the sheath **14** cannot be present on the laparoscope **12**, as the combination cannot fit through the lumen of the obturator. In this situation, the laparoscope **12** is used without a sheath **14** is used to place the first trocar. The laparoscope **12** is then inserted through the sheath **14**, and connection of the tubing set **16** occurs in the manner just described. With the obturator removed from the trocar, the laparoscope/sheath assembly is placed through the first trocar in the manner described.

I/We claim:

1. A view optimizing assembly comprising

a sheath sized and configured to receive a laparoscope including on its distal end a laparoscopic lens with a field of view, the sheath having a wall with a wall thickness, the sheath having a distal end including an internal stop that prevents advancement of the laparoscopic lens beyond the distal end of the sheath, so that laparoscopic lens rests in a desired, generally coterminous alignment with the distal end of the sheath,

a lumen in the wall of the sheath for conveying anhydrous carbon dioxide (CO2) from a source, the lumen being sized and configured to convey the anhydrous CO2 from the source at a flow rate of at least 1 liter per minute, and

a deflector assembly at the distal end of the sheath communicating with the lumen, the deflector assembly projecting a prescribed distance beyond the distal end of the sheath, defining an air channel distance Y, and also overhanging the laparoscopic lens by a prescribed transverse distance, defining a deflection width X, together the air channel distance Y and deflection distance X creating a flow path for the anhydrous CO2 across the laparoscopic lens, the channel distance Y being at least equal to the wall thickness of the sheath and not exceeding 1.5 times the wall thickness of the sheath, the deflection width X being be at least equally to two times the channel distance Y, but not extending into the field of view, whereby anhydrous CO2 in the flow path prevents fogging and deflects smoke and surgical debris away from the field of view during surgery.

2. A view optimizing assembly comprising

a sheath sized and configured to receive a laparoscope including on its distal end a laparoscopic lens,

a lumen in a wall of the sheath for conveying fluid,

a tubing set having one end sized and configured to couple to a pressurized source of anhydrous CO2 and a second end coupled to a quick exchange coupler, the quick exchange coupler include a normally closed one way valve to normally prevent flow communication of the anhydrous CO2 from the source,

a manifold carried by the sheath and communicating with the lumen, the manifold including a quick exchange coupling, the quick exchange coupling being sized and configured to mate with the quick exchange coupler of the tubing set, the quick exchange coupling of the manifold including an element that opens the normally closed one way valve in response to mating with the quick exchange coupler to convey anhydrous CO2 from the source into the lumen, and

a deflector assembly at the distal end of the sheath in flow communication with the lumen, the deflector assembly creating a flow path for the anhydrous CO2 conveyed in the lumen across the laparoscopic lens.

3. A surgical method comprising

providing a first laparoscope having a laparoscopic lens and a first characteristic,

providing a second laparoscope having a second laparoscopic lens and a second characteristic different than the first characteristic,

providing only one tubing set having one end sized and configured to couple to a pressurized source of anhydrous CO2 and a second end coupled to a quick exchange coupler, the quick exchange coupler include a normally closed one way valve to normally prevent flow communication of the anhydrous CO2 from the source,

providing a first sheath a sized and configured to receive the first laparoscope, the first sheath including a lumen in a wall of the first sheath for conveying fluid, a manifold carried by the first sheath and communicating with the lumen, the manifold including a quick exchange coupling, the quick exchange coupling being sized and configured to mate with the quick exchange coupler of the tubing set, the quick exchange coupling of the manifold including an element that opens the normally closed one way valve in response to mating with the quick exchange coupler to convey anhydrous CO2 from the source into the lumen, and a deflector assembly at the distal end of the first sheath in flow communication with the lumen, the deflector assembly creating a flow path for the anhydrous CO2 conveyed in the lumen across the laparoscopic lens of the first laparoscope,

providing a second sheath a sized and configured to receive the second laparoscope, the second sheath including a lumen in a wall of the second sheath for conveying fluid, a manifold carried by the second sheath and communicating with the lumen, the manifold including a quick exchange coupling, the quick exchange coupling being sized and configured to mate with the quick exchange coupler of the tubing set, the quick exchange coupling of the manifold including an element that opens the normally closed one way valve in response to mating with the quick exchange coupler to convey anhydrous CO2 from the source into the lumen, and a deflector assembly at the distal end of the first sheath in flow communication with the lumen, the deflector assembly creating a flow path for the anhydrous CO2 conveyed in the lumen across the laparoscopic lens of the second laparoscope,

inserting the first laparoscope into the first sheath,

inserting the second laparoscope into the second sheath,

coupling the quick exchange coupler of the tubing set to the quick exchange coupling of the manifold of the first sheath,

visualizing through the first laparoscope while the deflector assembly of the first sheath conveys anhydrous CO2 across the laparoscopic lens of the first laparoscope to prevent fogging and deflect smoke and surgical debris away from the field of view of the first laparoscopic lens,

exchanging the second laparoscope for the first laparoscope by decoupling the quick exchange coupler of the tubing set from the quick exchange coupling of the manifold of the first sheath, and coupling the quick exchange coupler of the tubing set to the quick exchange coupling of the manifold of the second sheath, and

visualizing through the second laparoscope while the deflector assembly of the second sheath conveys anhydrous CO2 across the laparoscopic lens of the second laparoscope to prevent fogging and deflect smoke and surgical debris away from the field of view of the second laparoscopic lens.

* * * * *

专利名称(译)	用于在手术镜的使用期间优化和维持手术视野的可视化的系统和方法

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摘要(译)

系统和方法利用具有偏转器组件的视图优化组件，该偏转器组件具有关键的物理，气动和光学特性，使得在微创手术期间可以进行术中除雾，手术碎片偏转和腹腔镜镜片的清洁，同时还保持可视化手术部位。视图优化组件可以结合快速交换特征，这使得用于维持清晰可视化的手术方法成为可能，包括能够快速更换具有不同操作特征的腹腔镜（例如，具有不同尖端角度，长度或直径的腹腔镜）完全在无菌手术区域，并且不干扰无菌手术区域中预先存在的手术设置。视图优化组件与现有的微创仪器套件集成在一起。它不会干扰手术设置，并且在外科手术室（OR）团队的过程或实践中需要最小的改变。