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**Mohajer-Shojaee**

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(54) **LAPAROSCOPIC CANNULA WITH SUTURING PASSAGE CUTOFF**

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(51) **Int. Cl.**

| | |
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| ***A61B 17/34*** | (2006.01) |
| ***A61B 17/02*** | (2006.01) |

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USPC ..... 600/201–210, 215, 235, 213; 604/158–161, 167.01–167.06

See application file for complete search history.

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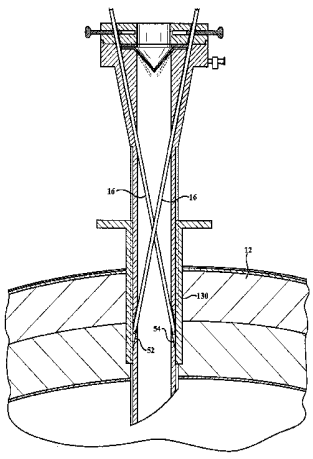
(57) **ABSTRACT**

A cannula for use in laparoscopic surgery has a central passage which may accept a trocar to create a laparoscopic incision in a body wall to an inner body cavity. A tubular section of the cannula is then pressed into the incision to form a port. The tubular section has passages through its walls for suturing needles and a source for insufflating gas. A tubular sleeve is slidably supported on the outer side of the tubular cannula for movement between a raised position clear of the needle passage exit ports and a lowered position blocking the exit ports to prevent insufflation gases from passing into the body wall.

**7 Claims, 9 Drawing Sheets**



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***A61B 17/06*** (2006.01)
*A61M 13/00* (2006.01)

(52) **U.S. Cl.**
CPC ..... *A61B 2017/3445* (2013.01); *A61B 2017/3449* (2013.01); *A61M 13/003* (2013.01)

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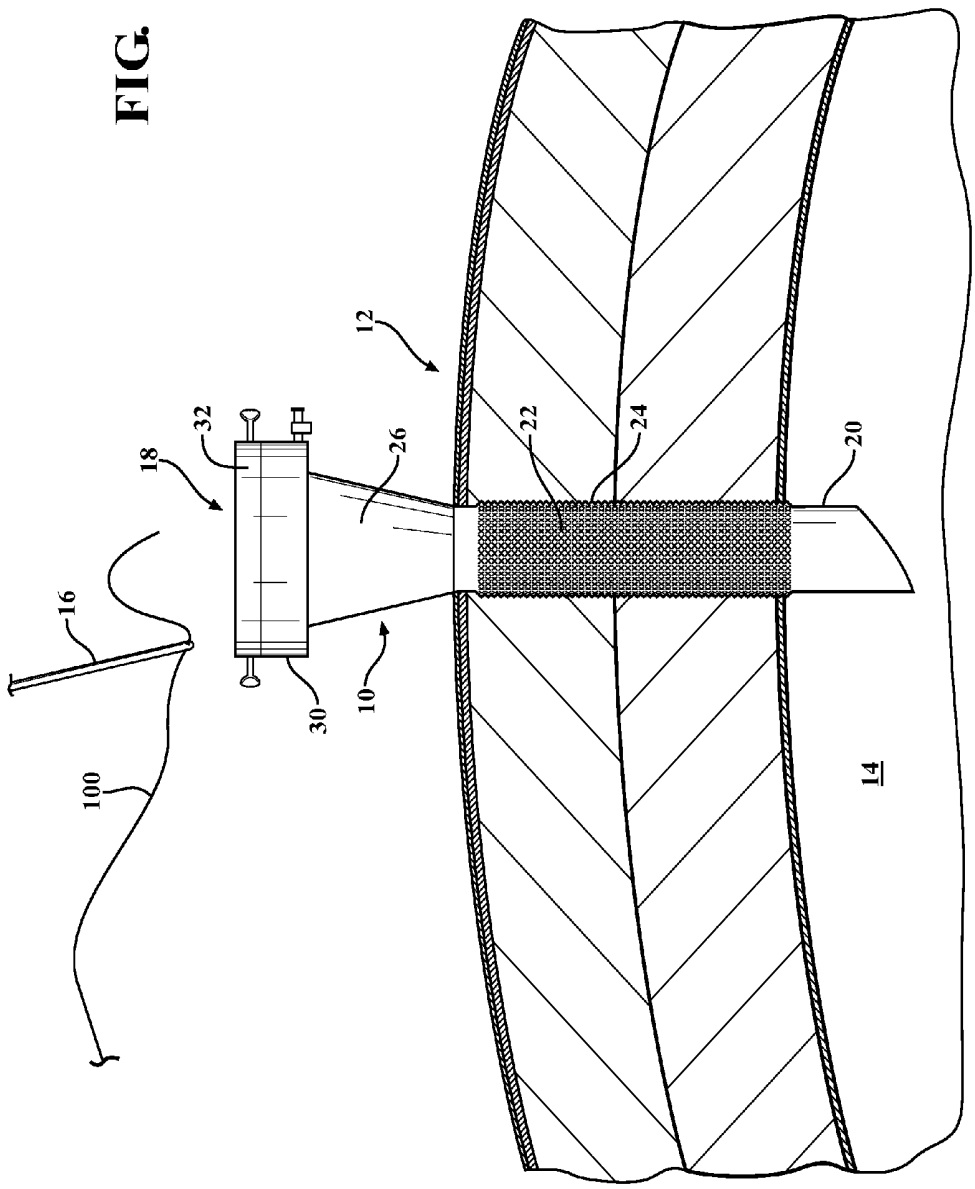
FIG. 1



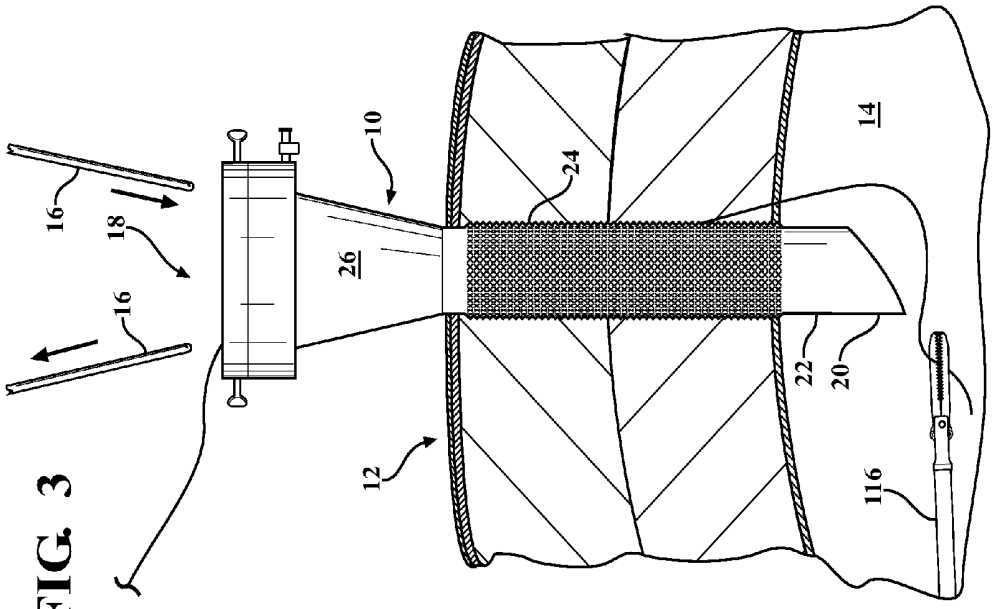



FIG. 3

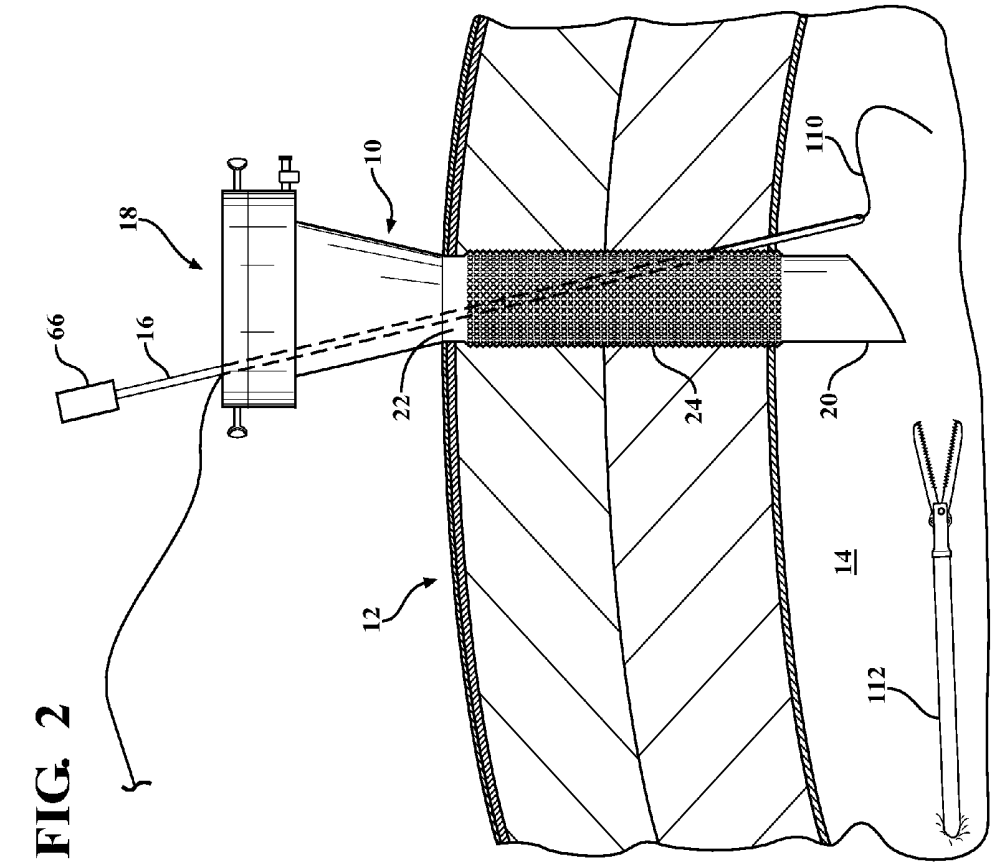



FIG. 2

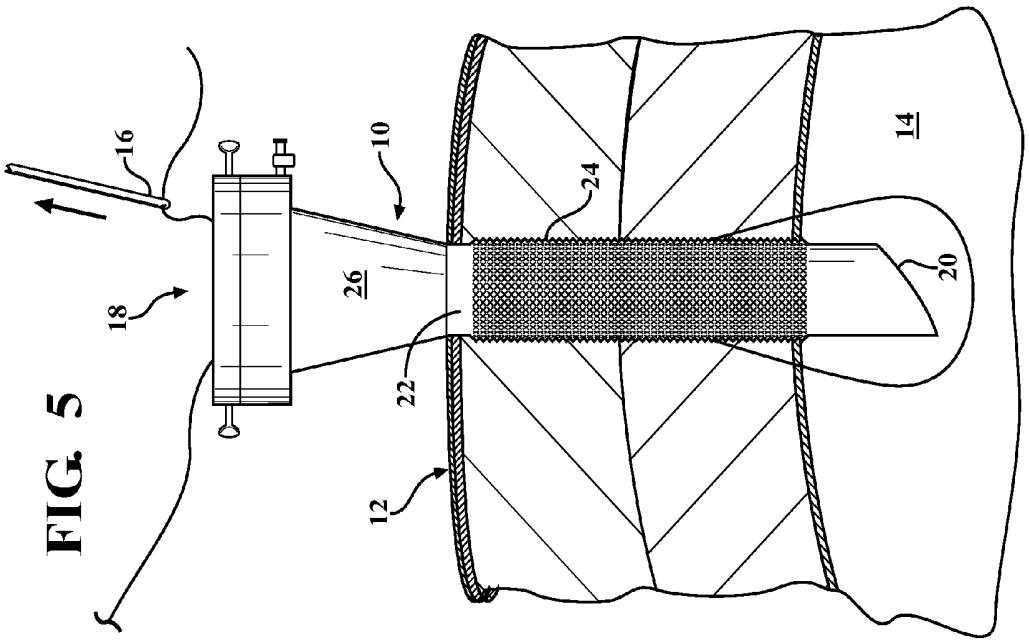



FIG. 5

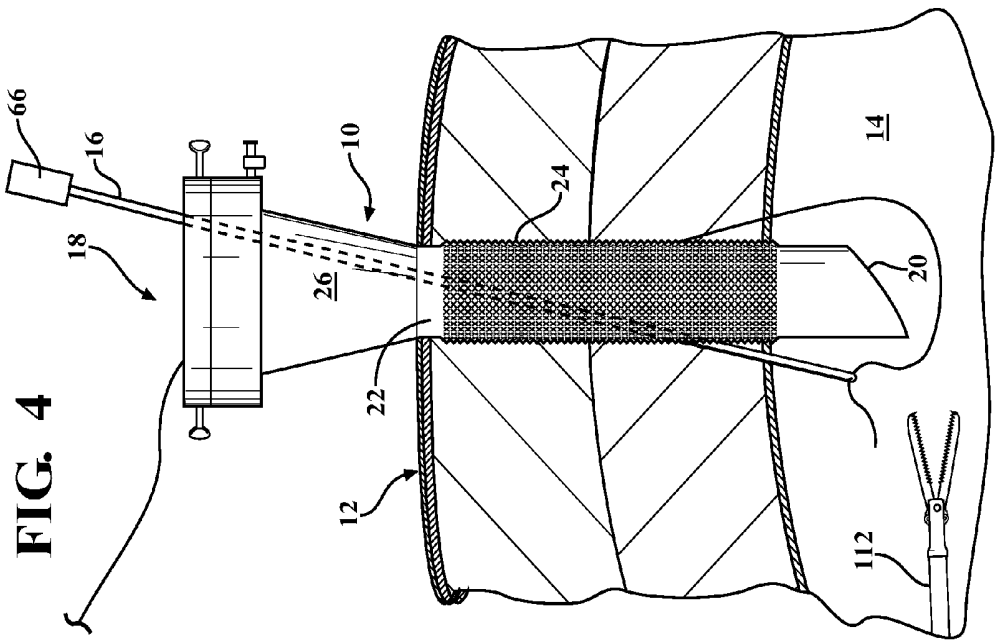



FIG. 4

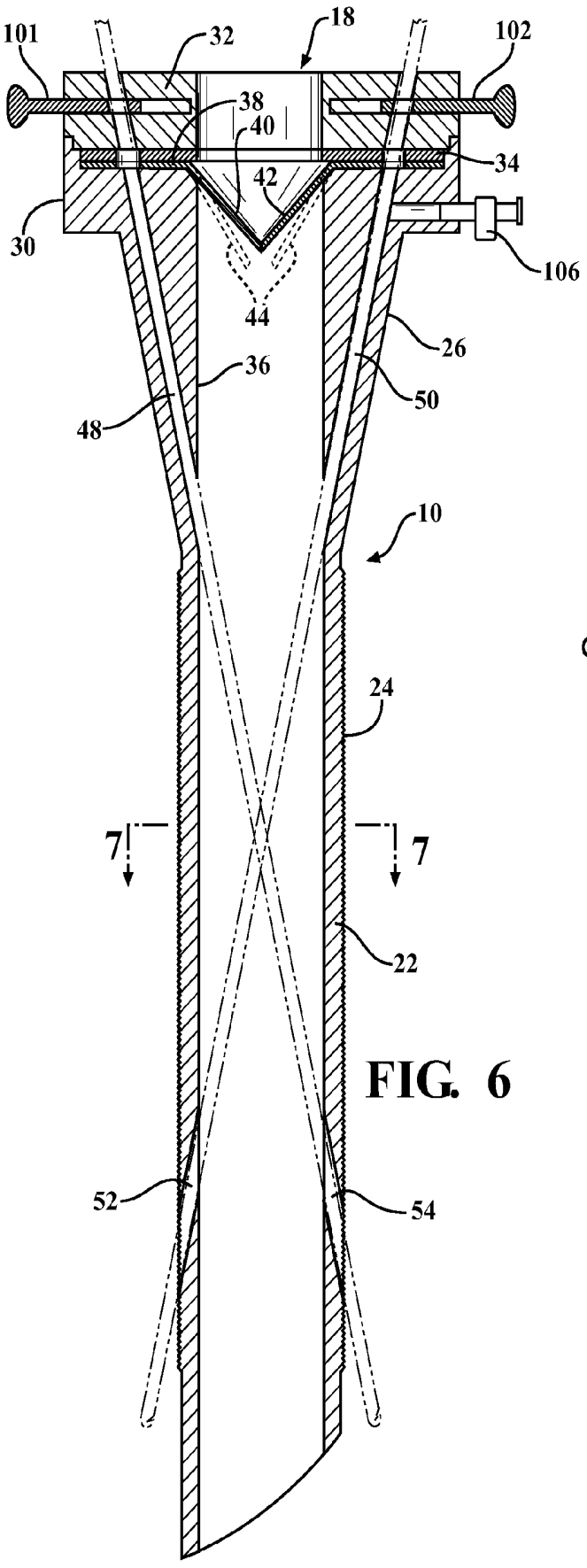

101
32
18
102
38
40
34
42
30
106
44
26
36
50
48
10
24
7
7
22
52
54

FIG. 6

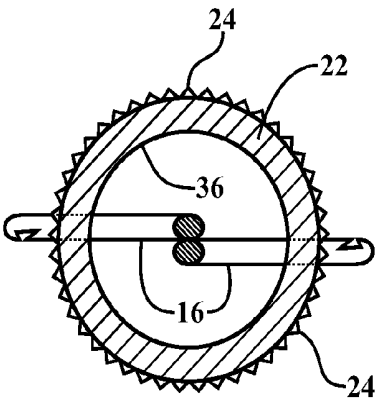

24
22
36
16
24

FIG. 7

FIG. 8

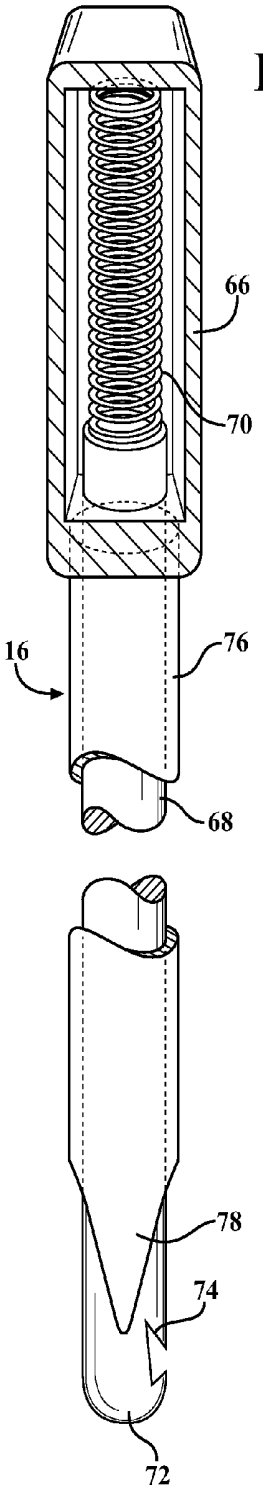



FIG. 9

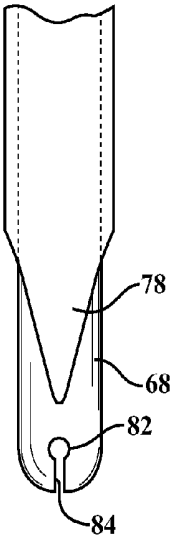
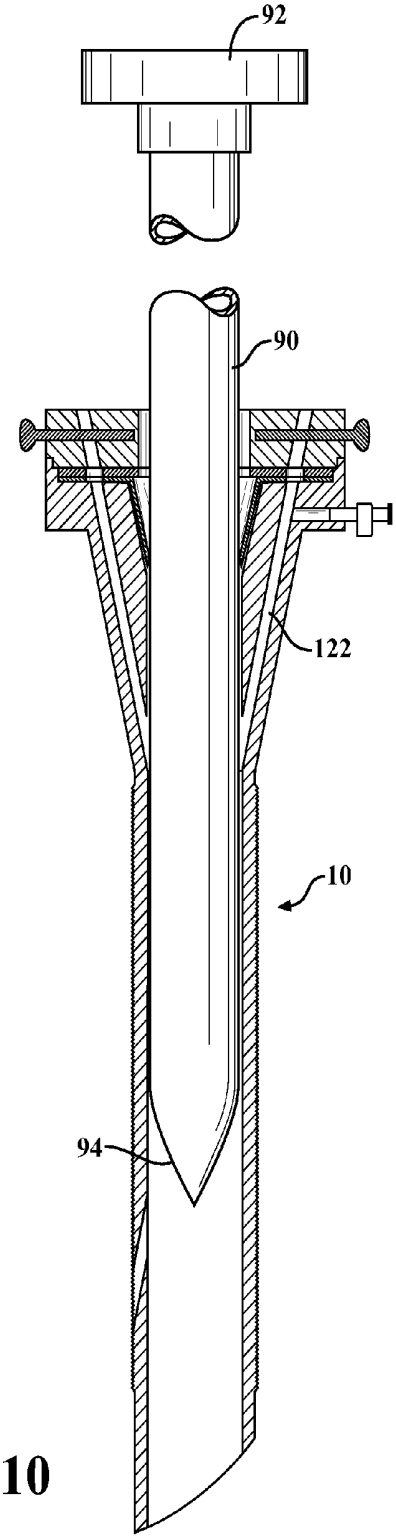



FIG. 10



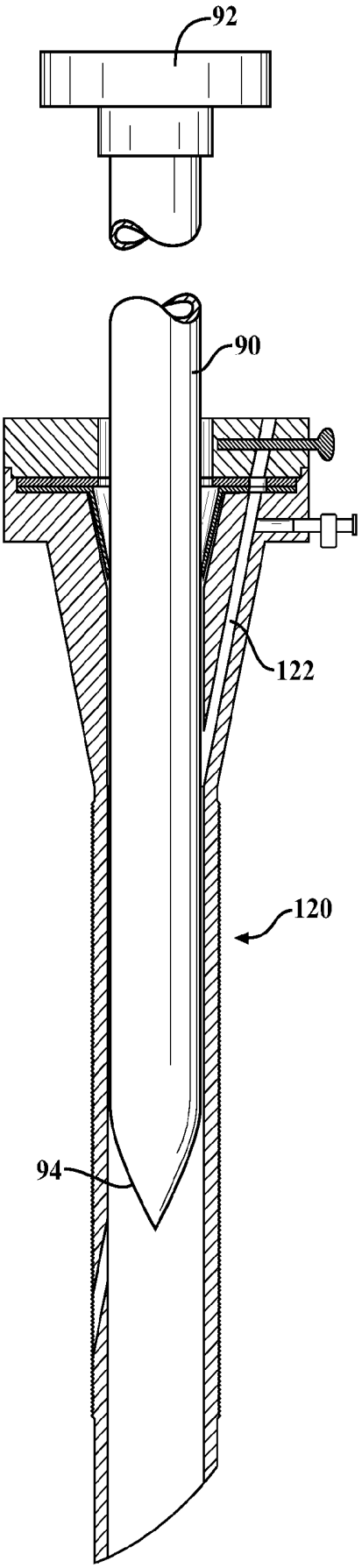
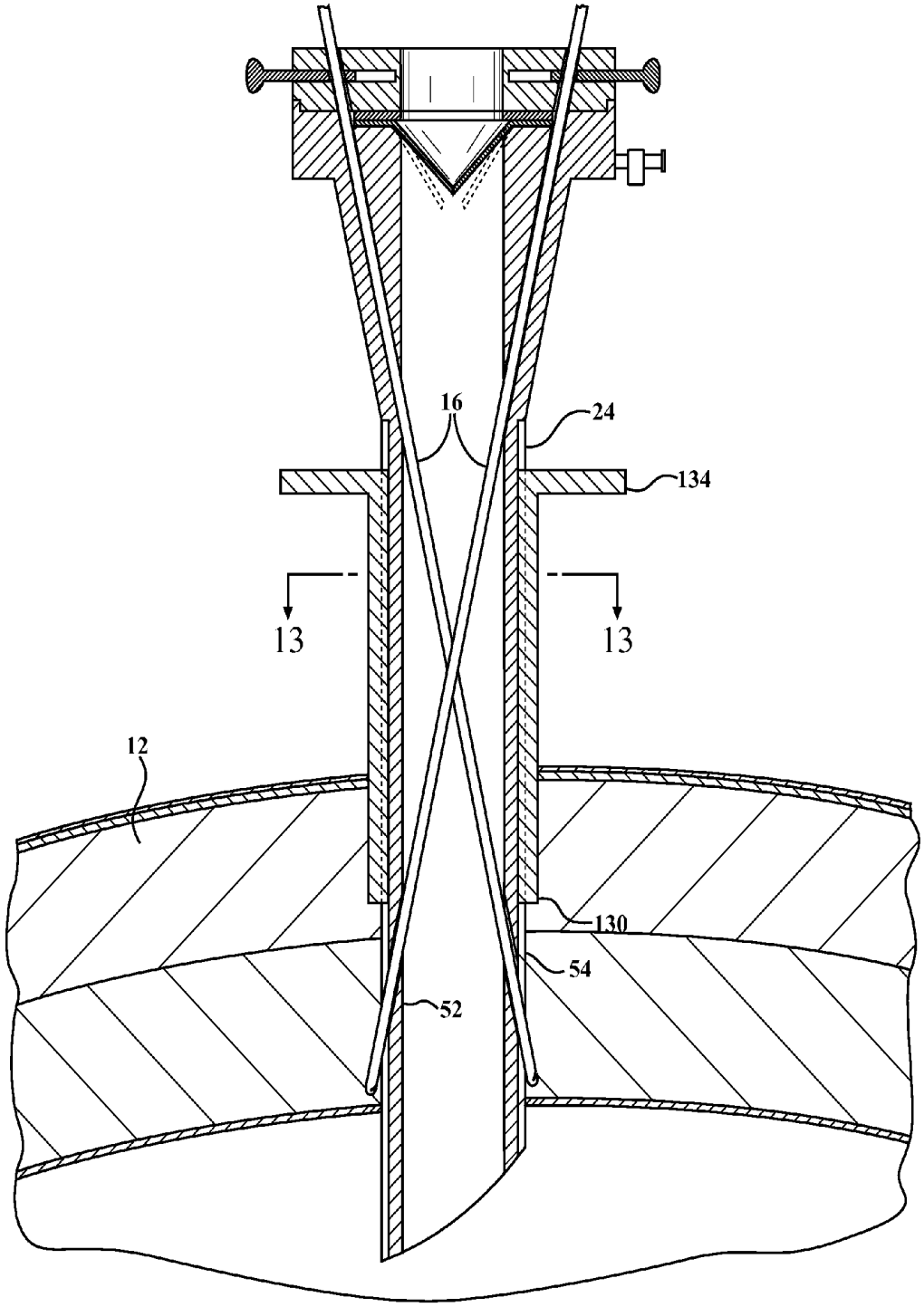



FIG. 11

FIG. 12



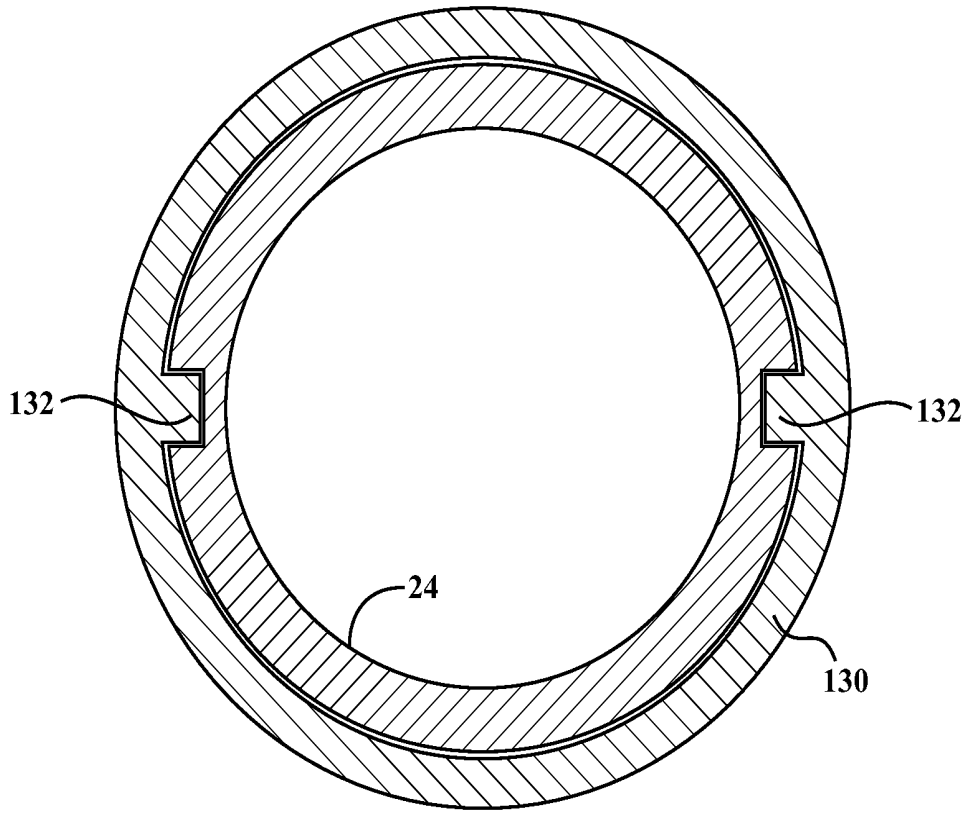
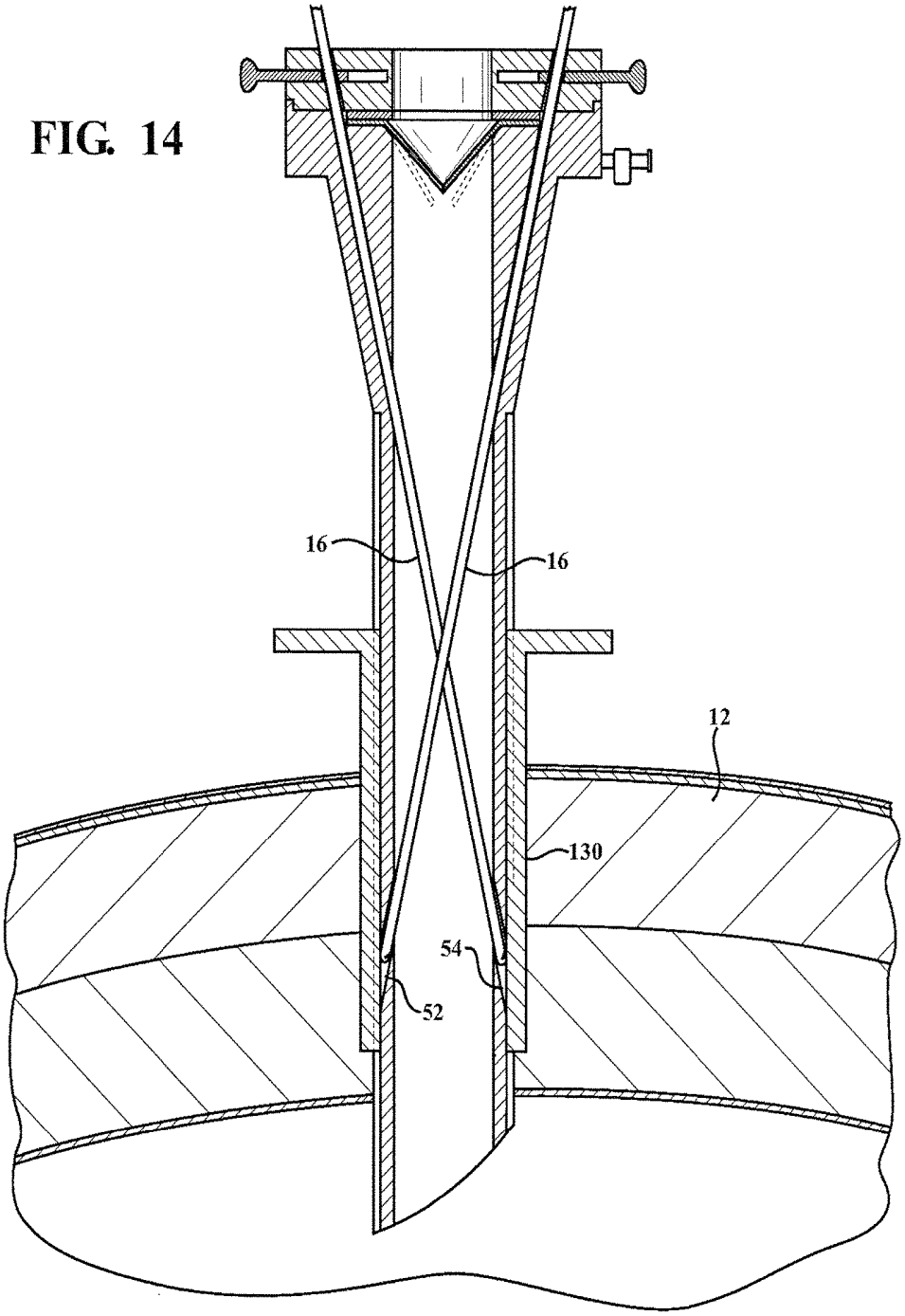



FIG. 13

FIG. 14



# LAPAROSCOPIC CANNULA WITH SUTURING PASSAGE CUTOFF

## CROSS-REFERENCE TO RELATED APPLICATIONS

This application is a continuation-in-part of U.S. patent application Ser. No. 13/984,240 filed Feb. 19, 2014, which is the U.S. national stage of PCT/US2012/025373 filed Feb. 16, 2012, which claims priority of U.S. Provisional Patent Application No. 61/443,286 filed Feb. 16, 2011, and claims the benefit of priority of U.S. Provisional Patent Application No. 62/090,953 filed Dec. 12, 2014, the contents of which are incorporated herein by reference.

## FIELD OF THE INVENTION

This invention relates to cannulas and accessories for use in laparoscopic surgery and more particularly to a cannula enabling suturing of a laparoscopic incision.

## BACKGROUND OF THE INVENTION

In the performance of a laparoscopic operation, an incision is first made through the body wall into a body cavity typically using a trocar, an elongated tube having a three point sharpened distal end. The trocar is often supported in a cannula, a shorter tube which passes into the incision made by the trocar and lines the wall of the incision, providing a port for entry into the incision. Various laparoscopic instruments such as oculars, cameras, or instruments similar to scissors or pliers may be introduced into the incision through the cannula to perform the necessary operation. The cannula also typically includes a port for receiving gas which may be introduced into the body cavity through the incision to inflate the cavity to increase the accessibility of the surgical site.

In typical laparoscopic procedures with most existing laparoscopic instruments, in order to close the incision and suture any cuts made in the cavity, it is necessary to remove the cannula, deflating the surgical cavity, and introduce a new suture guide which may have ports for needles connected to sutures for closing the incision. Other newer suturing devices do not require the removal of the cannula in order to introduce suturing devices, in that the suturing device itself is inserted through the center of the initial cannula. These suturing devices are cost prohibitive. Accordingly, after the suture carrying cannula or the suturing device is introduced, it is typically necessary to reinsufflate the body cavity.

## SUMMARY OF THE INVENTION

The present invention is directed toward a single laparoscopic tool which allows a surgeon to make an incision; enter a body cavity; inflate the cavity; perform an operation through the cannula of the tool, which serves as a port, along with other instruments inserted through additional ports; and then close the incision through the same cannula with a suture carried by one or more needles passed through passages formed through the wall of the cannula. Therefore, the entire operation from incision to suturing can be performed with a single cannula, substantially simplifying the operative process relative to previous laparoscopic techniques.

In a preferred embodiment of the invention, which will be subsequently described in detail, a generally cylindrical cannula has a laterally enlarged section at its proximal end, which end lies externally of an incision, containing one or a pair of inclined passages for receiving suture needles passing through the side walls of the cannula, where they allow the needles to enter the interior volume of the tubular section of the cannula. In the two needle version, needles inserted into these inclined passages from the proximal end cross one another, with slight lateral separation, approximately midway through the length of the tubular section of the cannula. Another pair of passages in the opposed side walls of the tubular section of the cannula are formed near the distal end and align with the two passages at the proximal end so that a suturing needle passed into the top of the cannula through one of the inclined passages extends across the width of the tubular section and can exit the cannula at one of the two distal passages.

Shortly beyond the proximal end of the cannula, each of the inclined passages passes through manually actuable valves which may be opened to allow the needles to pass through them and may be closed when the needles are removed to prevent the escape of the insufflating gases which have been passed through the cannula and into the body cavity.

A gas conduit controlled by a valve preferably feeds into one of the inclined passages at the proximal end of the cannula, when there is no needle in that passage, to allow inflation of the body cavity to provide clearance for the surgical operation. The proximal end of the tubular passage through the cannula carries a flap valve near its upper end which closes under the pressure of insufflating gases to prevent the escape of the gases through the proximal end of the cannula port.

The suturing needles used with the present invention must pass through a portion of the body wall section when they exit through the distal passages through the cannula wall so that the sutures can engage and bring together portions of the body cavity on opposed sides of the cannula in order to close off the incision. Accordingly, the suture needles must have the ability to cut through the cavity wall. The suture needles are accordingly formed with a central cylindrical section which has a blunt distal end with a suture-engaging configuration. The proximal end of the suture needle is disposed within a handle where it is engaged by a compression spring which biases the cylindrical section toward an extended position from the handle. The cylindrical section is surrounded by a sheath which has a pointed distal end capable of cutting through tissue. The proximal end of the cutting sheath is fixed to the handle. When the blunt end of the tubular section is unobstructed, the spring bias causes it to extend beyond the end of the cutting sheath. When the needle is pressed against the body wall, the blunt end of the tubular section is forced against the spring bias and the pointed end of the cutting sheath extends downwardly into the tissue so that upon further pressure on the handle of the needle it cuts through the tissue, outside of the wall of the body cavity, so that a suture carried by the distal end of the needle is within the body cavity. The free end of the suture within the body cavity is then grasped by a pliers-like tool introduced into the body cavity from another port and manipulated by the surgeon using an endoscope, introduced through still another port, to view the interior of the body cavity.

A second suturing needle is then introduced through the other cavity in the cannula so that it pierces the tissue of the body cavity at a point displaced from the point of entrance into the cavity of the first suturing needle. The pliers-like tool may be used to join the free end of the suture to the

distal end of the second needle. The second needle is then pulled back through the cannula to the exterior of the body cavity where the two ends of the suture may be knotted to secure the incision.

In one alternative embodiment of the invention, the cannula has only a single inclined passage for a suture needle which is used to carry a suture into the body cavity. The free end of the suture within the body cavity may then be grasped by an instrument introduced through a second port and detached from the needle. The entire cannula may then be rotated about its central axis while in the incision so that the suture may be reinserted on the needle end and drawn through the cannula passage, allowing the two ends of the suture to be knotted to close the incision. The two passage embodiment avoids the need to rotate the cannula within the cavity which may induce bleeding from the incision.

The insufflating gas used in laparoscopic operations is typically $CO_2$ because it is so easily absorbed in the body tissues and leaves no residue. The $CO_2$ may be combined with other similarly absorbable gases. Because of the high absorbability of the $CO_2$ in body tissues, a constant supply of the gas must be fed into the body cavity during the operation to maintain insufflation of the body cavity. In situations in which the distal exit cavities of the suturing needles from the cannula are located within the abdominal wall, rather than within the cavity itself, there is a possibility of $CO_2$ in liquids seeping into the tissue under pressure, causing subcutaneous emphysemas or other undesirable side effects.

In another alternative embodiment of the invention, in order to prevent the seepage of the gases into the tissues, a tubular sleeve is supported on the outer diameter of the cannula in such a way that it may be moved, typically manually, between a first position in which it covers the exit ports of the needle passages in the cannula to prevent the inflating gases from being introduced into the body tissue, and a second position, closer to the proximal end of the cannula, in which the sleeve does not extend over the outlet ports and allows the suturing needles to be introduced. Longitudinally extending tongues projecting from the opposed inner surfaces of the sleeve ride in longitudinal grooves formed in opposed sides of the cannula to guide the sleeve.

## BRIEF DESCRIPTION OF THE DRAWINGS

Other objects, advantages, and applications of the present invention will be made apparent by the following detailed description of preferred embodiments of the invention. The description makes reference to the accompanying drawings in which:

FIGS. **1-5** all represent sections through the wall of a body cavity in which the first embodiment of the cannula of the present invention has been inserted and the sequential steps employed in performing suturing of the wall of the body cavity using the cannula and the suturing needles of the present invention;

FIG. **6** is a cross-sectional view of the cannula of the present invention illustrating the paths of the two suturing needles in phantom lines;

FIG. **7** is a cross section through the drawing of FIG. **6**, taken along line **7-7**, illustrating the relationship of the two suturing needles as they pass through the barrel of the cannula;

FIG. **8** is a sectional view, partially broken away, of the suturing needle of the present invention;

FIG. **9** illustrates the cutting end of an alternative form of suturing needle;

FIG. **10** is a cross-sectional view of the first embodiment of the cannula of the present invention with a trocar inserted into the barrel of the cannula;

FIG. **11** is a cross-sectional view of a second embodiment of the cannula of the present invention with a trocar inserted into the barrel of the cannula;

FIG. **12** is a sectional view of an alternative form of my invention with a sliding sleeve to close the outputs of the needle passages when they are not accommodating needles;

FIG. **13** is a section through the cannula and sleeve along section **1**A of FIG. **12**; and

FIG. **14** is a view similar to FIG. **12** showing the sleeve blocking the exit ports of the needle passages.

## DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS OF THE INVENTION

FIGS. **1-5** illustrate a first embodiment of a cannula, generally indicated at **10**, disposed in an operating position within a wall, generally indicated at **12**, of a body cavity **14**. These drawings illustrate the sequence of operations in utilizing the cannula **10** and a pair of suture needles **16** to close the incision in the body wall **12** required to position the cannula **10** with its proximal end **18** externally of the body cavity and its distal end **20** within the body cavity.

The cannula **10**, illustrated in cross section in FIGS. **6** and **7**, includes a tubular section **22** of somewhat greater length than the body wall **12** so it may extend through the body wall with its lower end **20** in the underlying body cavity **14**. The tubular section **22** is formed with serrations **24** on its surface to firmly secure it within the body wall **12**.

At the proximal end of the cannula **10** the side walls of the cannula flare outwardly in a section **26** so that the width of the cannula on the proximal side of the tubular section **24** has a greater width than the balance of the tubular section.

At the extreme proximal end of the cannula **10** the walls extend laterally in a section **30** and a top member **32** is connected to the proximal end of the section **30** with a gasket **34** between them. The gasket **34** has a central hole which allows the continuation of the interior wall **36** of the tubular section **22** to extend the full length of the trocar **20**, as is best seen in FIG. **6**. A second gasket **38** is disposed directly beneath the gasket **34**. The gasket **38** has a pair of wall sections **40** and **42** at its center which act as a flap valve. In FIG. **6** the flap valve sections **40** and **42** illustrated in full line are shown closed and in dotted lines **44** are shown in an open position. The flap sections **44** are normally in the open position but when gas pressure is experienced on their distal side they are forced into the closed position of the full lines **40**, **42**.

As shown in FIG. **6**, a pair of inclined suture cavities **48** and **50** are formed through the sections **26**, **30** and **32**. Their proximal ends open at the top of the section **32** and the lower ends of these passages **48** and **50** merge with the tubular interior **36** of the trocar at the distal end of the wall section **26**. The passages **48** and **50** are adapted to receive two suture needles **16** which pass through the trocar **10** in the manner illustrated in the dotted lines in FIGS. **2**, **4** and **6**. The distal ends of the suture needles **16** pass through the side walls of the tubular section **22** of the trocar at a pair of slots in the side wall **52** and **54**.

As is best seen in FIG. **7**, the proximal passages **48** and **50** for the suture needles and the distal passages **52** and **54** are slightly separated laterally so that the two needles do not interfere with one another at the cross section **7-7** of FIG. **6**.

The needles **16** are illustrated in detail in FIG. **8**. The two suture needles are substantially identical. They each have a handle **66** at the proximal end and a cylindrical straight needle **68** having its proximal end within the handle **66** bearing against a compression spring **70**. The compression spring biases the needle cylinder **68** toward an extended position from the handle. The lower end of the needle **68** has a blunt end **72** and a side slot **74** adapted to capture a suture. The outer side of the tubular inner member **68** is surrounded by a tubular sheath **76** which has its proximal end fixed with respect to the handle **66** in such a manner that it is not subjected to the biasing action of the spring **70**. The distal end of the sheath **76** terminates in a sharpened cutting edge **78**.

When the suture needle **16** is manually pressed downwardly against a resistive surface such as the tissue of the body cavity **12**, the blunt end **72** forces the tube **68** to move upwardly within the handle compressing the spring **70** until the cutting tip **78** of the outer sheath **76** extends beyond the end **72** of the tube **68** and begins to penetrate the body tissue. When the cutting edge **78** has passed through the wall **12** into the body cavity **14**, there is no longer any pressure on the end **72** and it extends beyond the cutting tip **78** under the spring bias, so that the cutting tip **78** will not contact the interior body organs.

FIG. **9** illustrates an alternative form for the end of the tube **68**. Rather than having the edge configuration **74**, a hole **82** connected to the bottom of the needle **68** by passage **84** is employed. The suture may be forced through the narrow neck of the passage **84** into the hole **82** to retain the suture.

FIG. **10** illustrates a preferred manner of performing an incision through the body wall **12** so that the cannula **10** may line the incision and act as a port for the insertion of various laparoscopic instruments such as endoscopes, surgical cutters, and the like.

The cannula generally indicated at **120** in FIG. **11** represents an alternative embodiment having only a single inclined passage **122** for a suture needle. Otherwise, it is the same as the two passage embodiment and is similarly numbered. Accordingly, after a suture has been introduced to the body cavity **14** through the single passage, it must be grasped by an instrument **112** introduced through a second port and freed from the needle. The cannula **20** is rotated by 90 degrees about its central axis within the incision. The instrument **112** then reattaches the suture to the needle and the needle and attached suture are withdrawn through the trocar and the two ends of the suture are knotted to close the incision.

To start the incision a surgeon will use a scalpel to make a small cut through the outer edge of the body wall **12** and then will bring the slanted end **20** of the cannula **10** or **110** into contact with the incision. A trocar **90** (FIG. **10**) is then inserted through the central passage **36** of the cannula **110**. The trocar has a handle **92** at its proximal end and a sharpened cutter **94** at its distal end. By pressure imposed on the handle **92**, the trocar **94** will be forced through the body wall to form the laparoscopic incision. When the trocar end **94** is passed into the body cavity **14**, the cannula **10** is pressed down through the incision and the trocar is withdrawn.

The proximal ends of the two suture needle passages **48** and **50** in the cannula **10** are controlled by two valves **101** and **102**. These valves may be pushbutton valves or rotatable valves and they may be moved between a position in which the passages **48** and **50** are closed and positions wherein they are open to allow the entry of suture needles **16**. After the incision is made, with the valves **101** and **102** closed off, valve **106** which is connected to a source of inflating gas, preferably $CO_2$, is opened to feed $CO_2$ gas into the passage **50** leading to the interior volume **36** of the cannula **10** and into the body cavity **14**. The $CO_2$ inflates the body cavity to enlarge its area and provide the surgeon with increased operating room. After the cavity **14** is filled and inflated, the valve **106** is closed off.

The cannula **10** is then ready for use as a port for the performance of a laparoscopic operation and various devices such as an endoscope, a surgical cutter, and the like may be passed through the port.

The surgeon will typically create one or more additional ports at spaced points on the outer surface of the body tissue so that various operations may be performed through certain of the ports under a physician's observation through an endoscope in an additional port.

After the laparoscopic operation is completed, it is necessary to suture the incisions used to form the ports. This is generally done in the sequence illustrated by FIGS. **1-5** using the two needle trocar. First, a suture **100** is connected to the distal end of a suture needle **16**, one of the valves **101** or **102** is opened, and the needle is passed through that valve and through the interior of the cannula and out one of the exit ports **52** or **54**, cutting passages through the body tissue on the distal side of the passages **52** or **54**. This brings one end of the suture **110** into the body cavity **14** as illustrated in FIG. **2**.

Next, as illustrated in FIG. **3**, the free end of the suture is grasped by an instrument **112** which is introduced through another port (not shown) into the incision. The instrument **112** removes the suture from the end of the needle and the needle may then be withdrawn from the cannula and its entry valve closed, or it may be left within the cannula. Then, as illustrated in FIG. **4**, a second needle, or the same one that inserted the suture into the body cavity, if it has been removed, is inserted into the cavity through the opposite inclined passage used for the first insertion. The instrument **112** is manipulated to engage the free end of the suture with the suture engaging formation either **74** or **82** at the end of this needle within the incision and, as shown in FIG. **5**, the free end of the incision is pulled back through the passage occupied by the suture needle so that both free ends of the suture extend out of the proximal section **18** of the cannula. The cannula may then be removed and the suture knotted to close up the incision.

The cannula **10** may be removed from the incision at any time after the operation is completed. During the execution of the operation there is no need to lose the insufflating gas pressure so that the incision needs to be reinflated and the cannula **10** acts as a port for use in the entire operation.

Another embodiment of the invention is illustrated in FIG. **12** which is directed toward avoiding the danger of the insufflating gas, which maintains the gas pressure in the body cavity during the procedure despite losses of the gas by being absorbed in the body tissue flowing out the ports **52** and **54** into the tissue of the cavity wall **12**. This could cause subcutaneous emphysema or other undesirable effects. This is not a problem if the ports are within the body cavity **14**, but is a danger if the needle outlet ports fall within the thickness of the body wall over the cavity.

Accordingly, a tubular sleeve **130** of a thin but rigid material, such as stainless steel or plastic, surrounds the lower section of the cannula wall **24**. As disclosed in the cross section **13-13** through the sleeve **130** and the wall **24**, in this embodiment the lower, tubular section of the cannula wall **24** is formed with a pair of longitudinal slots on diametrically opposed points. The tubular sleeve **130** is

formed with complementary tongue members **132** that extend into the slots. Through a radially outward handle member **134** formed at the top of the sleeve **130**, the sleeve may be manually moved by the surgeon between an upper position illustrated in FIG. **12**, wherein its lower end is above the outlet ports **52** and **54** allowing the lower ends of the needles **16** to project out of the ports and a lowered position, illustrated in FIG. **14**, in which the lower ends of the tube **130** block the exit ports so that the insufflation gases cannot penetrate the cavity wall **12**. When the needles **16** project through the outlet ports **52** and **54**, as illustrated in FIG. **12**, they block the flow of insufflation gases through the ports. In a further embodiment, the blocking member is formed of a sheet of metal or plastic.

Having thus disclosed my invention I claim:

**1**. A cannula for use in laparoscopic surgery performed through a wall of a body cavity, the cannula comprising:

an elongated tubular section having a tubular section proximal end, a tubular section distal end, and a wall, the wall having an interior surface defining an interior of the tubular section and an exterior surface, the tubular section open at both the proximal and distal ends and having a central axis;

a first passage through the wall of the tubular section, inclined with respect to the central axis, the first passage comprising a first opening through the wall of the tubular section at a position adjacent the proximal end of the tubular section, and a second opening through the wall of the tubular section adjacent to the distal end of the tubular section at a position on the tubular wall diametrically opposed to the position of the first opening, the first and second openings being aligned so that a first straight suture needle may be passed through both the first and second openings with a section of the needle intermediate the first and second openings transversing an interior of the tubular section at an angle of inclination to said central axis, and with a distal end of the needle projecting out of the second opening and through the wall of the body cavity; and

a blocking member having a blocking member proximal end and a blocking member distal end, the blocking member slidably supported on the elongated tubular section for motion along said exterior surface of the wall of the tubular section between a first position in which the blocking member blocks flow of gases through said second opening and a second position clear of said second opening allowing passage of said first straight suture needle through said second opening, wherein the blocking member distal end is spaced apart from the distal end of the tubular section and is located proximal to the second opening when the blocking member is in said second position.

**2**. The cannula of claim **1**, wherein said blocking member comprises a tubular sleeve surrounding the tubular section of the cannula.

**3**. The cannula of claim **2**, where the blocking member is formed of a sheet of metal.

**4**. The cannula of claim **2**, where the blocking member is formed of sheet plastic.

**5**. The cannula of claim **1**, wherein the blocking member carries a projection extending radially outward relative to the central axis of the tubular section for use in movement of the blocking member between its first and second positions.

**6**. The cannula of claim **1**, wherein a pair of grooves extend parallel to said central axis on diametrically opposed sections of the exterior surface of the tubular section and the blocking member comprises a pair of inward radially extending tongue members adapted to ride in said grooves.

**7**. The cannula of claim **1**, further including a second passage through the wall of the tubular section at a position diametrically opposed to the first passage, the second passage being inclined with respect to the central axis of the tubular section at an angle complementary to the angle of inclination of the first passage, so that extensions of the first and second passages cross one another at a position in a central region of the tubular section; whereby said first straight needle may be passed through the first passage and a second straight needle may be passed through the second passage, exiting the tubular section through a third opening radially opposite to said second opening and said blocking member, when in its first position, blocks the flow of gases through both said second opening and said third opening.

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| 优先权 | PCT/US2012/025373 2012-02-06 WO<br>61/443286 2011-02-16 US<br>62/090953 2014-12-12 US | | |
| 其他公开文献 | US20150238184A1 | | |
| 外部链接 | Espacenet USPTO | | |


摘要(译)

用于腹腔镜手术的套管具有中心通道，该中央通道可以接受套管针以在体壁中形成腹腔镜切口至内体腔。然后将套管的管状部分压入切口以形成端口。管状部分具有穿过其壁的通道，用于缝合针和用于吹入气体的源。管状套管可滑动地支撑在管状套管的外侧上，用于在没有针通道出口的升高位置和阻塞出口的降低位置之间移动，以防止注入气体进入体壁。