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Incision-less laparoscopic instrument

Stuart Hart

Susana Lai-Yuen

Erin Moree

James Doulgeris

Benjamin T. Nelson

See next page for additional authors

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Authors

Stuart Hart, Susana Lai-Yuen, Erin Moree, James Doulgeris, Benjamin T. Nelson, Graham Roach, and Brandon Kruse



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Hart et al.

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- (54) **INCISION-LESS LAPAROSCOPIC INSTRUMENT**
- (71) Applicant: **University of South Florida**, Tampa, FL (US)
- (72) Inventors: **Stuart Hart**, Tampa, FL (US); **Susana Lai-Yuen**, Tampa, FL (US); **Erin Moree**, Tampa, FL (US); **James Doulgeris**, Oldsmar, FL (US); **Benjamin Taylor Nelson**, Tampa, FL (US); **Graham Roach**, San Antonio, TX (US); **Brandon Kruse**, Tampa, FL (US)
- (73) Assignee: **University of South Florida**, Tampa, FL (US)
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See application file for complete search history.

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Primary Examiner — David C Eastwood

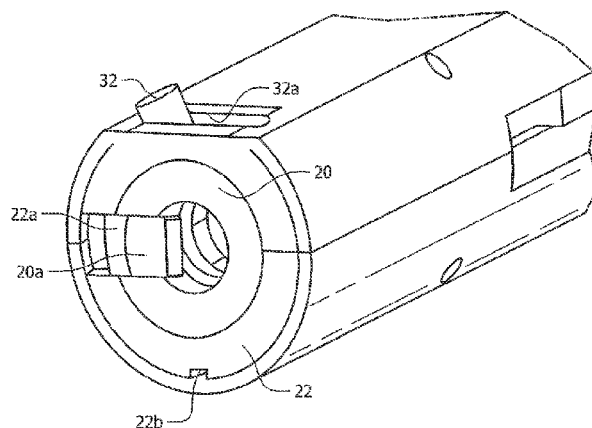
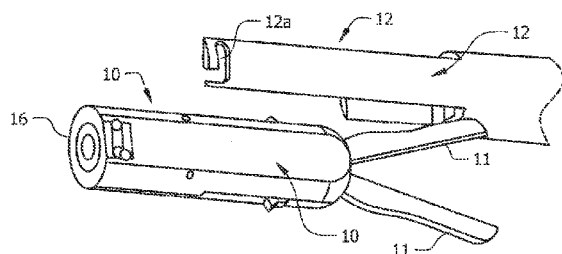
Assistant Examiner — Tin Nguyen

(74) *Attorney, Agent, or Firm* — Andriy Lytvyn; Smith & Hopen, P.A.

(57) **ABSTRACT**

A laparoscopic instrument is placed into the abdomen without the creation of a skin incision. The laparoscopic instrument includes a shaft that does not exceed 1.6 mm in diameter. The shaft has a beveled end and is inserted into an abdomen similar to the placement of a needle, without use of a scalpel. Operating instruments are introduced into the abdomen through the umbilical port using a docking device, and are then docked to the beveled end of the shaft after the shaft is introduced through the abdomen. Multiple types of operating instruments can be placed on the beveled end of the shaft during the surgical procedure. Each operating instrument is docked with a holster during introduction into and withdrawal from the umbilical port and is removed from the holster only when in use. When removed from the holster it is locked to the shaft and cannot be dropped.

6 Claims, 11 Drawing Sheets



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 (2013.01); *A61B 2017/00353* (2013.01); *A61B*
2017/00362 (2013.01); *A61B 2017/00464*
 (2013.01); *A61B 2017/00473* (2013.01); *A61B*
2017/00477 (2013.01); *A61B 2017/2931*
 (2013.01); *A61B 2017/3456* (2013.01)

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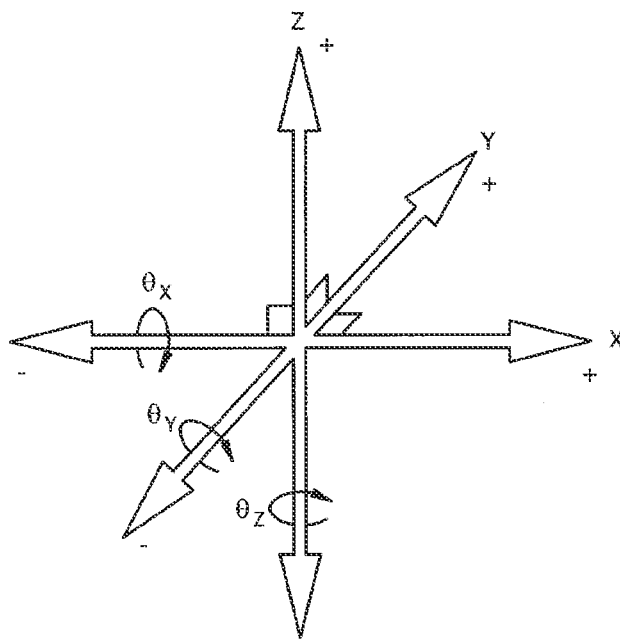


FIG. 1

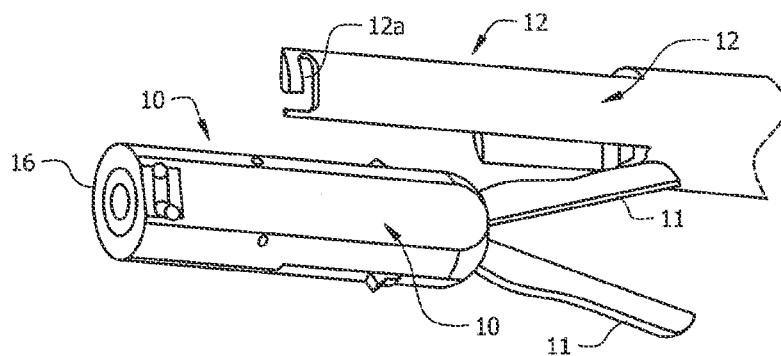


FIG. 2

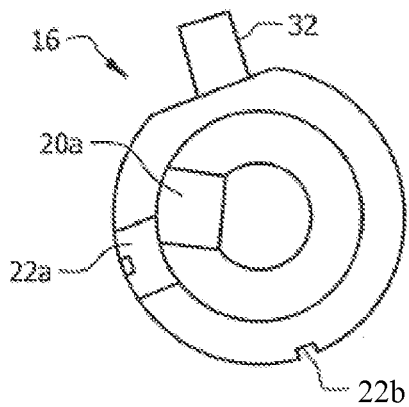


FIG. 3A

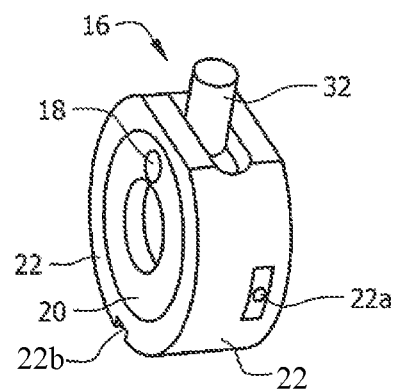


FIG. 3B

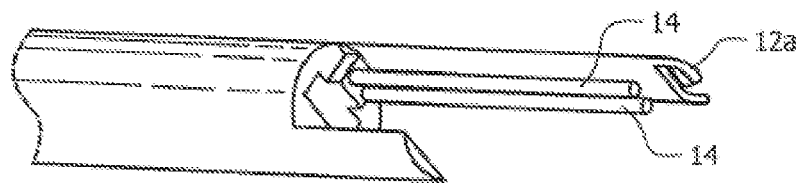


FIG. 4

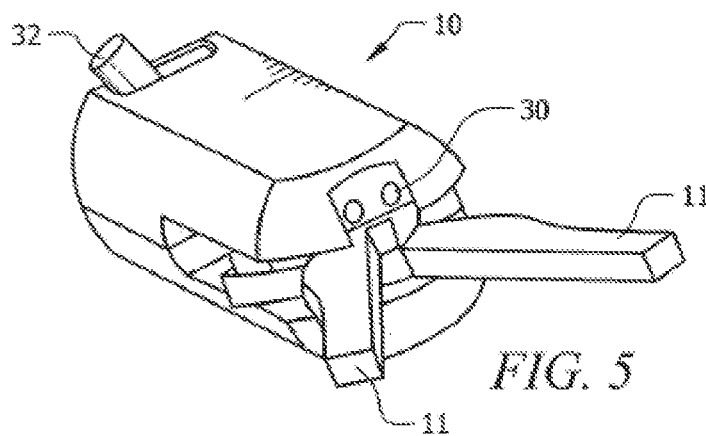


FIG. 5

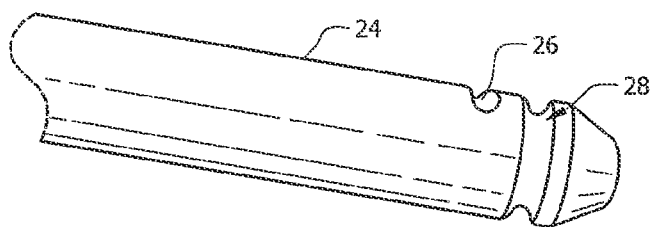


FIG. 6A

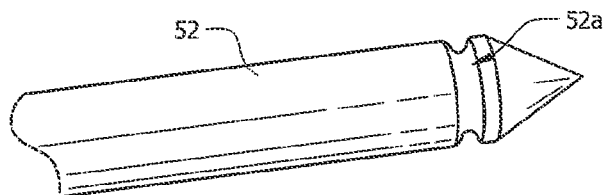


FIG. 6B

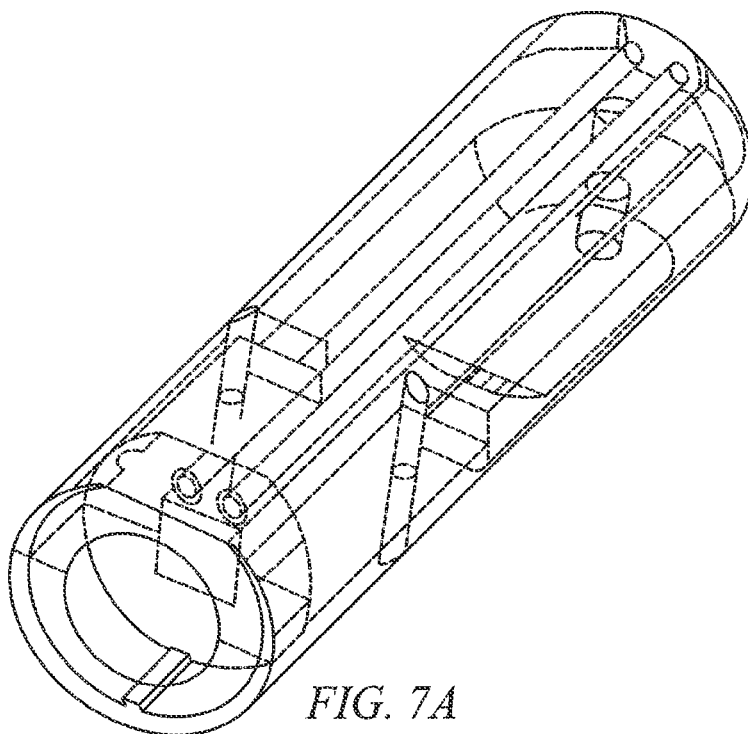


FIG. 7A

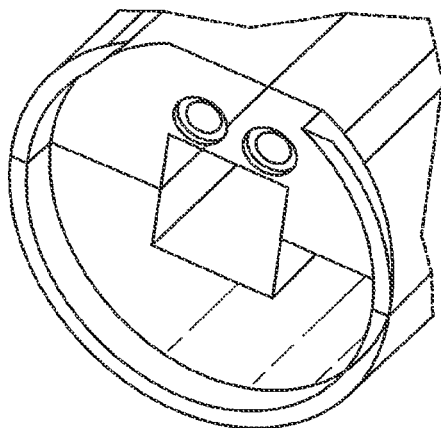


FIG. 7B

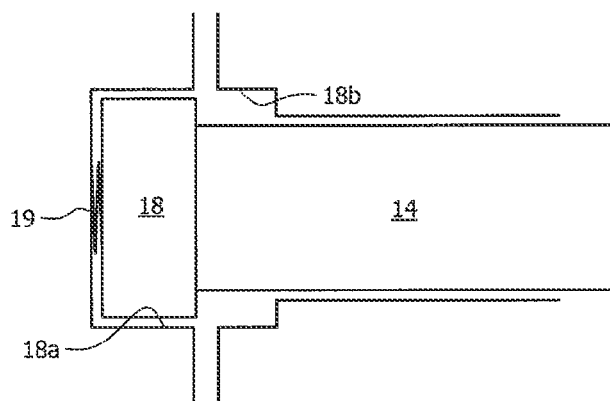


FIG. 7C

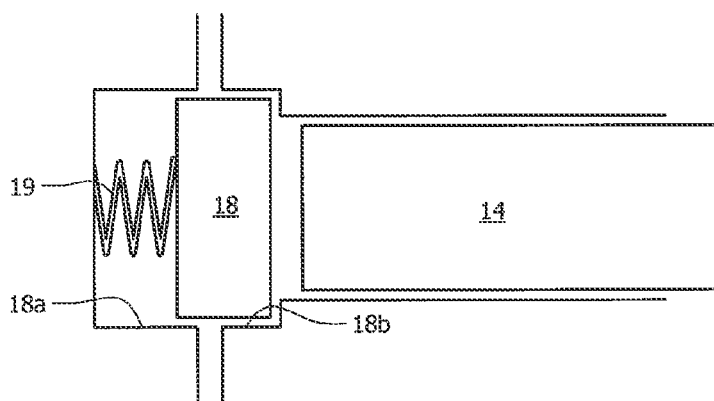
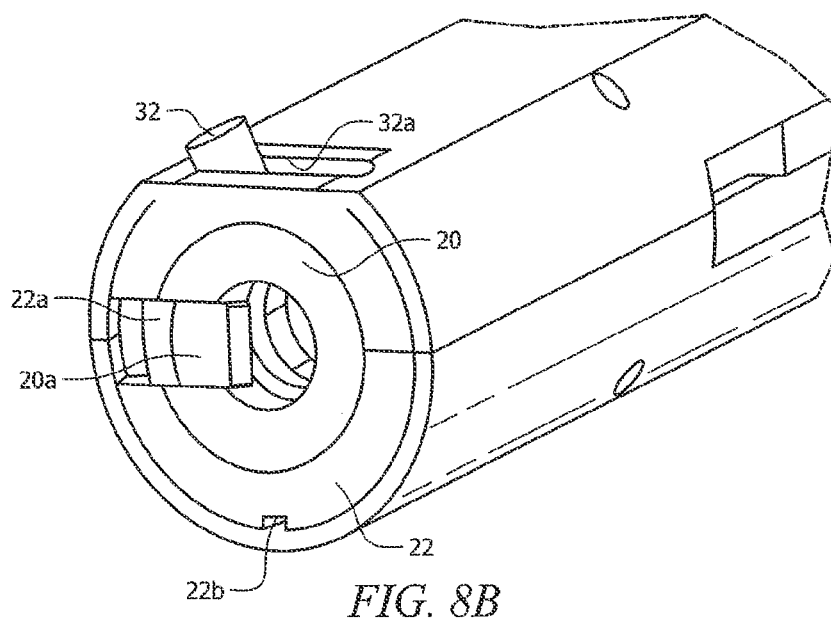
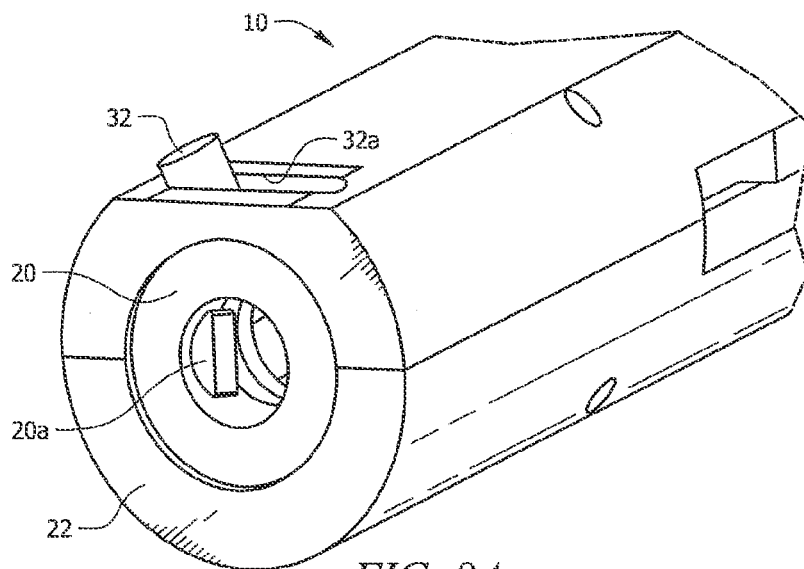


FIG. 7D



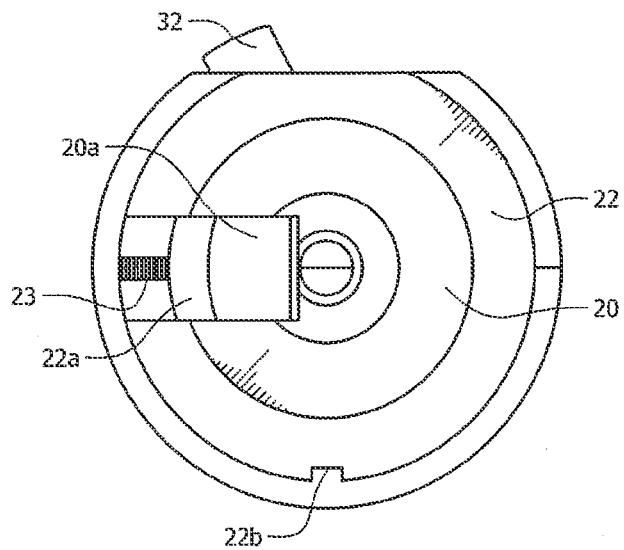


FIG. 8C

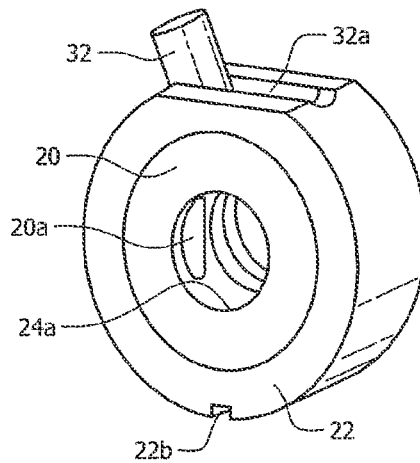


FIG. 9A

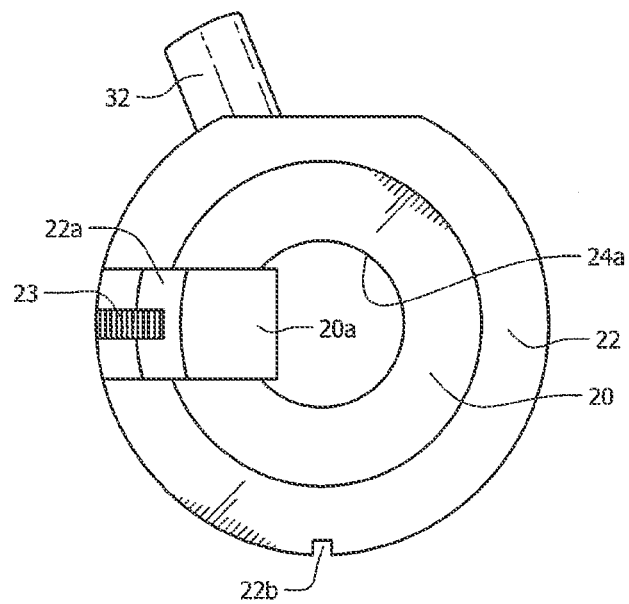


FIG. 9B

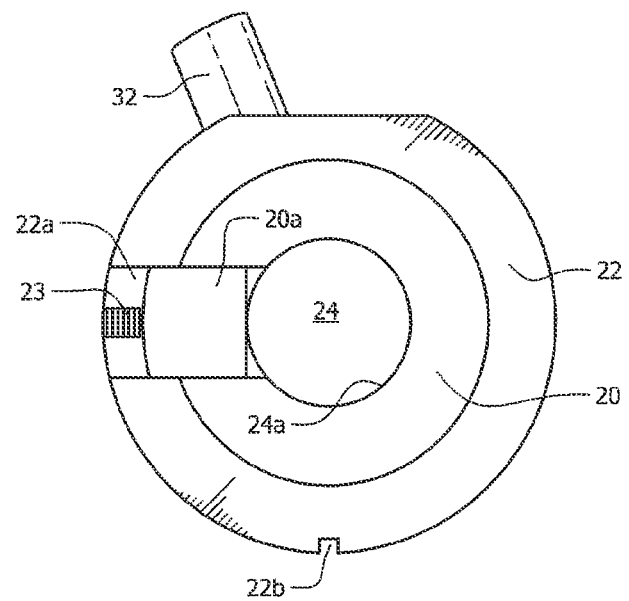


FIG. 9C

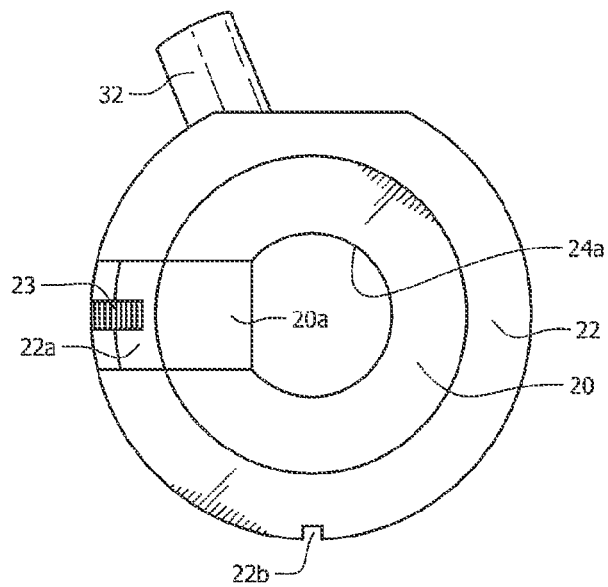


FIG. 9D

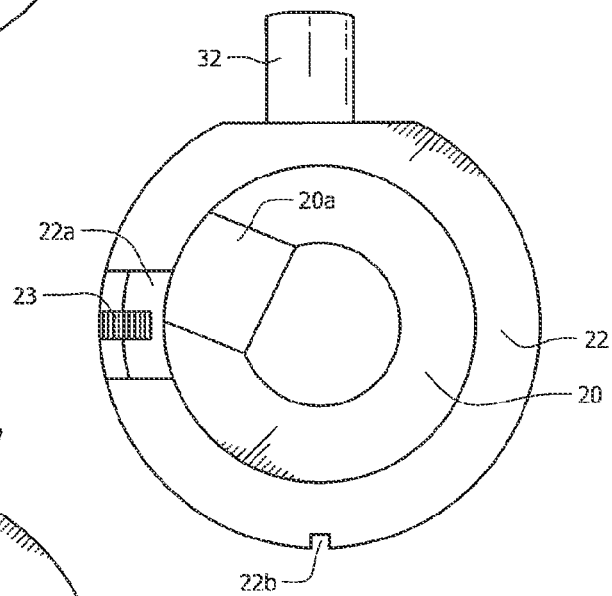


FIG. 9E

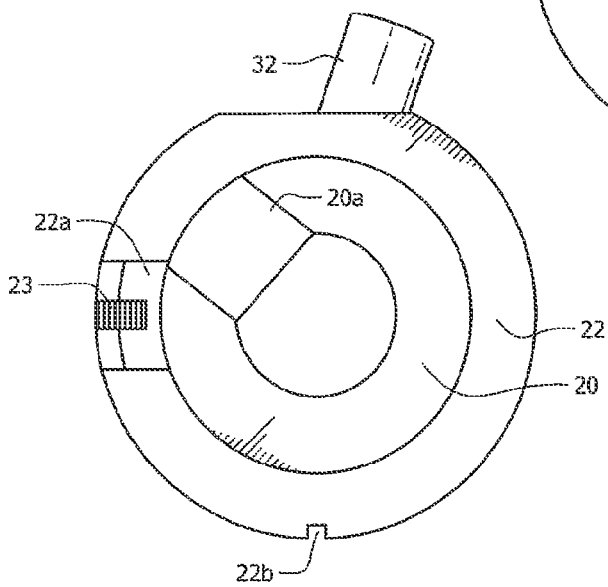
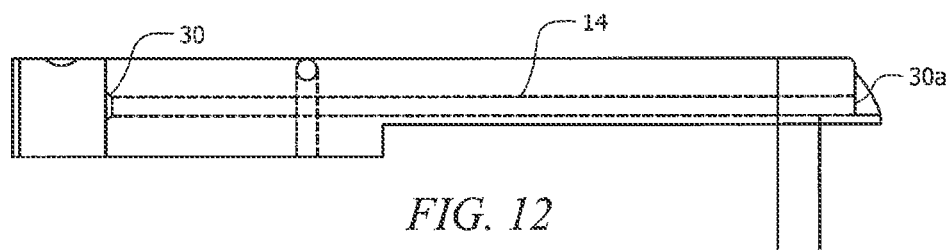
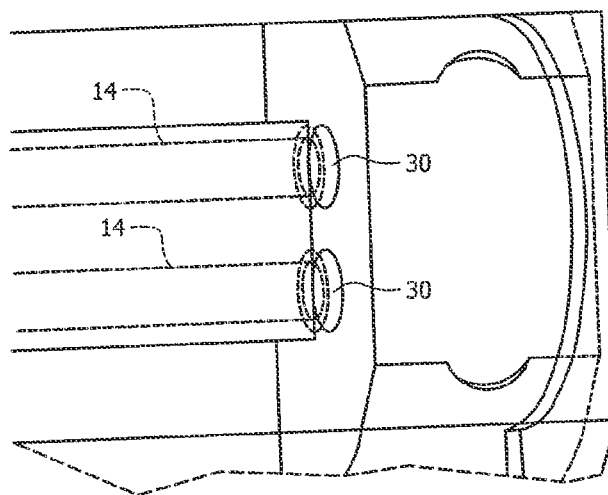
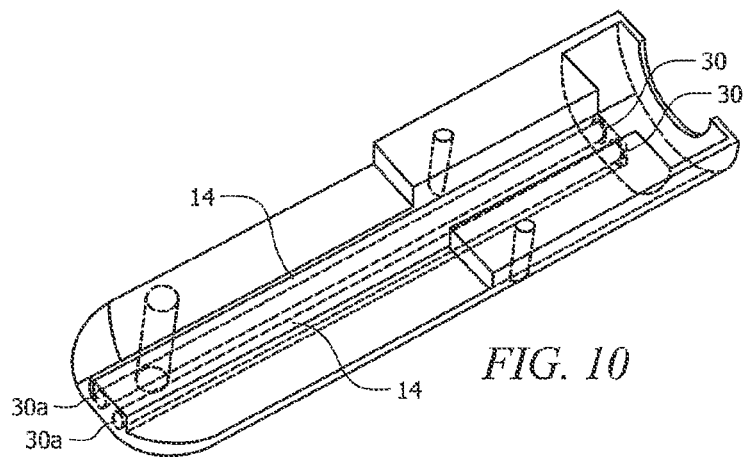


FIG. 9F



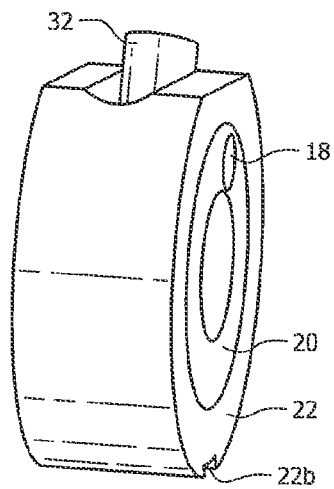


FIG. 13A

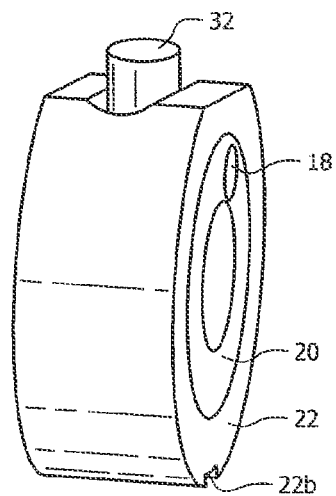


FIG. 13B

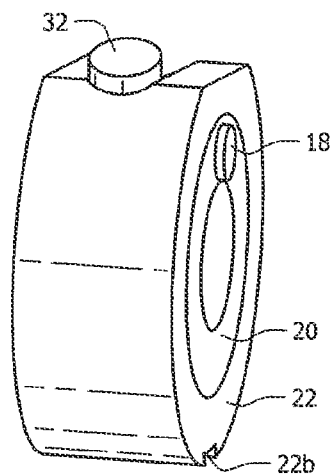


FIG. 13C

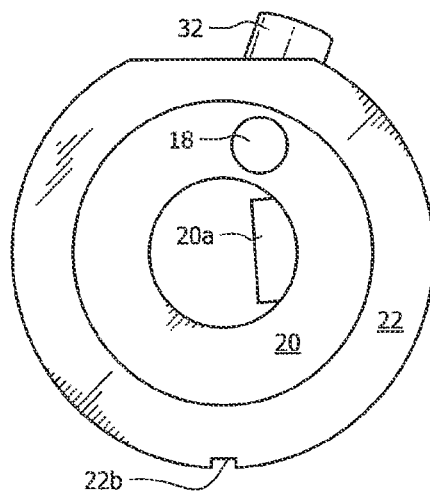


FIG. 14A

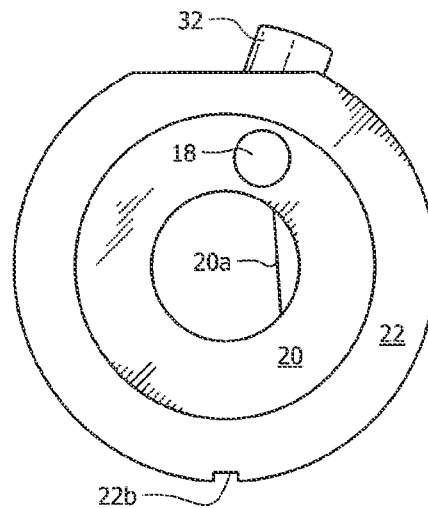


FIG. 14B

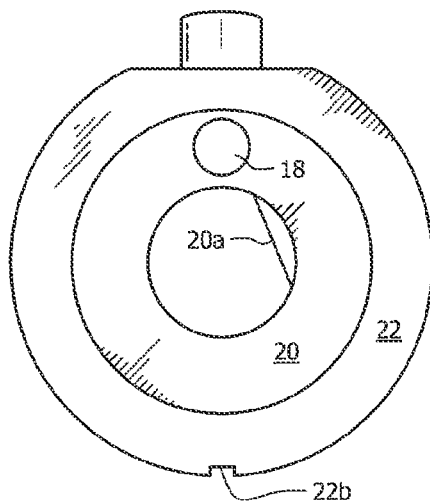


FIG. 14C

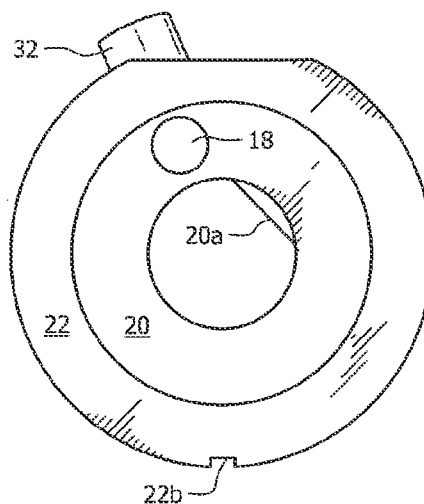


FIG. 14D

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INCISION-LESS LAPAROSCOPIC INSTRUMENT

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to the field of laparoscopic surgical devices.

2. Description of the Prior Art

Laparoscopic (minimally invasive) surgery has become the standard for performing numerous surgical procedures across various surgical specialties. Traditionally, an incision is made in the umbilicus for insertion of a port containing a camera device for visualization during laparoscopic surgery. Placement of laparoscopic instruments during laparoscopic surgery requires the creation of multiple skin incisions with a scalpel, and then placement of laparoscopic ports. Multiple laparoscopic instruments can then be passed through each laparoscopic port to perform the surgical procedure. Typically, laparoscopic ports range from five (5) to twelve millimeters (12 mm) in diameter, and leave an abdominal scar and contribute to post-operative pain. Usually, three to four laparoscopic ports are placed during traditional laparoscopic surgery.

Laparo-Endoscopic Single Site (LESS) surgery has been introduced as a means to perform minimally invasive surgery without noticeable abdominal incisions, and to improve post-operative pain. LESS surgery is performed entirely through a single incision in the umbilicus. This eliminates multiple incisions during laparoscopic surgery, but also creates many challenges. Since the surgery is performed entirely through a single umbilical incision, and the instruments are in close proximity to each other, the ability to manipulate instruments during the surgery is limited. This creates "sword fighting" in which the instruments constantly collide into each other during surgery, and contributes to inefficient surgical movements. There is also loss of triangulation, in which instruments are traditionally inserted into the abdomen at multiple different port sites and allows for easy manipulation of tissue since the angles of the instruments are varied. These challenges ultimately increase surgical operative time and reduce efficiency of the surgery.

Thus there is a need for a system that avoids instrument collision while still providing robust surgical devices. However, in view of the prior art considered as a whole at the time the present invention was made, it was not obvious to those of ordinary skill in the applicable art how such a system could be provided.

SUMMARY OF INVENTION

The novel laparoscopic instrument can be placed into an abdomen without the creation of a skin incision. The shaft of the laparoscopic instrument is 1.6 mm in diameter with a beveled end, resembling an intravenous needle. The beveled end is placed into the abdomen similar to the placement of a needle, without creation of a skin incision with a scalpel.

The operating instruments, such as graspers, cutting forceps or cautery instruments, are docked to the beveled end of the shaft after the shaft is placed into the abdomen. These operative instruments are introduced into the abdomen through the umbilical port using a docking device, and then docked to the beveled end of the shaft. When docking is completed, the docking device is removed and the surgical procedure is performed. Multiple types of instrument tips can be placed on the beveled end of the shaft during the surgical procedure using the docking device to engage and disengage

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the surgical instruments. At the end of the surgical procedure, the operative instruments are undocked and the 1.6 mm shaft is removed. This allows the surgeon to place multiple instruments, in any location, during the laparoscopic surgery, thus preserving triangulation and efficiency of the surgery without creating abdominal scars.

BRIEF DESCRIPTION OF THE DRAWINGS

For a fuller understanding of the invention, reference should be made to the following detailed description, taken in connection with the accompanying drawings, in which:

FIG. 1 depicts the six degrees of freedom of an unrestrained body;

FIG. 2 is an exploded perspective view of an operative instrument tip and holster;

FIG. 3A is a front elevational view of a locking mechanism;

FIG. 3B is a perspective view of the locking mechanism of FIG. 3A;

FIG. 4 is a perspective view of a holster key;

FIG. 5 is a perspective view of an operative instrument tip or cutting head;

FIG. 6A is a perspective view of the outer shaft;

FIG. 6B is a perspective view of the inner shaft;

FIG. 7A is a perspective view of the cutting head from the trailing end;

FIG. 7B is a perspective view of the cutting head from the leading end;

FIG. 7C is a schematic diagram of the face pin in its retracted configuration;

FIG. 7D is a schematic diagram of the face pin in its extended configuration;

FIG. 8A is a perspective view of the trailing end of the cutting head;

FIG. 8B is a partially cut-away view of the cutting head of FIG. 8A;

FIG. 8C is an end elevational view of the structure depicted in FIG. 8B;

FIG. 9A is a perspective view of the novel locking means in its position of repose;

FIG. 9B is an end view of the novel locking means in its position of repose;

FIG. 9C depicts the second position of the novel locking means;

FIG. 9D depicts the third position of the novel locking means;

FIG. 9E depicts the novel locking means in its fourth position;

FIG. 9F depicts the novel locking means in its fifth, locked position;

FIG. 10 is a perspective, cut-away view of the top half novel cutting head housing;

FIG. 11 is a top plan view of said top half of said cutting head housing;

FIG. 12 is a side elevational view of said top half of said cutting head housing;

FIG. 13A is a perspective view of the novel locking means in positions one, two and three;

FIG. 13B is a perspective view of the novel locking means in position four;

FIG. 13C is a perspective view of the novel locking means in position five;

FIG. 14A is an end view of the novel locking means in position one;

FIG. 14B is an end view of the novel locking means in position three;

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FIG. 14C is an end view of the novel locking means in position four; and

FIG. 14D is an end view of the novel locking means in position five.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

The present invention relates to a laparoscopic instrument that is placed into the abdomen at any preselected location without the creation of a skin incision. The shaft of the laparoscopic instrument is 1.6 mm in diameter with a beveled end that resembles an intravenous needle.

Selected operating instruments, such as graspers, cutting forceps or cautery instruments, having diameters that exceed 1.6 mm, are introduced into the abdomen through the umbilical port. The selected operating instrument is docked in a holster when it is introduced through said umbilical port. This prevents unwanted cutting or grasping of tissue, i.e., the operating instrument cannot be used until it is removed from the holster.

A novel locking or docking mechanism is positioned at the trailing end of the selected operating instrument and is engaged by the leading end of the laparoscopic instrument shaft. That shaft is hereinafter referred to as the outer shaft because it houses an inner shaft within its lumen and said inner shaft controls the opening and closing of the blades or graspers at the leading end of the selected operating instrument.

A predetermined surgical procedure is performed after the selected operating instrument is removed from the holster and said selected operating instrument is returned to the holster and locked therein when the surgical procedure is completed. The laparoscopic instrument is then disengaged from the locking mechanism and withdrawn from the abdomen. The selected operating instrument and its holster are withdrawn through said umbilical port.

Multiple types of instrument tips can be placed on the beveled end of the outer shaft during the surgical procedure using the docking device or locking mechanism to "dock" and "undock" the operating instruments. This allows the surgeon to place multiple instruments in any location during the laparoscopic surgery, thus preserving triangulation and efficiency of the surgery without creating abdominal scars.

To prevent an object from moving relative to another object, all degrees of freedom of motion must be constrained. An object with no constraints has six degrees of freedom (DOF) as depicted in FIG. 1: Translation along the X, Y, and Z axis, and rotation about the X, Y, and Z axis. Thus, for the operative instrument tip, all six of these DOF need to be constrained in order to lock the operative instrument tip onto the shaft.

The selected operating instrument locks onto the instrument outer shaft, restricting its movement on said outer shaft. It is impossible to drop the selected operating instrument because the docking and undocking of the selected operating instrument with the holster is performed by the same locking mechanism.

When operative instrument tip 10 having blades 11, also known as scissors or graspers, is docked inside holster 12 (FIG. 2), face pin depression pins 14 (FIG. 4) extend through operative instrument tip 10 to locking mechanism 16 at the trailing end of said operative instrument tip. Face pin depression pins 14 depress face pin 18 (FIG. 3) causing face pin 18 to be flush with inner lock ring 20. Face pin 18, when flush with inner lock ring 20, does not obstruct rotation of inner lock ring 20.

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Operative instrument tip 10 is hereinafter referred to as cutting head 10.

Inner lock ring 20 is circumscribed by outer lock ring 22 as depicted in FIGS. 3A and 3B. Keyway 22b formed in the outer periphery of outer lock ring 22 interlocks said outer lock ring to the housing of cutting head 10.

Outer shaft 24 (FIG. 6A) is inserted into locking mechanism 16 so that inner lock ring pin 20a (FIG. 3A) rests in lock groove 26 (FIG. 6) of outer shaft 24, and an O-ring, not depicted, associated with inner lock ring 20 is received within O-ring groove 28 (also FIG. 6A).

Inner shaft 52 (FIG. 6B) controls opening and closing of blades or graspers 11. Distal-to-proximal displacement of inner shaft 52 opens said blades or graspers and proximal-to-distal displacement closes them. The opposite effect can also be achieved by suitable mechanical linkages and all known linkages are within the scope of this invention.

Inner lock ring pin 20a and outer lock ring pin 22a of outer lock ring 22 are pushed into a position by outer shaft 24 that radially aligns them with one another. Lock ring pins 20a and 22a in said radially aligned position allow inner lock ring 20 to rotate inside outer lock ring 22 and keeps outer shaft 24 from sliding in and out.

By rotating outer shaft 24, inner lock ring 20 can rotate fully into position. This causes face pin 18 to align with face pin holes 30 (FIG. 5) and causes holster lock pin 32 to move into a position that is unlocked from holster 12. This is the refracted position of face pin 18. Outer shaft 24 is now locked onto cutting head 10 and can be removed from holster 12. Face pin 18 snaps back into place, i.e., into an extended configuration, when cutting head 10 is slightly removed from holster 12. When extended, face pin 18 prevents inner lock ring 20 from rotating inside cutting head 10.

Cutting head 10 is slid back onto holster 12 and outer shaft 24 is rotated fully in the counterclockwise direction to lock cutting head 10 back onto holster 12 and align lock ring pins 20a and 22a in radial alignment with one another when the surgical procedure is completed. Outer shaft 24 can be removed from cutting head 10 when lock ring pins 20a and 22a are radially aligned with one another.

A more detailed explanation of the above structure follows.

Cutting head 10 is depicted from its trailing and leading ends in FIGS. 7A and 7B, respectively. The hollow cylindrical space at the trailing end of said cutting head in FIG. 7A is occupied by locking mechanism 16. Face pin bores 30 receive the trailing ends of face pin depression pins 14 that urge face pin 18 into its retracted position when cutting head 10 is docked with holster 12. Face pin depression pins 14 enter into bores 30a (FIG. 7B) at the leading end of cutting head 10.

FIG. 7C depicts the retracted position of face pin 18 and FIG. 7B depicts the extended position of said face pin. Bias means 19 in the form of a compression spring is compressed when cutting head 10 is docked in holster 12 as depicted in FIG. 7A and said spring unloads and extends face pin 18 from face pin bore 18a when cutting head 10 is disconnected from said holster 12. When so extended, face pin 18 enters into bore 18b (FIG. 7C) formed in the trailing end of cutter head 12. Bore 18b is an enlargement of the bore or bores that extends between openings 30 and 30a. As depicted in FIG. 7D, the extended position of face pin 18 prevents relative rotation between inner ring 20 and cutting head 10 because the trailing end of face pin 18 is positioned within bore 18a formed in the leading side of inner ring 20 and the leading end of face pin 18 is positioned within bore 18b formed in the trailing end of cutting head 10.

FIG. 8A is a perspective view of the trailing end of cutting head 10, it being understood that cutting members 11 are

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positioned at the leading end thereof. FIG. 8B is a partially cut-away view of the cutting head of FIG. 8A, depicting the inner and outer locking pins 20a, 22a, respectively, in radial alignment with one another and in their respective radially innermost and locked positions. FIG. 8C is an end elevational view of the structure depicted in FIG. 8B, depicting spring 23 that urges said inner and outer lock pins in a radially inward direction when they are in alignment with one another.

FIGS. 9A and 9B depict the novel locking means in its position of repose in perspective view and end view, respectively. The locking means is locked in holster 12 but outer shaft 24 is not inserted therein. This is position No. 1: The rotation of inner ring 20 is prevented by outer lock pin 22a. Outer lock pin 22a is urged radially inwardly by lock pin spring 23 into inner lock pin 20 which is urged radially inwardly into shaft opening 24a.

FIG. 9C depicts the second position. As outer shaft 24 is inserted into opening 24a, said outer shaft pushes radially outwardly against inner lock pin 20a which presses radially outwardly against outer lock pin 22a, compressing lock pin spring 23. Rotation of inner lock ring 20 is prevented by inner lock pin 20a. As outer shaft 24 is inserted it pushes both lock pins 20a, 22a from their respective FIG. 9A positions, past the position in which they align with the inner and outer lock rings 20 and 22, and into position 2.

Position three is depicted in FIG. 9D. When outer shaft 24 is inserted to a sufficient extent, lock pin spring 23 urges inner lock pin 20a into square groove 24b of outer shaft 24. The depth of lock groove 24b is predetermined so that it allows lock pins 20a, 22a to align with lock rings 20, 22, respectively, thereby allowing inner lock ring 20 to rotate within outer lock ring 22.

FIG. 9E depicts the fourth position. Turning outer shaft 24 clockwise allows inner lock ring 20 to rotate within outer lock ring 22. Lock pins 20a, 22a are misaligned relative to one another when inner ring 20 is rotated and inner lock pin 20a cannot be pushed radially outwardly into the outer lock pin slot. Inner lock pin 20a is secured against the inner wall or lumen of outer lock ring 22 and shaft groove 24b and cannot move (except by rotating conjointly with inner lock ring 20) until it is again aligned with outer lock pin 22a.

FIG. 9F depicts the fifth position. This is the locked position. In this position holster lock knob 32 is captured within holster lock knob slot 12a (FIGS. 1 and 4) and cutting head 10 can be removed from holster 12. Holster lock knob 32 extends radially from inner ring 20 and rotates conjointly therewith.

When cutting head 10 is docked in holster 12, face pin 18 (FIG. 3B) is retracted into face pin bore 18a formed in the leading side of inner ring 20 by at least one face pin depression pin 14 as depicted in FIG. 7C.

The bore or bores that receive the face pin depression pin or pins are formed in the top half of the cutting head housing as depicted in FIGS. 7A, 7B, and 10. The trailing end of the bores is denoted 30 in FIGS. 7A, 11 and 12. The leading end of said bores is denoted 30a in FIGS. 7B, 10, and 12.

Inner lock pin 20a is securely held in between the inner wall or lumen of outer lock ring 22 and outer shaft groove 24b, which also prevents outer shaft 24 from being displaced axially in or out of cutting head 10. Inner lock ring 20 is locked into place by face pin 18, and outer shaft 24 is locked into place by inner lock pin 20a.

FIG. 10 is a perspective, cut-away view of the top half novel cutting head housing.

FIG. 11 is a top plan view of said top half of said cutting head housing.

FIG. 12 is a side elevational view of said top half of said cutting head housing.

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The embodiments disclosed herein provide a non-invasive surgical tool that is purely mechanical in nature.

The advantages set forth above, and those made apparent from the foregoing description, are efficiently attained. Since certain changes may be made in the above construction without departing from the scope of the invention, it is intended that all matters contained in the foregoing description or shown in the accompanying drawings shall be interpreted as illustrative and not in a limiting sense.

The following claims are intended to cover all of the generic and specific features of the invention herein disclosed, and all statements of the scope of the invention which, as a matter of language, might be said to fall therebetween.

What is claimed is:

1. An incision-less laparoscopic instrument, comprising:
 - an outer shaft having a diameter that does not exceed 1.6 mm;
 - said outer shaft having a beveled leading end resembling a beveled leading end of an intravenous needle, said beveled leading end of said outer shaft is adapted for insertion into tissue, thus requiring no incision and leaving no scar;
 - a cutting head having a leading end equipped with blades or graspers;
 - said cutting head having a cylindrical trailing end that defines a lumen;
 - a cylindrical locking mechanism positioned in said cylindrical trailing end, said locking mechanism comprising:
 - an inner ring and an outer ring;
 - said inner ring mounted within said outer ring;
 - said outer ring non-rotatably mounted within said cylindrical trailing end;
 - a radially-extending inner ring slot formed in said inner ring;
 - an inner ring locking pin slideably disposed within said inner ring slot;
 - a radially-extending outer ring slot formed in said outer ring;
 - an outer ring locking pin slideably disposed within said outer ring slot; and
 - a radially disposed bias means positioned between said lumen of said cylindrical trailing end and a radially outermost surface of said outer ring locking pin;
 - a holster for holding said cutting head when said cutting head is introduced through a patient's umbilical port and withdrawn through said umbilical port;
 - said leading end of said outer shaft releasably engaged to said cylindrical locking mechanism so that locking and unlocking of said cutting head to and from said holster is controlled by manipulation of said outer shaft.
2. The laparoscopic instrument of claim 1, further comprising:
 - said holster having a leading end and a trailing end;
 - a radially disposed holster lock pin mounted to said inner lock ring for conjoint rotation therewith; and
 - a cutting head slot formed in said trailing end of said cutting head to accommodate said holster lock pin.
3. The laparoscopic instrument of claim 2, further comprising:
 - a first face pin bore formed in a leading side of said inner lock ring;
 - a face pin bias means positioned in said first face pin bore;
 - a face pin disposed in said first face pin bore;
 - said face pin having a retracted position where said face pin bias means is compressed and said face pin is flush with said leading side of said inner lock ring;

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said face pin having an extended position where said face pin bias means is uncompressed and said face pin extends at least partially from said first face pin bore;

a face pin receiving bore formed in a trailing end of said cutter head for receiving said face pin when in said extended position;

said face pin preventing relative rotation between said inner ring and said cutting head when said face pin is in said extended position.

4. The laparoscopic tool of claim 3, further comprising:

a second face pin bore formed in said trailing end of said cutting head; and

said face pin extending into said second face pin bore when said face pin extends at least partially from said first face pin bore, said extension of said face pin preventing relative rotation between said inner ring and said cutting head.

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5. The laparoscopic instrument of claim 4, further comprising:

at least one longitudinally-extending face pin depression pin mounted to said holster;

at least one elongate face pin depression pin bore formed in said cutting head;

said at least one face pin depression pin disposed in said at least one face pin depression pin bore when said cutting head is docked to said holster;

said face pin being in said retracted position when said cutting head is docked to said holster.

6. The laparoscopic instrument of claim 5, further comprising:

said holster having a holster lock pin-receiving slot formed in a trailing end thereof;

said holster lock pin-receiving slot receiving said holster lock pin when said face pin is in said retracted position.

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