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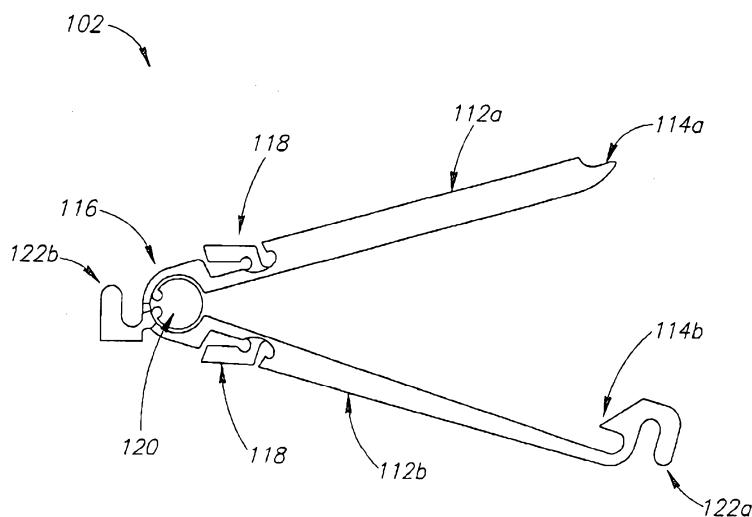


FIG.2A

(57) Abstract: A laparoscopic clip applier comprising multiple clips housed in a rigid sleeve, where the arms of the clips are oriented lengthwise in the sleeve, and a deployment mechanism for deploying the clips from a distal end of the sleeve via a perforation made by a needle provided with the distal end of the sleeve.

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## A LAPAROSCOPIC CLIP APPLIER

### **CROSS REFERENCE TO RELATED APPLICATIONS**

This application claims the benefit of U.S. Provisional Patent Application No. 5 61/879,256, filed September 18, 2013 and entitled "Laparoscopic Clip Applier", which is incorporated herein by reference in its entirety.

### **FIELD OF THE INVENTION**

The invention relates to the field of surgical clip application.

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### **BACKGROUND**

In order to operate on a given tissue or a blood vessel, surgeons must ligate or occlude nearby blood vessels to prevent patient blood loss. Surgeons employ small surgical clips and long cartridges within the clip applicators to ligate or occlude blood 15 vessels, or other tubular structures such as but not limited to cystic duct, uterine tubes, etc, in laparoscopic and endoscopic surgical procedures. These surgical clips need to perform multiple functions.

First, the surgical clip must be securely located on the blood vessel. Movement or slippage of the surgical clip on the vessel should be minimized or eliminated once the 20 clip has been applied. Second, the surgical clip should completely close the blood vessel to which it is applied. Movement or slippage of the surgical clip or failure to fully close a blood vessel may cause blood loss, a lethal drop in blood pressure, or result in a hematoma that may cause pressure on surrounding tissue, or local infection. Third, the surgical clip should be designed to minimize damage to the closed blood 25 vessel and surrounding tissue as much as possible. Surgical clips that cause tissue or blood vessel damage may result in internal bleeding, a lethal drop in blood pressure, infections, or longer recovery periods.

There are a variety of medical devices and procedures used for applying surgical 30 clips. Typically they require one or more surgical incisions, prolonging recovery and leading to potential complications, such as infections.

Laparoscopic surgery is an increasingly popular form of surgery. In laparoscopic surgery, several small incisions are made in the patient's abdomen and a tube, or a trocar, is inserted through each incision. These trocars often range in size between 5, 8, 10 and 12 mm in diameter. The surgical instruments, including staple or clip

applicators and extractors, are inserted through the trocars. Laparoscopic procedures generally require that any instrumentation inserted into the body be sealed, i.e., provisions must be made to ensure that gases do not enter or exit the body through the laparoscopic incision as, for example, in surgical procedures in which the surgical 5 region is insufflated. The incisions that are performed in order to introduce the trocars, may cause postoperative pain; prolonged recovery, and scars. Additionally, these incisions may result in local hernia, or weakness of abdominal wall and local infections.

The foregoing examples of the related art and limitations related therewith are 10 intended to be illustrative and not exclusive. Other limitations of the related art will become apparent to those of skill in the art upon a reading of the specification and a study of the figures.

## SUMMARY

15 The following embodiments and aspects thereof are described and illustrated in conjunction with systems, tools and methods which are meant to be exemplary and illustrative, not limiting in scope.

There is provided, in accordance with an embodiment, a laparoscopic clip 20 applier comprising: a handle, a rigid sleeve extending from the handle, multiple interconnected clips, each being normally-open by a proximal spring integral to the clip, where the clips are housed in the sleeve, and where the clips are provided with a self-locking mechanism at their distal end, and where each of the clips, when housed within the sleeve, is closed and unlocked, and a deployment mechanism operable by the handle and configured to: advance the clips towards a distal end of the sleeve, 25 thereby positioning a most distally-positioned clip of the clips for deployment by exposing the clip from the distal end of the sleeve, where the exposing causes the most distally-positioned clip to open, advance the sleeve relative to the exposed clip to close the exposed clip over a bodily tissue until the self-locking mechanism of the exposed clip engages, thereby deploying the exposed clip, and retract the sleeve relative to the exposed clip, thereby exposing an interconnecting mechanism disposed at a proximal 30 end of the exposed clip, to enable disconnecting the exposed clip from the clips housed in the sleeve.

In some embodiments, the clip applier further comprises a Veress needle comprising: the rigid sleeve, and an outer sleeve with a sharp distal end, where the

distal end of the most distally-positioned clip provides a blunt distal end for the rigid sleeve, and where the clips are deployed via a perforation made by the sharp distal end.

In some embodiments, the clip applier further comprises one or more prongs, where the self-locking mechanism is activated by a moment applied on the exposed 5 clip by the prongs.

In some embodiments, the prongs are disposed with the inner sleeve, and where the self-locking mechanism is activated by engaging the prongs with one or more niches provided with the exposed clip.

In some embodiments, the prongs are disposed with a pair of arms of the clip, 10 and where the self-locking mechanism is activated by engaging the prongs with the advancing sleeve.

In some embodiments, the self-locking mechanism comprises an elastic hook disposed at a distal end of a clip arm of the exposed clip, where the elastic hook is biased outwards, and where the elastic hook is folded inwards when the clip is housed 15 within the sleeve and protrudes outwards when the clip is exposed from the sleeve.

In some embodiments, a length of the elastic hook is greater than an inner diameter of the sleeve.

In some embodiments, the deployment mechanism includes a pusher for advancing the clips, where a proximal portion of the pusher is alternately flexible for 20 bending into a coil configuration and allowing the pusher to be housed in the handle, and a distal portion of the pusher is alternately straight and rigid for advancing the clips in the sleeve.

In some embodiments, the deployment mechanism includes one or more protrusions for engaging the pusher to control movement of the pusher from the coil 25 configuration to the straight rigid pusher for advancing the clips.

In some embodiments, the clip applier further comprises a dial for rotating the sleeve in synchrony with the clips, where a ball and socket joint provided with the pusher enables the handle to remain stationary relative to the rotated clips.

In some embodiments, a pair of clip arms of the interconnected clips housed in 30 the sleeve are oriented lengthwise along a length of the sleeve.

In some embodiments, the clips are made, at least partially, of superelastic material.

In some embodiments, an axial distance between the exposed clip and the handle throughout the sleeve advancement steps remains constant.

In some embodiments, a diameter of the rigid sleeve is micro-laparoscopic.

In some embodiments, the clips are made of Nitinol.

There is further provided, in accordance with an embodiment, a laparoscopic clip applier comprising: a handle, a rigid sleeve extending from the handle, multiple interconnected, normally-closed clips where the clips are housed in the sleeve, and where each of the clips, when housed within the sleeve, is closed, and a deployment mechanism operable by the handle and configured to: advance the clips towards a distal end of the sleeve, thereby positioning a most distally-positioned clip of the clips for deployment by exposing the clip from the distal end of the sleeve, retract the sleeve relative to the exposed clip in a first step to open the exposed clip by compressing a hinge of the clip, retract the sleeve relative to the exposed clip in a second step to close the exposed clip over a bodily tissue, and retract the sleeve relative to the exposed clip to expose an interconnecting mechanism disposed at a proximal end of the exposed clip and enable disconnecting the exposed clip from the clips housed in the sleeve.

15 In some embodiments, the clip applier further comprises a Veress needle comprising: the rigid sleeve, and an outer sleeve with a sharp distal end, where the distal end of the most distally-positioned clip provides a blunt distal end for the rigid sleeve, and where the clips are deployed via a perforation made by the sharp distal end.

20 In some embodiments, the hinge is compressed by at least one protrusion disposed at the distal end of the retracting sleeve.

25 In some embodiments, the deployment mechanism includes a pusher for advancing the clips, where a portion of the pusher is alternately flexible for bending into a coil configuration allowing the pusher to be housed in the handle, and a distal portion of the pusher is alternately straight and rigid for advancing the clips in the sleeve.

In some embodiments, the deployment mechanism includes one or more protrusions for engaging the pusher to control the advancement of the pusher from the coil configuration to the straight rigid pusher for advancing the clips.

30 In some embodiments, the clip applier further comprises a dial for rotating the sleeve in synchrony with the clips, where a ball and socket joint provided with the pusher enables the handle to remain stationary relative to the rotated clips.

In some embodiments, a pair of clip arms of the interconnected clips are oriented lengthwise with the sleeve.

In some embodiments, the clips are made of superelastic material.

In some embodiments, an axial distance between the exposed clip and the handle throughout the sleeve retraction steps remains constant.

In some embodiments, a diameter of the rigid sleeve is micro-laparoscopic.

There is further provided, in accordance with an embodiment, a laparoscopic  
5 clip applier comprising: a handle, a rigid sleeve extending from the handle, multiple  
clips, that are normally-opened by a proximal spring, where the clips are housed in the  
sleeve, and where the clips are provided with a self locking mechanism at their distal  
end, and where each of the clips, when housed within the sleeve, is closed and  
unlocked, and a deployment mechanism operable by the handle and configured to:  
10 advance the clips towards a distal end of the sleeve, thereby positioning a most  
distally-positioned clip of the clips for deployment by exposing the clip from the distal  
end of the sleeve, where the exposing causes the most distally-positioned clip to open,  
advance the sleeve relative to the exposed clip to close the exposed clip over a bodily  
tissue until the self locking mechanism of the exposed clip engages, thereby deploying  
15 the exposed clip.

In some embodiments, a distance between the exposed clip and the handle  
throughout the moving, closing and locking steps remains constant.

In some embodiments, the clip applier further comprises a Veress needle  
comprising: the rigid sleeve, and an outer sleeve with a sharp distal end, where the  
20 distal end of the most distally-positioned clip provides a blunt distal end for the rigid  
sleeve, and where the clips are deployed via a perforation made by the sharp distal end.

In some embodiments, the deployment mechanism includes one or more  
ratchets for advancing and deploying the clips.

In some embodiments, the clip applier further comprises one or more prongs,  
25 where the self locking mechanism is activated by the prongs.

In some embodiments, the clips housed in the sleeve rotate in synchrony with a  
rotation of the sleeve.

In some embodiments, a pair of clip arms of the clips are oriented lengthwise  
with the sleeve.

30 In some embodiments, the clips are made of superelastic material.

In some embodiments, a diameter of the rigid sleeve is micro-laparoscopic.

There is further provided, in accordance with an embodiment, a laparoscopic  
clip applier comprising: multiple clips, a rigid sleeve housing the multiple clips, where  
a pair of clip arms of the clips are oriented lengthwise along a length of the sleeve, and

a deployment mechanism for deploying the multiple clips from a distal end of the sleeve via a perforation made by a needle that is provided with the distal end of the sleeve.

In some embodiments, the sleeve and the needle form a Veress needle.

5 In some embodiments, the clip applier further comprises a handle for operating the deployment mechanism.

In some embodiments, the deployment mechanism includes a clip advancement mechanism for advancing the clips in the sleeve to expose a most distally positioned clip of the clips housed in the sleeve from the distal end of the sleeve.

10 In some embodiments, the deployment mechanism further comprises a sleeve maneuvering mechanism for advancing and retracting the sleeve with respect to the exposed clip, thereby controlling a deployment of the exposed clip.

15 In some embodiments, the clips are interconnected in the sleeve via a head disposed at a distal end of a proximal clip interconnected to a tail disposed at the proximal end of a distal clip.

20 In some embodiments, the clip advancement mechanism includes a pusher for advancing the clips in the sleeve where a proximal portion of the pusher is alternately flexible for bending into a coil configuration and allowing the pusher to be housed in the handle, and a distal portion is alternately straight and rigid for penetrating the sleeve to advance the clips in the sleeve.

In some embodiments, the clip applier further comprises a dial for rotating the sleeve in synchrony with the clips, where a ball and socket joint provided with the pusher enables the handle to remain stationary relative to the rotated clips.

25 In some embodiments, the clips are each normally-open and where the clips are housed in a closed and unlocked configuration in the sleeve.

In some embodiments, each of the clips includes a self-locking mechanism.

In some embodiments, the clip applier of further comprises one or more prongs for applying a moment to close the clips and activate the self-locking mechanism.

30 In some embodiments, the prong is disposed with the distal end of the sleeve and where the deployment mechanism deploys the clips by: advancing, via the clip advancement mechanism, the clips to expose a most distally positioned clip housed in the sleeve from the distal end of the sleeve, advancing, via the sleeve maneuvering system, the sleeve with respect to the exposed clip thereby engaging the prongs with a niche provided on a clip arm of the exposed clip and applying a moment that closes the

clip arms until the self locking mechanism of the clip engages, thereby locking the clip over a bodily tissue, and retracting, via the sleeve maneuvering system, the sleeve with respect to the exposed clip, thereby exposing an interconnecting mechanism disposed at a proximal end of the exposed clip, to enable disconnecting the exposed clip from the clips housed in the sleeve.

In some embodiments, an axial distance between the exposed clip and the handle throughout the advancing and retracting the sleeve steps remains constant.

In some embodiments, the prong is disposed with a pair of clip arms provided with the clip, and where the deployment mechanism deploys the clips by advancing, via the clip advancement mechanism, the clips to expose the most distally positioned clip housed in the sleeve from the distal end of the sleeve, advancing, via the sleeve maneuvering system, the sleeve with respect to the exposed clip thereby pushing the distal end of the sleeve against the prongs and applying a moment that closes the clip arms until the self locking mechanism of the clip engages, thereby locking the clip over a bodily tissue, and retracting, via the sleeve maneuvering system, the sleeve with respect to the exposed clip, thereby exposing an interconnecting mechanism disposed at a proximal end of the exposed clip, to enable disconnecting the exposed clip from the clips housed in the sleeve.

In some embodiments, an axial distance between the exposed clip and the handle throughout the advancing and retracting the sleeve steps remains constant.

In some embodiments, the self-locking mechanism comprises an elastic hook disposed at a distal end of a clip arm of the exposed clip, where the elastic hook is biased outwards, and where the elastic hook is folded inwards when the clip is housed within the sleeve and protrudes outwards when the clip is exposed from the sleeve, and where a length of the elastic hook is greater than a diameter of the sleeve.

In some embodiments, the clip advancement mechanism further comprises: a secondary sleeve, and multiple ratchets provided with the sleeves for advancing and deploying the clips housed in the sleeve.

In some embodiments, the clips are normally-closed and are housed in a closed configuration in the sleeve.

In some embodiments, the clip applier further comprises one or more protrusions at the distal end of the sleeve, and where the deployment mechanism deploys clips by: advancing, via the clip advancement mechanism, the clips housed in the sleeve to expose at least a portion of the most distally positioned clip in the sleeve

from the distal end of the sleeve, retracting, via the sleeve maneuvering system, the sleeve with respect to the at least partially exposed clip to engage the protrusion with a clip hinge provided at a proximal end of the exposed clip, compressing the clip hinge, thereby opening the clip, retracting, via the sleeve maneuvering system, the sleeve with respect to the exposed clip to disengage the prong from the clip hinge, thereby closing the clip arms over a bodily tissue, and retracting, via the sleeve maneuvering system, the sleeve with respect to the exposed clip, thereby exposing an interconnecting mechanism disposed at a proximal end of the exposed clip, to enable disconnecting the exposed clip from the clips housed in the sleeve.

10 In some embodiments, an axial distance between the exposed clip and the handle throughout the advancing and retracting the sleeve steps remains constant.

In some embodiments, a diameter of the rigid sleeve is micro-laparoscopic.

15 There is further provided, in accordance with an embodiment, a surgical clip comprising: a pair of clip arms, a self-locking mechanism provided at a distal end of the arms, a hinge spring connecting the arms, where the hinge biases the arms open, an interconnecting head disposed at a distal end of the self-locking mechanism, and an interconnecting tail disposed at a proximal end of the hinge spring, where the interconnecting head and interconnecting tail enable interconnecting multiple ones of the clip.

20 In some embodiments, the clip arms provide with one or more prongs for engaging with the sleeve to activate the self-locking mechanism.

In some embodiments, the clip arms provide one or more niches for engaging with the sleeve to activate the self-locking mechanism.

25 In some embodiments, the self-locking mechanism comprises an elastic hook disposed at a distal end of a clip arm of the exposed clip, where the elastic hook is biased outwards, and where the elastic hook is folded inwards when the clip is housed within the sleeve and protrudes outwards when the clip is exposed from the sleeve.

30 There is further provided, in accordance with an embodiment, a surgical clip comprising: a pair of clip arms, a hinge spring connecting the arms, where the hinge biases the arms closed, and where the hinge spring is configured, when compressed, to open the clip arms, an interconnecting head disposed at the distal end of the clip arms, and an interconnecting tail disposed at the proximal end of the hinge spring, where the interconnecting head and the interconnecting tail enable interconnecting multiple ones of the clip.

There is further provided, in accordance with an embodiment, a method for deploying a clip using a laparoscopic clip applier, the method comprising: positioning a clip applier to deploy a surgical clip housed in a rigid sleeve provided with the clip applier, where the sleeve houses multiple interconnected surgical clips, where each of 5 the clips, when housed within the sleeve, is closed and unlocked, and where the clip arms of the clip are aligned lengthwise with a length of the sleeve, and where the clip is provided with a self locking mechanism at its distal end and is normally-open by a proximal spring integral to the clip, operating a handle extending from the sleeve to: advance the clips towards a distal end of the sleeve, thereby position a most distally 10 positioned clip for deployment by exposing the clip from the distal end of the sleeve, where the exposing causes the most distally-positioned clip to open, advance the sleeve relative to the exposed clip to close the exposed clip over a bodily tissue until the self locking mechanism of the exposed clip engages, thereby deploying the exposed clip, and retract the sleeve relative to the exposed clip to expose an 15 interconnecting mechanism disposed at a proximal end of the exposed clip, to enable disconnecting the exposed clip from the clips housed in the sleeve.

In some embodiments, exposing the portion of the most distally positioned clip from the distal end of the sleeve further comprises perforating a body cavity wall with a Veress needle comprised in the clip applier, where the Veress needle comprises: the 20 rigid sleeve, and an outer sleeve with a sharp distal end, where the distal end of the most distally-positioned clip provides a blunt distal end for the rigid sleeve, and where the clips are deployed via a perforation made by the sharp distal end.

In some embodiments, advancing the sleeve relative to the exposed clip to close and lock the exposed clip further comprises applying a moment on the clip via 25 one or more prongs provided with the clip applier.

In some embodiments, the prongs are disposed with the inner sleeve, and where the self locking mechanism is activated by engaging the prongs with one or more niches provided with the clips.

In some embodiments, the prongs are disposed with a pair of arms of the 30 exposed clip, and where the self locking mechanism is activated by engaging the prongs with the sleeve.

In some embodiments, engaging the self locking mechanism comprises engaging an elastic hook disposed at a distal end of a clip arm of the exposed clip with another clip arm of the exposed clips, where the elastic hook is biased outwards, and

where the elastic hook is folded inwards when the clip is housed within the sleeve and protrudes outwards when the clip is exposed from the sleeve, and where a length of the elastic hook is greater than a diameter of the sleeve.

5 In some embodiments, advancing the clips further comprises advancing a pusher for advancing the clips, where a portion of the pusher is alternately flexible for bending into a coil configuration allowing it to be stored in the handle, and alternately straight and rigid for advancing the clips in the sleeve.

10 In some embodiments, the method further comprises one or more ratchets for engaging the pusher to control the advancement of the pusher from the coil configuration to the straight rigid pusher for advancing the clips.

In some embodiments, the method further comprises rotating a dial provided with the handle to rotate the clips housed in the sleeve in synchrony with a rotation of the sleeve, where a ball and socket joint provided with the pusher enables the handle to remain stationary relative to the rotated clips.

15 In some embodiments, the sleeve houses the interconnected clips with a pair of clip arms of the interconnected clips oriented lengthwise along a length of the sleeve.

In some embodiments, the sleeve houses the clips that are made of superelastic mater.

20 In some embodiments, an axial distance between the exposed clip and the handle throughout the sleeve advancement steps remains constant.

In some embodiments, a diameter of the rigid sleeve is micro-laparoscopic.

There is further provided, in accordance with an embodiment, a method for deploying a clip using a laparoscopic clip applier, the method comprising: positioning a clip applier to deploy a surgical clip housed in a rigid sleeve provided with the clip applier, where the sleeve houses multiple interconnected surgical clips that are each normally closed by a proximal spring integral to the clip, and where the clip, when housed within the sleeve, is closed, and operating a handle extending from the sleeve to advance the clips towards a distal end of the sleeve, thereby position a most distally positioned clip for deployment by exposing the clip from the distal end of the sleeve, 25 retract the sleeve relative to the exposed clip in a first step to open the exposed clip by compressing the hinge of the clip, retract the sleeve relative to the exposed clip in a second step to close the exposed clip over a bodily tissue, and retract the sleeve relative to the exposed clip to exposing an interconnecting mechanism disposed at a 30

proximal end of the exposed clip and enable disconnecting the exposed clip from the clips housed in the sleeve.

In some embodiments, exposing the portion of the most distally positioned clip from the distal end of the sleeve further comprises perforating a body cavity wall with a Veress needle provided with the clip applier, where the Veress needle includes the rigid sleeve, and an outer sleeve with a sharp distal end, where the distal end of the most distally-positioned clip provides a blunt distal end for the rigid sleeve, and where the clips are deployed via a perforation made by the sharp distal end.

In some embodiments, compressing the hinge comprises compressing by a protrusion disposed at the distal end of the retracting sleeve.

In some embodiments, advancing the clips further comprises advancing a pusher for advancing the clips, where a portion of the pusher is alternately flexible for bending into a coil configuration allowing it to be stored in the handle, and alternately straight and rigid for advancing the clips in the sleeve.

In some embodiments, the method further comprises one or more ratchets for engaging the pusher to control the advancement of the pusher from the coil configuration to the straight rigid pusher for advancing the clips.

In some embodiments, the method further comprises rotating a dial provided with the handle to rotate the clips housed in the sleeve in synchrony with a rotation of the sleeve, where a ball and socket joint provided with the pusher enables the handle to remain stationary relative to the rotated clips.

In some embodiments, the sleeve houses the interconnected clips with a pair of clip arms of the interconnected clips oriented lengthwise along a length of the sleeve.

In some embodiments, the sleeve houses the interconnected clip that are made of superelastic material.

In some embodiments, an axial distance between the exposed clip and the handle throughout the sleeve retraction steps remains constant.

In some embodiments, a diameter of the rigid sleeve is micro-laparoscopic.

There is further provided, in accordance with an embodiment, a method for deploying a clip using a micro-laparoscopic clip applier, the method comprising: positioning a clip applier to deploy a surgical clip from a rigid sleeve housing multiple ones of the surgical clips, where a pair of clip arms of the clips are oriented lengthwise along a length of the sleeve, and deploying the multiple clips from a distal end of the

sleeve via a perforation made by a needle that is disposed at the distal end of the sleeve.

In some embodiments deploying the clip from the distal end of the sleeve via a perforation made by a needle comprises deploying via a Veress needle.

5 In addition to the exemplary aspects and embodiments described above, further aspects and embodiments will become apparent by reference to the figures and by study of the following detailed description.

### BRIEF DESCRIPTION OF THE FIGURES

10 Exemplary embodiments are illustrated in referenced figures. Dimensions of components and features shown in the figures are generally chosen for convenience and clarity of presentation and are not necessarily shown to scale. The figures are listed below.

15 FIG. 1A-C, taken together, illustrate different stages of a micro-laparoscopic clip application system, in accordance with an embodiment of the invention;

FIG. 2A illustrates an exemplary clip for deploying using the system of Figs. 1A-C, in accordance with an embodiment of the invention;

FIG. 2B illustrates another exemplary clip for deploying using the system of Figs. 1A-C, in accordance with an embodiment of the invention;

20 FIGS. 2C-E illustrate another exemplary clip for deploying using the system of Figs. 1A-C, in accordance with an embodiment of the invention;

FIG. 2F illustrates another exemplary clip for deploying using the system of Figs. 1A-C, in accordance with an embodiment of the invention;

25 FIGS. 3A-C, taken together, illustrate a system for locking a clip onto tissue, in accordance with an embodiment of the invention;

FIGS. 4A-D, taken together, illustrate a handle for controlling the deployment of a clip, in accordance with an embodiment of the invention;

FIG. 5 illustrates another view of the handle of Figs. 4A-D, in accordance with an embodiment of the invention;

30 FIGS. 6A-C, taken together, illustrate another view of view of the handle of Figs. 4A-B, in accordance with an embodiment of the invention;

FIG. 7A illustrates an exemplary clip for deploying using the system of Figs. 1A-C, in accordance with an embodiment of the invention;

FIGS. 7B-D, taken together, illustrate an exemplary deployment of the clip illustrated in Fig. 7A in accordance with another embodiment of the invention; and

FIG. 8 illustrates a ratcheted cartridge mechanism configured to deploy one or more clips into a body cavity, operative in accordance with an embodiment of the invention.

## DETAILED DESCRIPTION

An illustrative embodiment of the present invention relates to a micro-laparoscopic clip applier and method of use, where micro-laparoscopy typically, though not always, refers to the use of tools with a diameter of between 2 to 3 mm, or less, and a micro-laparoscopic device is a device whose sleeve is approximately 3 mm in diameter or less. Minimizing the size of the instruments for applying surgical clips, and reducing them to less than 3 mm is desirable in order to reduce the size of the incisions on the abdominal wall, and the accompanying side effects and complications.

These instruments may be introduced percutaneously, piercing the abdominal wall, or other cavity wall such as the thoracic cavity, without the need of a trocar. In that case the size of the puncture is even smaller and it retracts after removing the instrument.

In general, the micro-laparoscopic clip applier includes multiple surgical clips with a micro-laparoscopic delivery system for deploying the clips onto tissue without requiring surgical incision, thus incurring less pain for the patient, fast clinical recovery and better cosmesis. The clip applier may be introduced percutaneously into a cavity, such as but not limited to the abdominal cavity, or thoracic cavity, to name a few. Although the system is particularly described for use in methods for micro-laparoscopic clip application, it will be understood that the invention is not so limited and can be used in other laparoscopic application contexts. Although the systems and method described below refer to micro-laparoscopic clip application, they are equally applicable to laparoscopic clip application, and thus any reference to micro-laparoscopic clip application may be understood to be equally relevant to laparoscopic clip application.

FIGS. 1 through 8, wherein like parts are designated by like reference numerals throughout, illustrate a micro-laparoscopic clip applier and a method of use according to the present invention. Although the present invention will be described with reference to the figures, it should be understood that many alternative forms can embody the present invention. One of ordinary skill in the art will additionally

appreciate different ways to alter the parameters disclosed, such as the size, shape, or type of elements or materials, in a manner still in keeping with the spirit and scope of the present invention.

Reference is now made Figs. 1A-C, which, taken together, show a simplified 5 illustration of a system for micro-laparoscopic clip application, operative in accordance with an embodiment of the invention. In the system of Fig. 1A, a micro-laparoscopic clip applier **100** may be disposed with one or more surgical clips **102** (not shown). A more detailed description of clips **102** is given below with respect to Figs. 2 and 3A-B.

10 Clip applier **100** may be disposed with a needle mechanism for applying multiple clips **102** percutaneously via a combined deployment of a sharpened tip **104** that is suitable for piercing through a body cavity wall and a blunt tip **106**, which may comprise a distal end of any of clips **102**. For example, the distal end of applier **100** may comprise a Veress needle.

15 Clip applier **100** may be disposed with an optionally stiff, or rigid inner sleeve **108** with a blunt distal end for housing multiple clips **102**. The clips housed in sleeve **108** may have their arms oriented lengthwise along the length of the sleeve, and the distal end of the most distally positioned clip **102** housed in sleeve **108** may form blunt tip **106**. Sharp tip **104** may form a distal end of an outer sleeve **110** encasing inner 20 sleeve **108** and providing a needle to applier **100**. Sharp tip **104** and blunt tip **106** may move in relation to each other, such as by moving inner and outer sleeves **108** and **110**, thereby alternately exposing or recessing sharp tip **104** and blunt tip **106**.

The following example describes deploying a surgical clip via a Veress needle configuration, as known in the art. Referring to Fig. 1A, when the distal end of system 25 **100** is situated outside a body cavity wall **112**, a spring (not shown) connecting the inner and outer sleeves **108** and **110** biases blunt tip **106** coupled with inner sleeve **108** to protrude, and sharp tip **104** integrated with the outer sleeve **110** to be recessed.

Referring to Fig. 1B, upon pressing the needle against a wall of a body cavity, the tissue wall pushes blunt tip **106** backwards causing blunt tip **106** to recess, 30 exposing sharp tip **104**, thereby enabling penetration of the body cavity wall.

Referring to Fig. 1C, after penetrating the body cavity wall, the spring may bias the blunt tip **106** to protrude beyond sharp tip **104** to protect any adjacent organs from injury. In this manner, clip **102** is deployed from the distal end of the sleeve housing it,

via a perforation made by sharp tip **104**, enabling a controlled and safe application of clip **102** in the body cavity, which will be described in greater detail below.

Alternatively, the advancement and retraction of tips **104** and **106** may be controlled by an operator.

5 The following steps describe an exemplary method for deploying a clip percutaneously using the system of Figs. 1A-C, in accordance with an embodiment of the invention. A needle disposed with a sharp tip, a blunt tip, and surgical clips may be pressed against a wall of a body cavity. The blunt tip may be pushed back by the body cavity wall, thereby recessing the blunt tip and exposing the sharp tip. The body cavity wall may be penetrated by the sharp tip. After penetration, a spring coupled with the sharp and blunt tips may release and push the blunt tip forward, past the sharp tip, thereby protecting the surrounding tissue from the sharp tip. The clip may be advanced from the blunt tip and deployed, such as by applying the method described below, thereby ligating a tissue, such as a blood vessel, with the clip.

10

15 Reference is now made to Fig. 2A which illustrates a clip **102** operative with an embodiment of the invention. Clip **102** may be made from any suitable material, such as stainless steel, titanium, or regular Nitinol, plastic, elastic or a biodegradable material. In some embodiments the clips are made at least partially of superelastic material. In some embodiments, the length of clip **102** may range from 2 mm to 30 mm  
20 long, and optionally range from 5 mm to 20 mm long. In some embodiments the clip diameter may be less than 1mm. In some embodiments the clip diameter may be less than 2mm. In some embodiments the clip diameter may be less than 3mm. In some embodiment, system **100** may house approximately 20 clips, in other embodiment system **100** may house between 10 and 20 clips, or between 5 to 10 clips. Clips **102**  
25 may apply a force of at least 1N when ligating a bodily tissue. In another embodiment, the effective length for compressing the ligated tissue may be at least 70% of the length of the clip.

Clip **102** may be disposed with arms **112a** and **112b** that are configured to ligate bodily tissue, such as a blood vessel, via locking units **114a** and **114b** positioned  
30 at the distal ends of arms **112a** and **112b** and forming locking mechanism **114**. For example, locking units **114a** and **114b** may provide a one-way locking mechanism with a squeezable arm-to-arm locking mechanism that provides a protrusion on one arm for matching to a groove or recess provided on the other arm. Alternatively, the clip locking mechanism may include a protrusion engaging a recess or hole on the

proximal end of the clip when compressed, or a ring which is pushed forward over the arms causing them to approximate and compress the tissue.

Arms **112a** and **112b** may be configured in a variety of forms to suit a specific functionality. For example the clip arms may be disposed with one or more serrations, 5 teeth or roughened surface on the surface that make contact with the tissue to improve tissue grasping and ligation; alternatively the arms may be smooth; the arms may be curved and have an arc shape when clamped, alternatively, they may be straight.

Clip arms **112a** and **112b** may be connected by a hinge, such as an integrally-formed hinge **116** that is configured to bias arms **112a** and **112b** to open upon being 10 advanced out from sleeve **108**. Clip **102** may be disposed with one or more flexible or springy prongs **118** that branch from arms **112a** and **112b** for applying a moment to close the clips and activate the clip locking mechanism. Advantageously, prongs **118** are configured to lie parallel to arms **112a** and **112b**, thereby allowing clips **102** to 15 advance smoothly within sleeve **108**. Upon advancing and exposing clip **102** from the distal end of sleeve **108**, hinge **116** may bias arms **112a** and **112b** open, causing prongs **118** to radiate outwards from arms **112a** and **112b** to enable closing and locking clip **102**, which will be described in greater detail below. Clip **102** may provide a barrier **120**, such as a ring, for blocking tissue from entering into hinge **116**. Additionally, barrier **120** may provide lateral stability to arms **112a** and **112b**, reducing sideways 20 moment and providing increased control for deploying clip **102**.

Clip **102** may be further provided with an interconnecting mechanism **122** for interconnecting clips **102** housed in sleeve **108**. Mechanism **122** may comprise a distally positioned 'head' **122a** disposed with a proximal clip for connecting to a proximally positioned 'tail' **122b** disposed with a distal clip, thereby connecting the 25 clips housed in sleeve **108**. Interconnected clips **102** may be advanced within sleeve **108** by a pusher which will be described in greater detail below. For example, in one embodiment head **122a** and tail **122b** may be hooks configured to interconnect in a 'handshake' configuration. In one embodiment, head **122a** of the most distally positioned clip in sleeve **108** may form blunt tip **106**. Upon deployment, distal clip 30 **102a** may be disconnected from the subsequent clip **102b** positioned directly proximal to by releasing the interconnection mechanism **122** connecting the two clips, such as by shifting sleeve **108** sideways to release tail **122b** of the deployed clip from head **122a** of the subsequent clip .

In this manner, multiple interconnected clips **102** may be housed in sleeve **108** for deployment by arranging the clips sequentially with clip arms **112a** and **112b** oriented lengthwise along the length of sleeve **108** and engaging tail **122b** of a distally positioned clip with head **122a** of a proximally positioned clip. In this manner, 5 advancing a proximally positioned clip may advance the remaining clips in the sleeve, and position a most distally positioned clip for deployment.

Interconnecting mechanism **122** may fit snugly within sleeve **108**, preventing lateral displacement of the clips **102**.

Clips **102** may be housed within inner sleeve **108** in a manner that enables clips 10 **102** to be stored in close proximity to each other, while preventing clip arms **112a** and **112b** from locking. For example, contact between the arms may be prevented by configuring inner sleeve **108** with a diameter large enough to accommodate clips **102** without applying pressure on clip locking mechanism **114**. Additionally one or more slender rods, wires or strips (not shown) may be provided to interpose between the clip 15 arms within inner sleeve **108** to prevent the arms from locking. In one embodiment, inner sleeve **108** may have a diameter which is sufficiently large to house clip **102** in a manner that prohibits locking of clip **102** within the inner sleeve **108**, such as a diameter ranging between 0.2mm and 5 mm, and optionally between 1 mm and 2.5 mm.

20 Reference is now made to Fig. 2B which illustrates an isometric view of a clip **142** operative with another embodiment of the invention. Clip **142** may be substantially similar to clip **102** with the noted trait that clip **142** may be provided with a rounded geometry, such as a circular cross-section, thus improving the fit of clip **142** within cylindrical sleeve **108** and which may reduce wiggle room and prevent the clip 25 from twisting out of alignment. Arms **152a** and **152b** and prongs **158**, corresponding to arms **112a** and **112b** and prongs **118**, may provide a semi-circular cross-section so that when arms **112a** and **112b** are closed and prongs **158** are compressed, such as when clip **142** is positioned within sleeve **108** prior to deployment, clip **142** is disposed with a cylindrical shape for fitting within cylindrical sleeve **108**. Similarly, head **162a** 30 forming blunt tip **162a**, optionally engaged with tail **162b**, corresponding to head **122a**, tail **122b**, and tip **106** above, may provide a circular cross-section enabling a smooth transition within cylindrical sleeve **108** and reducing possibilities for misalignment within the sleeve.

Reference is now made to Figs. 2C-D which, taken together, illustrate another clip operative with an embodiment of the invention. A clip **1002**, similar to clip **102** above may be disposed with a locking mechanism **1014** comprising an elastic hook, or prong, **1014c** disposed at the distal end of arm **1012b** for catching arm **1012a** to lock clip **1002**, thereby activating the locking mechanism of the clip. Hook **1014c**, normally biased outwards, may be compressed to lie tucked, or folded inwards between arms **1012a** and **1012b** while clip **1002** is housed within sleeve **108**, preventing the clips from locking prior to deployment and enable their smooth advancement within sleeve **108**. Upon advancing and exposing clip **1002** from the distal end of sleeve **108**, proximal hinge **1016** connecting clip arms **1012a** and **1012b** may bias the arms open. Additionally, elastic hook **1014c** may protrude outwards from arm **112b** in a manner that allows hook **1014c** to catch arm **1012a** as the clip arms close.

The length of elastic hook **1014c** may be greater than the inner diameter of sleeve **108**, and may overlap slightly with arm **1012a** so that pushing the clip arm **1012a** towards clip arm **1012b**, such as by advancing sleeve **108** over the clip arms, engages the distal end of arm **1012a** with hook **1014c**, thereby locking the clip.

In one embodiment, Hook **1014c** may engage arm **1012a** in a latch-type, or geometric interlocking configuration **1200**, requiring a greater force for unlocking clip **1002** than for locking clip **1002**, as illustrated in Fig. 2E.

In this manner, the clip may be housed within sleeve **108** in an unlocked position, and may be closed and locked during deployment without necessitating a differential moment provided by prongs or other mechanisms. Furthermore, the length of hook **1014c** may allow clip arms **1012a** and **1012b** to close and lock while not lying completely parallel to each other. For example clip arms may provide a small gap between the arms and may span a small non-zero angle when closed and locked with hook **1014c**.

Reference is now made to Fig. 3A-C which, taken together, illustrate an exemplary deployment of the clips described above by applier **100**, operative with an embodiment of the invention. The description below refers to clips **102** for exemplary reasons only, however the description of Figs. 3A-C equally applies to deploying any of the clips described herein.

Referring to Fig. 3A, clip **102a** is shown in an open position after advancing out of applier **100**, details of the advancement mechanism will be described in greater detail below with respect to Figs. 4A-C, 5A-B, and 6A-C. While housed within inner

sleeve **108**, prongs **118** may be compressed to radially align with arms **112a** and **112b** so as not to protrude from the arms, enabling a smooth advancement of clips **102** in sleeve **108**. Upon advancing clips **102** forward towards the distal end of sleeve **108**, the most distally positioned clip **102** may be positioned for deployment by exposing at least a portion of the clip from the distal end of sleeve **108**, such as exposing arms **112a** and **112b** and hinge **116**, causing arms **112a** and **112b** to open. The elasticity of prongs **118** may bias the proximal ends of prongs **118** to protrude radially outwards from arms **112a** and **112b**. As a result, a wider angle may be spanned by the proximal ends of prongs **118** than the angle spanned by arms **112a** and **112b**.

10 Referring to Fig. 3B, inner sleeve **108** may be moved relative to the clip positioned at the distal end of sleeve **108**, such as by advancing sleeve **108** over clip arms **112a** and **112b** to push against the protruded prongs, thereby applying a moment by prongs to push the clip arms together so that the clip arms lie substantially parallel to each other and close over a bodily tissue. Inner sleeve **108** may be disposed with a 15 contoured distal end to allow sleeve **108** to advance over arms **112a** and **112b** without pinching the tissue positioned within the clip arms **112a** and **112b**, such as by disposing sleeve **108** with hollowed side walls, or carved out slots at the distal tip.

Further moving the inner sleeve forward relative to the positioned clip may 20 further push the distal end of inner sleeve **108** against the proximal ends of prongs **118**, pushing the distal end of prongs **118** against arms **112a** and **112b** thereby applying a moment that pushes arms **112a** and **112b** together and result their engagement at their distal tip by engagement of locking means **114a** and **114b**, as illustrated in Fig. 3C.

It may be noted that upon advancing the clips to expose and position the most distally positioned clip at the distal end of the sleeve for deployment, the axial distance 25 of the exposed clip with respect to the bodily tissue as well as to the clip applier is unchanged throughout the closing and locking steps. This is achieved by moving sleeve **108** relative to the positioned clip while keeping the clip axially stationary. Furthermore, the sleeve and clip interconnecting means, which will be described in greater detail below, provide radial stability during deployment to maintain a steady 30 radial orientation of the clip throughout the clip closing and locking steps.

The differential height, or angle spanned by the proximal ends of prongs **118** provides the differential moment required for sleeve **108** to lock arms **112a** and **112b** together over the tissue and engage locking units **114a** and **114b**.

Clips **102** may be advanced in sleeve **108** via any suitable advancement technique. An exemplary advancement technique is described in greater detail below.

Reference is now made to Fig. 2F which illustrates a surgical clip in accordance with another embodiment of the invention. Clip **172** may be substantially similar to clips **102** and **142** above with the notable difference that, in place of prongs **118**, clip **172** may be disposed with niches **188** at the proximal end of arms **182a** and **182b**, corresponding to arms **112a** and **112b**, respectively. The deployment of clips **172** may be similar to the deployment of clips **102** described above with respect to Figs. 3A-C with the notable different that sleeve **178**, corresponding to sleeve **108**, may be disposed at the distal end with flexible sleeve prongs **178a** for engaging with niches **188** as clip **172** advances from the distal end of sleeve **178**. Prongs **178a** may apply a moment to close the clips and activate the self locking mechanism of the clip. Prongs **178a** may be biased radially inwards to engage with niches **188** but may be sufficiently flexible so as not to exert pressure on arms **182** and **182b** as clip advances from the distal end of sleeve **178**. In this manner, clip arms **182a** and **182b** may be exposed from sleeve **178** without engaging locking mechanism **184**, corresponding to mechanism **114** above.

Upon advancing clips **172** distally in sleeve **178**, hinge **176** of the most distally positioned clip **172** in sleeve **178** may be exposed from sleeve **178**, biasing arms **182a** and **182b** to open. The elasticity of prongs **188** provided at the distal end of inner sleeve, may bias the distal ends of prongs **188** to protrude radially inwards toward arms **182a** and **182b** and engage with niches **178a**. The advancement of inner sleeve **178** may push the distal ends of prongs **188** of inner sleeve **178** against niches **178a**, provided on arms **182a** and **182b**, thereby applying a moment that pushes arms **182a** and **182b** together and result in their engagement at their distal tip by engagement of locking means **184a** and **184b**, as illustrated in Fig. 2C.

In one embodiment, prongs **188**, may be wider proximally than distally and may be provided with a groove for engaging the corresponding clip arm in order to support the clip and prevent any radial misalignment of the clip while the sleeve is moved relative to the clip during deployment.

Clips **172** may be advanced in sleeve **178** via any suitable advancement technique. An exemplary advancement technique is described in greater detail below. Advantageously, the inward protrusion of the prongs provided at the distal end of inner sleeve and that engage reciprocal recessions on the clip arms, provides the differential

moment required to lock arms **182a** and **182b** **172b** together over the tissue and engage locking units **184a** and **184b**.

The following steps describe an exemplar method for deploying a clip percutaneously using the system of Figs. 3A-C, in accordance with an embodiment of the invention. A clip disposed with springy prongs branching from the clip arms is housed in a sleeve with the prongs compressed to align radially with the arms, thereby allowing the clip to advance smoothly within the sleeve. The clip is advanced from the sleeve exposing the prongs from the sleeve. The clip hinge is exposed from the sleeve, and the clip arms are opened. The springy prongs extend outwards and protrude from the arms, thereby providing a wider angle spanned by the prongs than by the clip arms. The sleeve is advanced, and the distal end of the sleeve is pushed initially against the clip arms closing them on tissue by the moment applied, and then the end of the sleeve is pushed against the proximal end of the prongs. The additional moment is applied by the prongs to the clip arms. The clip arms are locked by engaging a locking mechanism disposed at the distal end of the clip, and the tissue is ligated.

Referring back to Fig. 3A, interconnecting mechanism **122** comprising distally positioned 'head' **122a** and proximally positioned 'tail' **122b** may enable advancement of clips **102** within sleeve **108** for deployment, by each clip pushing the next one. A proximal pusher that is interconnected with the most proximal clip, is used to advance the most proximal clip by pushing it. For example, in one embodiment head **122a** and tail **122b** may be hooks configured to interconnect in a 'handshake' configuration. When positioned distally, head **122a** may form blunt tip **106**. The interconnecting head of distal clip and tail of proximal clip representing the handshake region is situated within the lumen of the surrounding sleeve and fits snugly within it during clip opening, closing and locking on tissue. Therefore, this clip tail **122b** will be firmly held during deployment preventing rotation or displacement. After locking the clip on tissue the sleeve is retracted exposing the handshake region and the distal clip **102a** may be unlocked from the previous clip **102b** positioned directly proximal to it by shifting sleeve **108** sideways in a manner to unlock tail **122b** of the deployed clip from head **122a** of the subsequent clip. Advantageously, sleeve **108** is configured to be sideways maneuverable in a manner that does not alter the positioning clip **102**. Interconnecting clips **102** via interconnecting mechanism **122** may allow for simple and easy deployment of multiple clips **102** stored in sleeve **108**, allowing the operator

to control the advancement of the clips in sleeve **108** by controlling the motion of the most proximally positioned clip, and which will be described in greater detail below.

The following steps describe an exemplar method for advancing a clip for deployment, using the system of Figs. 3A-B, in accordance with an embodiment of the invention. Multiple clips may be provided for deployment by positioning the clips in a sleeve disposed with a needle at the distal end. The clips may include an interconnecting mechanism, such as by providing a head at the distal end of the clip that is configured to interconnect with a tail provided at the proximal end of the clip. The clips may be arranged sequentially in the sleeve by engaging the tail of a distally positioned clip with the head of a proximally positioned clip, thereby interconnecting the clips.

Reference is now made to Figs. 4A-D which, taken together, illustrate an exemplary system for controlling the deployment of the interconnected clips housed in the inner sleeve, in accordance with an embodiment of the invention. Although the description below refers to clip **102**, this is for exemplary purposes only, and the description may be similarly applicable for the deployment of any of the clips described herein, with any differences noted below.

Applier **100** may provide a handle **430** for operating a deployment mechanism included with handle **430** for deploying any of the clips described above.

Sleeves **108** and **110** may extend from handle **430** allowing the deployment mechanism to deploy the clips housed in inner sleeve **108** via a perforation in a body cavity wall made using sharp tip **104** provided with the distal end of outer sleeve **110** of the Veress needle.

Handle **430** may include a mechanism for maneuvering sleeve **108** with respect to the clips housed in the sleeve. The sleeve maneuvering mechanism may include a trigger **432**, extending from handle **430**, for moving inner sleeve **108**, to deploy any of the clips described above. Trigger **432** may connect to inner sleeve **108** via a hinge **434** and spring **436** that may translate retrograde motion by trigger **432**, such as by the operator, to compress spring **436** and advance sleeve **108** forward and push prongs **118** or **158** for locking clip **102** or **142**, respectively, in accordance with the method described above. Releasing trigger **432** may release spring **436** via hinge **434**, and return sleeve **108** to its former position.

Handle **430** may similarly be applied to deploy clip **172** with the notable difference that advancing sleeve **178** forward over clip **102** may cause prongs **188**,

disposed at the distal end of sleeve **178**, to engage with niches **178a**, disposed on clip arms **182a** and **182b**, thereby applying a moment for closing and locking clip arms **182a** and **182b**.

Reference is now made to Figs. 4A-D, which illustrate an exemplary deployment of clip **102** using handle **430**. The most distally positioned clip **102** housed in sleeve **108** may be exposed from the distal end of sleeve and positioned for deployment via any suitable clip advancement method. An exemplary clip advancement method is described in greater detail below.

Referring to Fig. 4A, while trigger **432** may be in an initial position, inner sleeve **108** may be in a recessed position and arms **112a** and **112b** of clip **102** may be open.

Referring to Fig. 4B, trigger **432** may be squeezed, or pushed proximally with respect to clip **102**, and hinge **434** may translate the proximal motion of trigger **432** to at least partially compress spring **436** and push sleeve **108** distally, advancing sleeve **108** forward with respect to exposed clip **102** to press against prongs **118** which apply a moment to close clip arms **112a** and **112b**, as described above.

Referring to Fig. 4C, trigger **432** may be further pressed proximally, thereby further compressing spring **436** via hinge **434** to further advance sleeve **108** with respect to the exposed clip and press against prongs **118** to apply a moment thereby locking clip **102** via mechanism **114**.

Referring to Fig. 4D, releasing trigger **432** may release spring **436** which may push trigger **432** distally and pull sleeve **108** proximally to retract the sleeve with respect to the deployed clip, such as to almost reach the distal end of outer sleeve **110**. Interconnecting mechanism **122** may be exposed from the distal end of sleeve **108**, and the deployed clip **102** may be released from the next most distally positioned clip **102** housed in sleeve **108** by disengaging interconnecting head **122a** from tail **122b**, such as by having the operator shift handle **430** sideways to release the interlocking mechanism.

It may be noted that upon positioning any of the above clips for deployment at the distal end of the inner sleeve, the axial distance between the positioned clip and the handle remains constant throughout the sleeve moving, clip closing and clip locking steps. By moving the sleeve relative to the clip throughout the deployment, and maintaining the clip's axial positioning, the positioned clip isn't dislodged or misaligned during deployment. Furthermore, the axial distance from the clip to the

handle, and therefore, the operator is kept constant. In this way, the operator may accurately position the clip for deployment, and deploy the clip by maneuvering the sleeve, knowing that the position of the deployed clip will not change.

5 In one embodiment, sleeve **108** may be provided with lateral restricting means along a portion of its length to reduce the profile of the sleeve channel to a rectangular like shape and prevent any of the clips described above to rotate within the sleeve.

It may be noted that the handle mechanism described above is exemplary only and that other suitable methods for maneuvering sleeve **108** or **178** for deploy any of the above clips may be applied.

10 The following steps describe an exemplar method for advancing a clip for deployment, by operating a handle, such as the handle illustrated in Figs. 4A-D, in accordance with an embodiment of the invention. A trigger connected to a hinge may be provided to advance the sleeve illustrated in Figs. 3A, and 4A-C for deploying a clip. The trigger may be squeezed backwards, or proximally, activating the hinge that  
15 translates the proximal motion of the trigger to a forward or distal motion of the sleeve. In this manner, squeezing the trigger may push the sleeve forward against the clip arms to close the clip. Squeezing the trigger further pushes the sleeve further against the clip prongs to lock the clip. In this manner, by controlling the trigger, an operator may control the closing and locking of the clip.

20 Reference is now made to Fig. 5 which illustrates a clip advancement mechanism included with the deployment mechanism of handle **430** for advancing clips **102** for deployment in accordance with system **100** described above. Although the description below refers to clip **102**, this is for exemplary purposes only, and the description may be similarly applicable for the deployment of any of the clips  
25 described above, with any differences noted below.

Handle **430** may include a pusher **440** that penetrates sleeve **108** to advance, and thereby deploy clips **102**. The distal end of pusher **440** may provide an interconnecting mechanism, such as interconnecting 'head' **122a**, for engaging with tail **122b** of the most proximally positioned clip **102** in sleeve **108**. In this manner, advancement of pusher **440** may advance interconnected clips **102** within sleeve **108**,  
30 thereby deploying the clips.

In one embodiment, a proximal portion of pusher **440a** may be disposed to be folded into a coil for storing within handle **430**. In some embodiments, pusher **440a** may be made of flexible material, such as: Nylon, Polyethylene, etc, allowing it to be

stored within handle **430** in a compact manner, such as by winding pusher **440a** into a coil, where the length of pusher **440a** when unwound may be similar to the length of sleeve **108**. Alternatively, in another embodiment, pusher **440a** may be made of straight interconnected segments that are connected by integral hinges, or real hinges such as but not exclusively of a ball and socket type, allowing a portion of the pusher to be alternately flexible for bending into a coiled configuration while housed in the handle, or alternately in a straight and rigid configuration for penetrating the sleeve to advance the clips in the sleeve. In some embodiments, most of the length of the slender sleeve **108** may be exploited to house clips for deployment while the pusher **440a** is coiled in a compact manner within the handle. As the clips are deployed by the operator, pusher **440a** may be advanced within the sleeve **108**, such as by advancing the clips one by one for subsequent deployment.

A dial **448** may be provided with handle **430** for rotating sleeve **108** together with any clips **102** housed within sleeve **108**. For example, sleeve **108** may provide means for synchronizing a rotation of the clips housed within the sleeve with a rotation of the sleeve via the dial. In some embodiments, the orientation of clips **142** may be synchronized with the sleeve by virtue of their good fit within the sleeve, such as for round clip **142**. Other embodiments for clips may have their orientation synchronized using a ridge or any other suitable means within the sleeve to rotate the clips together with the rotation of the sleeve.

A joint **440b**, such as a ball and socket joint, may be provided with pusher **440** to connect the rigid distal portion of pusher **440** coupled to clips **102** via interconnect mechanism **122** to the alternately flexible proximal portion of pusher **440a** housed within handle **430**. In this manner the clips housed in sleeve **108** and connected to distal pusher **440** may rotate in synchrony with a rotation of sleeve **108** via dial **448** independently of the proximal flexible portion of pusher **440a** housed in handle **430**, enabling the handle to remain stationary relative to the rotating clips. Thus, the orientation of sleeve **108** and correspondingly of the clips **102** housed within the sleeve, may be controlled and manipulated via dial **448** and joint **440b** in a manner that is convenient for the operator applying the clips, by not requiring a corresponding orienting of the handle. In one embodiment, dial **448** may rotate sleeve **108** by 360 degrees.

In one embodiment, pusher **440** may be configured with multiple grooves **440a**, or ridges for engaging with a ratchet mechanism **442**, such as comprising

ratchets, or protrusions **442a**, **442b**, and **442c** that are provided with handle **430** for controlling the movement of pusher **440**. For example, the protrusions may control the advancement of the pusher from its coiled configuration within the handle to its rigid configuration for advancing the clips within the sleeve. Additionally, the protrusions 5 may prevent retrograde motion of the clips within the sleeve.

Reference is now made to Figs. 6A-C which, taken together, illustrate an exemplary application of ratchet mechanism **442** for advancing clips **102** in sleeve **608**, according to an embodiment of the invention. Ratchet **442a** may be a fixed ratchet and **442b** may be a moving ratchet means. These ratchet means may provide a straight 10 angle for interfacing with the distal sides of the grooves and a gradient angle for interfacing with the proximal sides of the grooves to enable forward advancement and prevent retrograde motion of pusher **440**. Similarly, ratchet means **442c** may be a locking ratchet which provides a gradient angle for interfacing with the gradient angle of ratchet **442b** and a straight angle for interfacing with the proximal sides of the 15 grooves to disable forward advancement of pusher **432**.

Ratchet mechanisms **442a**, **442b**, and **442c** may be manipulated by a grip **444** coupled to a spring **446** to enabling the operator to advance pusher **540**, as follows:

Referring to Fig. 6A, ratchets **442b** and **442c** may together engage a proximal groove **440a** disposed on an overside of pusher **440**, while ratchet **442a** may engage 20 with a distal groove **440b** disposed with an underside side of pusher **440**, where overside and underside are to be understood as relative opposite sides of pusher **440**.

Referring to Fig. 6B, grip **444** may be pushed forward, causing spring **446** to compress and release ratchet **442c** from its engagement with proximal groove **440a**, and additionally, release ratchet **442a** from its engagement with the underside groove 25 of pusher **440**. The forward motion of grip **444**, attached to ratchet **442b**, may pull forward pusher **440** engaged with ratchet **442b** via groove **440a**. In some embodiment, the distance that pusher is advanced by each activation of grip **444** is one clip length. When spring **446** is at rest, ratchets **442a** engage distal grooves **440b** of pusher **440** preventing retrograde motion of pusher **440**, while ratchet **442c** is biased by ratchet 30 **442b** to engage a proximal groove **440a**, preventing forward motion, as illustrated in Fig. 6B. In this configuration, pusher **440** is locked, thereby preventing any advancement of the clips.

Referring to Fig. 6C, the forward motion of pusher **440** may cause fixed ratchet **442a** to engage with the groove positioned on the underside of the groove engaged by

ratchet **442b**, while ratchet **442c** may engage with the next proximally positioned groove on pusher **440**. In this manner, pusher may be advanced groove by groove, where each activation of grip **444** may engage ratchets **442** from distally positioned to proximally positioned grooves of pusher **440**.

5 Releasing grip **444** may release spring **446** and return ratchet **442b** proximally by to the state illustrated in Fig. 6A, ready for the next advancement.

In this manner, an operator may maneuver grip **444** coupled to spring **446** to advance pusher **440** thereby advancing the above described clips for deployment, while ratchets **442** control the forward motion of pusher **440** to position one clip at a 10 time for deployment, and prevent retrograde motion of the clips.

It may be noted that ratchet mechanism **442** is exemplary only and that any suitable method for controlling the advancement of the clips described above within sleeve **108** may be applied to system **100**.

The following steps describe an exemplary method for advancing a clip for 15 deployment, such as by using the system illustrated in Figs. 5A-B and 6, in accordance with an embodiment of the invention. A pusher may be provided with the clip applier to advance the clips stored within the sleeve. The pusher may engage the proximally positioned clip in the sleeve, such as via an interconnecting mechanism similar to the mechanism connecting the clips. A grip coupled with a spring and one or more ratchets 20 may be activated to advance the pusher forward and position a clip for deployment. A ratchet may engage a distal groove provided with the pusher to prevent retrograde motion of the pusher in an initial position of the grip. The grip may be pushed causing the spring to extend and advance the moving ratchet from the proximal groove together with the pusher forward until the pusher proximal groove is engaged by the 25 fixed ratchet. The grip may be released, causing the spring to release backwards, bringing the moving ratchet to a more proximal groove of the pusher and making it ready for an addition step forward. The forward advancement of the pusher into the sleeve may advance the proximal clip forward into the sleeve, and thereby position the distally positioned clip in the sleeve for deployment. Advantageously, the grip, spring 30 and ratchets are configured to advance the pusher forward by a distance equal to the length of a clip, thereby advancing the pusher into the sleeve by one clip length, and positioning the subsequent clip for deployment by activating the trigger. An additional ratchet may be provided to prevent further advancement of the pusher after a clip has been positioned for deployment.

Thus, by coordinating the advancement of the clips within the sleeve using the system illustrated in Figs. 5A-B and 6A-C, with the closing and locking of the clip using the system illustrated in Figs. 4A-C, the positioning and deployment of the clip may be controlled by an operator using the handle described above.

5 It may be noted that the above systems are illustrative only, and that any suitable mechanism for advancing the clips for deployment within the sleeve, and for engaging the locking mechanism of the clips may be applied for deploying clips **102** using system **100**.

Reference is now made to Figs. 7A-D which, taken together, illustrate another 10 exemplary clip for deployment via system **100**, operative with an embodiment of the invention. Referring to Fig. 7A, a clip **702** may have a loop-shaped clip hinge **716**, such as a spring loop, with arms **712a** and **712b** extending out from the distal ends of the loop with the upper arm connected to the lower end of the loop and the lower arm connected to the upper end of the loop. Clip **702** may be normally closed, such as by 15 configuring hinge **716** to bias arms **712a** and **712b** closed, and to open arms **712a** and **712b** when compressed. Clip **702** is advantageously provided with an interconnecting head **722a** and an interconnecting tail **722b** that operate in a manner similar to head **122a** and tail **122b** described above, enabling any of interconnected clips **702** to advance through inner sleeve **708** in a similar manner to the advancement of 20 interconnected clips **102** within sleeve **108**. Clip arms **712a** and **712b** may be disposed with a lengthwise slit.

A handle **430A**, similar to handle **430**, may be provided to operate a deployment mechanism for clips **702** in a manner similar to that described for Figs. 5A-B, and 6A-C above. Multiple interconnected clips **702** may be housed within inner 25 sleeve **708** in their normally-closed configuration. Sleeve **708** may extend from handle **430A** and may include a pusher **440** for advancing clips **702** towards the distal end of inner sleeve **708** to expose the most distally positioned clip **702** in sleeve **708** from the distal end of sleeve **708**.

The distal end of pusher **440** may be disposed with a hook, such as 30 interconnecting 'head' **722a**, for engaging with a tail **722b**, of the most proximally positioned clip **702** within sleeve **708**. Thus, referring to Fig. 7A, by controlling the advancement of pusher **440**, the operator may control the advancement of clips **702** within sleeve **708**, and position clips **702** for deployment, as described above.

Handle **430A** may be substantially similar to handle **430** with a notable difference that activating trigger **432** may connect to sleeve **708** via hinge **434** in a manner to cause sleeve **708** to retract, as opposed to advance, such as for clip **102**. For example, hinge **434** may translate retrograde motion of trigger **432** to retrograde motion of sleeve **708**, thereby pulling sleeve **708** back with respect to clip **702**. In this manner, controlled activation of trigger **432** may control a retreat of sleeve **708**, and deploy the clip, as follows:

At least one protrusion **724** may be provided at the distal end inner sleeve **708**, corresponding to inner sleeve **108** above, for engaging with hinge **716** to compress hinge **716**, thereby opening arms **712a** and **712b**. As shown in Fig. 7B, a clip **702** may be positioned at the distal end of a sleeve provided with a clip applier, such as by advancing the pusher using a ratchet mechanism similar to that described in Figs 6A-C. The arms **712a** and **712b**, in a normally closed configuration may protrude beyond the distal end of inner sleeve **708**, while hinge **716** may be housed within sleeve **708**.

Referring to Fig. 7C, sleeve **708** may be retracted with respect to the positioned clip **702** by activating trigger **432** to move sleeve **708** proximally relative to clip **702** in a first moving step. Protrusions **724** positioned at the distal end of sleeve **708** may make contact with a distal portion of clip hinge **716** and apply pressure to squeeze or compress clip hinge **716** in a manner that opens clip arms **712a** and **712b**.

Referring to Fig. 7D, trigger **432** coupled to hinge **434** may be further activated to retract sleeve **708** with respect to clip **702a** and move sleeve **708** proximally relative to clip **702** in a second moving step that exposes clip hinge **716** from the distal end of sleeve **708** and positions protrusions **720** at the proximal end of hinge **716**. This may release the pressure applied by protrusions **720** on clip hinge **716** and return clip hinge **716** to its natural state of biasing arms **712a** and **712b** closed.

Sleeve **708** may be moved proximally in a third retracting step with respect to the exposed clip, to expose interlocking mechanism **722** of the deployed clip from the distal end of sleeve **708**, allowing the operator to disconnect the deployed clip from the remaining clips housed in sleeve **708**, such as by shifting the clip applier sideways.

During the deployment stages described above, from when clip **708** is positioned for deployment at the distal end of sleeve **708**, throughout the moving steps of sleeve **708** and until the clip is closed over the blood vessel, the axial distance between the clip **702** and handle **430** may remain constant. The movement of sleeve **708** throughout the deployment of clip **702** has no effect on the axial distance of the

clip from the handle, and therefore, the operator. In this way, the operator may accurately position the clip for deployment, and deploy the clip by maneuvering the sleeve, knowing that the position of the deployed clip will not change.

The following steps describe an exemplary method for deploying the clip illustrated in Figs. 7B-D, in accordance with an embodiment of the invention. A clip may be positioned at the distal end of a sleeve provided with a clip applier by advancing the pusher using a ratchet mechanism similar to that described in Fig 6. The clip may be positioned such that the clip arms may be exposed from the distal end of the sleeve, while a hinge disposed at the proximal end of the clip is enclosed within the sleeve. The sleeve may be withdrawn in a first retreat step, such as by using a handle similar to the handle described above. One or more protrusions disposed at the distal end of the sleeve may engage with the distal side of the enclosed hinge and exert pressure on the hinge by squeezing it. The clip arms may open. The sleeve may be withdrawn in a second retreat step to position the protrusions at the proximal side of the hinge, thereby releasing the pressure from the hinge, causing the clip arms to close and lock, thereby deploying the clip. The sleeve may be withdrawn by a third retreat step to expose the hinge and an interconnecting mechanism disposed at the proximal end of the clip from the sleeve. The sleeve may be shifted in a manner to release the interconnecting mechanism, while not displacing the deployed clip. The next clip may be positioned at the distal end of a sleeve provided with a clip applier by advancing the pusher again using a ratchet mechanism similar to that described in Fig 6.

Reference is now made to Fig. 8 which illustrates a ratcheted cartridge mechanism for advancing one or more clips for deployment into a body cavity, operative with an embodiment of the invention. In the system of Fig. 8A, a cartridge mechanism **800** configured for housing clips **802** is disposed with multiple concentric tubular structures, or sleeves, coupled with anchoring protrusions, such as ratchets, for advancing clips **802**. Clips **802** are substantially similar to clips **102** with the notable difference that clips **802** are not disposed with interconnecting mechanism **122**, and thus are advanced within the interconnecting sleeves using any suitable advancement mechanism, such as by using a ratcheted advancement mechanism described below.

A handle mechanism similar to handle **430** may be provided with system **800** for deploying clips **802**, in a manner similar to the deployment of clips **102** by maneuvering one or more sleeves provided to house and deploy clips **802** and which

are described below. The sleeves may be maneuvered by a trigger mechanism, similar to trigger 432.

Innermost sleeve 808, corresponding to inner sleeve 112 of Fig. 1A, may house multiple clips 802 in a manner similar to that described above. Sleeve 808 may 5 provide one or more anchoring protrusions 850 for engaging with clip 802 to prevent retrograde movement of clip 802 within cartridge 800. An intermediate sleeve 852 surrounding or enclosing innermost sleeve 808 may be provided with one or more advancement protrusions 854 that are configured to engage with and push clip 802 forward towards the distal end of mechanism 800. Advancement protrusions 854 are 10 configured to protrude through a longitudinal groove or window 856 that is provided with innermost sleeve 808 to enable engaging with clip 802. In order to advance clip 802, anchoring protrusion 850 may engage with clip 802 and hold clip 802 in place while intermediate sleeve 852 is pulled back a predetermined distance, such as the length of a clip, towards the proximal end of cartridge 800. Intermediate sleeve 852 15 may then be advanced forward, causing advancement protrusion 854 to engage with clip 802, pulling it forward towards the distal end of cartridge 800. The most distally positioned advancement protrusion 854A of intermediate sleeve is configured to engage and position the most distal clip 802 to a deployable position within a pair of integral jaws 856 of innermost sleeve, such as by being held in place by one or more 20 grooves provided with jaws 234.

Protrusion 854A may be biased by outermost sleeve 810, disposed with sharp tip 804 and corresponding to outer sleeve 110 of Fig. 1A, in a manner to engage clip 802 only when clip 802 is being advanced. Upon positioning clip 802 for deployment at the distal end of cartridge 800, protrusion 854A extends past the distal end of outermost sleeve 810, thereby no longer engaging with clip 802. Any further advancement by intermediate sleeve 852 serves to compress clip 802.

Intermediate sleeve 852 may be advanced over innermost sleeve 808 (not shown) and clip arms 812a and 812b, thereby compressing arms 812a and 812b and engaging locking mechanism 814 to lock over the tissue. Prongs, such as in any of the 30 embodiments described above may be provided with either of clips 802 or sleeve 802 to activate the locking mechanism.

Advantageously, when there is one last clip for deployment within sleeve 808, advancement of outermost sleeve 810 over the integral jaws does not lock the clip, but

rather only reversibly approximates clip arms **812a** and **812b**, thereby allowing the deployment of clip **802** when it is the last clip disposed within sleeve **808**.

The following method describes multiple steps for deploying a clip using a micro-laparoscopic clip applier, in accordance with an embodiment of the invention. A 5 clip applier is positioning to deploy a surgical clip housed in a rigid sleeve provided with the clip applier, where the sleeve houses multiple interconnected surgical clips, and each of the clips, when housed within the sleeve is closed and unlocked, and where each of the clips is provided with a self locking mechanism at its distal end and is normally-open by a proximal integral spring disposed with each of the clips. The 10 clip arms of the interconnected clips housed in the sleeve may be oriented lengthwise along a length of the sleeve, and the clips may be made of superelastic material

In some embodiments, exposing the clip may include perforating a body cavity wall with a Veress needle provided with the clip applier, where the Veress needle includes an inner sleeve with a blunt distal end, and an outer sleeve with a sharp distal 15 end, and where the sleeve housing the clips comprises the inner sleeve, and where the distal end of the most distally-positioned clip comprises the blunt distal end, and where the clips are exposed via the perforation made by the sharp distal end.

A handle extending from the sleeve may be operated to advance the clips towards a distal end of the sleeve, and position a most distally positioned clip for 20 deployment by exposing the clip from the distal end of the sleeve, where the exposing causes the clip to open.

Optionally, the clips may be advanced by a pusher, where portion of the pusher is alternately flexible for bending into a coil configuration allowing it to be stored in the handle, and alternately straight and rigid for advancing the clips in the sleeve. One 25 or more ratchets may engage the pusher to control the advancement of the pusher from the coil configuration to the straight rigid pusher for advancing the clips.

A dial may be provided with the handle may be rotated to rotate the clips housed in the sleeve in synchrony with a rotation of the sleeve, where a ball and socket joint provided with the pusher enables the handle to remain stationary relative to the 30 rotated clips.

The sleeve may be advanced relative to the exposed clip to close the exposed clip over a bodily tissue until the self locking mechanism of the exposed clip engages, thereby deploying the exposed clip, where an axial distance between the exposed clip and the handle throughout the sleeve advancing steps remains constant.

In some embodiments, advancing the sleeve relative to the exposed clip to close and lock the exposed clip further comprises applying a moment on the clip via one or more prongs provided with the clip applier. Optionally, the prongs may be disposed with the inner sleeve, and the self locking mechanism may be activated by 5 engaging the prongs with one or more niches provided with the clips. Alternatively, the prongs may be disposed with the clip arms and the self locking mechanism may be activated by engaging the prongs with the sleeve.

In another embodiment, engaging the self locking mechanism comprises 10 engaging a hook disposed at a distal end of one clip arm disposed with the exposed clip with the other clip arm of the exposed clip.

Upon closing and locking the clip, the sleeve may be retracted relative to the exposed clip to expose an interconnecting mechanism disposed at a proximal end of the exposed clip, to enable disconnecting the deployed clip from the remaining clips housed in the sleeve.

15 The following method describes multiple steps for deploying a clip using a micro-laparoscopic clip applier, in accordance with another embodiment of the invention. A clip applier is positioning to deploy a surgical clip housed in a rigid sleeve provided with the clip applier, where the sleeve houses multiple interconnected surgical clips, and each of the clips, when housed within the sleeve is closed and is 20 normally-closed by a proximal integral spring disposed with each of the clips. The clip arms of the interconnected clips housed in the sleeve may be oriented lengthwise along a length of the sleeve, and the clips may be made of superelastic material

In some embodiments, exposing the clip may include perforating a body cavity wall with a Veress needle provided with the clip applier, where the Veress needle 25 includes an inner sleeve with a blunt distal end, and an outer sleeve with a sharp distal end, and where the sleeve housing the clips comprises the inner sleeve, and where the distal end of the most distally-positioned clip comprises the blunt distal end, and where the clips are exposed via the perforation made by the sharp distal end.

A handle extending from the sleeve may be operated to advance the clips 30 towards a distal end of the sleeve, and position a most distally positioned clip for deployment by exposing the clip from the distal end of the sleeve.

Optionally, the clips may be advanced by a pusher, where portion of the pusher is alternately flexible for bending into a coil configuration allowing it to be stored in the handle, and alternately straight and rigid for advancing the clips in the

sleeve. One or more ratchets may engage the pusher to control the advancement of the pusher from the coil configuration to the straight rigid pusher for advancing the clips.

A dial may be provided with the handle may be rotated to rotate the clips housed in the sleeve in synchrony with a rotation of the sleeve, where a ball and socket 5 joint provided with the pusher enables the handle to remain stationary relative to the rotated clips.

The sleeve may be retracted relative to the exposed clip in a first step to open the exposed clip by compressing the hinge of the clip. The sleeve may be retracted relative to the exposed clip in a second step to close the exposed clip over a bodily 10 tissue, where an axial distance between the exposed clip and the handle throughout the sleeve retracting steps may remain constant. The sleeve may be retracted further relative to the exposed clip to expose an interconnecting mechanism disposed at a proximal end of the exposed clip to enable disconnecting the exposed clip from the other clips housed in the sleeve.

15 Thus, by disposing a laparoscopic clip applier in accordance with the system and method described above, such as by employing a user friendly miniature advancement mechanism for maneuvering surgical clips within a retractable needle, specific minimally-invasive procedures medical procedures such as Cholecystectomy, removal of ovary, sterilization, hysterectomy, bariatric surgery, thoracoscopy, etc. can be easily 20 performed by the present device, overcoming size constraint hurdles that are associated with prior art devices.

Numerous modifications and alternative embodiments of the present invention will be apparent to those skilled in the art in view of the foregoing description. Accordingly, this description is to be construed as illustrative only and is for the 25 purpose of teaching those skilled in the art the best mode for carrying out the present invention. Details of the structure may vary substantially without departing from the spirit of the present invention, and exclusive use of all modifications that come within the scope of the appended claims is reserved. Within this specification embodiments have been described in a way which enables a clear and concise specification to be 30 written, but it is intended and will be appreciated that embodiments may be variously combined or separated without parting from the invention. It is intended that the present invention be limited only to the extent required by the appended claims and the applicable rules of law.

It is to be understood that the following claims are to cover all generic and specific features of the invention described herein, and all statements of the scope of the invention which, as a matter of language, might be said to fall therebetween.

## CLAIMS

1. A laparoscopic clip applier comprising:
  - a proximal handle configured for controlling a position said clip applier;
  - a rigid sleeve extending from said handle;
  - a trigger connected to said sleeve to advance said sleeve distally with respect to said handle and to retract said sleeve proximally with respect to said handle in response to manipulating said trigger with respect to said handle in first direction and a second direction respectively;
  - multiple interconnected clips, each clip of said multiple interconnected clips being normally-open by a proximal spring integral to the clip,
    - wherein each said clip is configured to be housed in said sleeve, and
    - wherein each said clip is provided with a self-locking mechanism at its distal end, and
    - wherein each said clip, when housed within said sleeve, is configured to be closed and unlocked; and
  - a pusher operable to move with respect to said handle and configured to:
    - advance said multiple interconnected clips distally with respect to said handle and to position a most distally-positioned clip of said multiple interconnected clips into a deployment position;
    - wherein retracting said sleeve with said trigger exposes said most distally-positioned clip from said distal end of said sleeve, and causes said most distally-positioned clip to open while remaining in said deployment position axially stationary with respect to said handle,
    - wherein advancing said sleeve with said trigger, while said pusher retains said exposed most distally-positioned clip in said deployment position axially stationary with respect to the handle, closes said exposed most distally-positioned clip until said self-locking mechanism of said exposed most distally-positioned clip engages.
2. The clip applier of claim 1, further comprising further retracting said sleeve proximally relative to said handle, while said pusher retains said exposed most distally-positioned clip in said deployment position axially stationary with respect to

the handle exposes an interconnecting mechanism disposed at a proximal end of said exposed most distally-positioned clip, to enable disconnecting said exposed most distally-positioned clip from a proximal clip of said multiple interconnected clips; said proximal clip housed in said sleeve.

3. The clip applier of claim 1, further comprising a Veress needle comprising:
  - 3.1. said rigid sleeve, and
  - 3.2. an outer sleeve with a sharp distal end for forming a perforation in an outer wall of a body cavity,
    - 3.2.1. wherein said distal end of said most distally-positioned clip is configured to provide a blunt distal end for said rigid sleeve configured to pass through said perforation made by said sharp distal end of said outer sleeve.
4. The clip applier of claim 1, wherein said self-locking mechanism comprises an elastic hook disposed at said distal end of said most distally-positioned clip, wherein said elastic hook is biased outwards, and wherein said elastic hook is configured to be folded inwards when said most distally-positioned clip is housed within said sleeve and to protrude outwards when said most distally-positioned clip is exposed from said sleeve.
5. The clip applier of claim 1, wherein a proximal portion of said pusher is alternately flexible and configured to bend into a coil configuration thereby allowing said pusher to be housed in said handle, and a distal portion of said pusher is alternately straight and rigid and configured to advance said multiple interconnected clips in said sleeve.
6. The clip applier of claim 5, wherein said handle includes one or more protrusions configured to engage said pusher to control a movement of said pusher from said coil configuration to a straight rigid configuration when advancing said multiple interconnected clips.
7. The clip applier of claim 5, further comprising a dial configured to rotate said sleeve in synchrony with said multiple interconnected clips, wherein a ball and socket joint provided with said pusher is configured enable said handle to remain axially stationary relative to said multiple interconnected clips while said sleeve rotates.

8. The clip applier of claim 1, wherein each said clip of said multiple interconnected clips housed in said sleeve includes at least two arms oriented lengthwise along a length of said sleeve.
9. The clip applier of claim 1, wherein each said clip is made, at least partially, of superelastic material.
10. The clip applier of claim 1, wherein a diameter of said rigid sleeve is micro-laparoscopic.
11. The clip applier of claim 1, wherein a distal tip of said rigid sleeve is disposed with carved out slots configured to allow said rigid sleeve to advance over said exposed most distally-positioned clip without pinching bodily tissue.
12. A method for deploying a clip using a laparoscopic clip applier, the method comprising:
  - positioning as a unit a clip applier including a handle, a trigger, multiple interconnected surgical clips, a rigid sleeve and a pusher to position a most distally-positioned clip of said multiple interconnected surgical clips housed in said rigid sleeve,
    - wherein said multiple interconnected clips includes at least a proximal clip and said most distally-positioned clip and wherein each said clip of said multiple interconnected clips includes at least two arms;
    - wherein said sleeve is configured to house said multiple interconnected surgical clips with said arms aligned lengthwise with a length of the sleeve, and wherein each said clip is provided with a self locking mechanism at its distal end and is normally-open by a proximal spring integral to said clip; and
  - operating said pusher to:
    - advance said multiple interconnected surgical clips distally with respect to said sleeve, while said handle, trigger and sleeve remain stationary with respect to each other, thereby positioning said most distally-positioned clip into a deployment position
  - exposing said most distally-positioned clip from a distal end of said sleeve, wherein said exposing causes said most distally-positioned clip to open,

manipulating said trigger with respect to said handle to advance said sleeve distally relative to said exposed most distally-positioned clip thereby closing said exposed most distally-positioned clip while maintaining a constant axial distance between said exposed most distally-positioned clip and said handle and said pusher and wherein said closing said exposed most distally-positioned clip engages said self locking mechanism of said exposed most distally-positioned clip.

13. The method of claim 12, further comprising:

further retracting said sleeve relative to said handle and said exposed most distally-positioned clip thereby exposing an interconnecting mechanism disposed at a proximal end of said exposed most distally-positioned clip while maintaining said constant axial distance between said exposed most distally-positioned clip and said handle, and wherein said exposing said interconnecting mechanism enables disconnecting said exposed most distally-positioned clip from said proximal clip housed in said sleeve.

14. The method of claim 12 wherein said clip applier includes a Veress needle including an outer sleeve with a sharp distal end and wherein said positioning said clip applier further comprises:

perforating wall of a body cavity with said Veress needle

by exposing said sharp distal end of said outer sleeve by pushing a blunt distal end of said most distally-positioned clip and said rigid sleeve proximally into said outer sleeve, and

inserting said blunt distal end of said most distally-positioned clip into said body cavity through a perforation made by said sharp distal end of said outer sleeve.

15. The method of claim 12 wherein said operating said pusher includes straightening a portion of said pusher from a coil configuration allowing it to be stored in said handle to a straight and rigid configuration for advancing said multiple interconnected clips in said sleeve.

16. The method of claim 12, wherein said manipulating said trigger to advance said sleeve relative to said exposed most distally-positioned clip to close said exposed

most distally-positioned clip includes closing said most distally-positioned clip over a bodily tissue without said sleeve pinching said bodily tissue.

17. The clip applier of claim 1, wherein said trigger is distal to said handle.
18. The clip applier of claim 1, wherein said pusher is configured for axially positioning a subsequent clip of said multiple interconnected clips to said deployment position at a same axially position relative to said handle as for, said most distally-positioned clip.
19. The clip applier of claim 1, further comprising:  
a ratchet limiting movement of said pusher to advance a single clip at a time.
20. The method of claim 12, further comprising:  
further operating said pusher to position a subsequent clip of said multiple interconnected clips to said deployment position at a same axially position relative to said handle as for, said most distally-positioned clip.

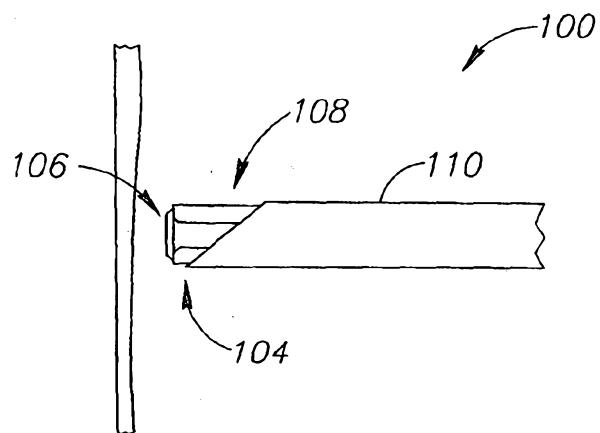


FIG. 1A

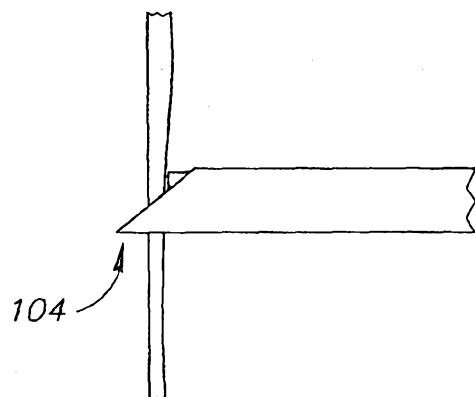


FIG. 1B

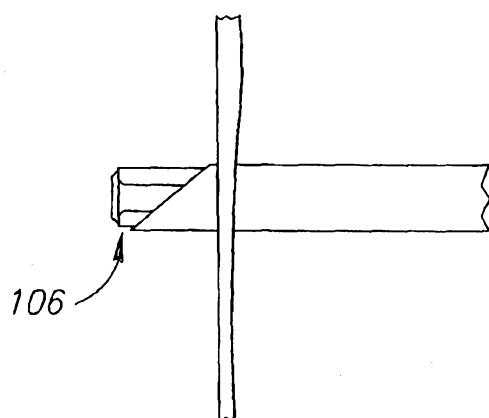


FIG. 1C

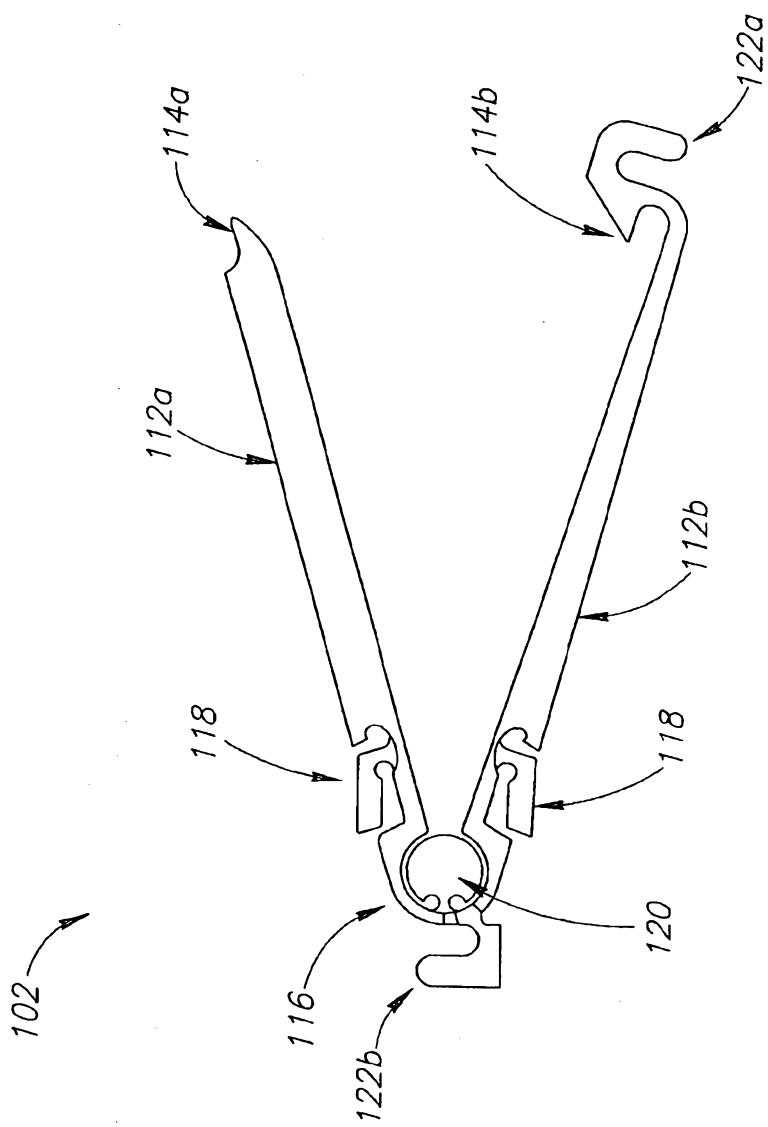


FIG.2A

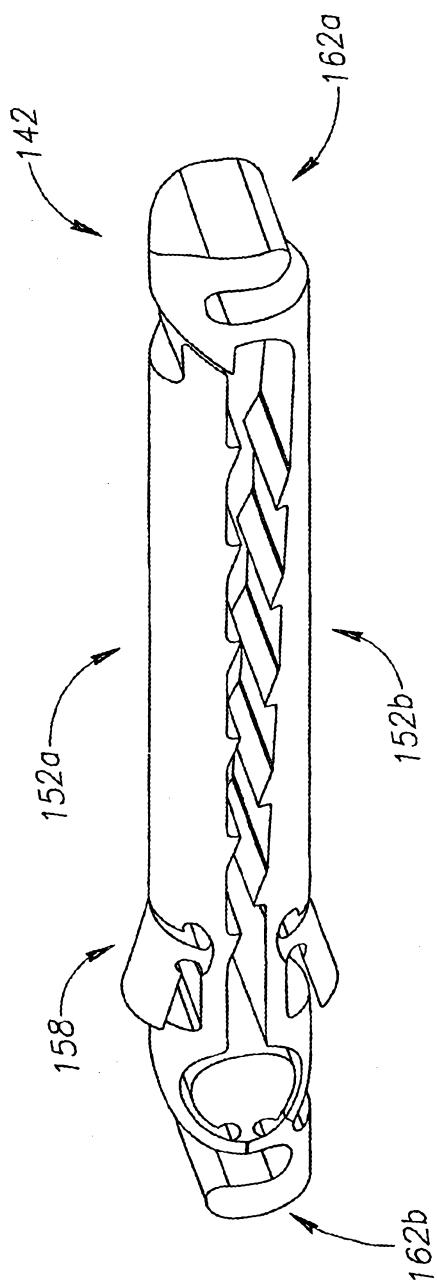


FIG.2B

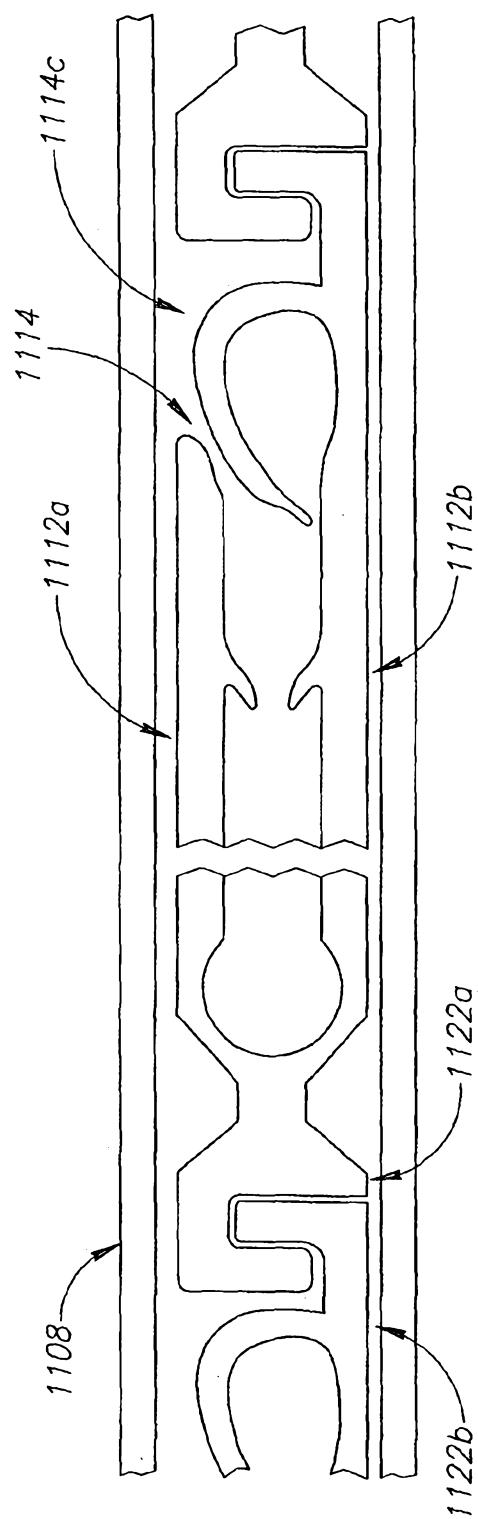


FIG.2C

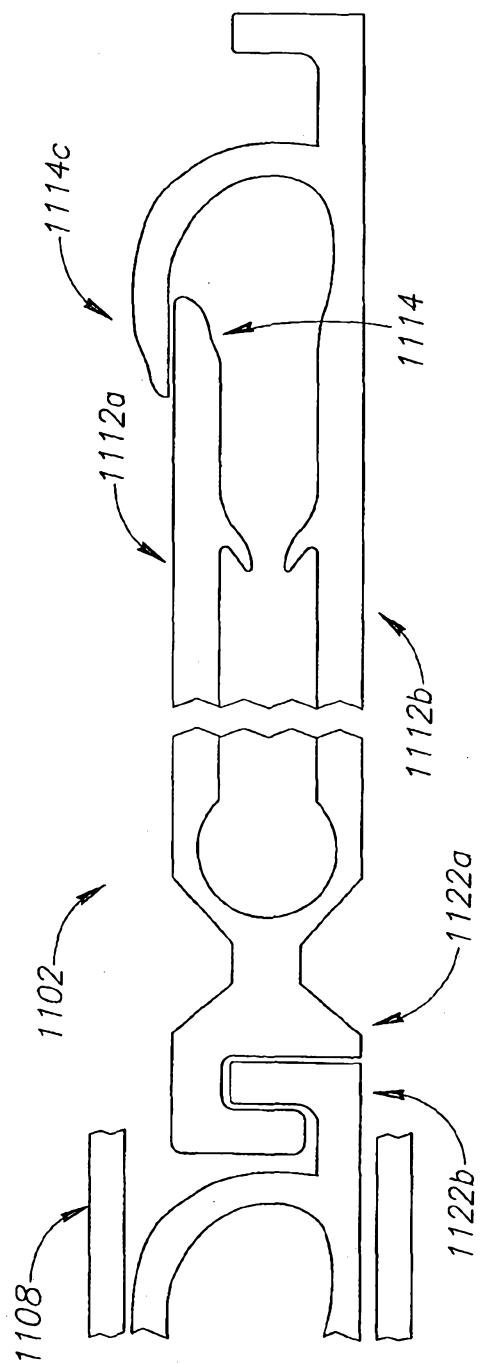


FIG.2D

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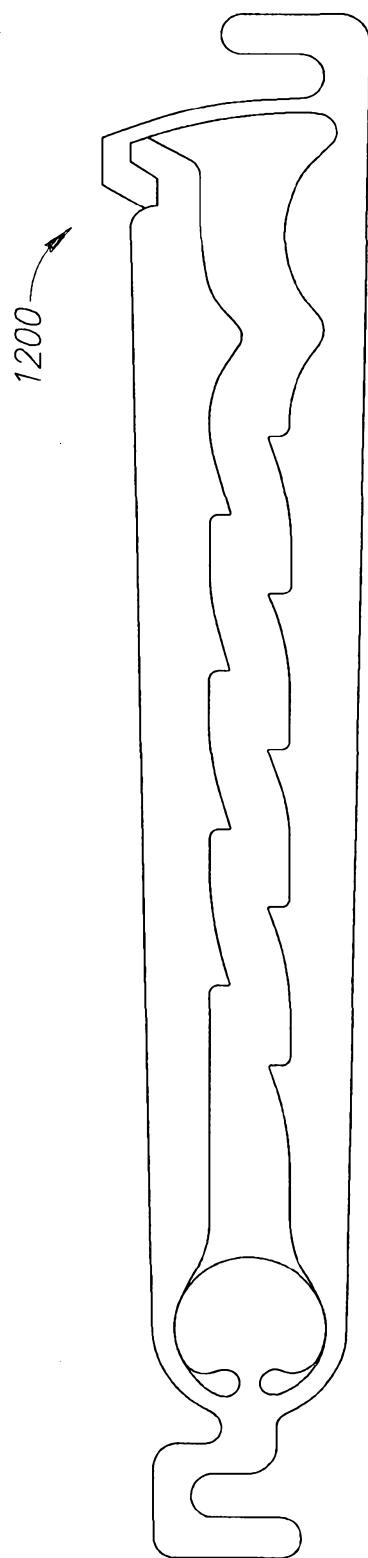


FIG.2E

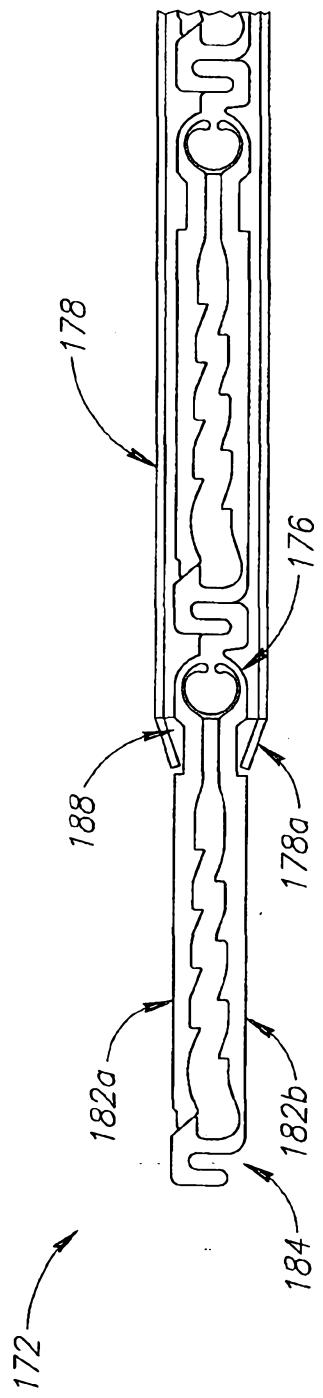


FIG.2F

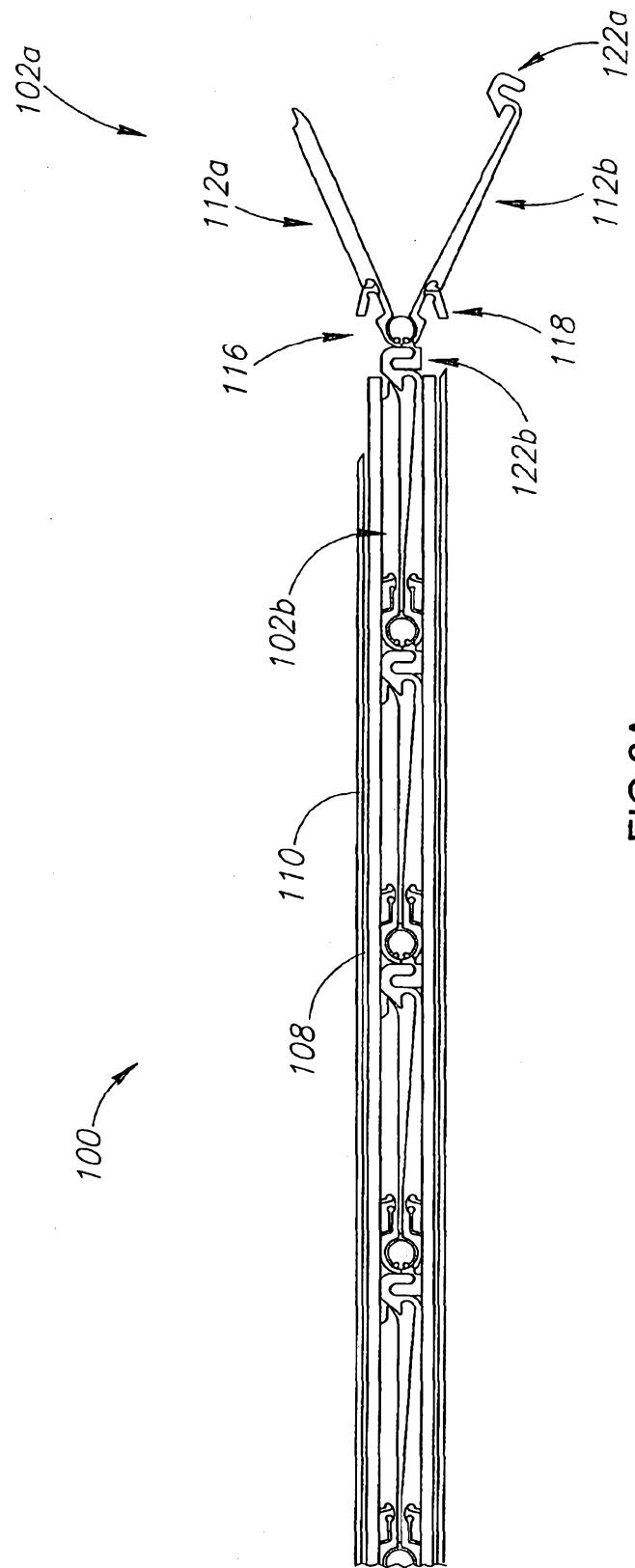


FIG.3A

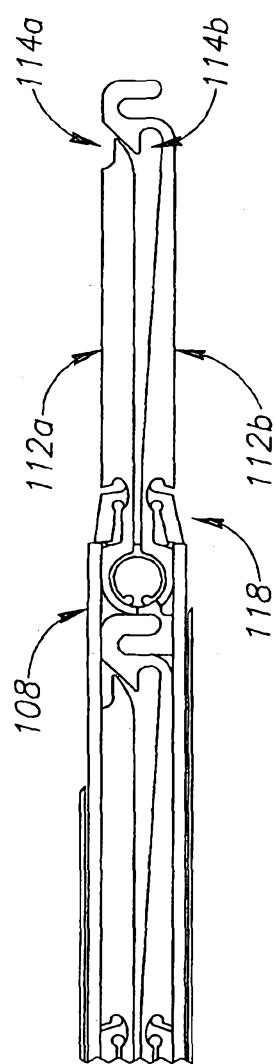


FIG. 3B

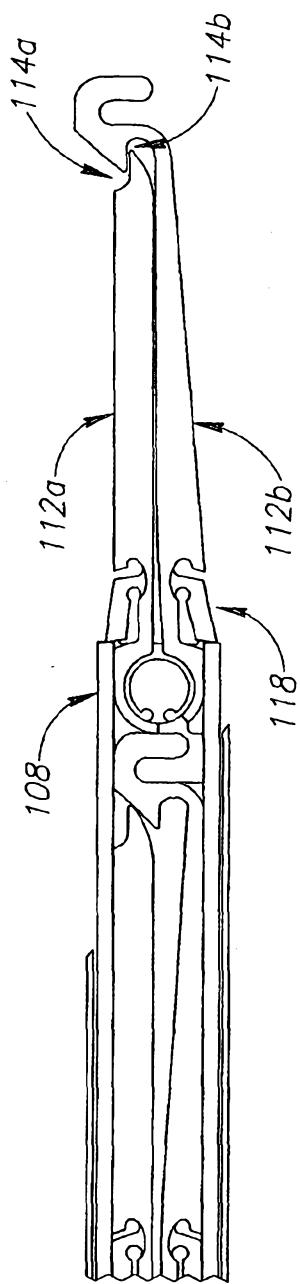


FIG. 3C

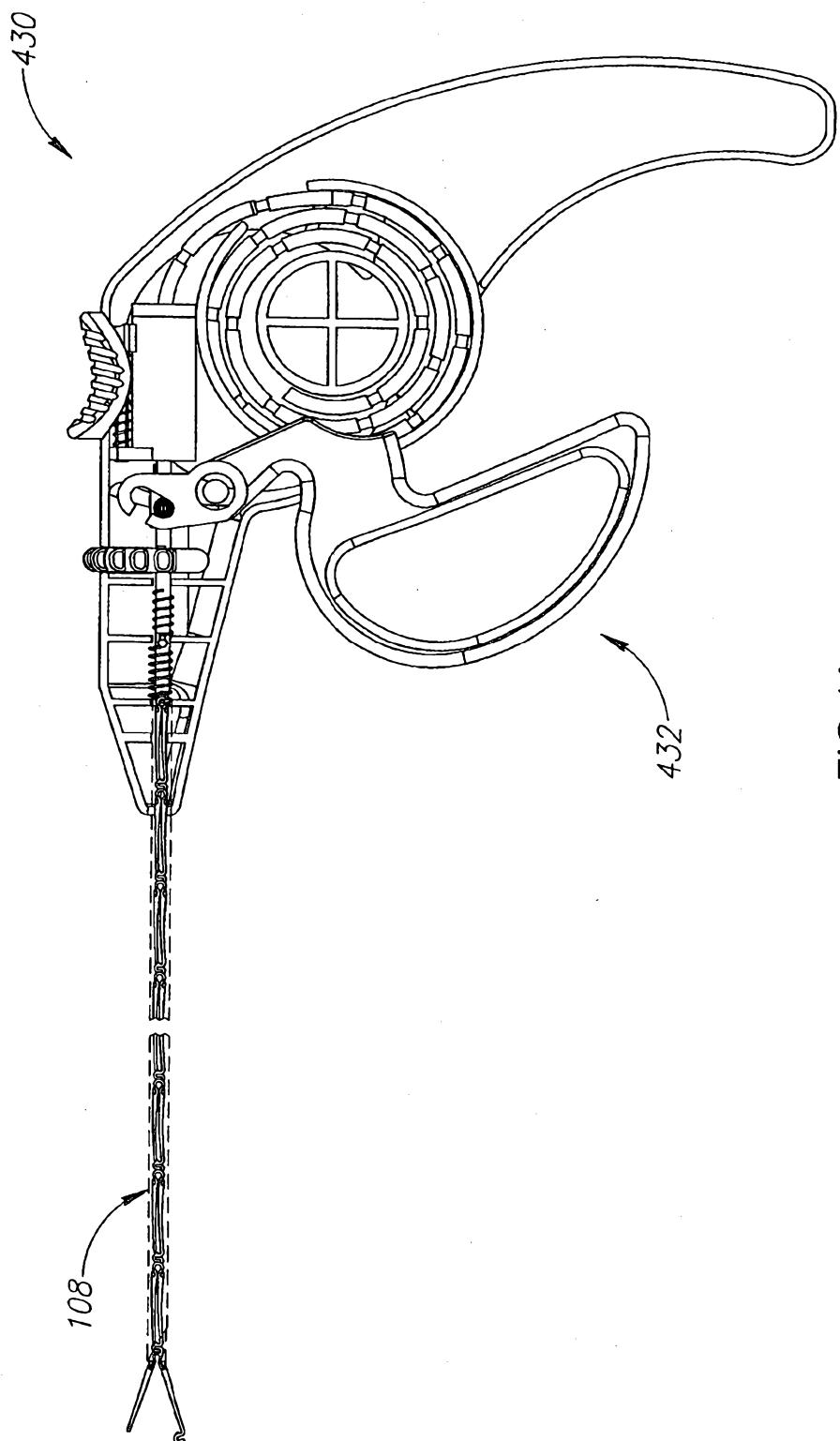


FIG.4A

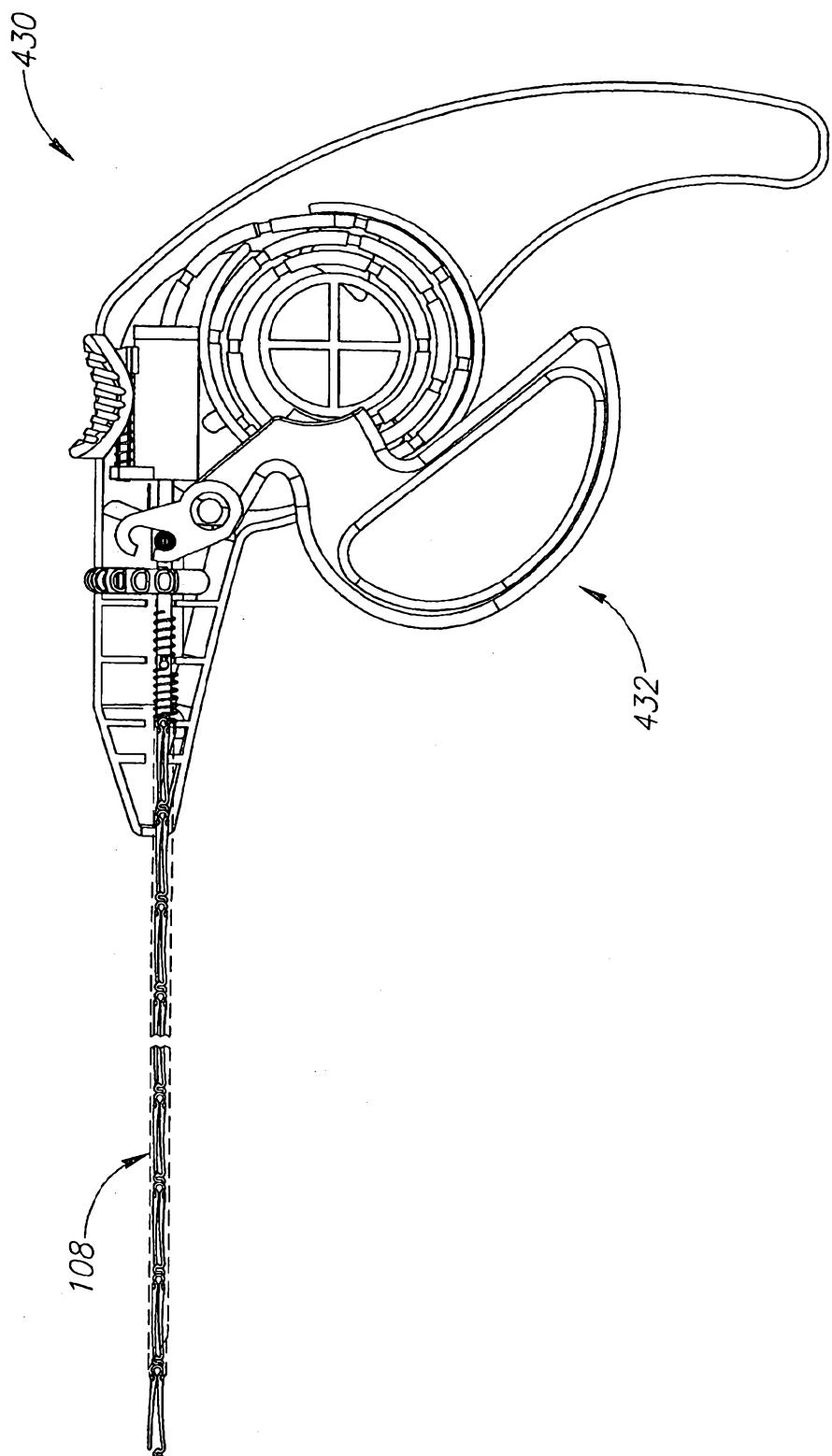


FIG.4B

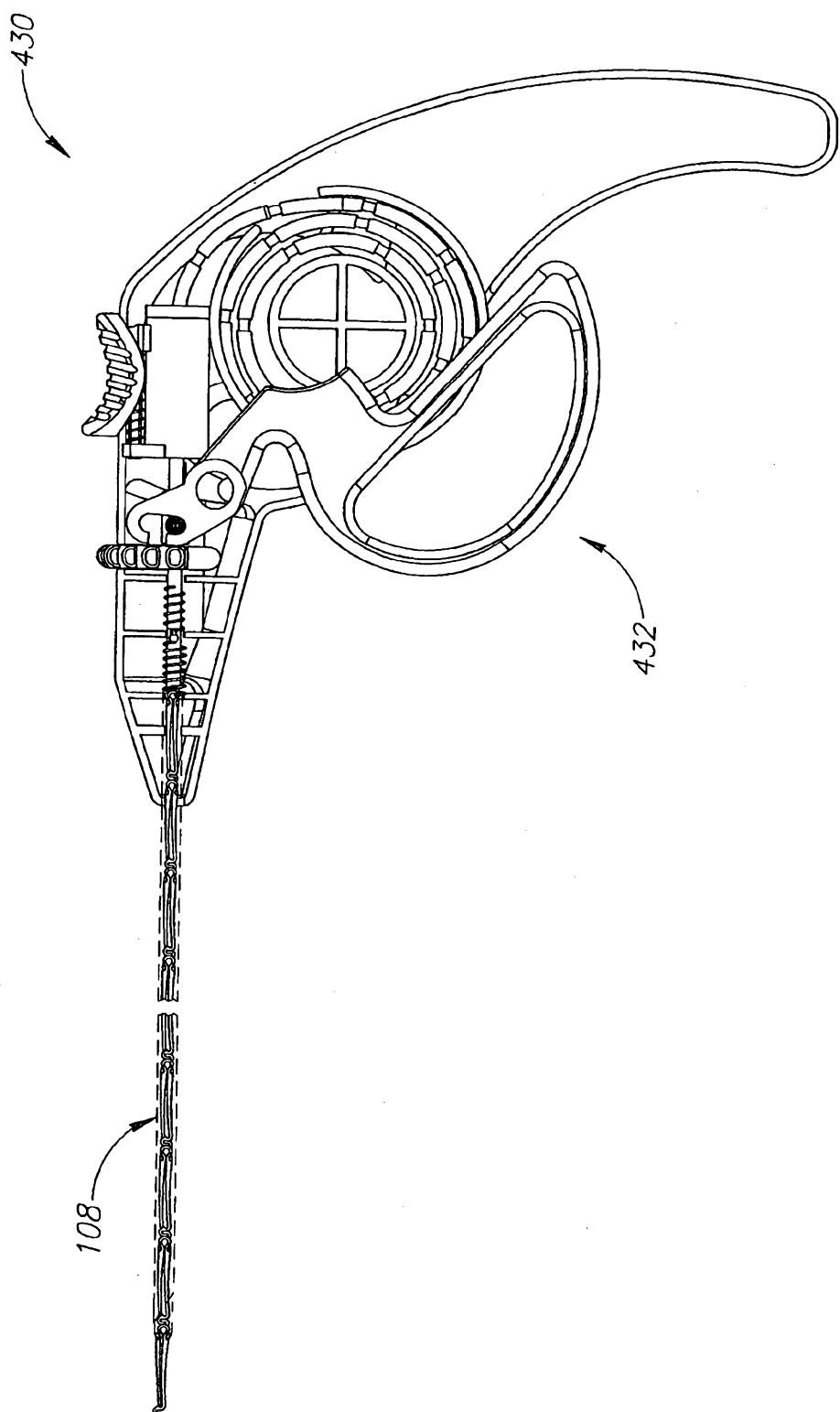


FIG.4C

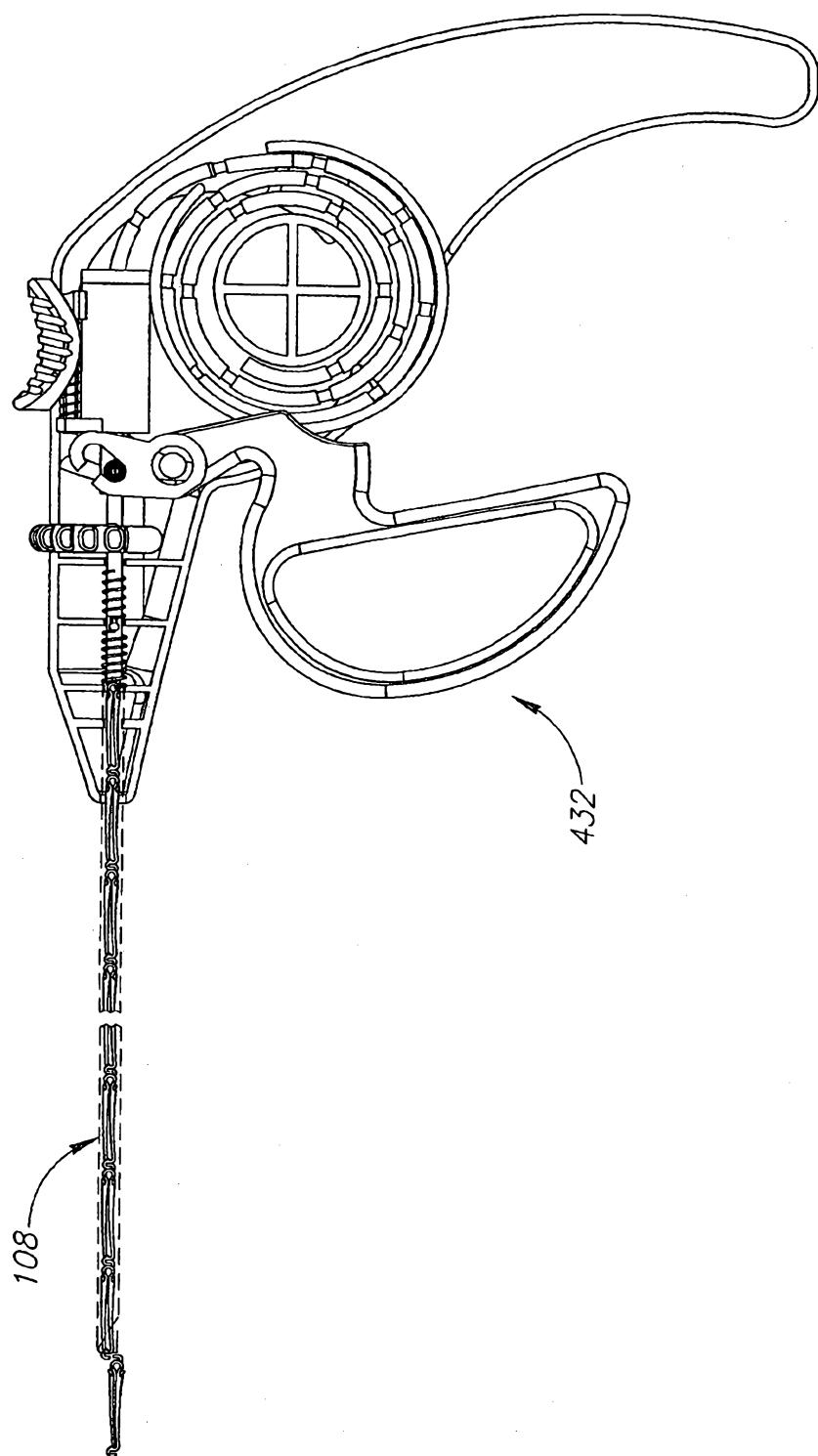


FIG.4D

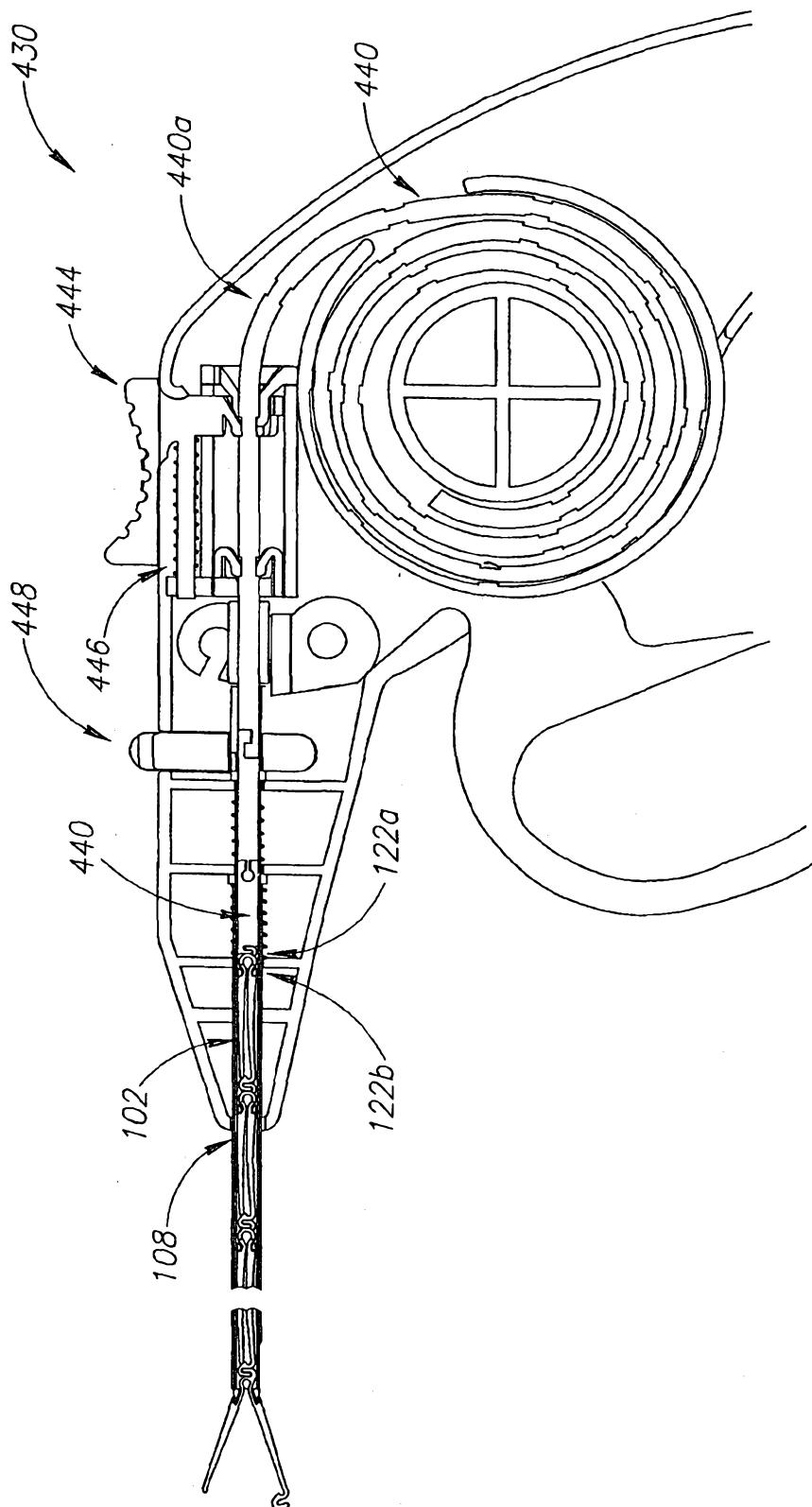
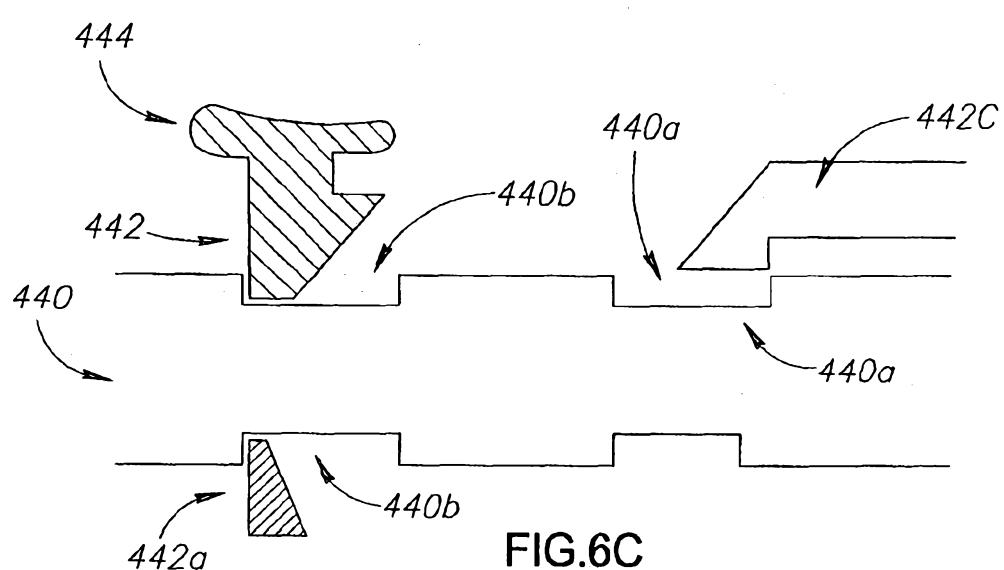
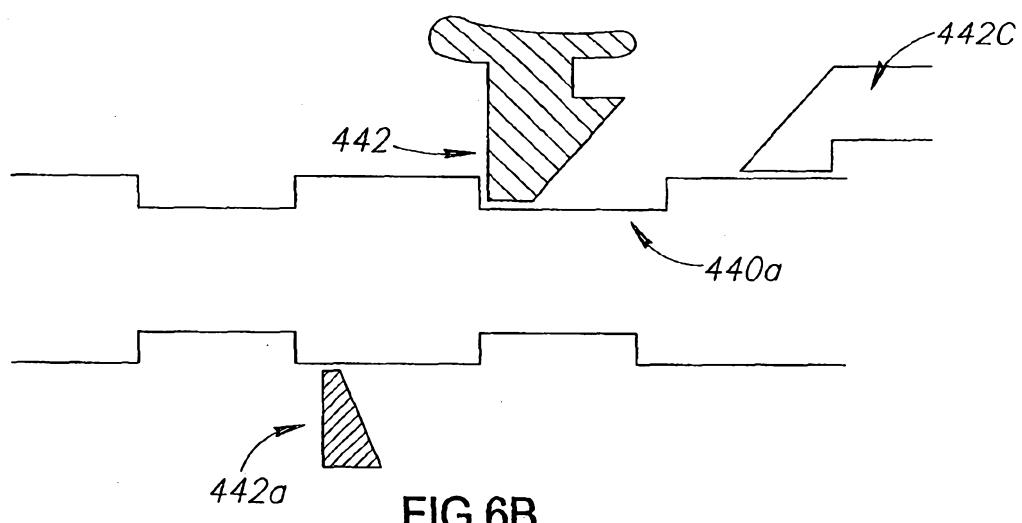
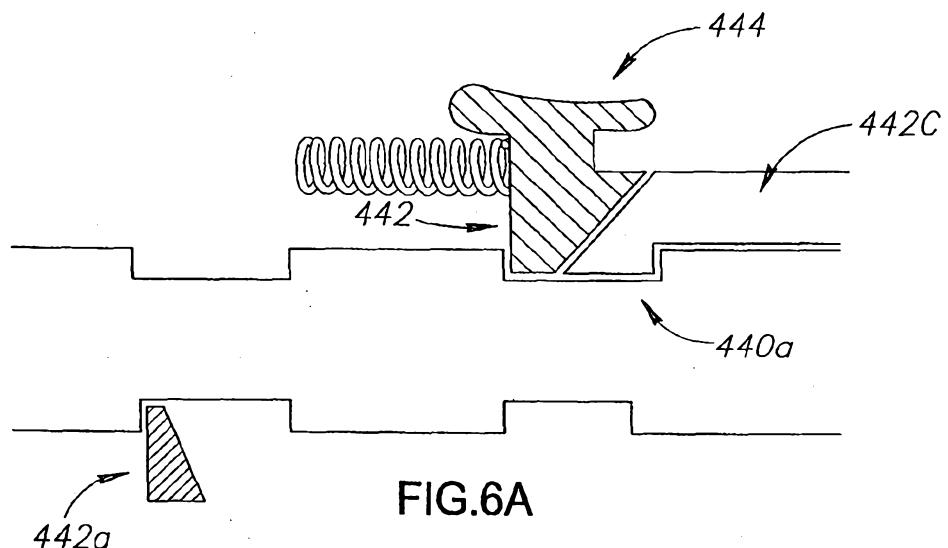
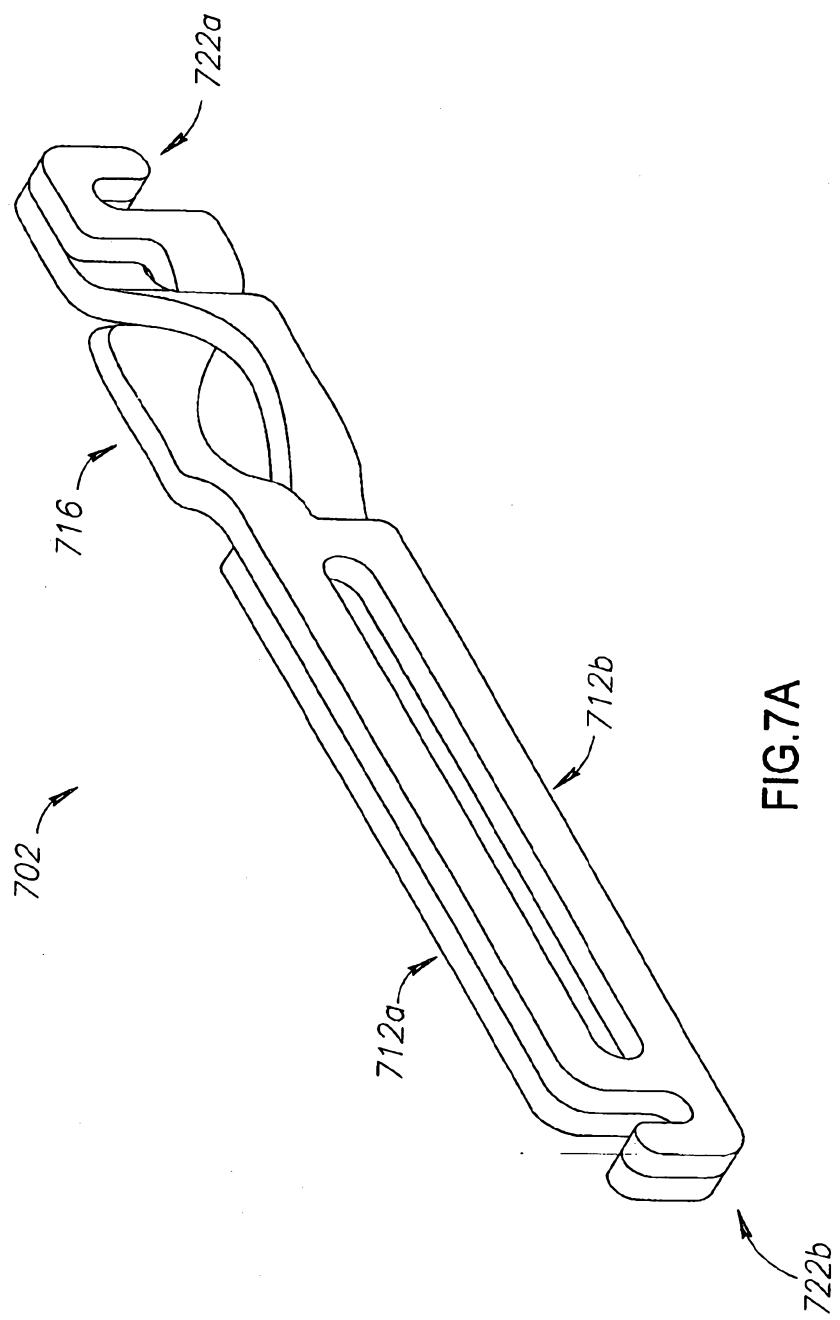


FIG.5

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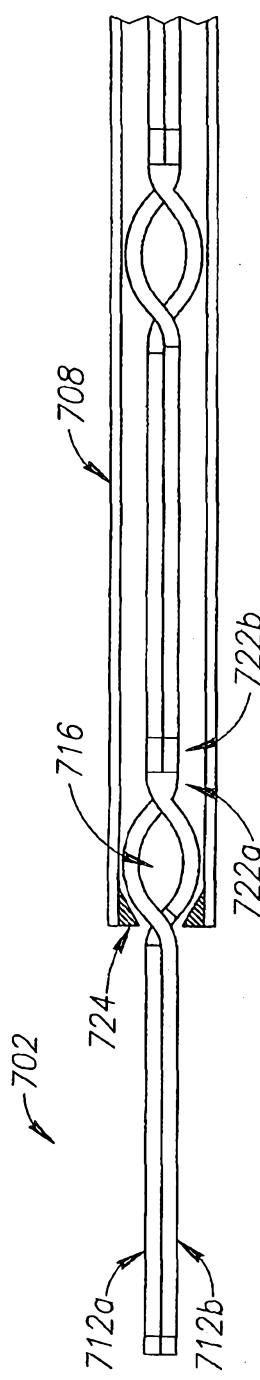


FIG.7B

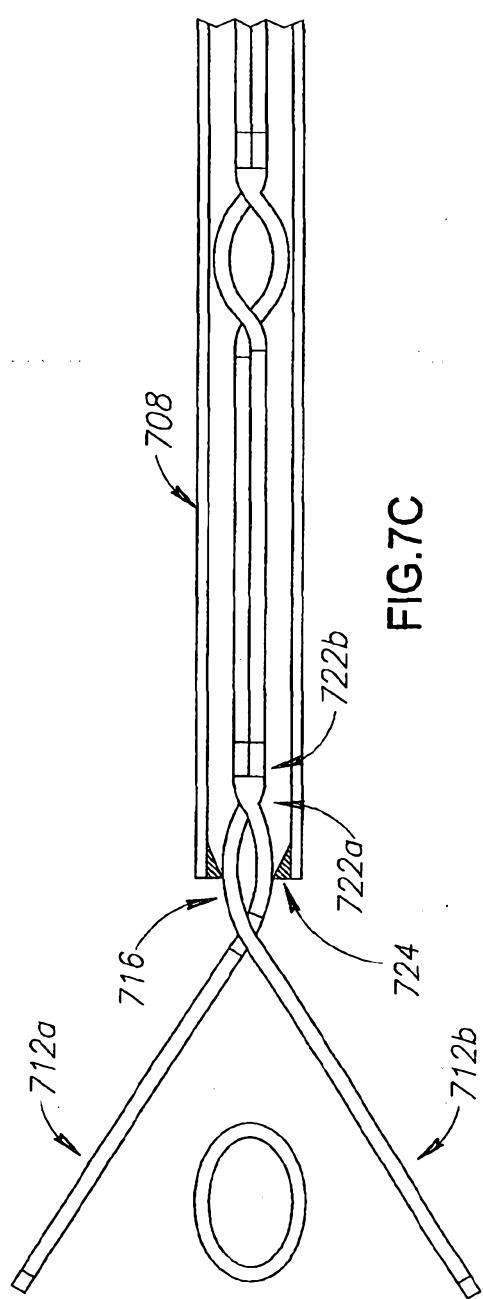


FIG.7C

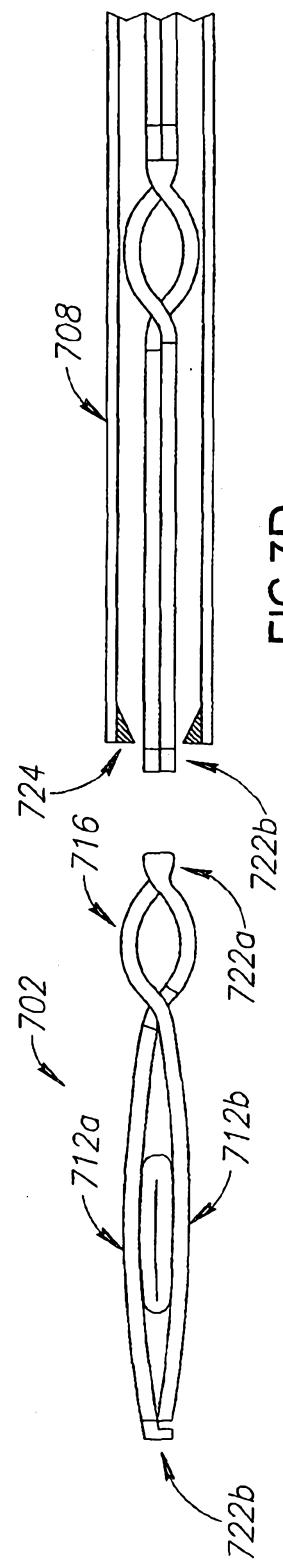


FIG.7D

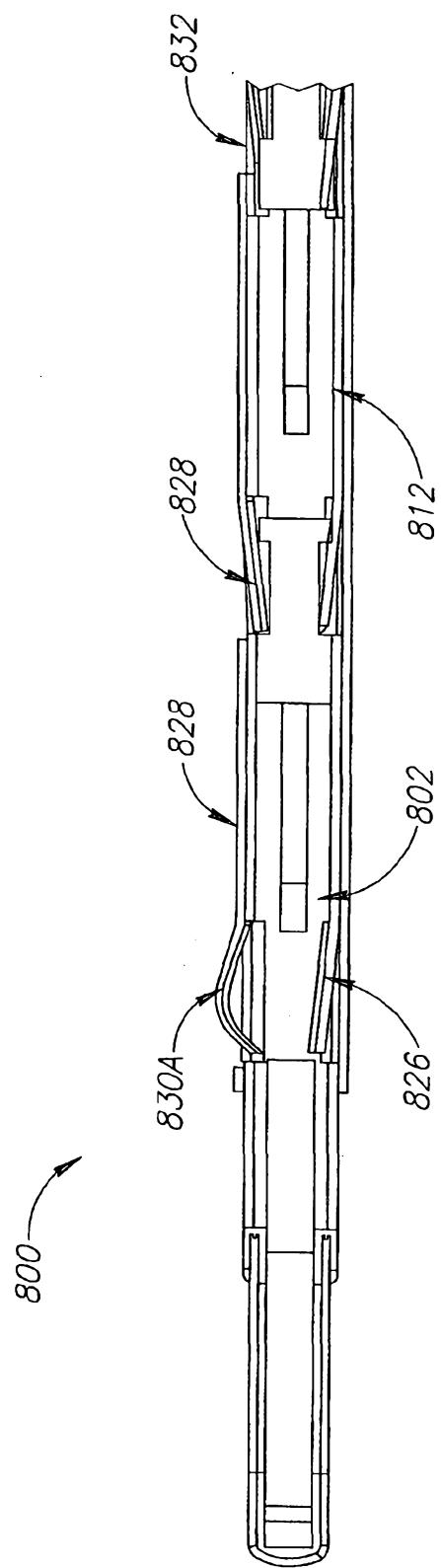


FIG.8