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(12) **United States Patent**
Scott et al.

(10) **Patent No.: US 10,524,773 B2**
(45) **Date of Patent: Jan. 7, 2020**

(54) **METHOD FOR INTRA-ABDOMINALLY MOVING AN ORGAN**

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(72) Inventors: **J. Stephen Scott**, Wentzville, MO (US); **Jeffrey Smith**, New Hope, PA (US)

(73) Assignee: **Freehold Surgical, Inc.**, New Hope, PA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 293 days.

(21) Appl. No.: **15/727,886**

(22) Filed: **Oct. 9, 2017**

(65) **Prior Publication Data**

US 2018/0028168 A1 Feb. 1, 2018

Related U.S. Application Data

(63) Continuation of application No. 15/604,366, filed on May 24, 2017, now Pat. No. 9,782,160, which is a (Continued)

(51) **Int. Cl.**
A61B 17/02 (2006.01)
A61B 17/04 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***A61B 17/0218*** (2013.01); ***A61B 17/0401*** (2013.01); ***A61B 17/0466*** (2013.01); ***A61B 17/0482*** (2013.01); ***A61B 17/0487*** (2013.01); ***A61B 17/062*** (2013.01); ***A61B 17/0643*** (2013.01); ***A61B 17/083*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC A61B 17/0218; A61B 17/0466; A61B 17/0401; A61B 17/083; A61B 17/062; A61B 17/0643; A61B 17/0487; A61B 17/0482; A61B 2017/0461; A61B 2017/0647; A61B 2017/06071; A61B 2017/06057; A61B 2017/0496;
(Continued)

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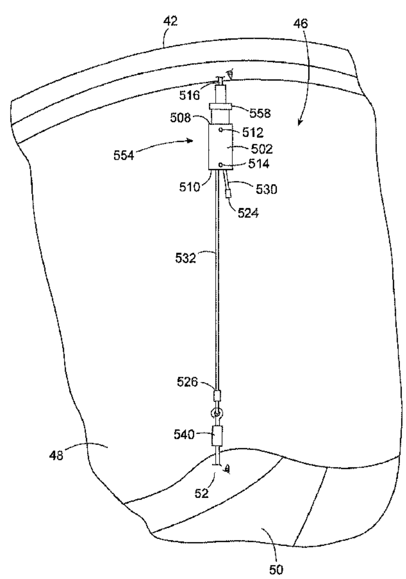
Primary Examiner — Kaylee R Wilson
(74) *Attorney, Agent, or Firm* — K. David Crockett, Esq.; Crockett & Crockett, PC

(57) **ABSTRACT**

A surgical tissue connector system for moving a first internal body tissue to a position away from a second internal body tissue and then holding the first internal body tissue in the position. Tissue connectors are secured to cords such that the length of cord between the tissue connectors can be easily adjusted in a laparoscopic work space.

16 Claims, 49 Drawing Sheets



Related U.S. Application Data

continuation of application No. 15/298,144, filed on Oct. 19, 2016, now Pat. No. 9,687,218, which is a continuation of application No. 14/240,928, filed as application No. PCT/US2011/001494 on Aug. 25, 2011, now abandoned.

(51) **Int. Cl.**

A61B 17/064	(2006.01)
A61B 17/062	(2006.01)
A61B 17/08	(2006.01)
A61B 17/06	(2006.01)

(52) **U.S. Cl.**

CPC *A61B 2017/0225* (2013.01); *A61B 2017/0417* (2013.01); *A61B 2017/0448* (2013.01); *A61B 2017/0461* (2013.01); *A61B 2017/0464* (2013.01); *A61B 2017/0496* (2013.01); *A61B 2017/0647* (2013.01); *A61B 2017/06057* (2013.01); *A61B 2017/06071* (2013.01)

(58) **Field of Classification Search**

CPC A61B 2017/0464; A61B 2017/0448; A61B 2017/0417; A61B 2017/0225

See application file for complete search history.

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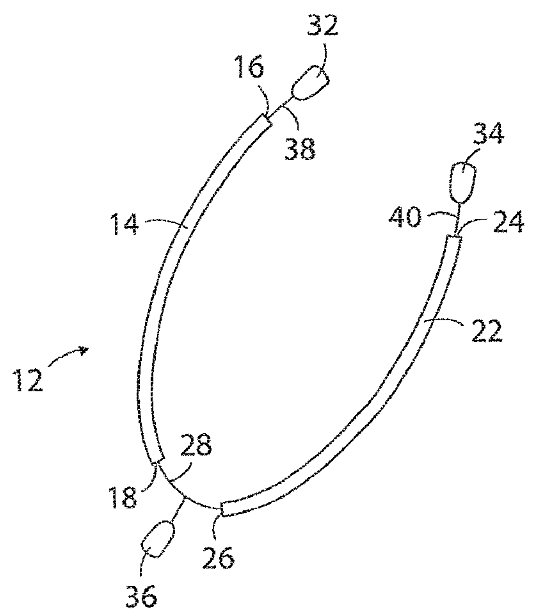


FIG. 1

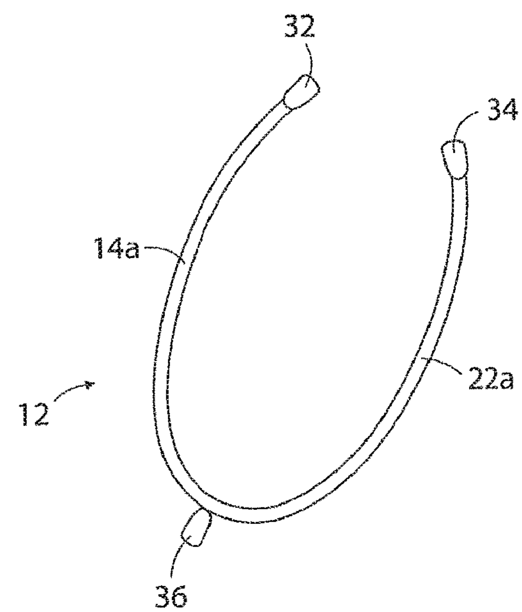


FIG. 2

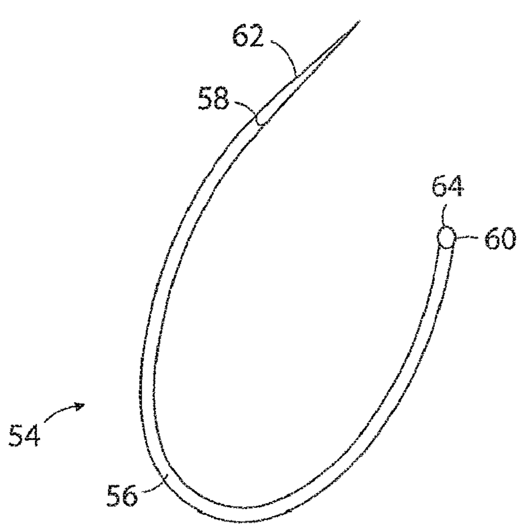
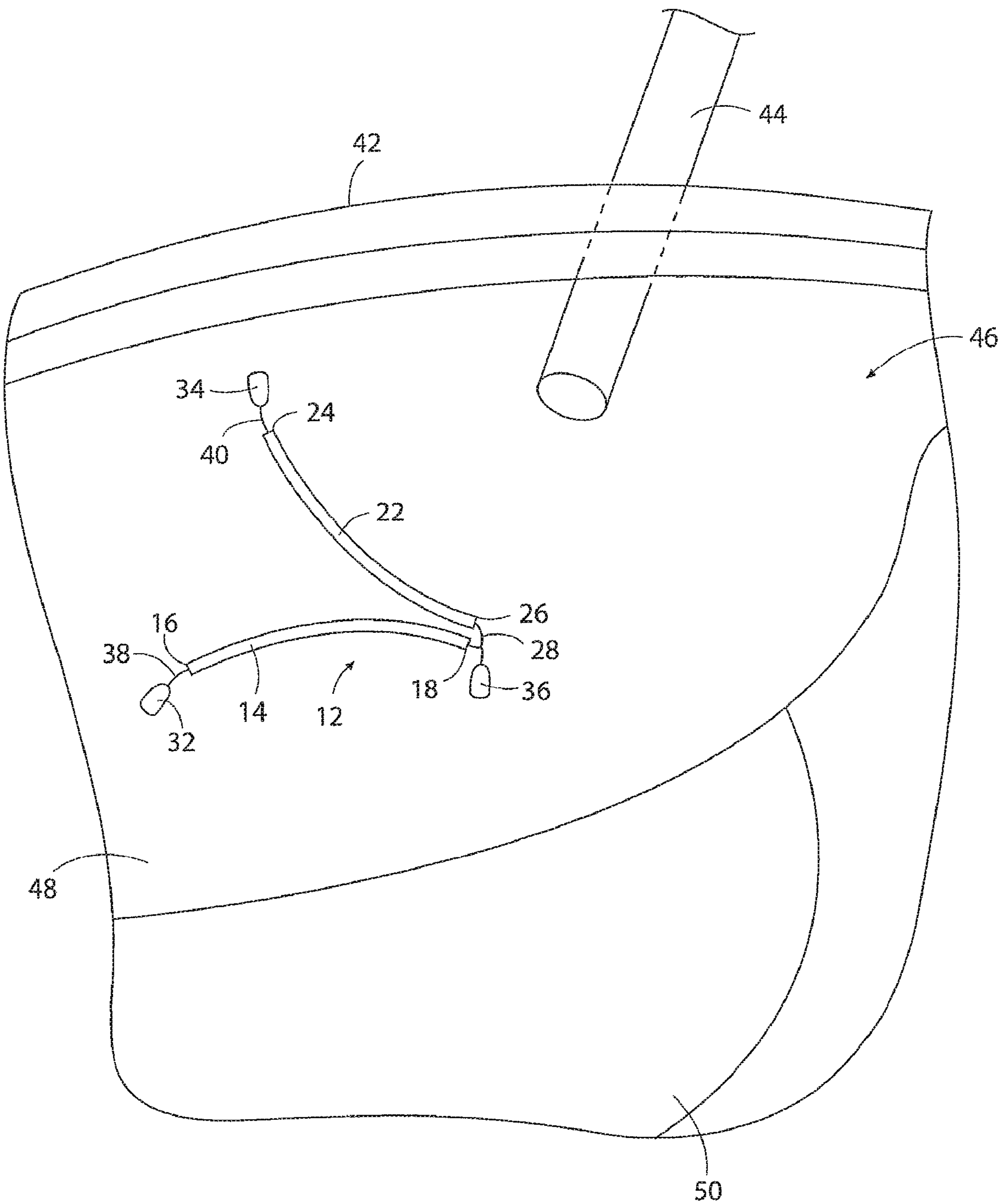


FIG. 3



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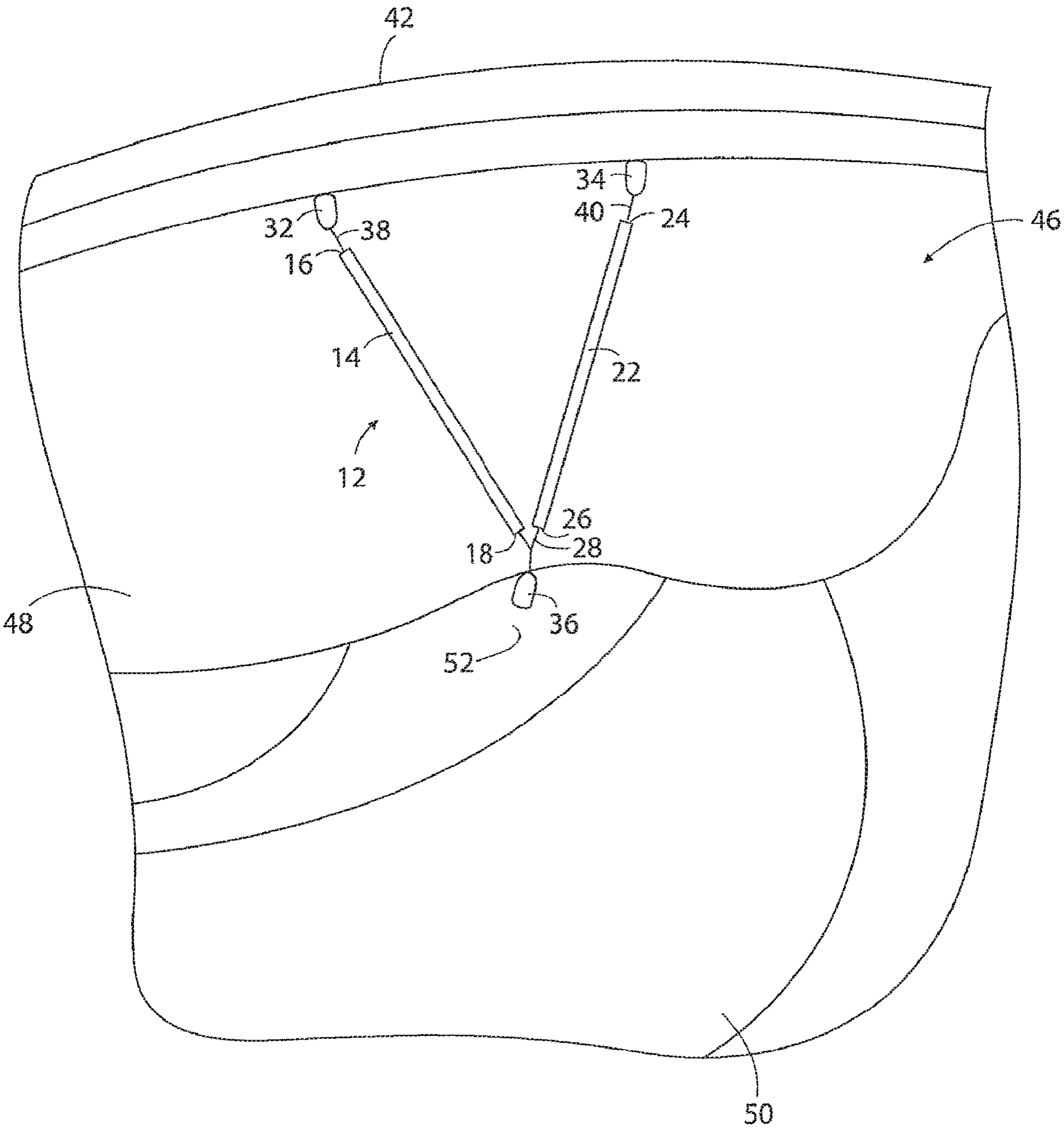

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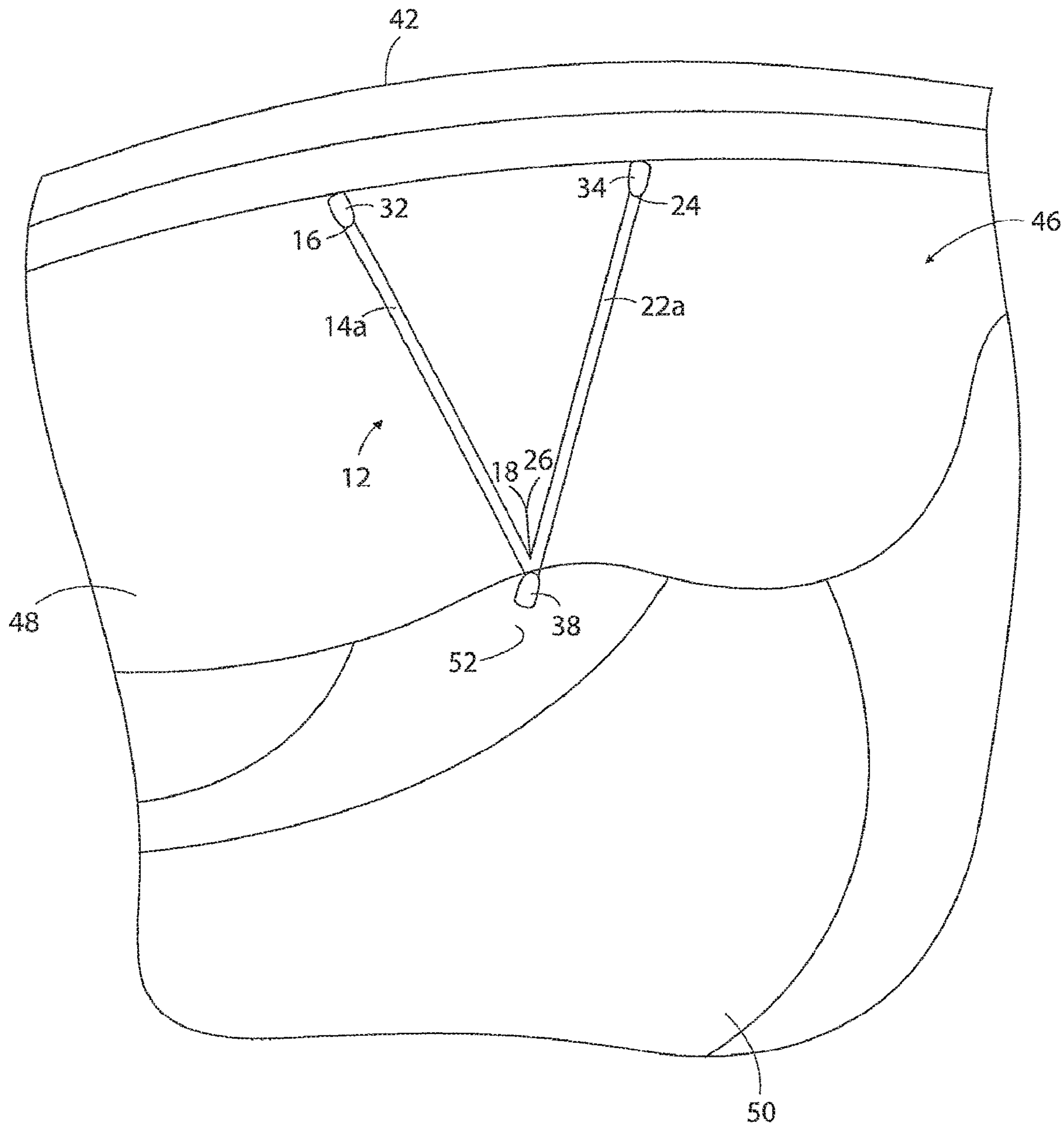

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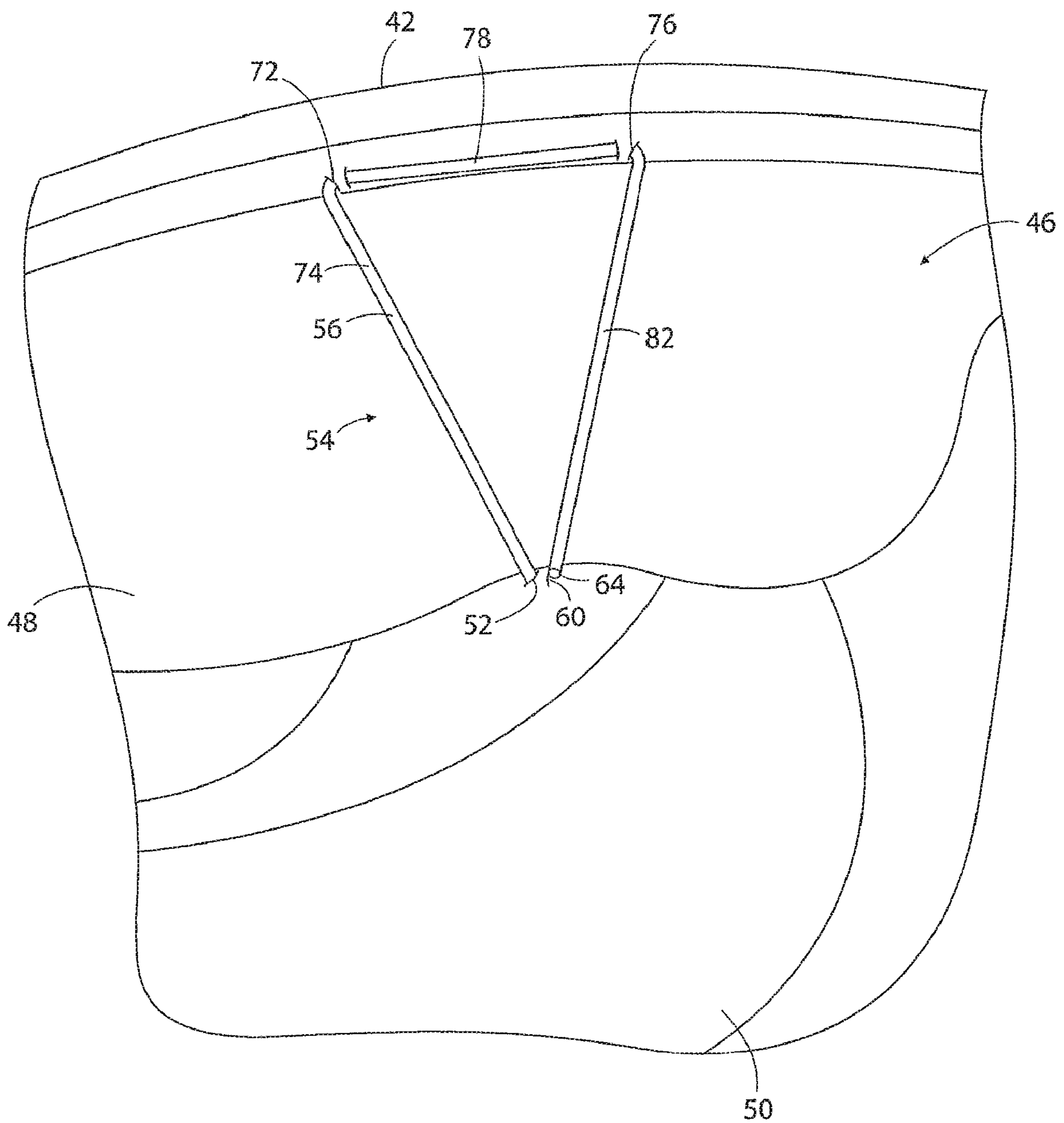

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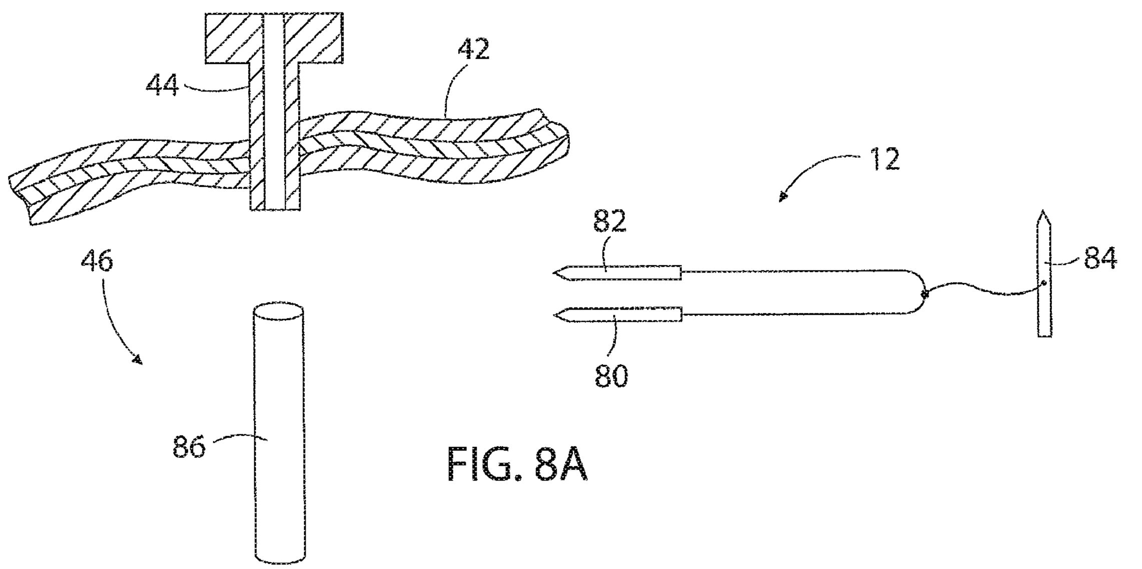


FIG. 8A

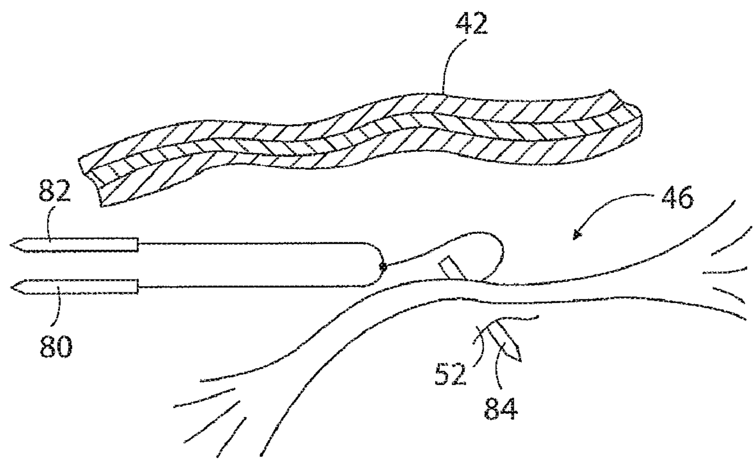


FIG. 8B

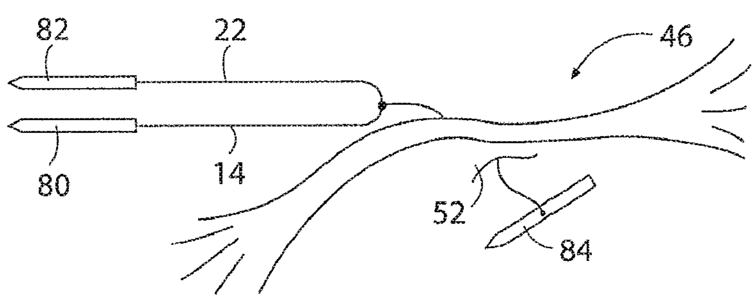


FIG. 8C

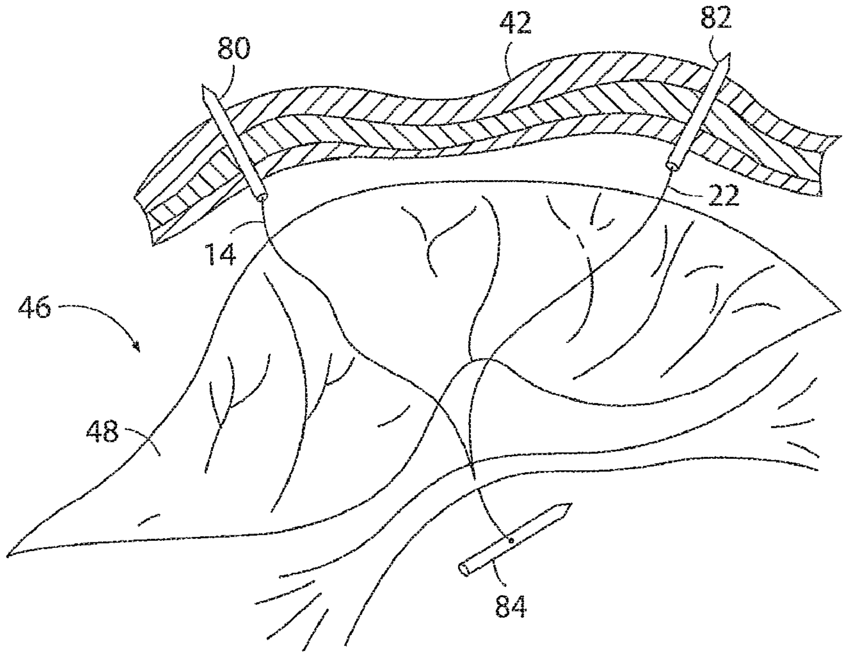
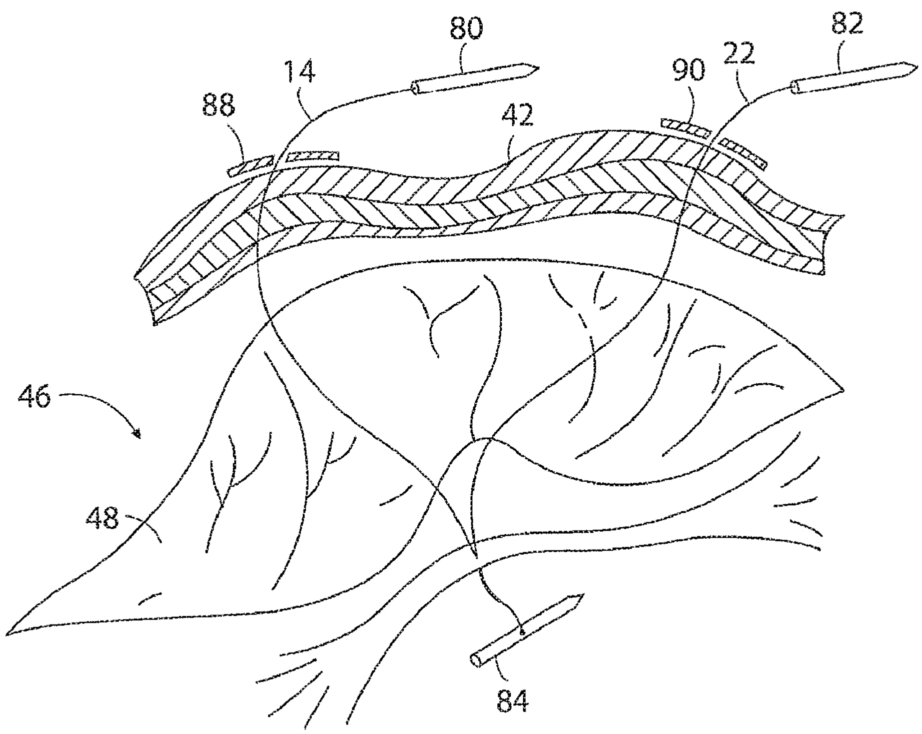


FIG. 8D



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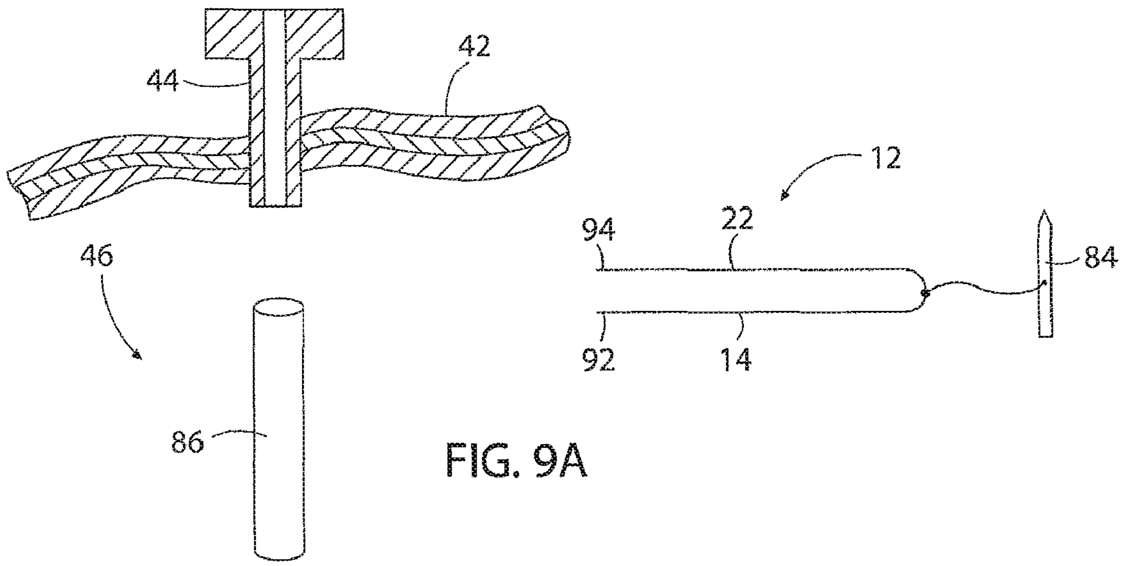
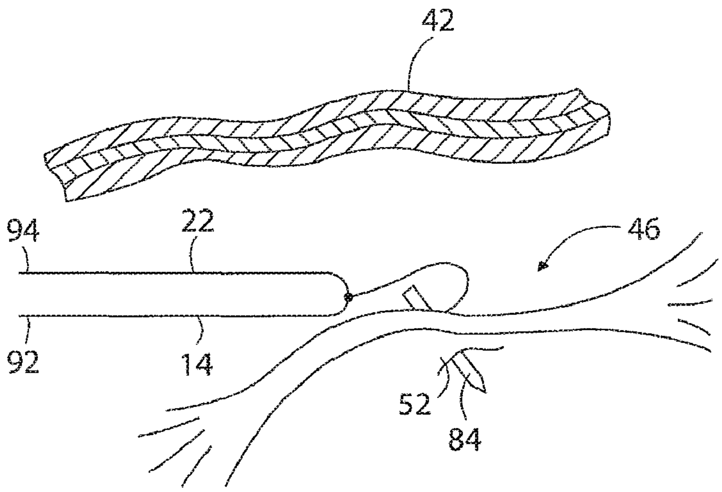


FIG. 9A



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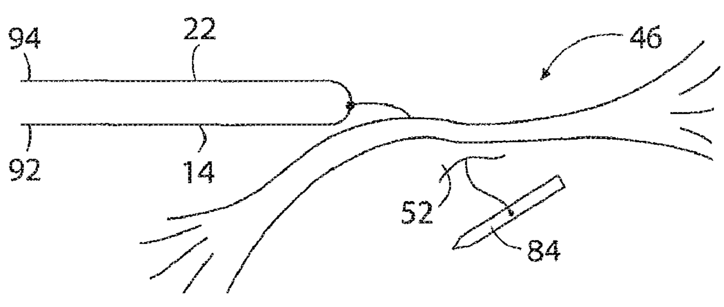


FIG. 9C

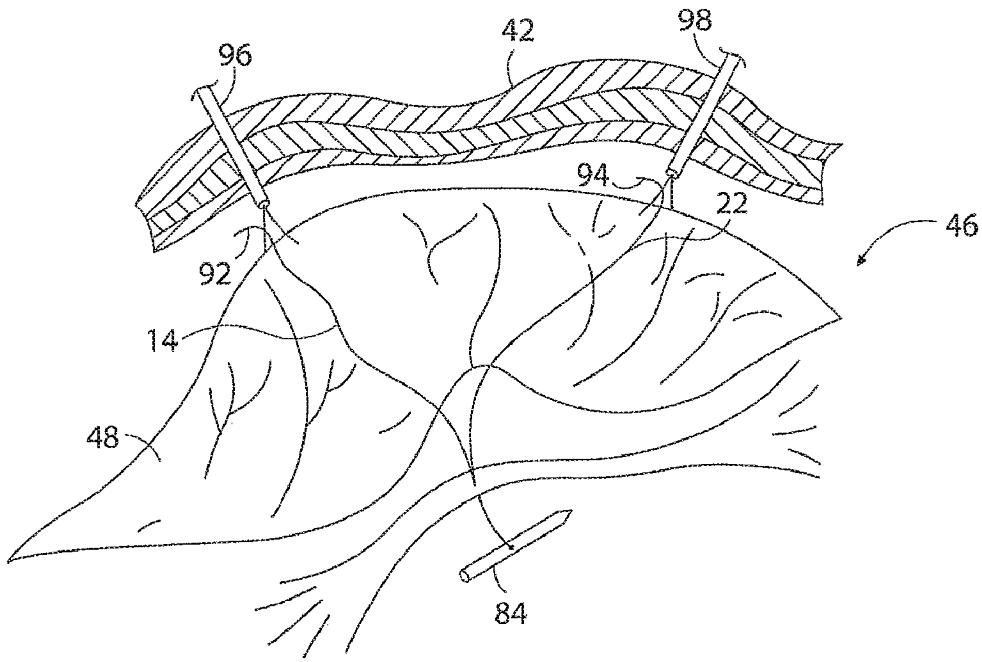


FIG. 9D

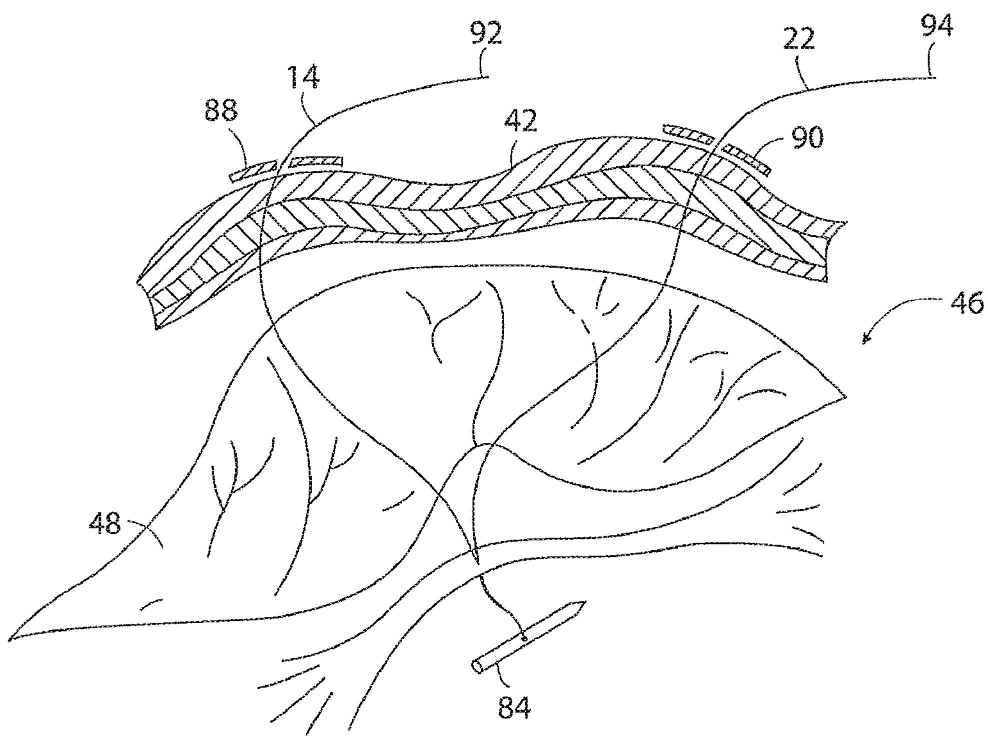


FIG. 9E

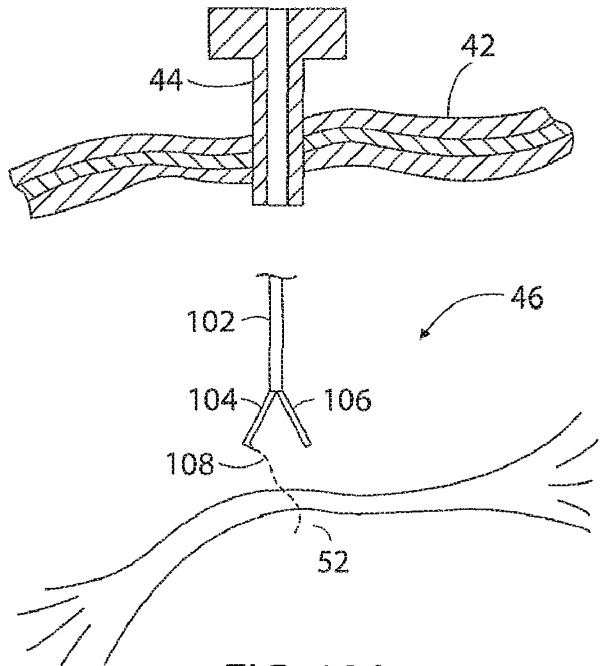
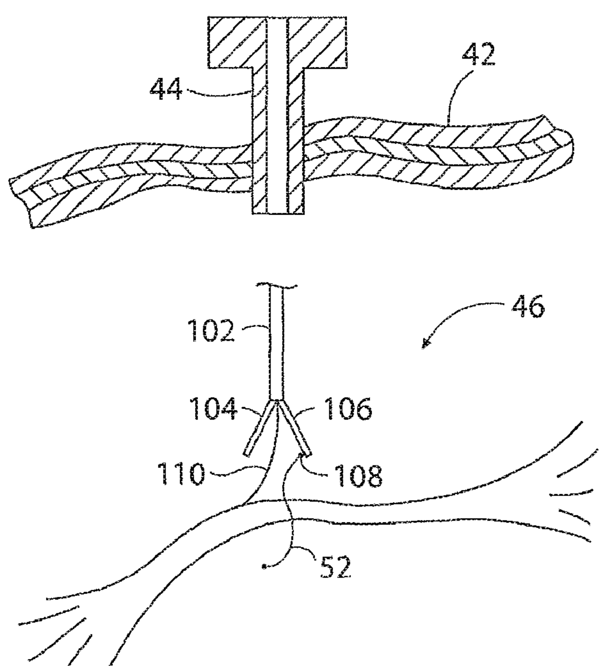


FIG. 10A



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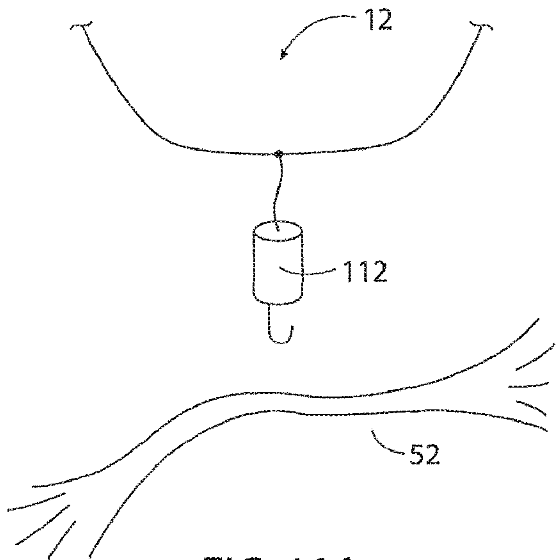


FIG. 11A

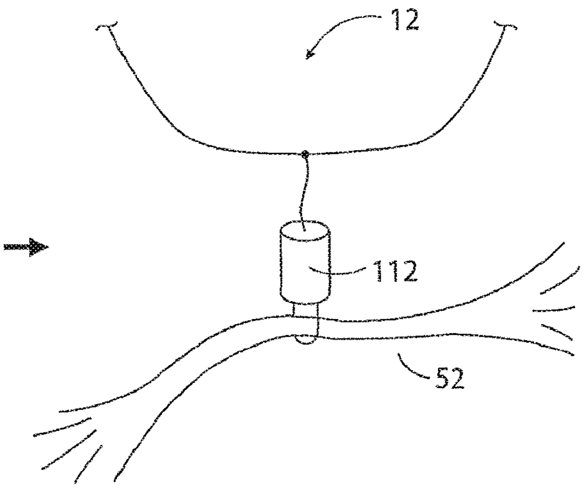


FIG. 11B

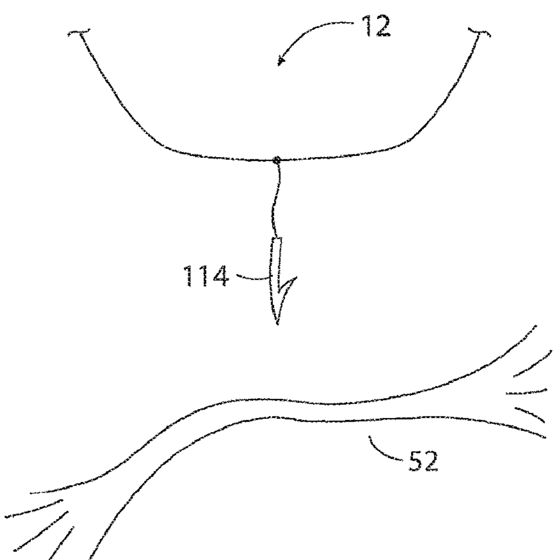


FIG. 12A

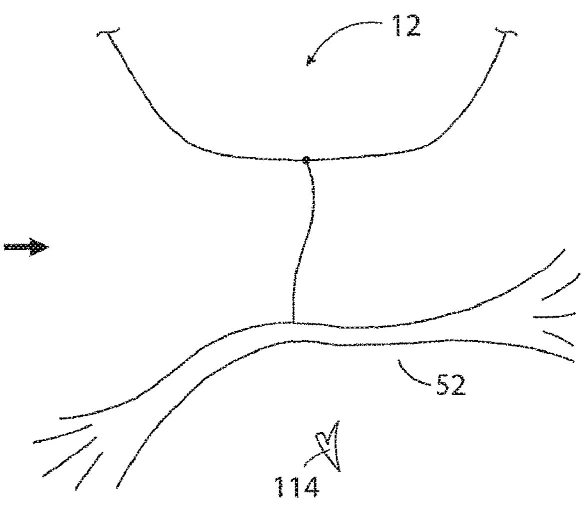


FIG. 12B

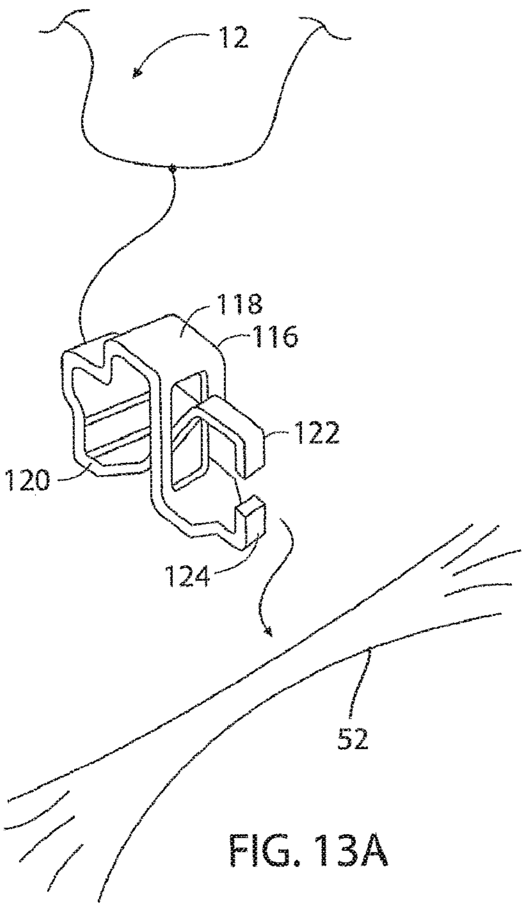
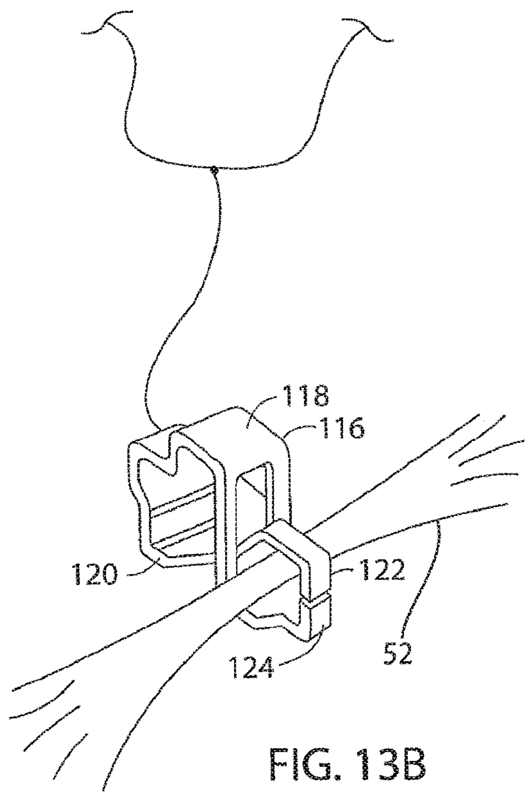


FIG. 13A



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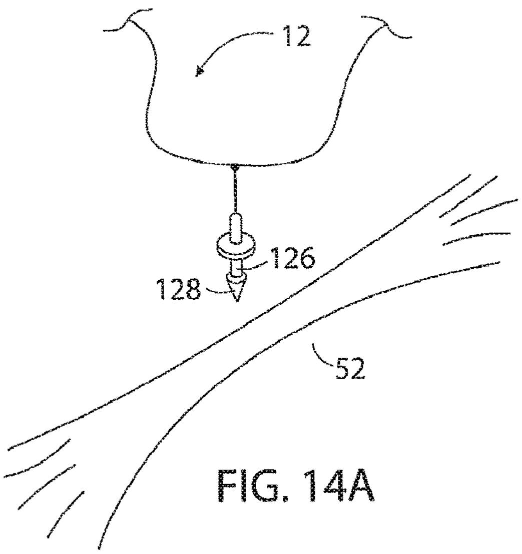
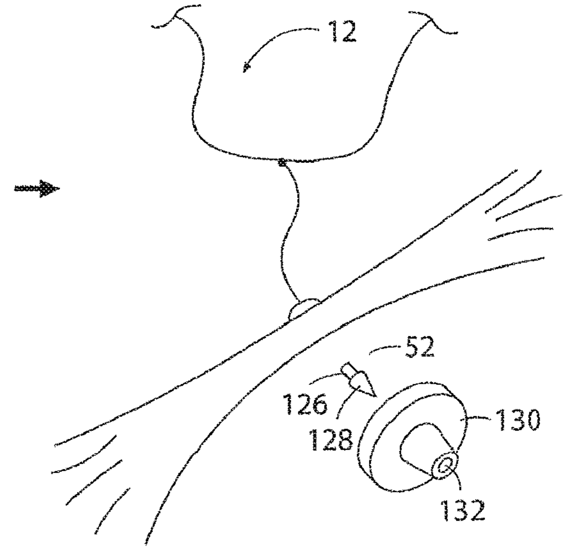


FIG. 14A



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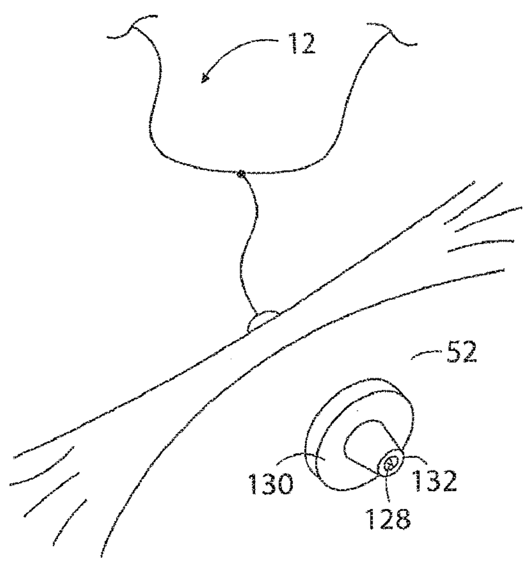


FIG. 14C

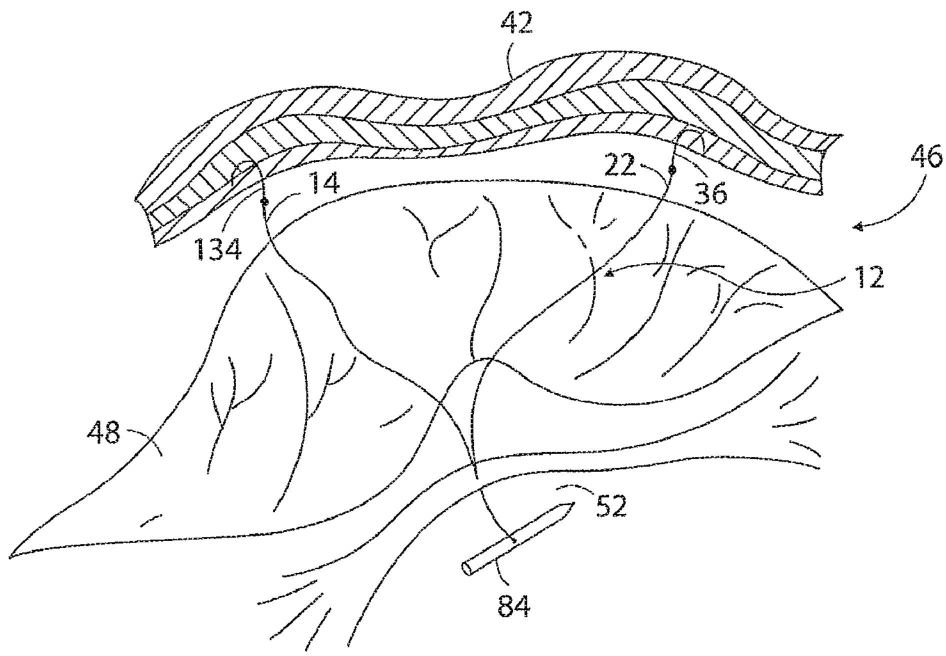


FIG. 15B

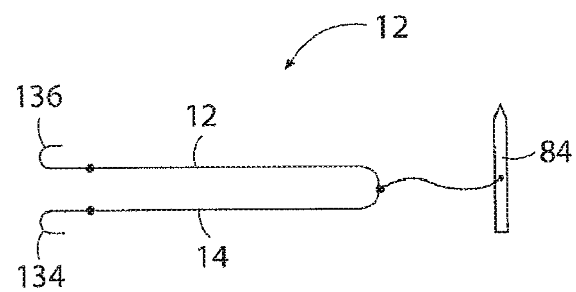


FIG.15A

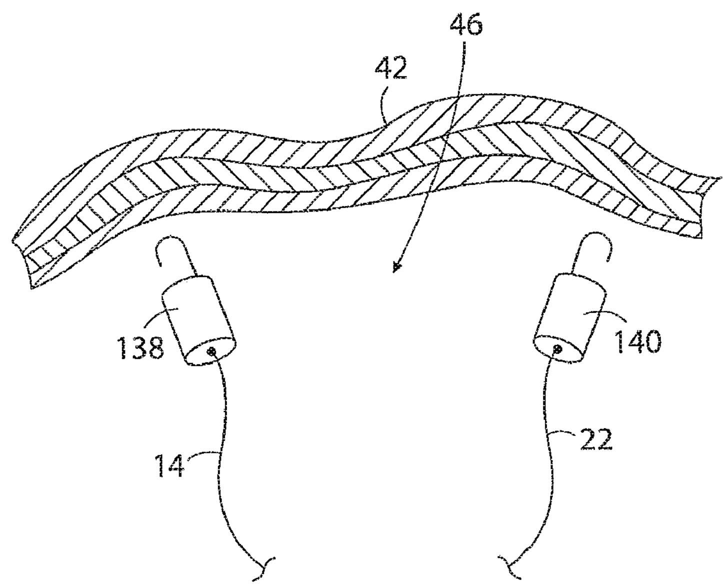
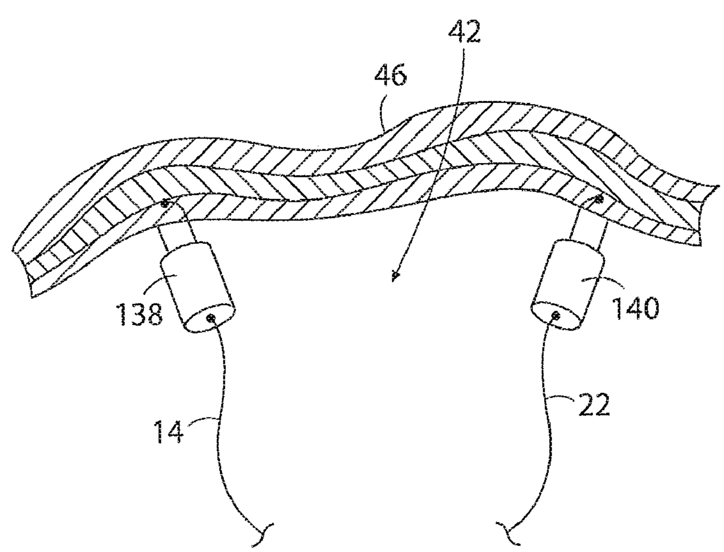


FIG. 16A



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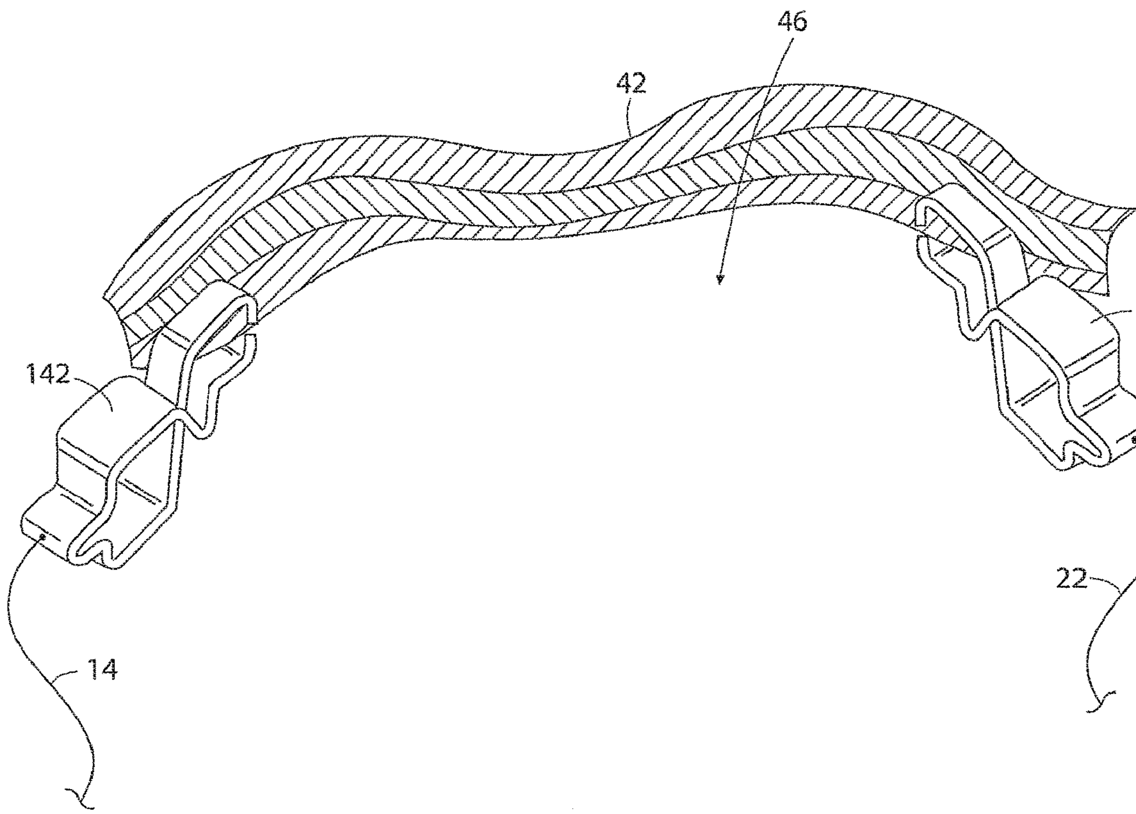


FIG. 17

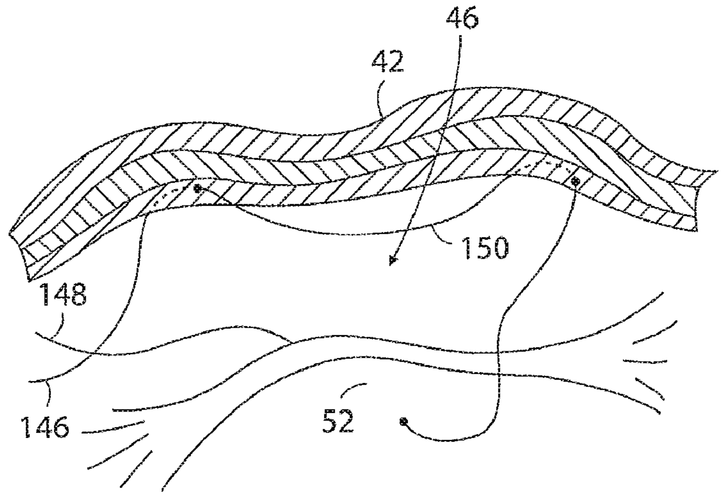


FIG. 18A

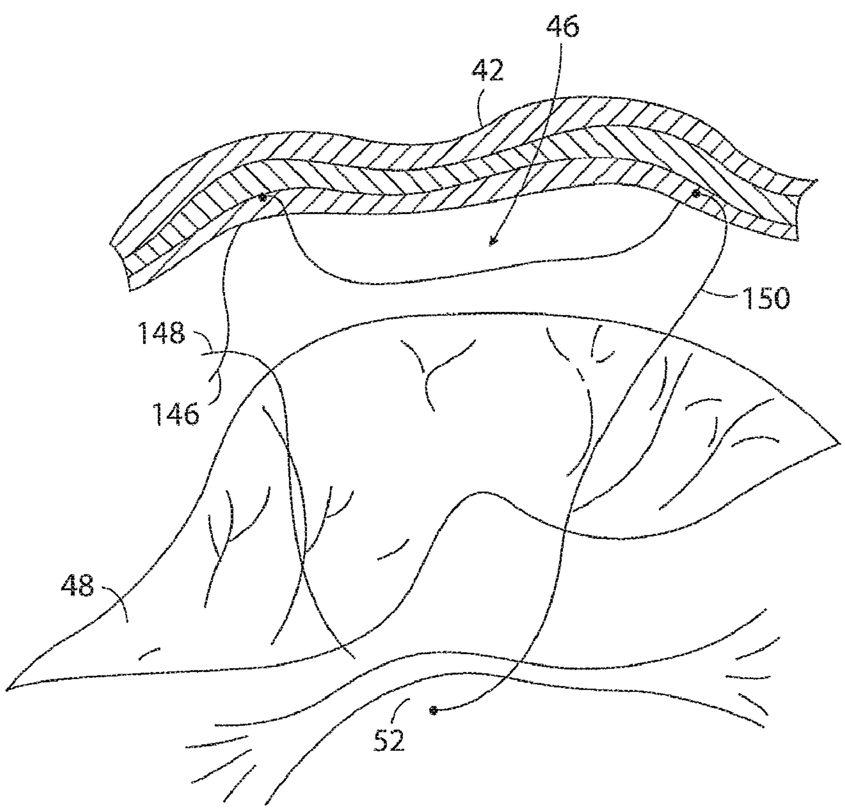


FIG. 18B

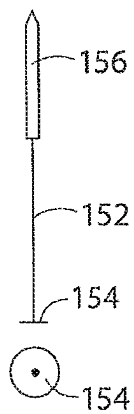


FIG. 19A

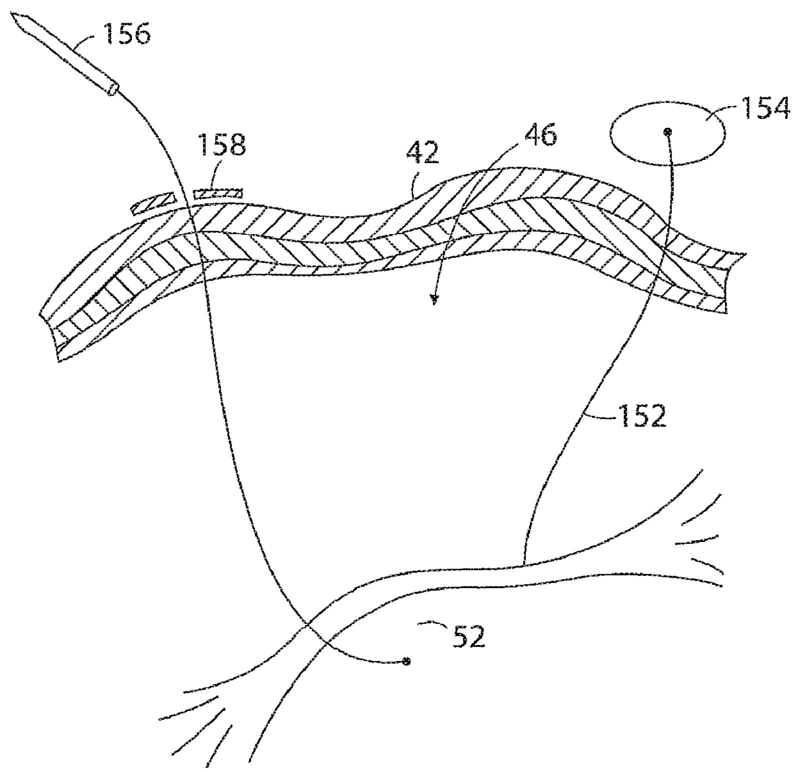
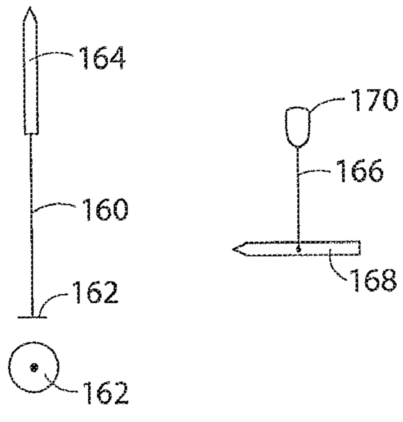


FIG. 19B



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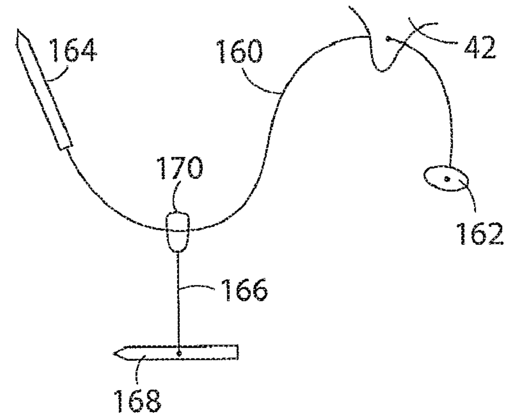


FIG. 20B

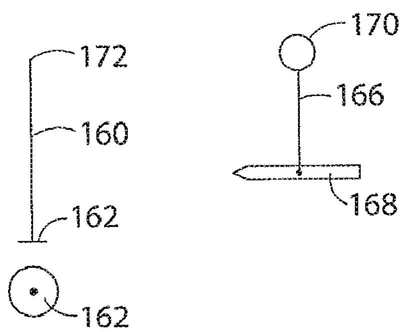
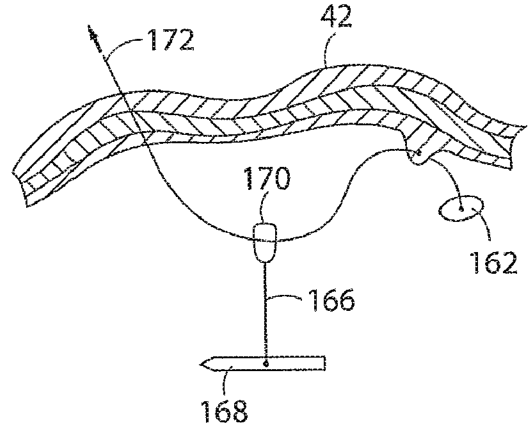


FIG. 21A



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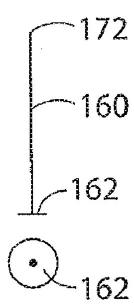


FIG. 22A

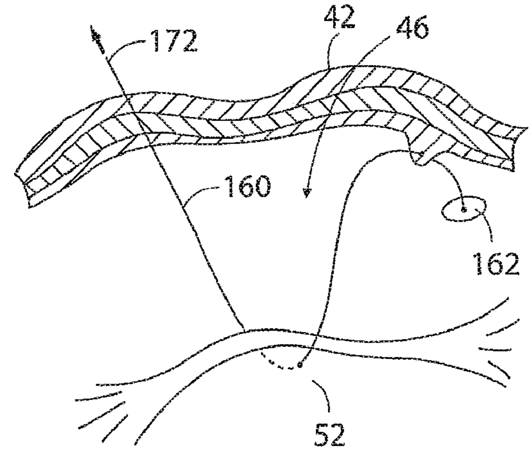


FIG. 22B

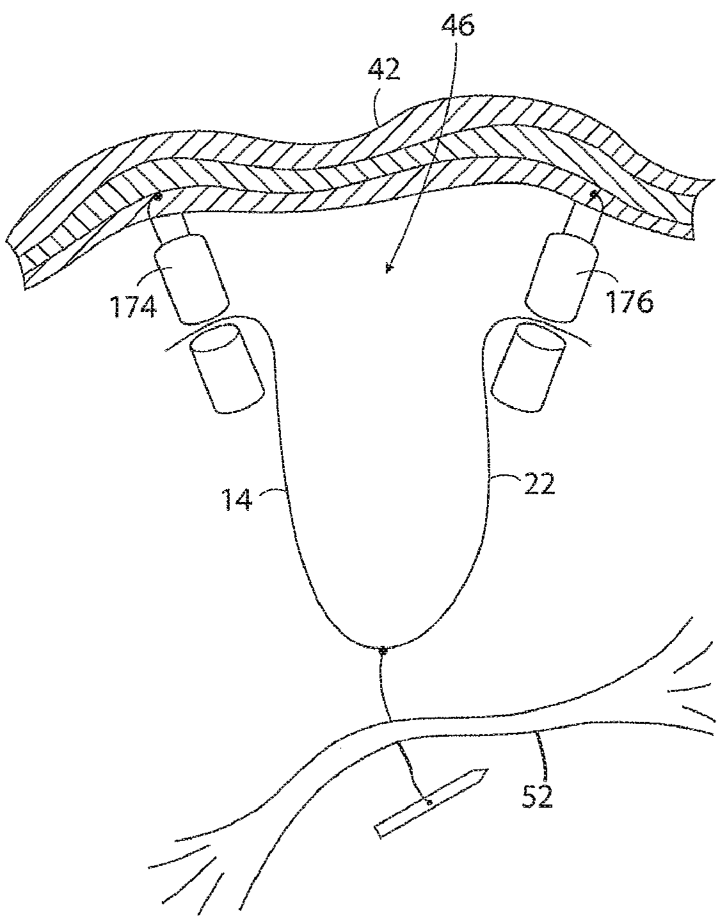


FIG. 23

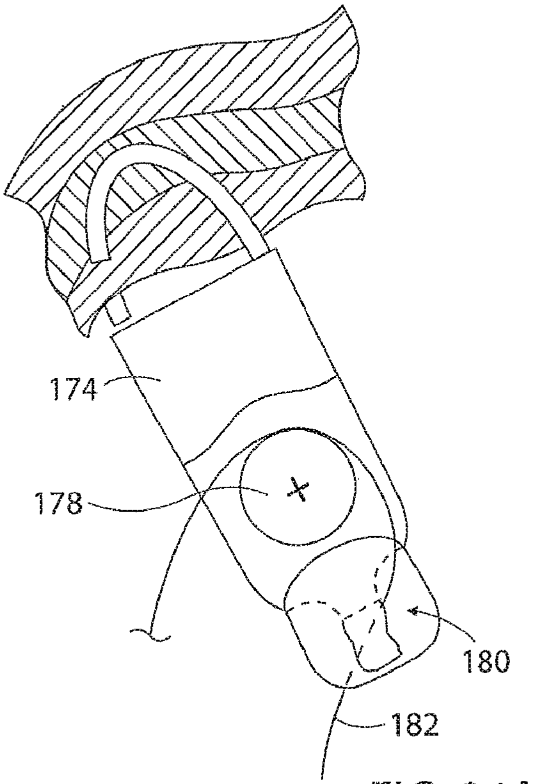


FIG. 24A

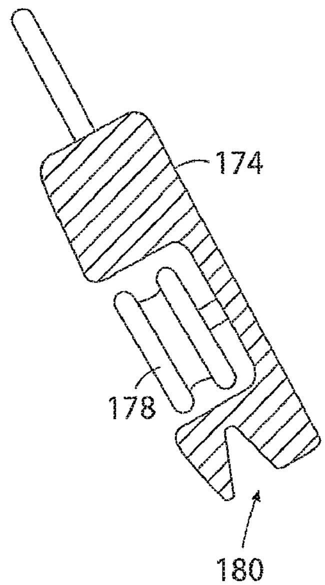


FIG. 24B

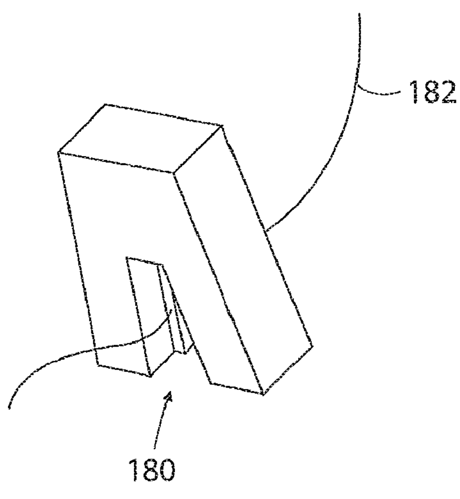


FIG. 24C

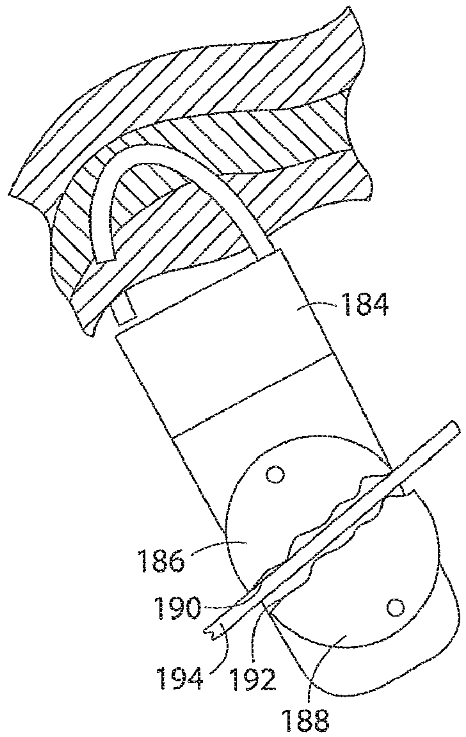


FIG. 25

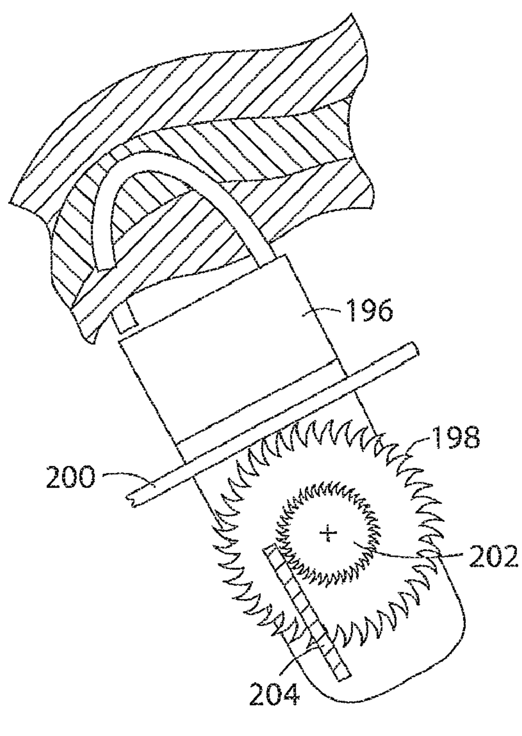


FIG. 26

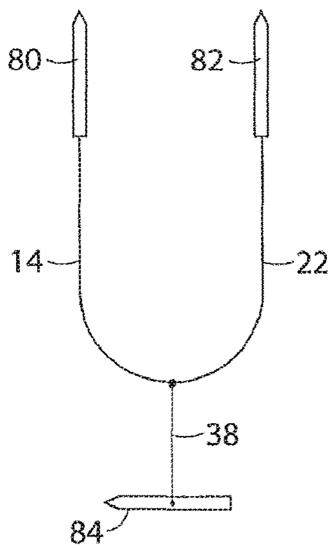


FIG. 27

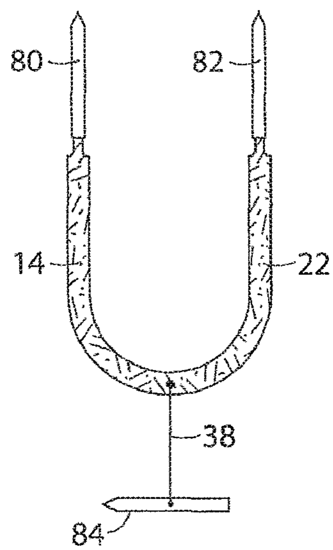
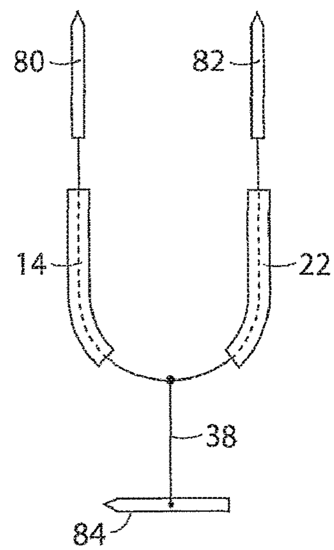


FIG. 28



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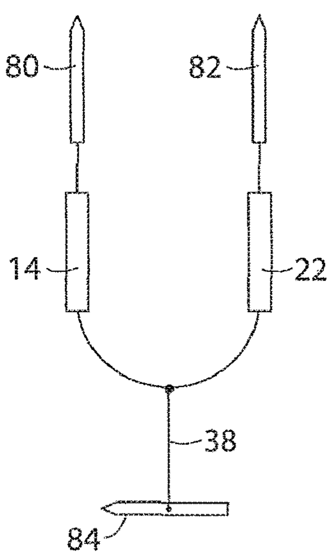


FIG. 30

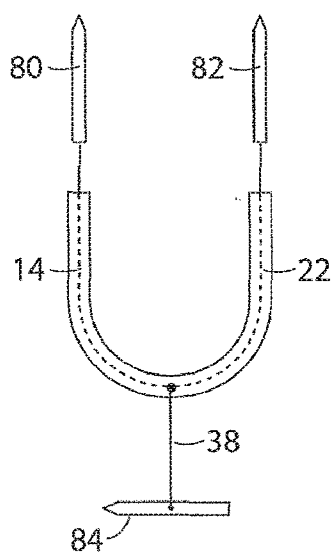


FIG. 31

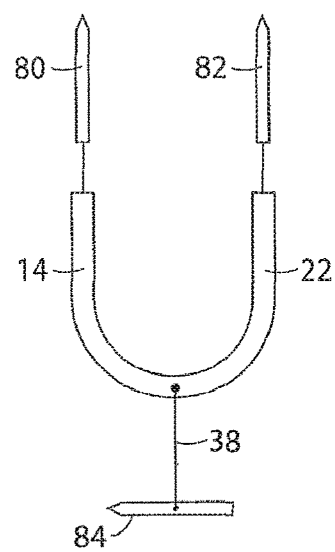


FIG. 32

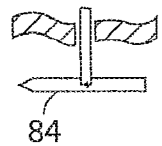


FIG. 33

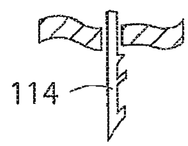


FIG. 34

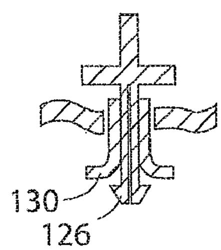


FIG. 35

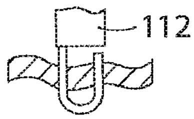


FIG. 36

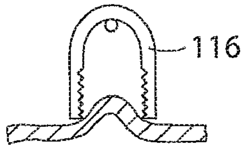


FIG. 37

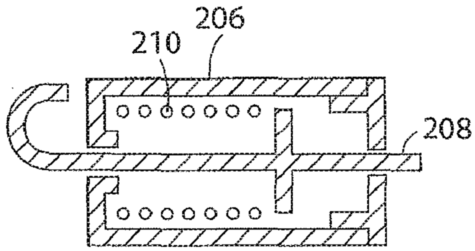


FIG. 38

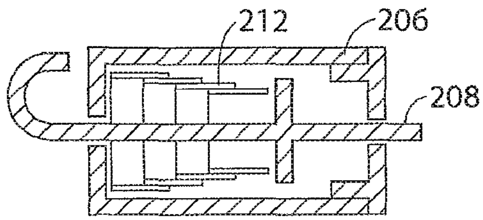


FIG. 39A

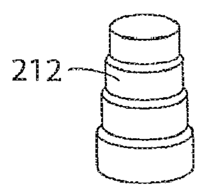


FIG. 39B

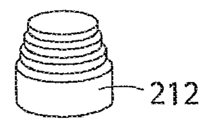


FIG. 39C

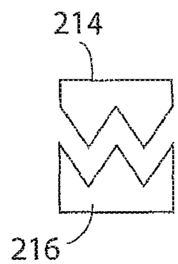


FIG. 40B

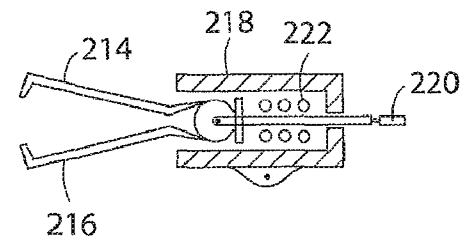


FIG. 40A

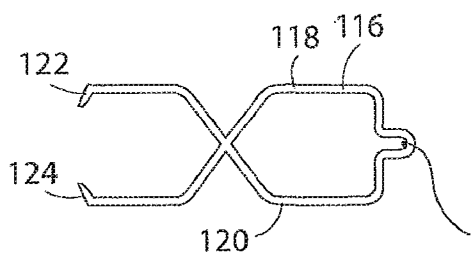


FIG. 41

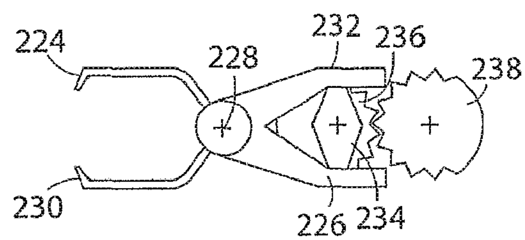


FIG. 42

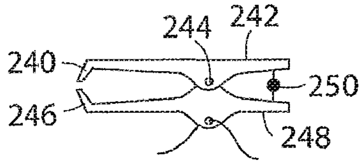


FIG. 43

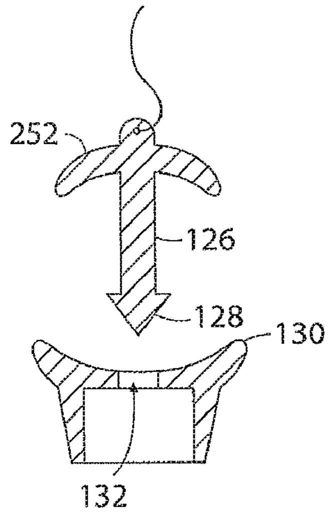


FIG. 44A

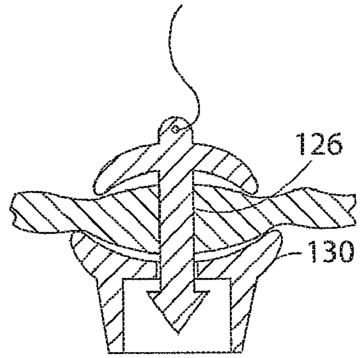


FIG. 44B

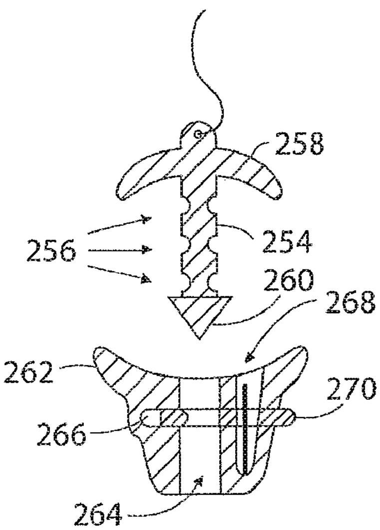


FIG. 45A

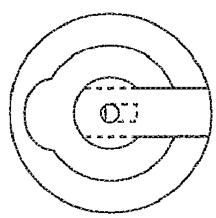


FIG. 45B

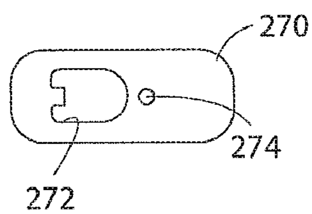


FIG. 45C

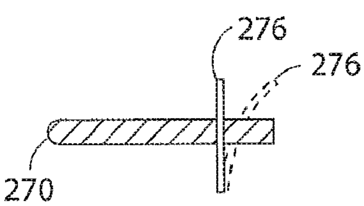


FIG. 45D

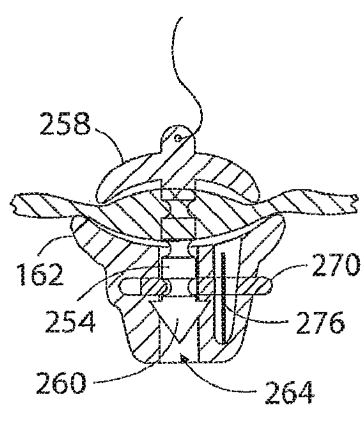


FIG. 45E

FIG. 46A

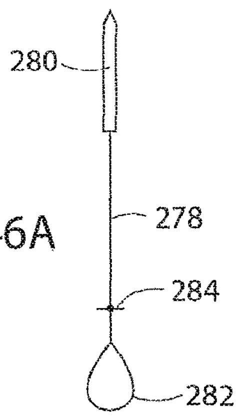
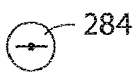


FIG. 46B



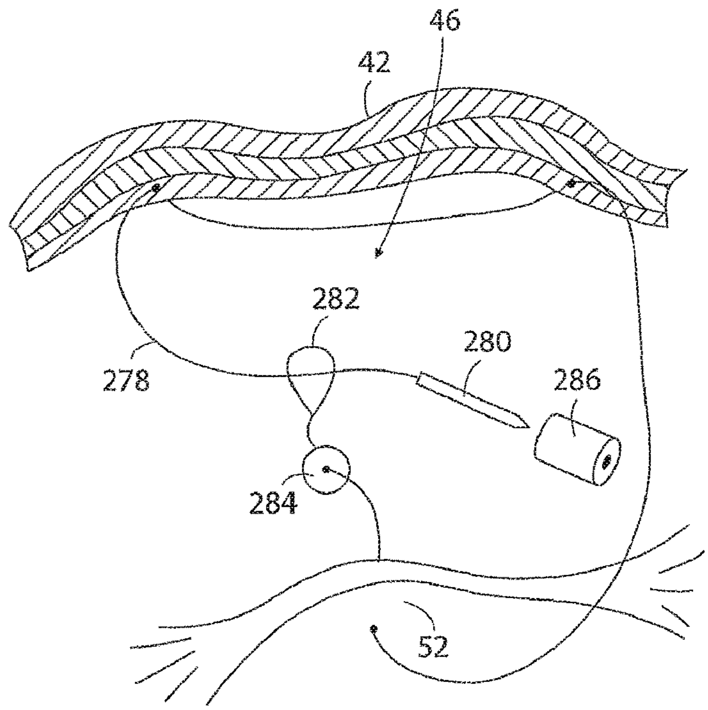


FIG. 46C

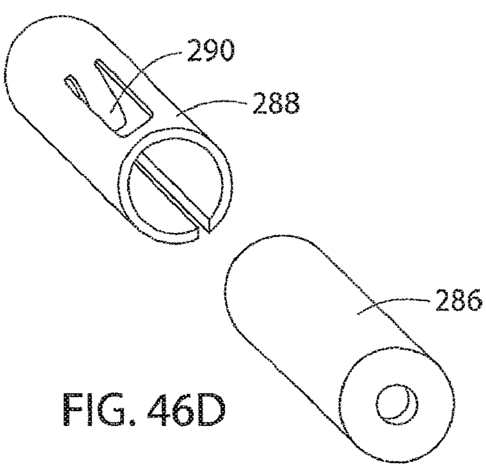


FIG. 46D

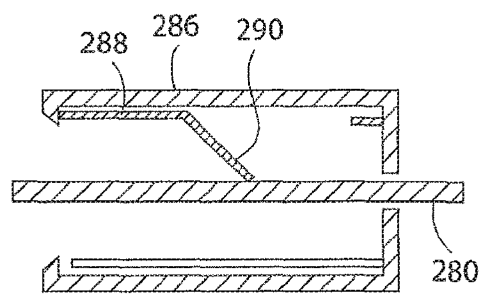


FIG. 46E

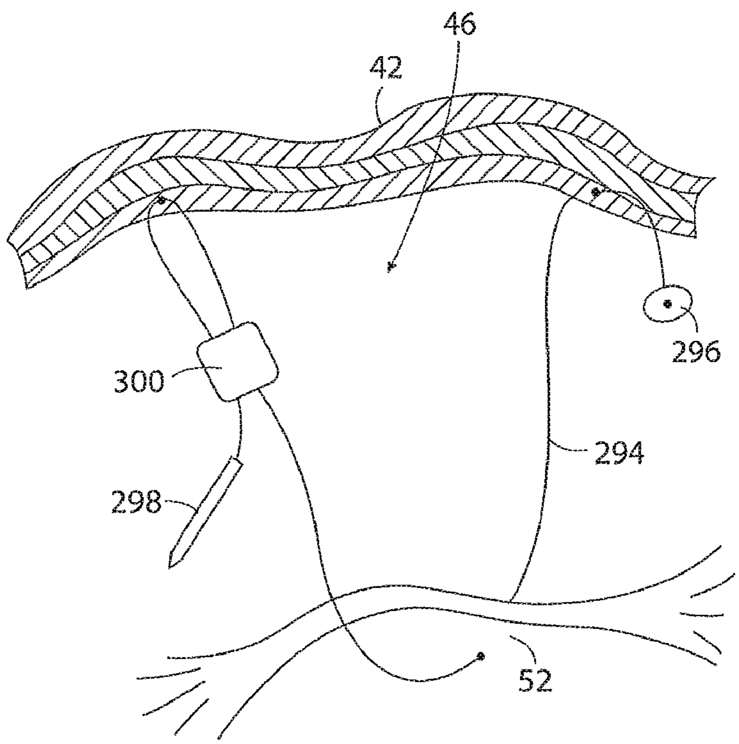


FIG. 47A

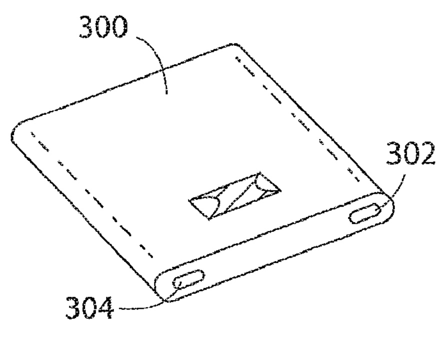


FIG. 47B

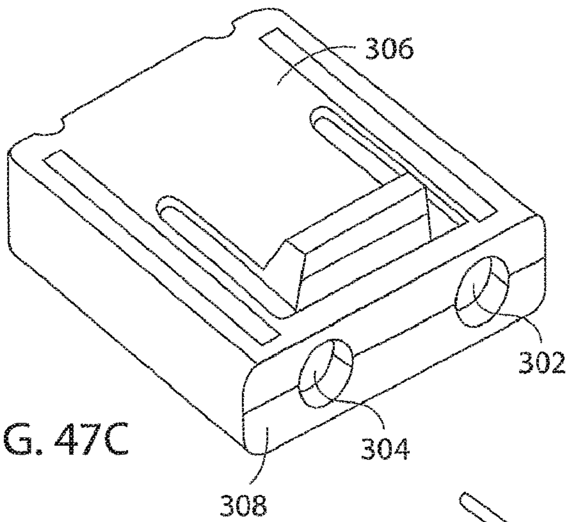


FIG. 47C

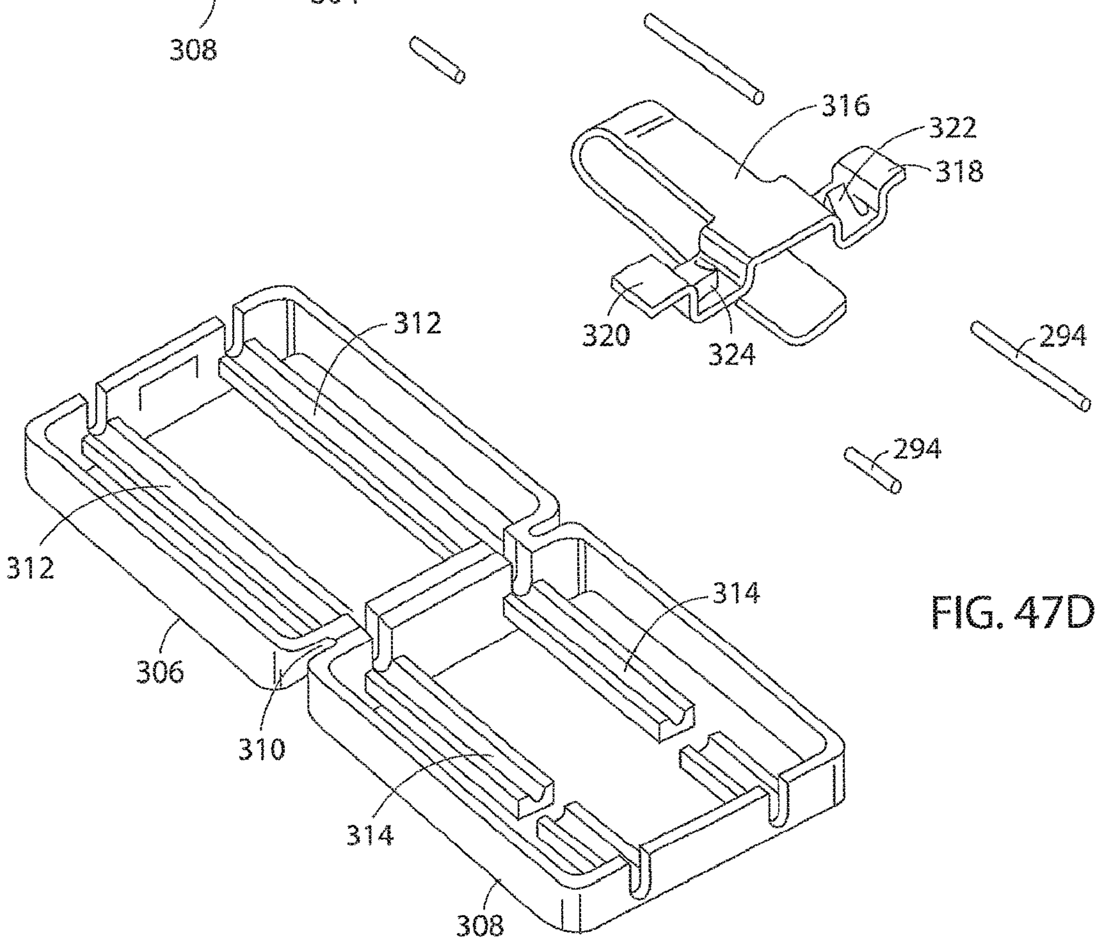


FIG. 47D

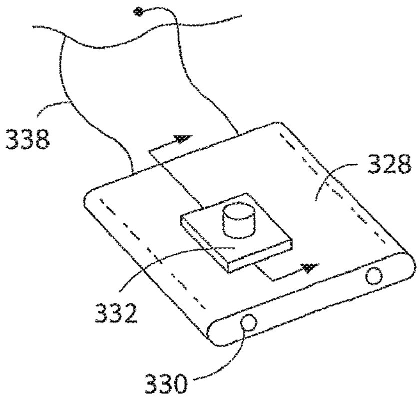


FIG. 48A

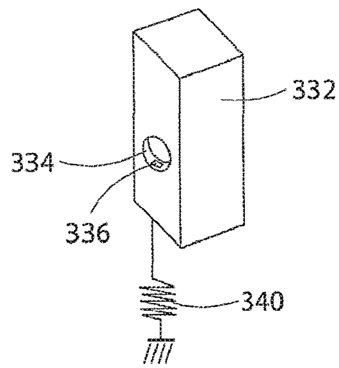


FIG. 48B

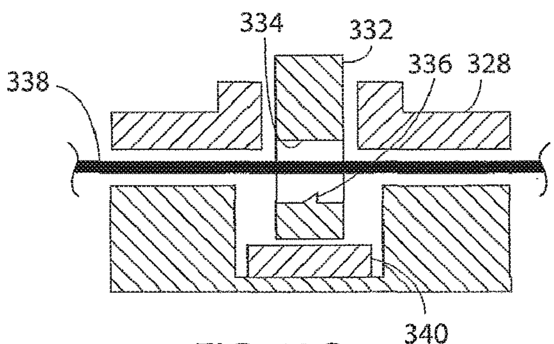


FIG. 48C

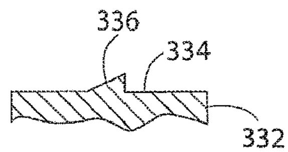


FIG. 48D

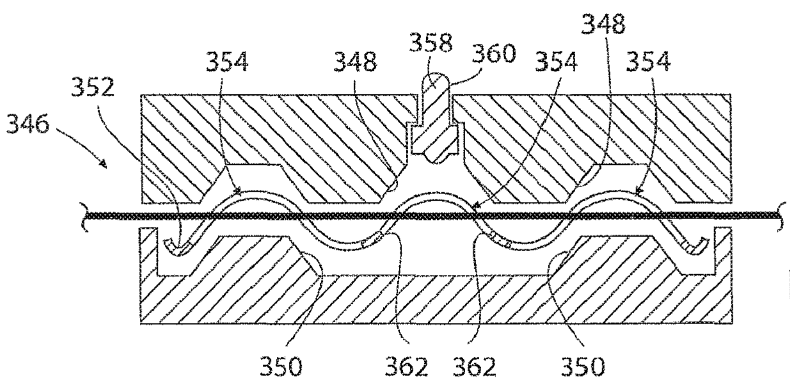


FIG. 49A

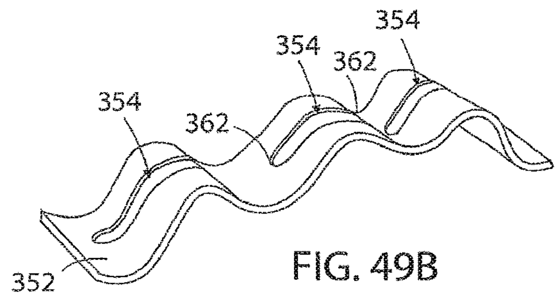


FIG. 49B

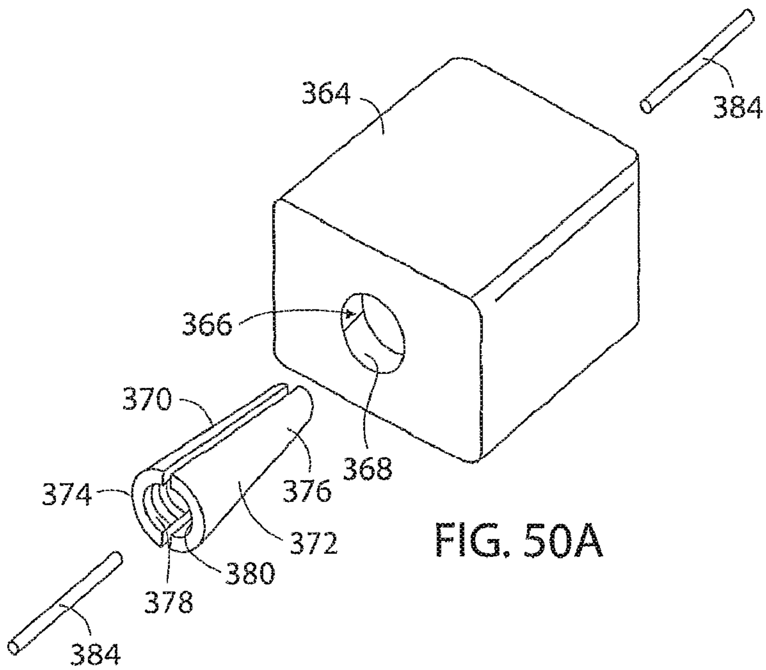


FIG. 50A

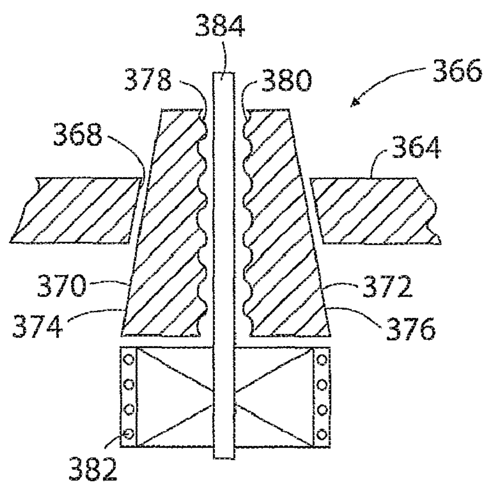


FIG. 50B

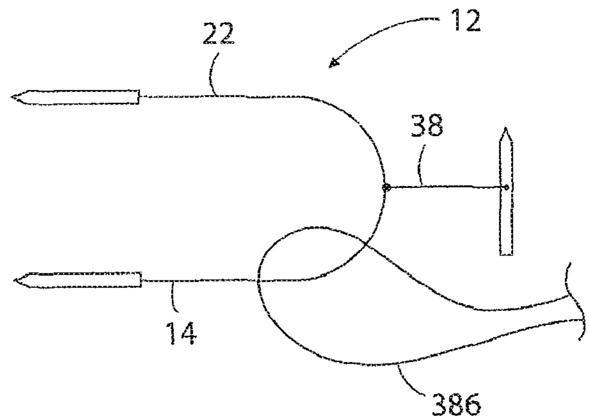


FIG. 51A

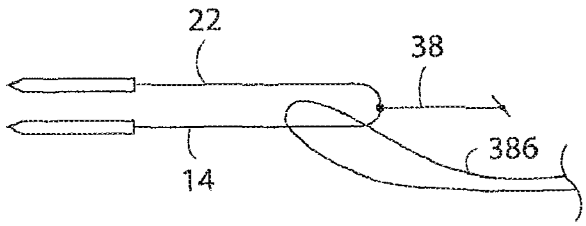


FIG. 51B

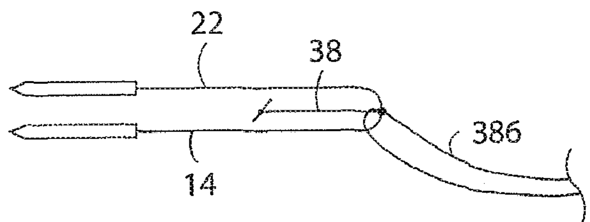


FIG. 51C

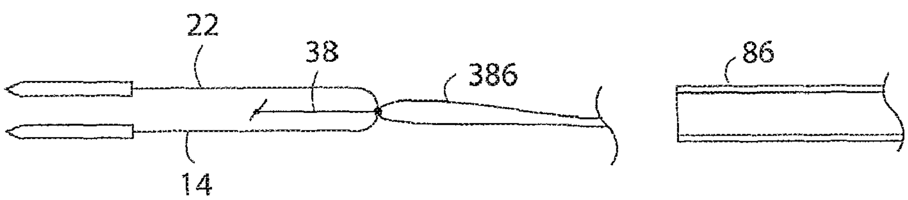


FIG. 51D

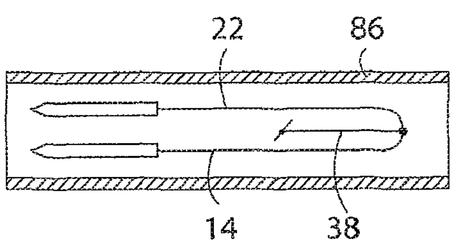


FIG. 51E

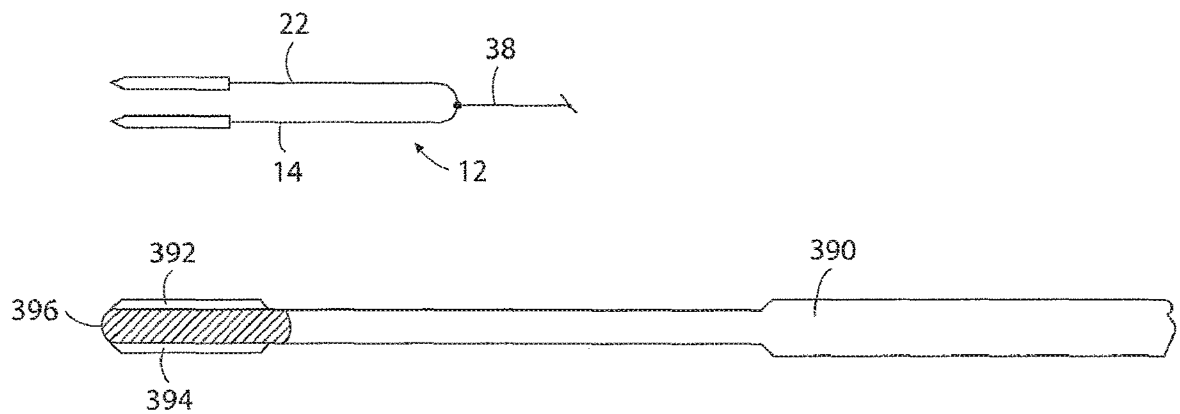


FIG. 52A

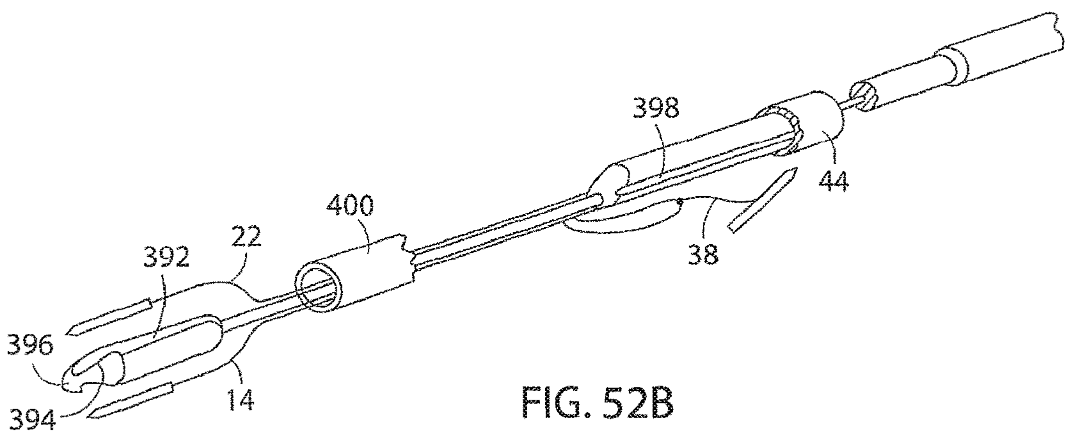


FIG. 52B

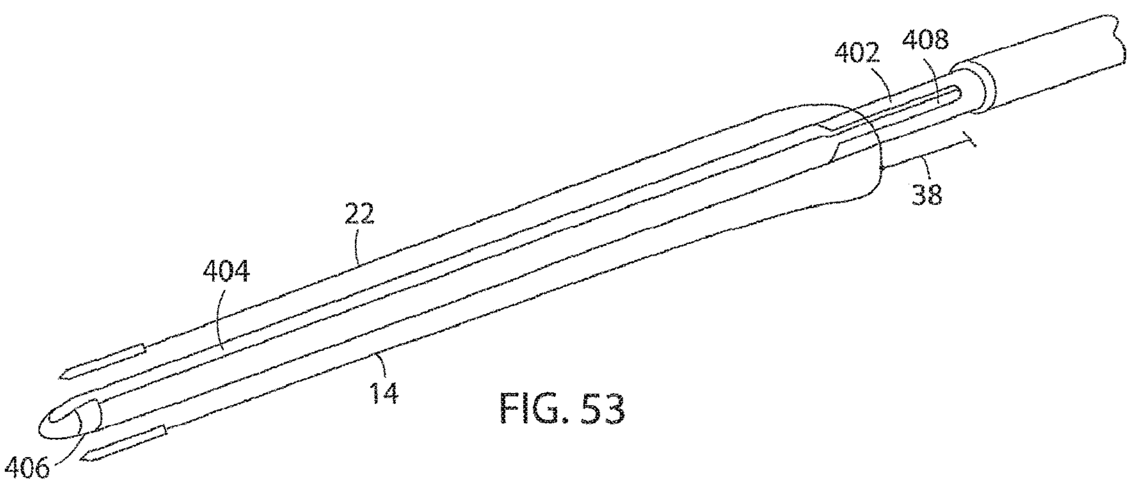


FIG. 53

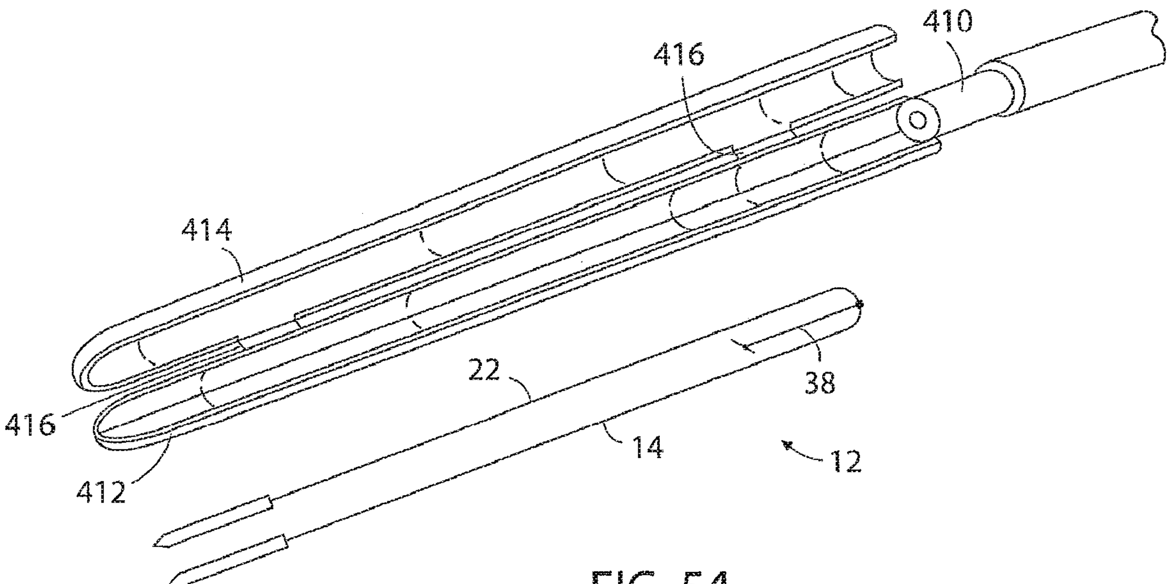


FIG. 54

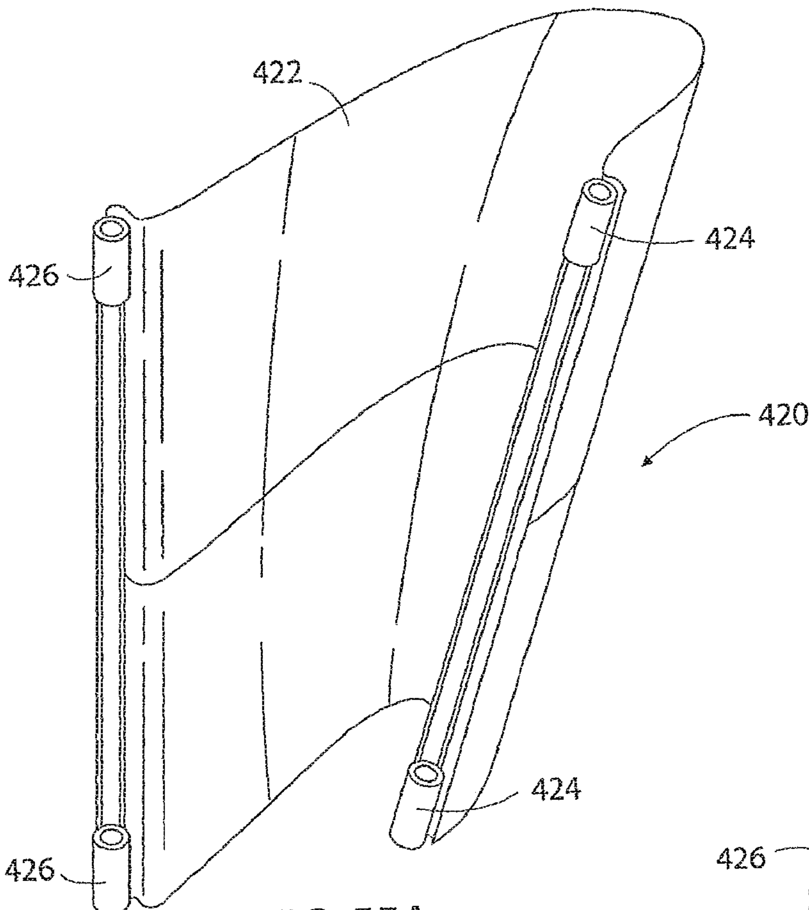


FIG. 55A

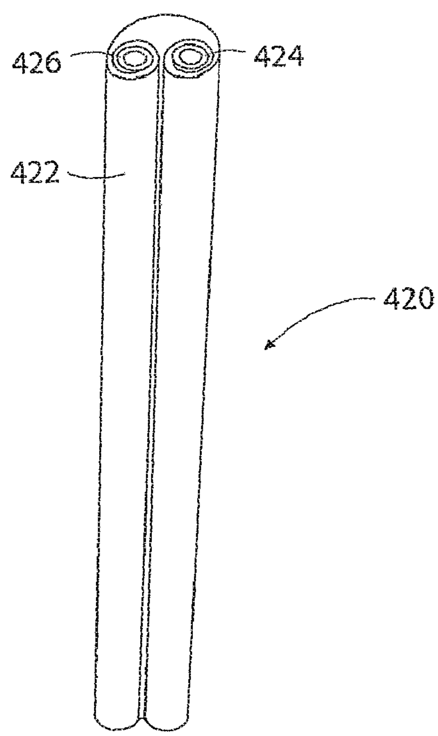


FIG. 55B

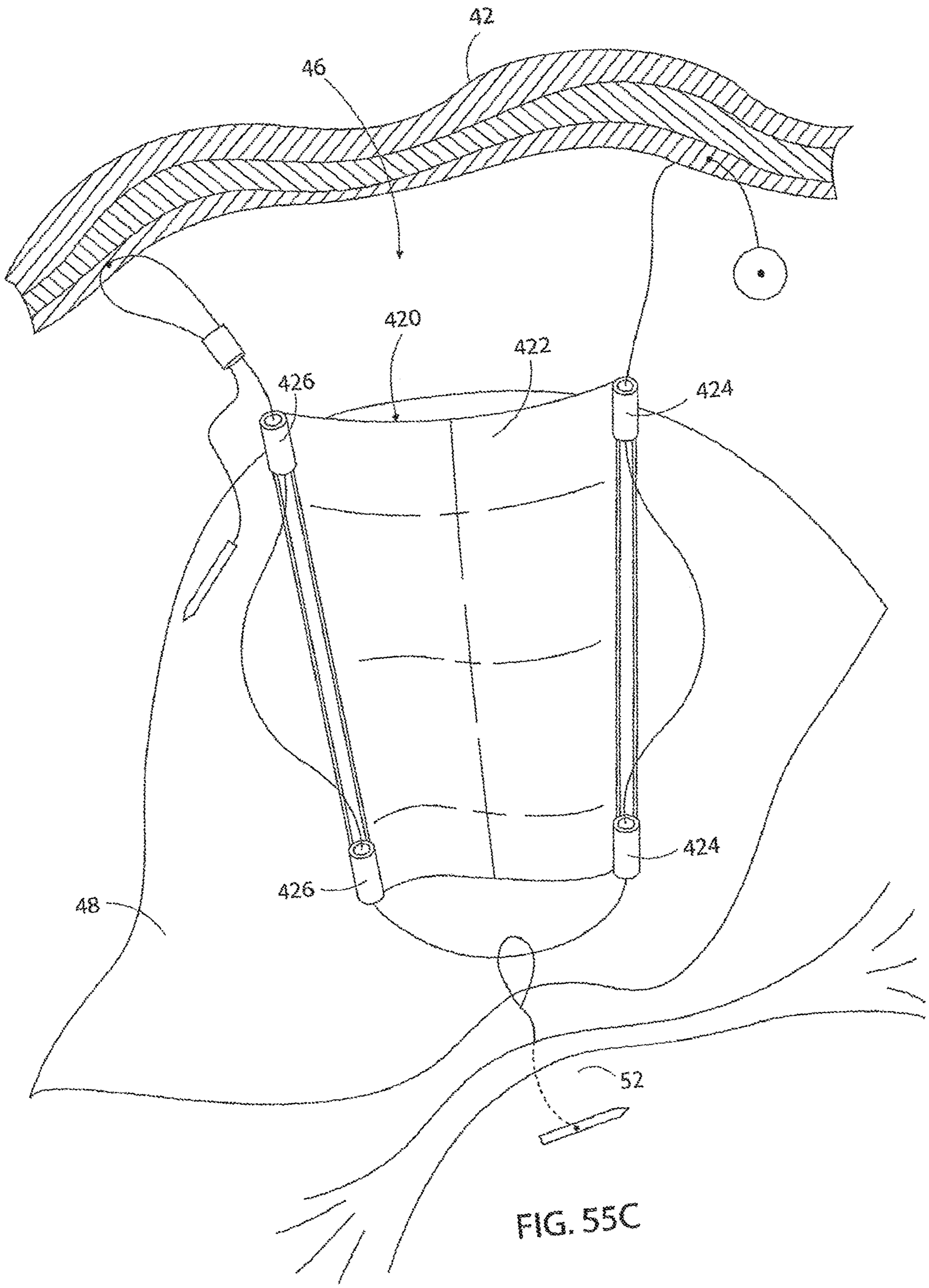


FIG. 55C

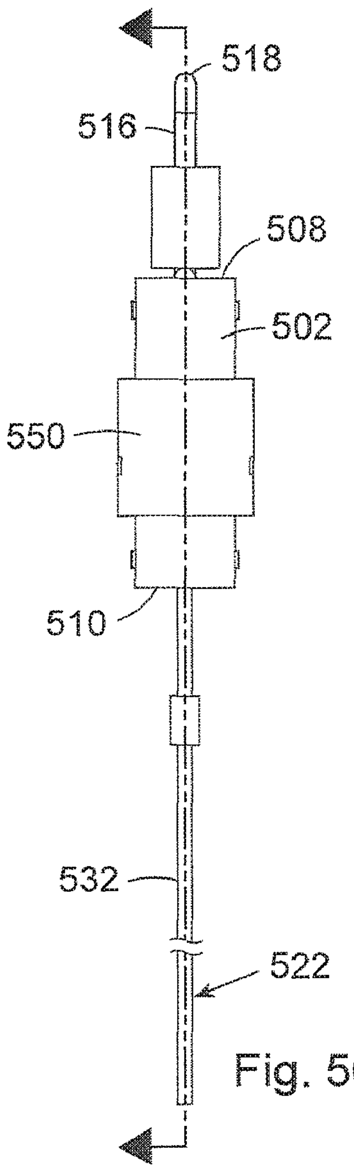


Fig. 56B

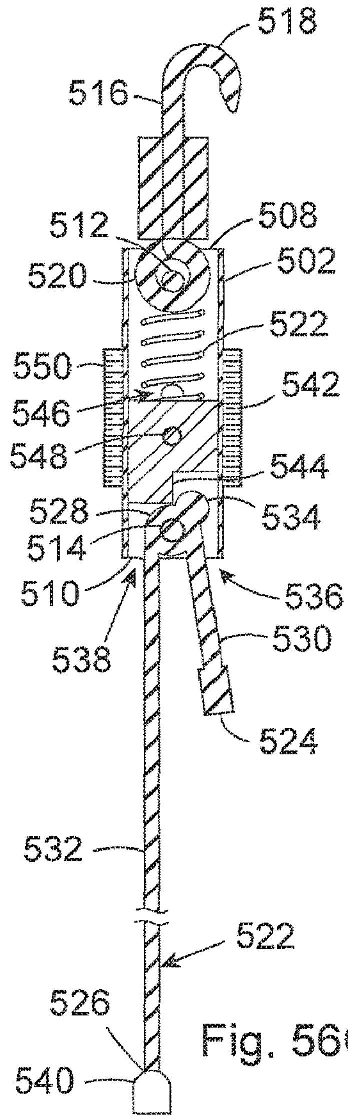


Fig. 56C

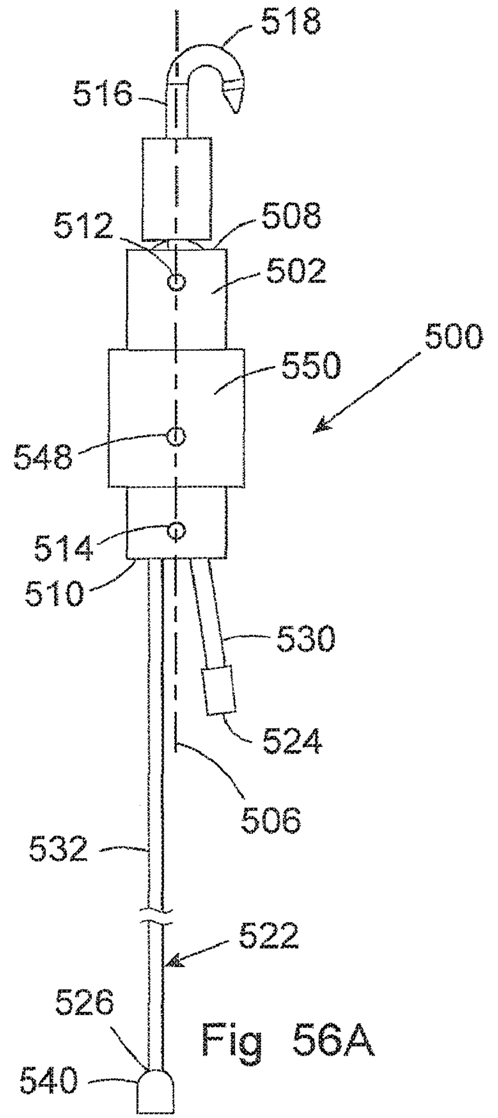


Fig 56A

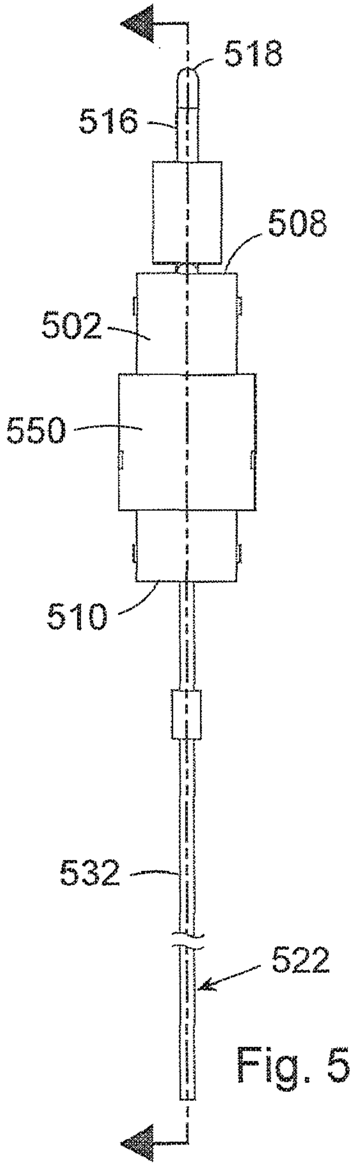


Fig. 57B

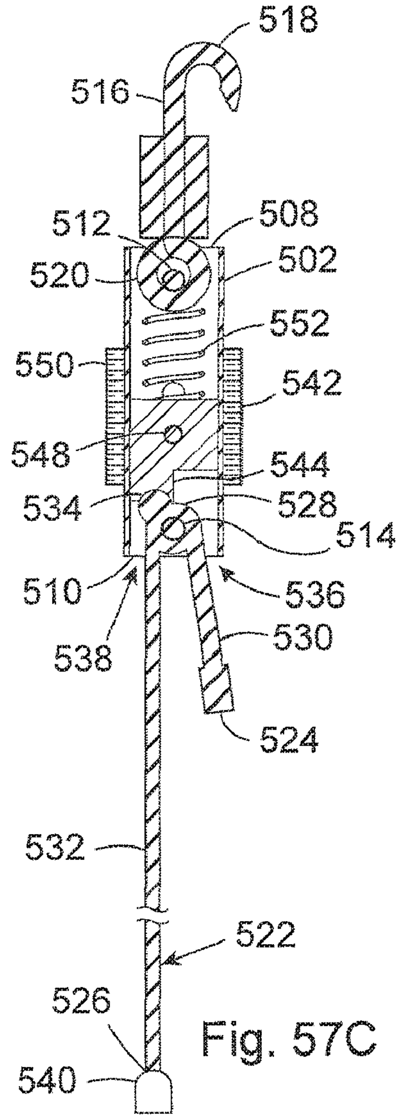


Fig. 57C

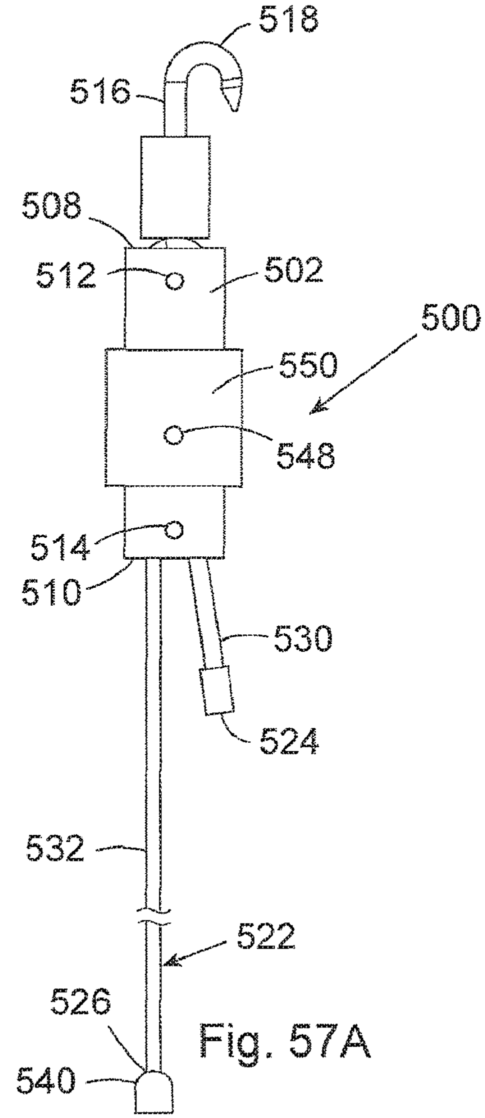


Fig. 57A

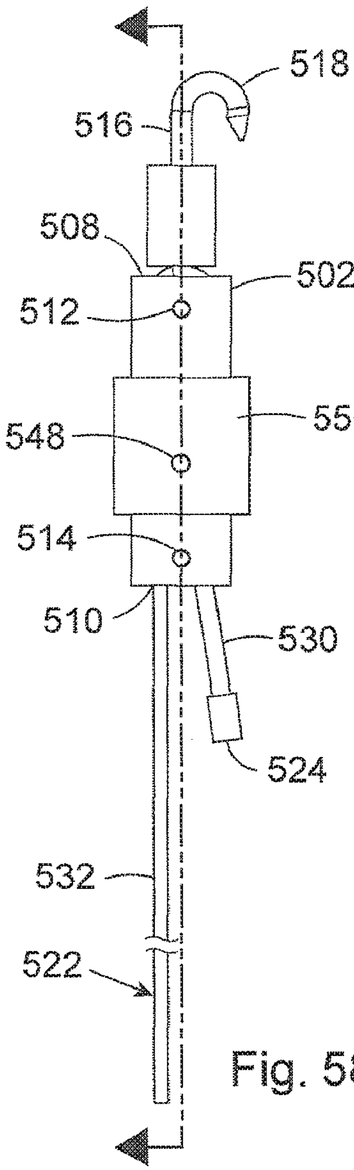


Fig. 58B

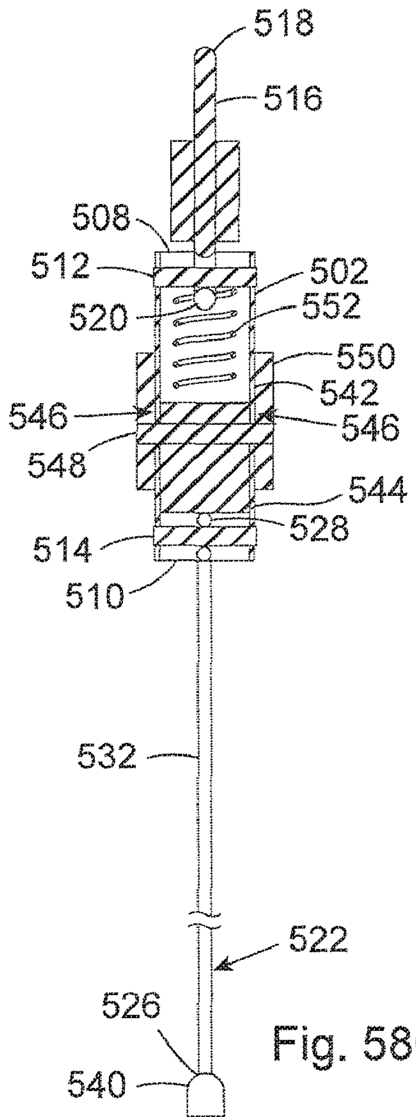


Fig. 58C

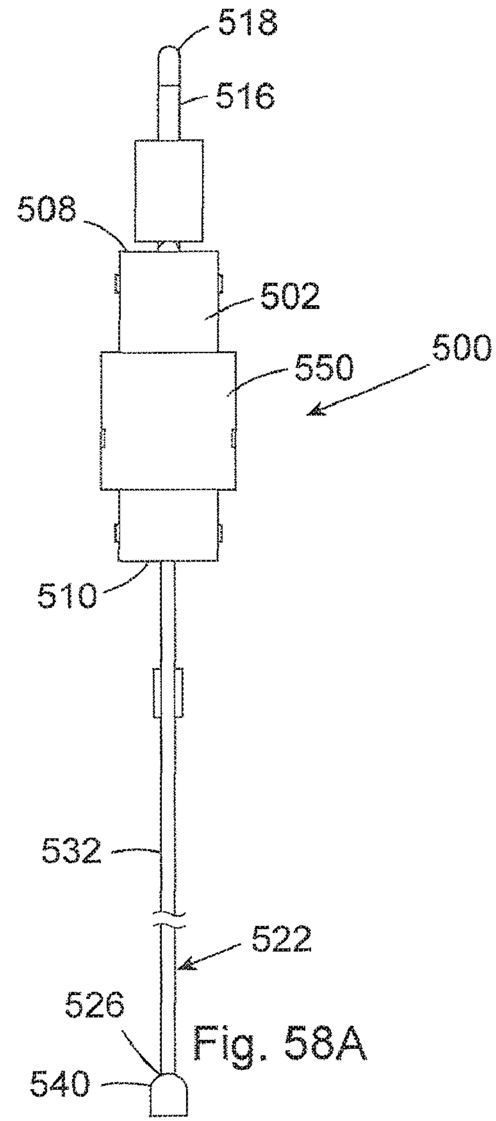


Fig. 58A

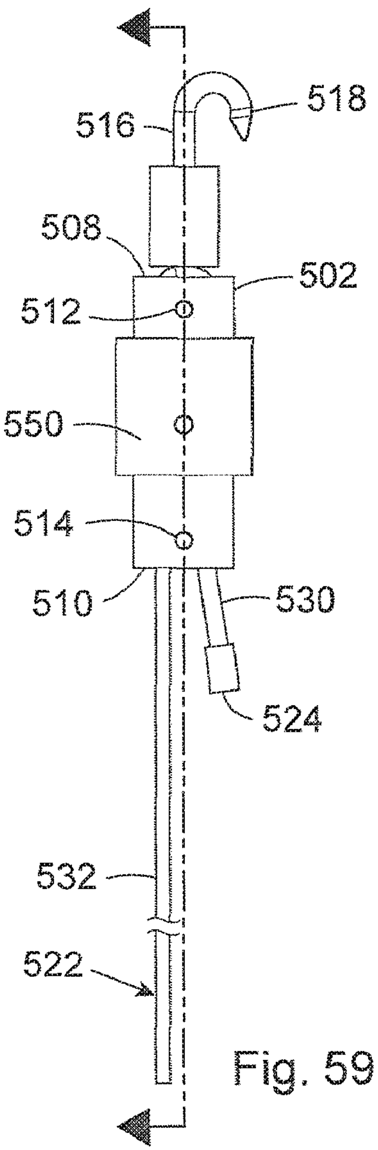


Fig. 59B

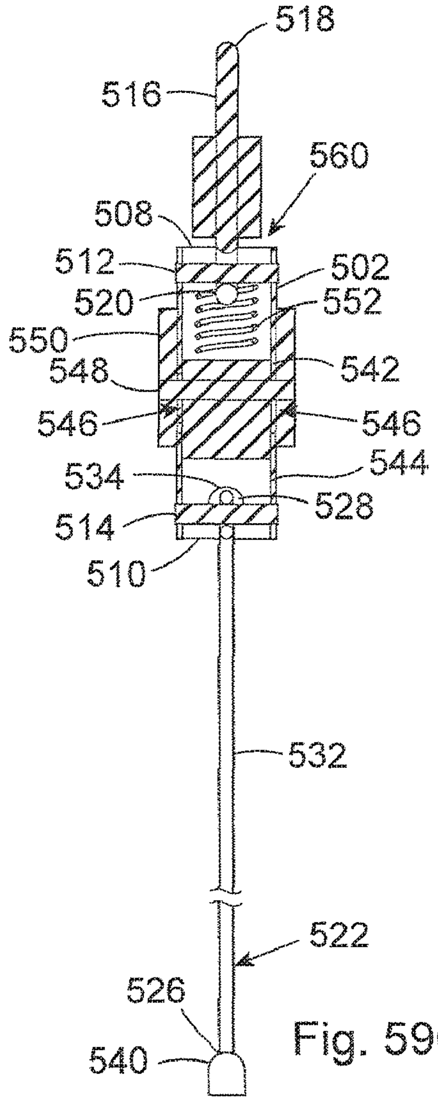


Fig. 59C

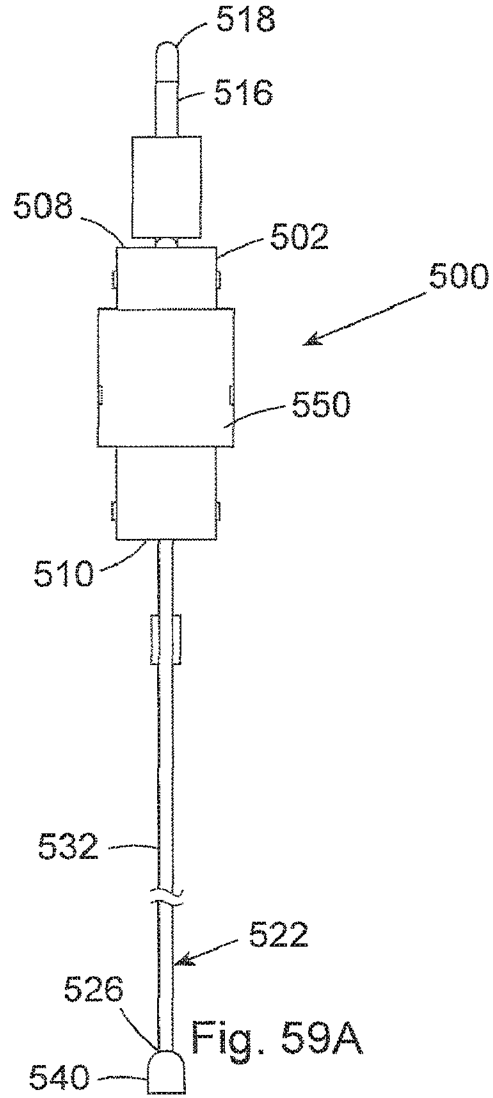


Fig. 59A

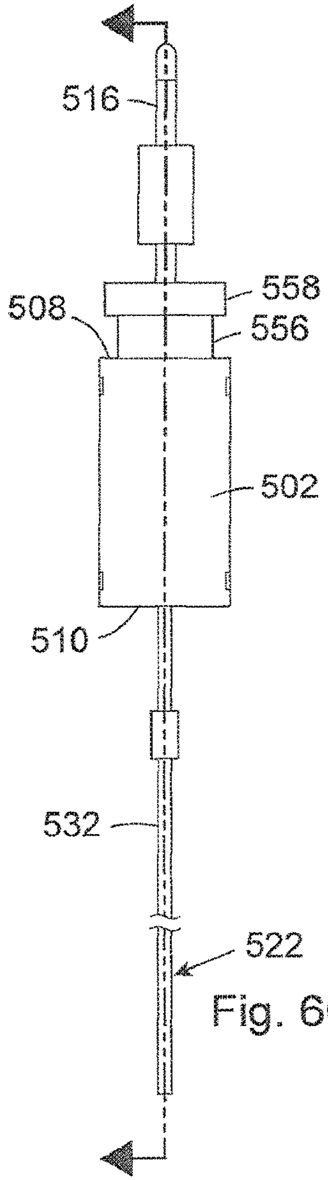


Fig. 60B

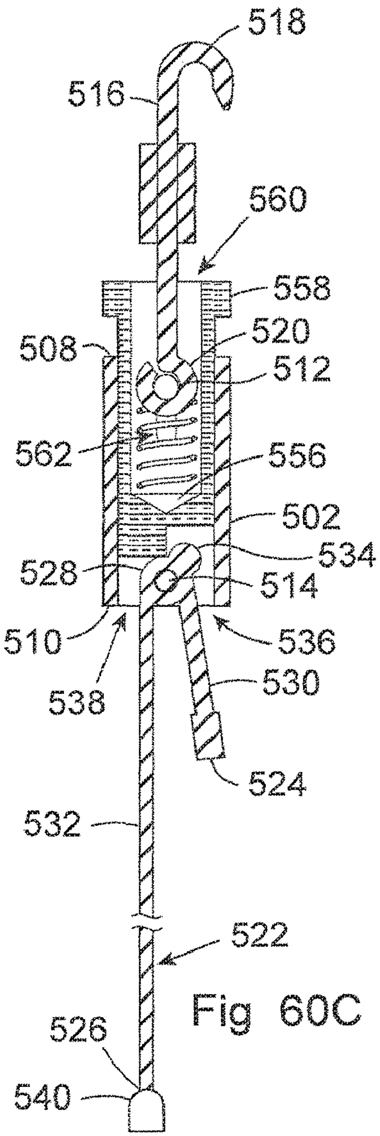


Fig 60C

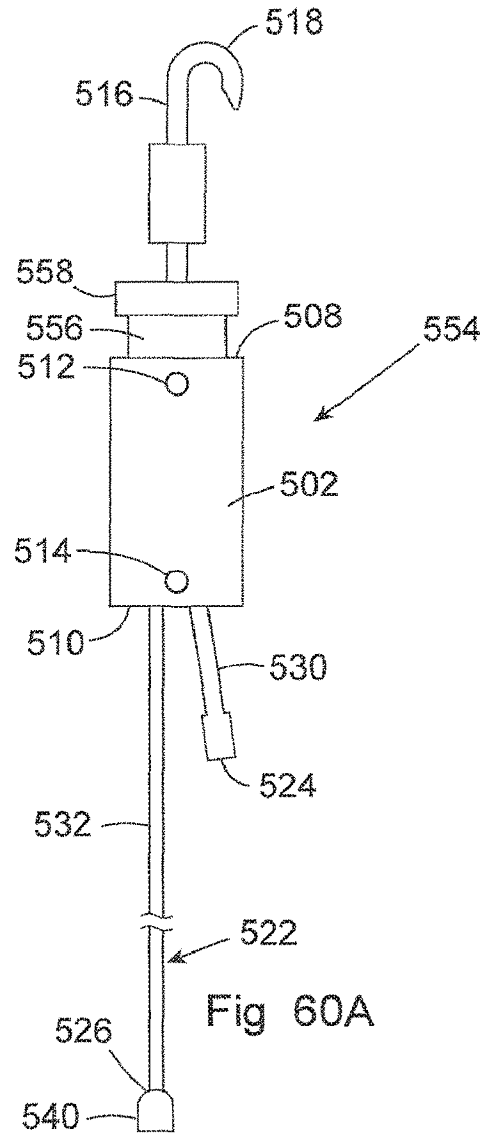


Fig 60A

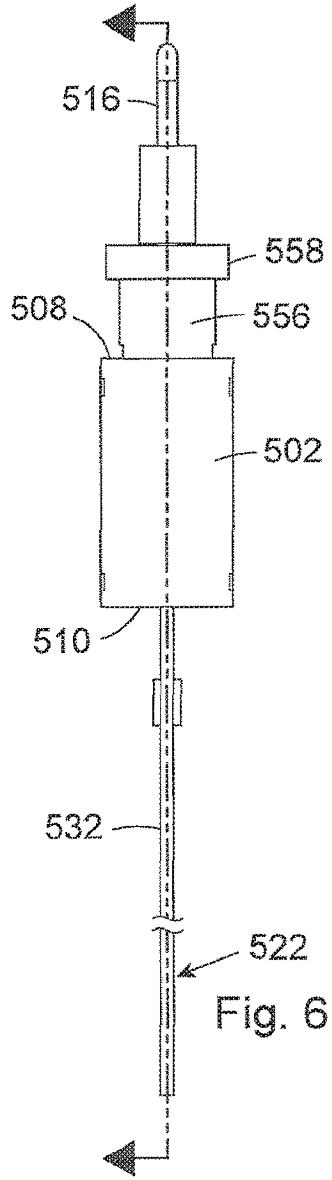


Fig. 61B

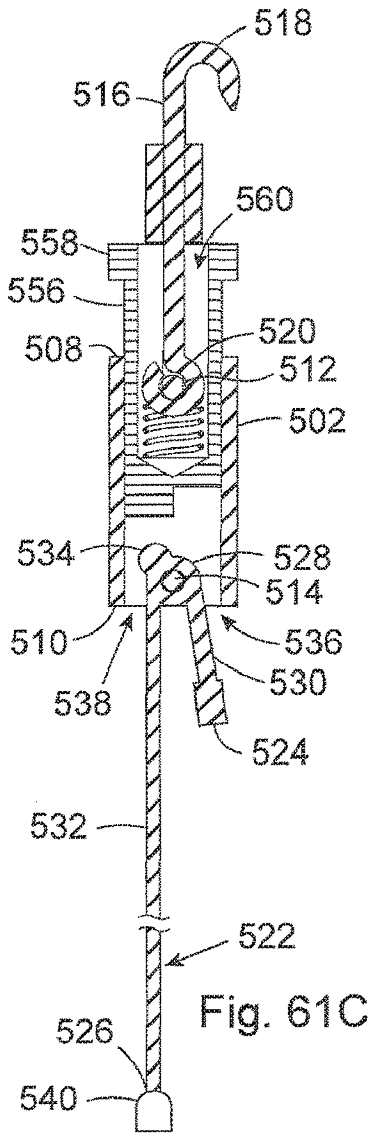


Fig. 61C

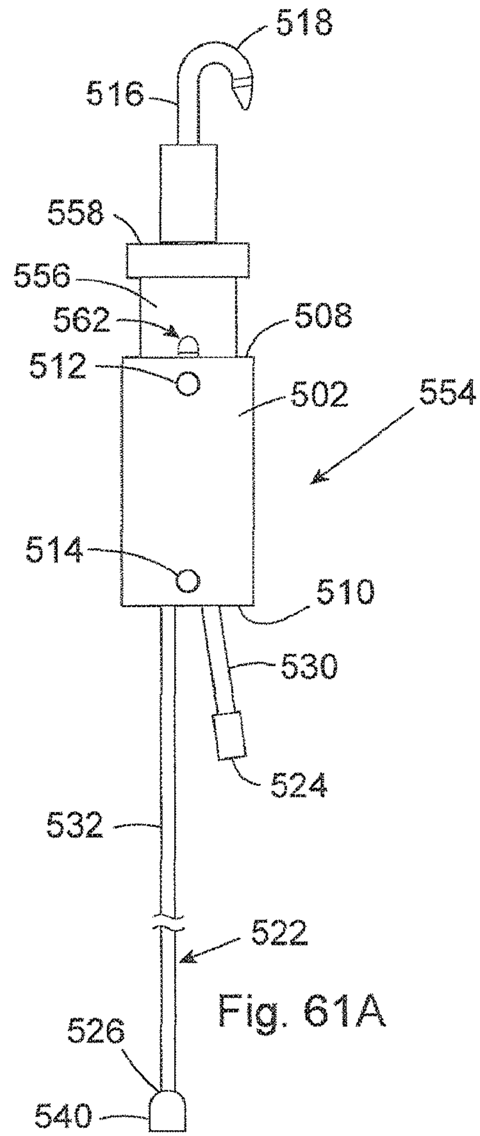


Fig. 61A

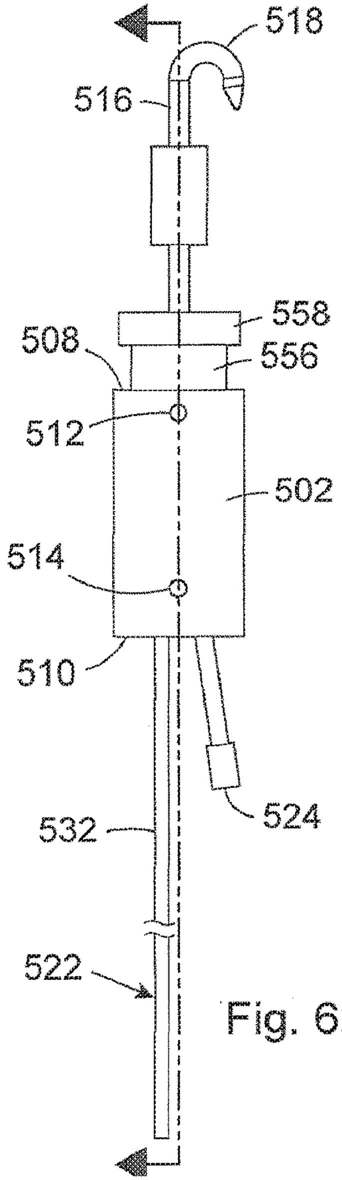


Fig. 62B

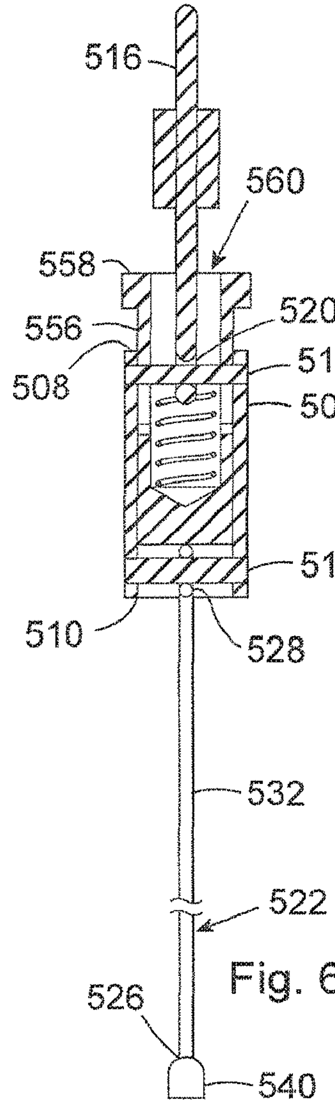


Fig. 62C

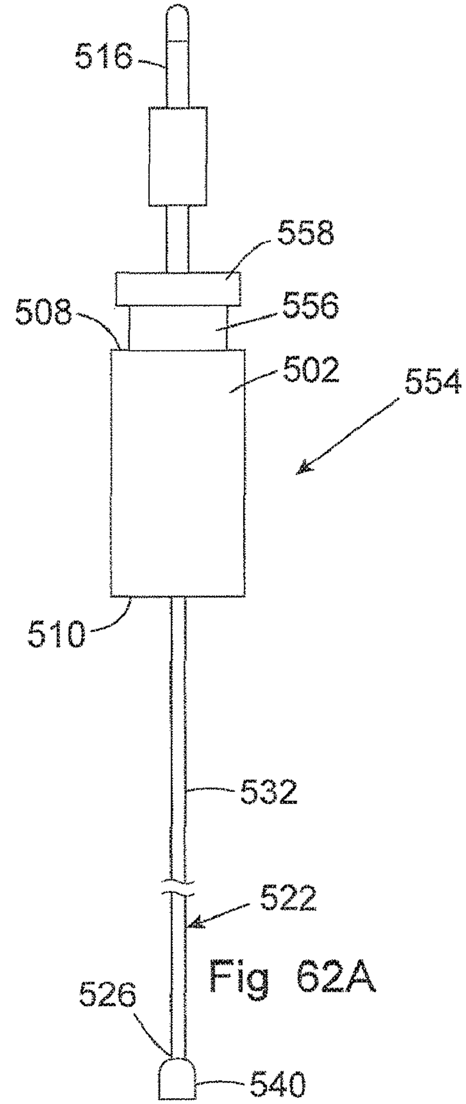


Fig 62A

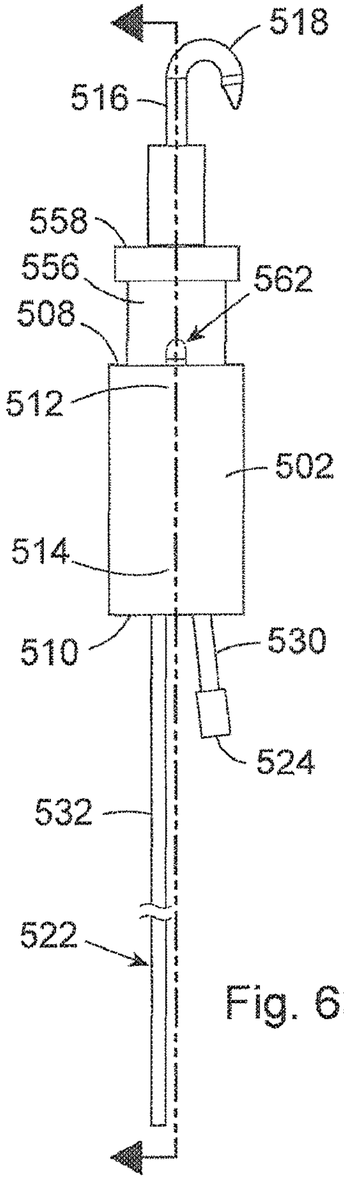


Fig. 63B

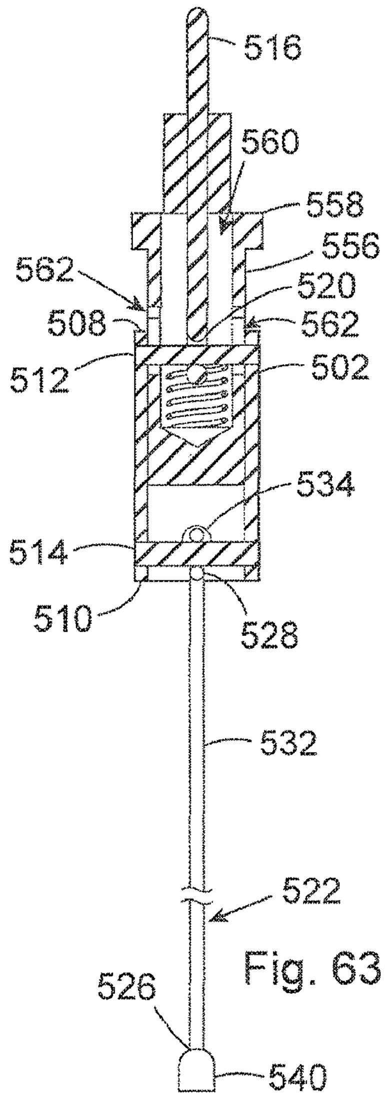


Fig. 63C

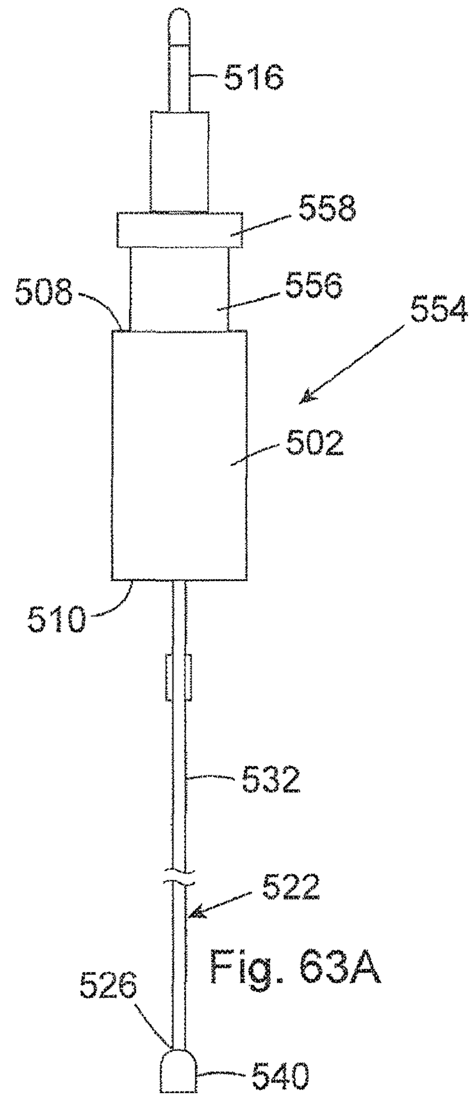


Fig. 63A

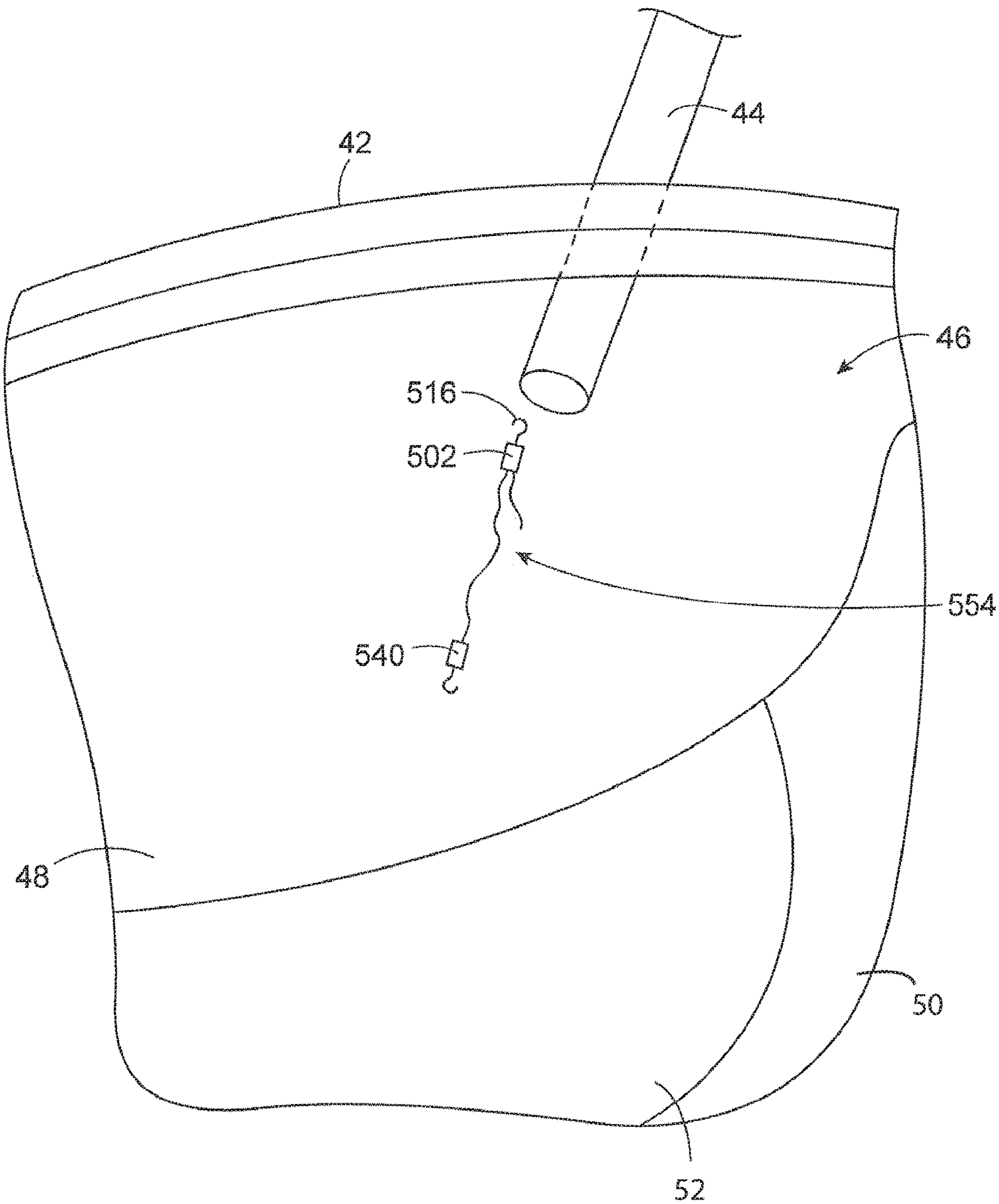


Fig. 64

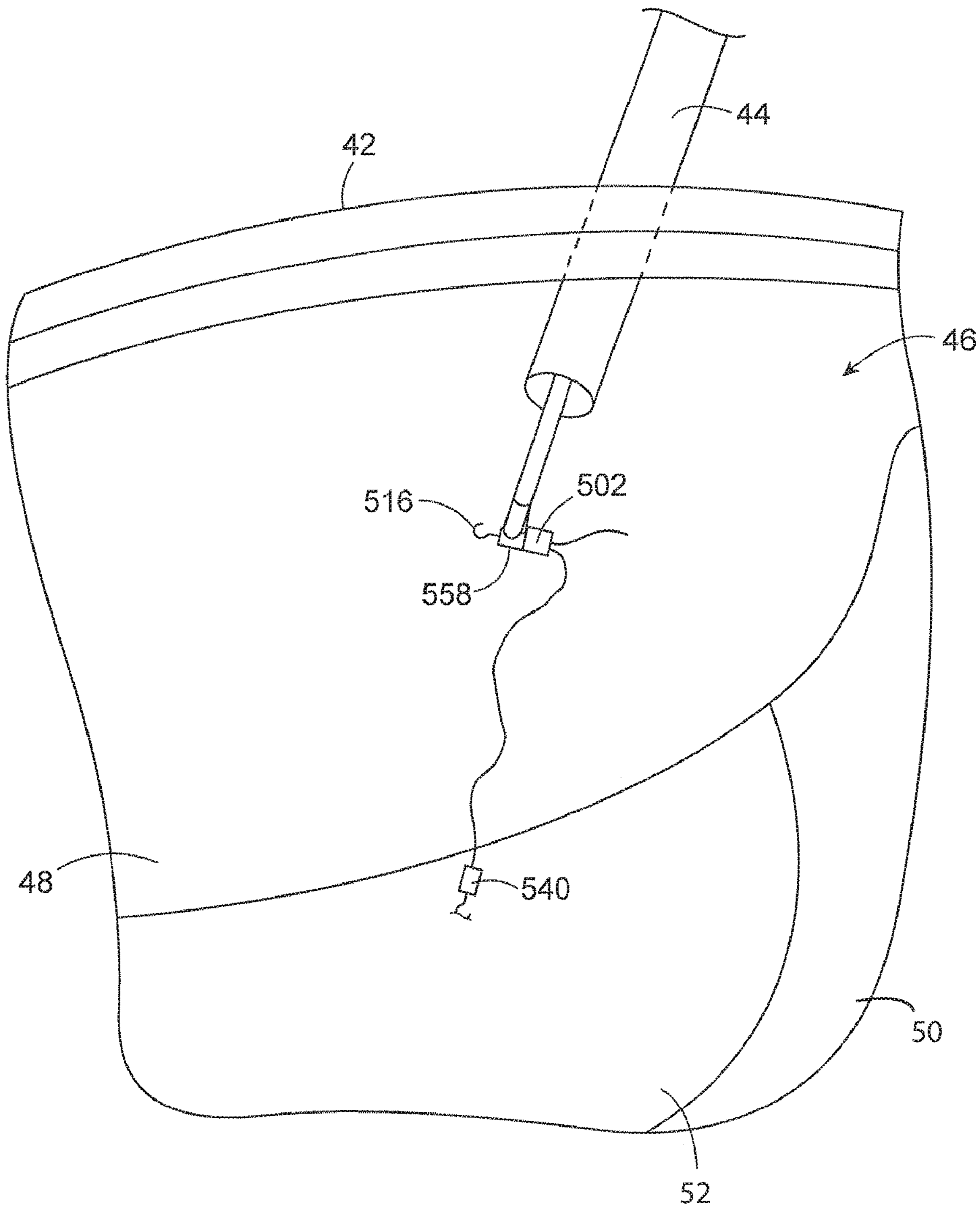


Fig. 65

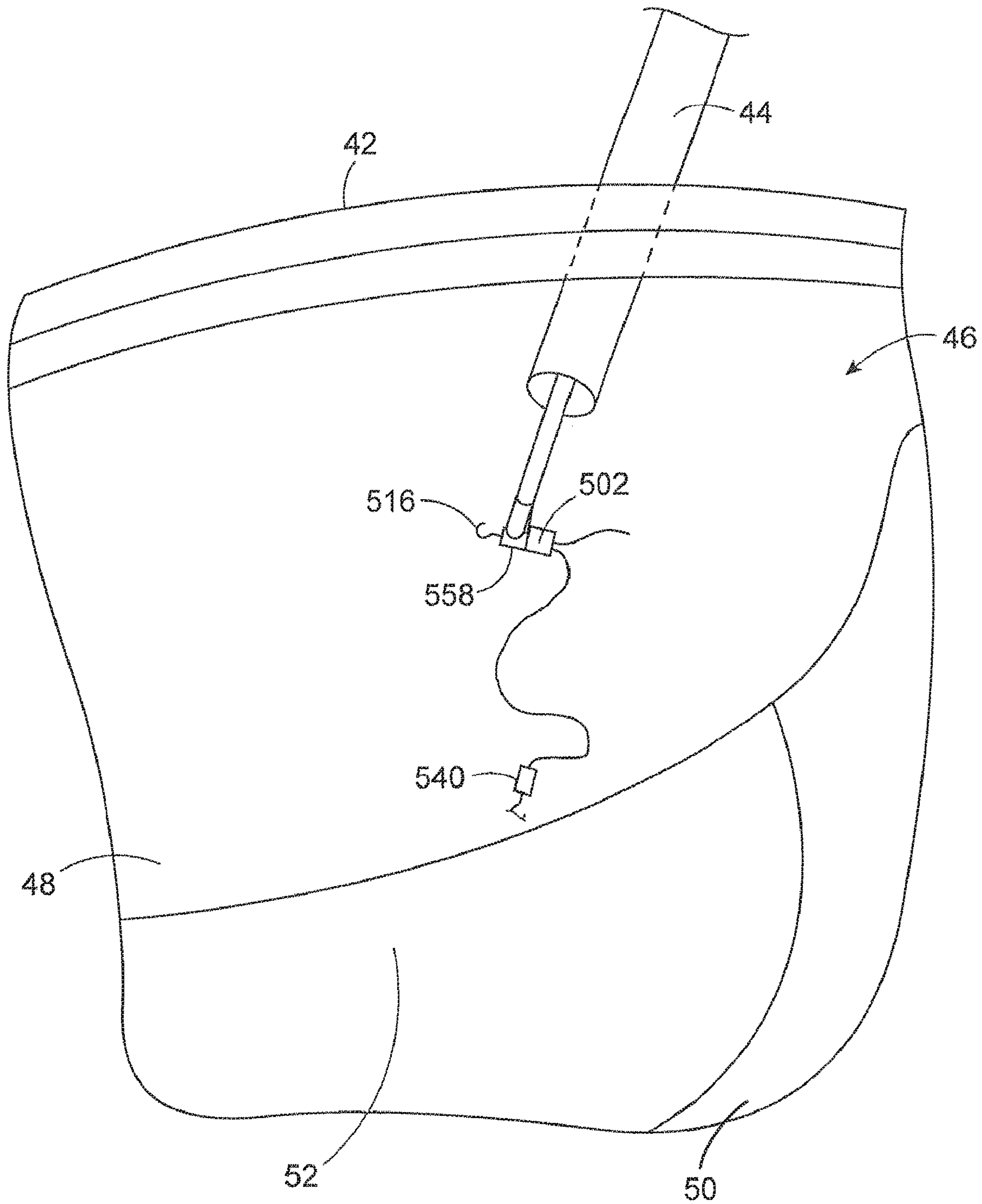


Fig. 66

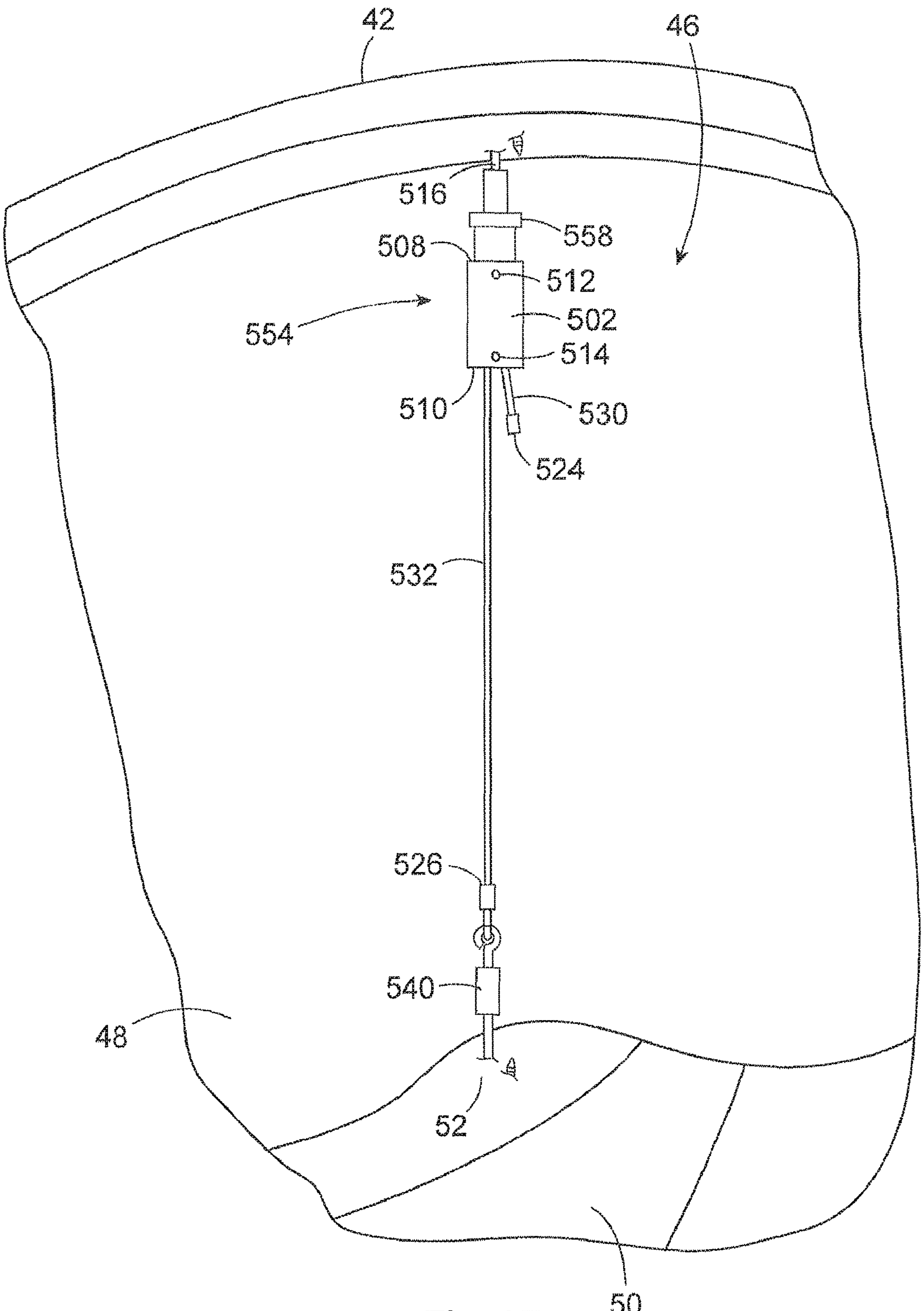


Fig. 67

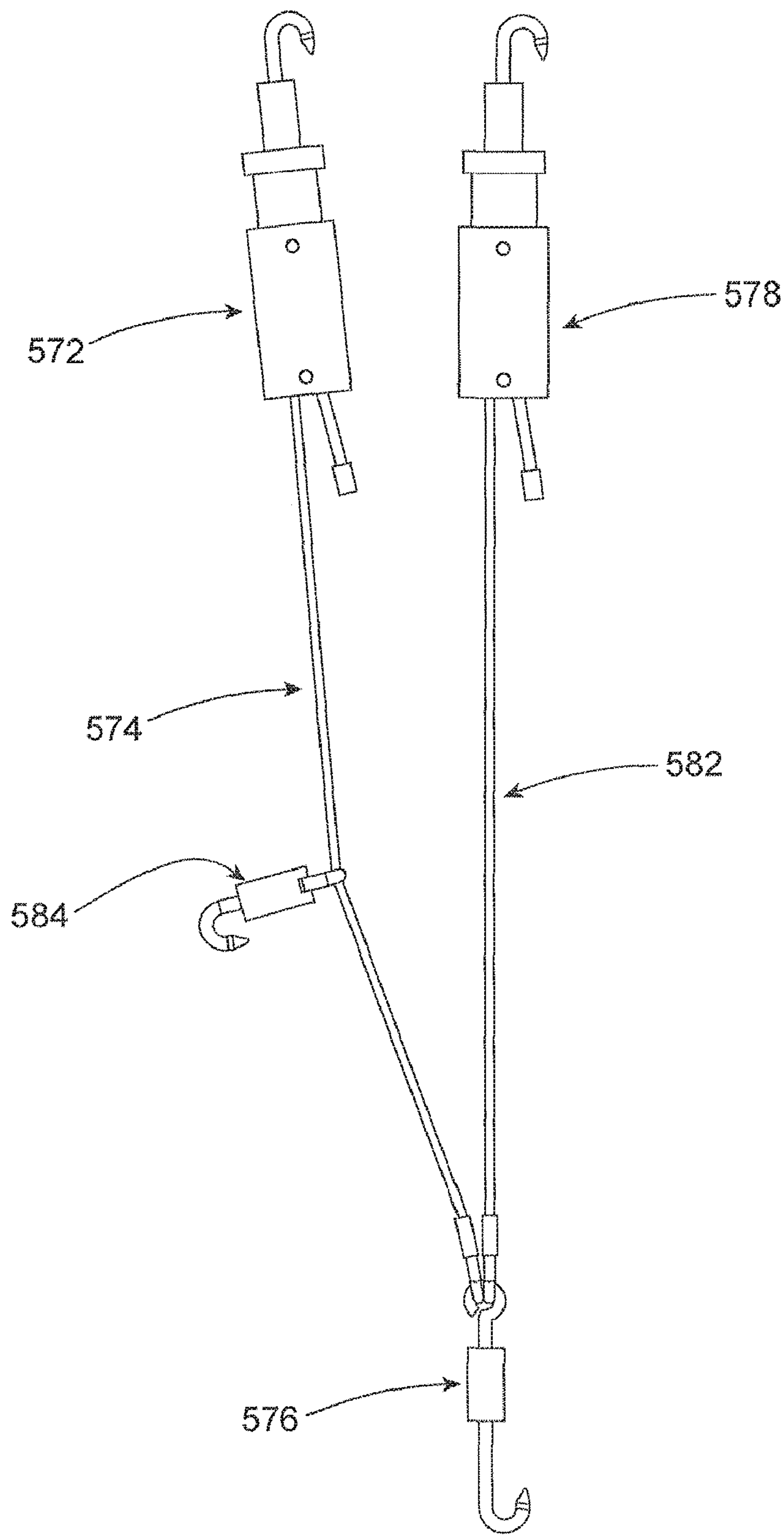


Fig. 68

METHOD FOR INTRA-ABDOMINALLY MOVING AN ORGAN

This application is a continuation of U.S. application Ser. No. 15/604,366, filed May 24, 2017, now U.S. Pat. No. 9,782,160, which is a continuation of U.S. application Ser. No. 15/298,144, filed Oct. 19, 2016, pending, which is a continuation of U.S. application Ser. No. 14/240,928, filed Feb. 25, 2014, now abandoned, which is a national stage of PCT Application PCT/US2011/001494 filed Aug. 25, 2011.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention is directed to an apparatus and its method of use in intra-abdominally moving a first internal organ to a position away from a second internal organ where the apparatus holds the first internal organ in the position without further manual input. More specifically, the present invention is directed to an apparatus that is inserted through the abdominal wall and into the abdominal cavity, and the method of using the apparatus in the abdominal cavity to move a human liver to a position away from a human stomach where the apparatus holds the liver in the position without further manual input, thereby providing surgical access to the stomach.

2. Description of the Related Art

In laparoscopic surgical procedures, it is often necessary to make incisions through the abdominal wall for the sole purpose of providing access to the abdominal cavity for surgical graspers or other similar types of retracting instruments that are used to move one internal organ to a position away from a second internal organ to gain surgical access to the second internal organ. The incisions made for the surgical graspers or similar retracting instruments are in addition to the incisions made in the abdominal wall for the surgical instruments used in performing the surgical procedure on the second organ.

Furthermore, it is often necessary that an additional surgeon or surgical assistant be present solely for the purpose of manipulating the surgical graspers or other similar retracting instruments in moving the first internal organ to a position away from the second internal organ, and then manually holding the first internal organ in the position during the surgical procedure performed on the second internal organ.

The need for the additional surgical personnel to manipulate and hold the surgical graspers or other similar retracting instruments during the surgical procedure increases the costs of surgery. In addition, the additional incisions in the abdominal wall required for the surgical graspers or other similar retracting instruments often results in additional discomfort to the patient following surgery and additional scarring.

What is needed to overcome these disadvantages associated with the above-described type of laparoscopic surgical procedure is an apparatus that can be operated to intra-abdominally move a first internal organ to a position away from a second internal organ and then hold the first internal organ in the position without requiring additional manual input other than that provided by the surgeon and without requiring additional abdominal incisions other than those required for the surgery.

SUMMARY OF THE INVENTION

The present invention overcomes the above-described shortcomings of laparoscopic surgical procedures by providing an apparatus that can be inserted into the abdominal cavity through the same incision to be used in a laparoscopic surgery procedure, and the method of using the apparatus to move or retract a first internal organ, for example the liver, away from a second internal organ, for example the stomach, and then hold the first internal organ in the retracted position providing surgical access to the second internal organ without requiring further manual input.

The apparatus is constructed of component parts that are often used in laparoscopic as well as other types of surgical procedures. The component parts will be described herein using their common understood names and their functions, without going into details of the particular constructions of the component parts.

The basic construction of the apparatus of the invention includes a length of cord. The cord could be comprised of a first cord segment having a flexible length with opposite first and second ends, and a second cord segment having a flexible length with opposite first and second ends. The cord segments could be provided by lengths of suture, lengths of tubing such as IV tubing, lengths of umbilical tape or elastic strips, or other equivalent cord constructions. The first and second cord segments could be separate cord segments that are attached together, or could be two cord segments of a single continuous length of cord.

In one embodiment of the apparatus, first, second, and third separate tissue connectors are attached to the first and second cord segments. The tissue connectors can be any type of known tissue connector that can be manually manipulated to connect to body tissue, and then manually manipulated to be removed from the body tissue without leaving any significant damage to the body tissue. In addition, the tissue connectors can be biocompatible tissue connectors that are designed to be left in the abdominal cavity after the surgery. Some examples of such tissue connectors include suture needles, ‘T’ bars, graspers, barbed needles, hooks, clasps, rivet assemblies, or any other equivalent type of connector. The first and third tissue connectors are attached to the opposite ends of the first cord segment and the second and third tissue connectors are attached to the opposite ends of the second cord segment. This positions the first and second tissue connectors at the opposite ends of the combined lengths of the first and second cord segments, and positions the third tissue connector at an intermediate position of the combined lengths of the first and second cord segments.

In the use of the apparatus according to the method of the invention, the apparatus is first manually passed through the abdominal wall, for example through an incision or a cannula in the abdominal wall, and is positioned in the abdominal cavity in the area of the first and second internal organs. The third tissue connector is then manually connected to tissue adjacent the first internal organ. This positions the ends of the first and second cord segments connected to the third tissue connector between the first and second internal organs and on an opposite side of the first internal organ from the abdominal wall. The first tissue connector attached to the opposite end of the first cord segment from the third tissue connector is manually moved causing the length of the first cord segment to move and engage across the first internal organ and to move the first internal organ toward the position away from the second internal organ. The first tissue connector is then manually connected to the abdominal wall.

The second tissue connector attached to the opposite end of the second cord segment from the third tissue connector is then manually moved causing the second cord segment to move and engage across the first internal organ and move the first internal organ toward the position away from the second internal organ. The second tissue connector is then manually connected to the abdominal wall.

In the above matter, the first and second cord segments engaging across the first internal organ hold the first internal organ at the position away from the second internal organ without further manual input. This provides surgical access to the second internal organ.

In a further embodiment of the apparatus of the invention, the apparatus is comprised of a cord having a continuous flexible length with opposite first and second ends. A needle is attached to one end of the length of cord and a knot is formed in the opposite end of the length of cord.

According to the method of use of this embodiment of the apparatus, the apparatus is first positioned inside the abdominal cavity in the same manner as the previously-described embodiment. The knotted end of the length of cord is then connected to tissue adjacent the first internal organ by first passing the needle through the tissue and then manually pulling the length of cord through the tissue. This attaches the knotted end of the cord to the tissue between the first and second internal organs.

The needle is then passed through the inter-abdominal wall and manually moved back into the abdominal cavity, causing a first segment of the length of cord to engage across the first internal organ and move the first internal organ toward the position away from the second internal organ.

The needle is then again inserted through the inter-abdominal wall at a location spaced from the first insertion of the needle through the inter-abdominal wall, and the needle and length of cord are pulled manually into the abdominal cavity.

The needle and the end of the length of cord attached to the needle are f<then passed through the knot formed at the opposite end of the length of cord and pulled tight, causing a second segment of the length of cord to engage across and move the first internal organ toward the position away from a second internal organ. A knot is then tied between the opposite ends of the length of cord and the portion of the cord extending from the knot to the needle is cut and removed with the needle from the abdominal cavity. The length of cord left in the abdominal cavity forms a triangular loop with first and second cord segments that engage across and hold the first internal organ in the position away from the second internal organ without manual input. In this manner, surgical access is provided to the second internal organ without manual input.

A still further embodiment of the apparatus of the invention is comprised of a cord having a continuous flexible length with opposite first and second ends, and a tissue connector assembly with a releasable one-way cord lock connected to an intermediate portion of the cord.

The tissue connector assembly has a base formed as a cylindrical housing. The base housing has a length with opposite first and second ends and a hollow interior bore extending through the housing. A rod is attached to the base and is positioned in the interior bore adjacent the housing second end.

A first tissue connector is provided on the base and extends from the base first end. As in previous embodiments, the tissue connector can be any known type of tissue connector.

The intermediate portion of the cord length is attached to the base by being wrapped around the rod in the base housing. A first portion or first percentage of the cord length extends from the cord intermediate portion and from the base second end to the cord first end. A second portion or second percentage of the cord length extends from the cord intermediate portion and from the base second end to the cord second end.

A releasable one-way lock is mounted in the interior bore of the base for movement of the lock between first and second positions of the lock relative to the base. The lock is biased by a spring toward the first position. In the first position of the lock relative to the base, the lock engages with the intermediate portion of the cord wrapped around the rod and allows the cord first portion to be pulled from the base second end to thereby increase a length or percentage of the cord first portion while decreasing a length or percentage of the cord second portion, but the lock prevents the cord second portion from being pulled from the base second end. In the second position of the lock relative to the base the lock is disengaged from the cord and allows the cord second portion to be pulled from the base second end to thereby increase the length or percentage of the cord second portion while decreasing the length or percentage of the cord first portion.

A second tissue connector is provided at the cord second end. Again, the second tissue connector can be any known type of tissue connector. A percentage of the cord length extends between the first and second tissue connectors. This percentage of the cord length is adjustable.

There is an actuator on the base that is operatively connected to the lock. The actuator is movable between first and second positions of the actuator relative to the base. When the actuator is moved from the first position to its second position it causes the lock to move from its first position to its second position and releases the one-way lock. The spring bias of the lock also biases the actuator from its second position toward its first position.

In the use of this embodiment of the apparatus according to the method of the invention, the apparatus is first positioned inside the abdominal cavity in the same manner as the previously described embodiments.

With the apparatus positioned in the abdominal cavity, the second tissue connector at the cord's second end is connected to tissue adjacent to the first internal organ or to the organ itself. The tissue connector assembly with the releasable one-way cord lock is then grasped at the actuator and moved toward the abdominal wall, causing the cord second portion to be extended across the first internal organ. When the cord second portion is pulled tight continued movement of the tissue connector assembly causes the actuator to move to its second position. This releases the lock and allows the cord second portion to be pulled from the base second end increasing the length or percentage of the cord second portion and decreasing the length or percentage of the cord first portion. The first tissue connector is then connected to the abdominal wall and the actuator is released, causing the actuator and the lock to move to their first position due to the bias of the spring. The cord first portion is then grasped and pulled from the second end of the base. This in turn causes the length or percentage of the cord second portion to decrease. As the cord first portion is pulled from the base second end the length or percentage of the cord second portion continues to decrease and causes the cord second portion to engage across the first internal organ and move the first internal organ toward the position away from the second internal organ. With the releasable one-way lock biased to the first position relative to the base, the cord second portion cannot be pulled from the base.

In the above manner, the shortened length of the cord second portion extending between the first tissue connector connected to the abdominal wall and the second tissue connector connected to the body tissue adjacent the first internal organ engages across the first internal organ and holds the first internal organ at the position away from the second internal organ without further manual input. This provides surgical access to the second internal organ.

When it is desired to remove the apparatus of the invention, the actuator is grasped and moved from its first position to its second position relative to the apparatus base. This in turn causes the lock to move from its first position to its second position releasing the lock, and allows the cord second portion to be pulled from the base second end increasing the length or percentage of the cord second portion while decreasing the length or percentage of the cord first portion. This allows the cord second portion to disengage from the first internal organ and produces a sufficient length of the cord second portion to allow the first tissue connector to be removed from the abdominal wall and the second tissue connector at the cord second end to be removed from the body tissue adjacent the first internal organ or from the organ. The apparatus then can be removed from the abdominal cavity.

As described above, the embodiments of the apparatus of the invention and their methods of use enable intra-abdominally moving a first internal organ to a position away from a second internal organ where each of the embodiments of the apparatus holds the first internal organ in the position without manual input.

DESCRIPTION OF THE DRAWING FIGURES

Further features of the apparatus of the invention and its method of use are set forth in the following detailed description of the apparatus and method and are shown in the drawing figures.

FIG. **1** is a plan view of one embodiment of the apparatus of the invention.

FIG. **2** is a plan view of a further embodiment of the apparatus of the invention.

FIG. **3** is a plan view of a still further embodiment of the apparatus of the invention.

FIG. **4** is a representation of the apparatus of FIG. **1** being inserted into the abdominal cavity.

FIG. **5** is a representation of the apparatus of FIG. **1** being used according to the method of the invention.

FIG. **6** is a representation of the apparatus of FIG. **2** in use according to the method of the invention.

FIG. **7** is a representation of the apparatus of FIG. **3** in use according to the method of the invention.

FIGS. **8**A-**8**E represent the insertion of one embodiment of the apparatus into the abdominal cavity and one method of use of the apparatus.

FIGS. **9**A-**9**E represent the insertion of a further embodiment of the apparatus into the abdominal cavity and the method of using the apparatus.

FIGS. **10**A and **10**B represent the insertion of a further embodiment of the apparatus into the abdominal cavity and the method of using the apparatus.

FIGS. **11**A and **11**B represent a further embodiment of the apparatus and its method of use.

FIGS. **12**A and **12**B represent a further embodiment of the apparatus and its method of use.

FIGS. **13**A and **13**B represent a further embodiment of the apparatus and its method of use.

FIGS. **14**A-**14**C represent a further embodiment of the apparatus and its method of use.

FIGS. **15**A and **15**B represent a further embodiment of the apparatus and its method of use.

FIGS. **16**A and **16**B represent a further embodiment of the apparatus and its method of use.

FIG. **17** represents a further embodiment of the apparatus and its method of use.

FIGS. **18**A and **18**B represent a further embodiment of the apparatus and its method of use.

FIGS. **19**A and **19**B represent a further embodiment of the apparatus and its method of use.

FIGS. **20**A and **20**B represent a further embodiment of the apparatus and its method of use.

FIGS. **21** A and **21**B represent a further embodiment of the apparatus and its method of use.

FIGS. **22**A and **22**B represent a further embodiment of the apparatus and its method of use.

FIG. **23** represents a further embodiment of the apparatus and its method of use.

FIGS. **24**A-**24**C represent component parts of a further embodiment of the apparatus.

FIG. **25** represents a component part of a further embodiment of the apparatus.

FIG. **26** represents a component part of a further embodiment of the apparatus.

FIG. **27** represents represent a further embodiment of the apparatus.

FIG. **28** represents represent a further embodiment of the apparatus.

FIG. **29** represents a further embodiment of the apparatus.

FIG. **30** represents a further embodiment of the apparatus.

FIG. **31** represents a further embodiment of the apparatus.

FIG. **32** represents a further embodiment of the apparatus.

FIG. **33** represents a component part of an embodiment of the apparatus.

FIG. **34** represents a component part of an embodiment of the apparatus.

FIG. **35** represents a component part of an embodiment of the apparatus.

FIG. **36** represents a component part of an embodiment of the apparatus.

FIG. **37** represents a component part of an embodiment of the apparatus.

FIG. **38** represents a component part of an embodiment of the apparatus.

FIGS. **39**A-**39**C represent component parts of an embodiment of the apparatus.

FIGS. **40**A and **40**B represent component parts of an embodiment of the apparatus.

FIG. **41** represents a component part of an embodiment of the apparatus.

FIG. **42** represents a component part of an embodiment of the apparatus.

FIG. **43** represents a component part of an embodiment of the apparatus.

FIGS. **44**A and **44**B represent component parts of an embodiment of the apparatus.

FIGS. **45**A-**45**E represent component parts of an embodiment of the apparatus.

FIGS. **46**A-**46**E represent component parts of an embodiment of the apparatus and its method of use.

FIGS. **47**A-**47**D represent component parts of an embodiment of the apparatus and its method of use.

FIGS. **48**A-**48**D represent component parts of an embodiment of the apparatus and its method of use.

FIGS. **49**A and **49**B represent component parts of an embodiment of the apparatus and its method of use.

FIGS. **50**A and **50**B represent component parts of an embodiment of the apparatus and its method of use.

FIGS. **51**A-**51**E represent a method of positioning an embodiment of the apparatus in an abdominal insertion device.

FIGS. **52**A and **52**B represent embodiments of the apparatus and an insertion device and the method of mounting the apparatus on the insertion device.

FIG. **53** represents embodiments of the apparatus and an insertion device and a method of mounting the apparatus on the insertion device.

FIG. **54** represents embodiments of the apparatus and an insertion device and a method of mounting the apparatus in the insertion device.

FIGS. **55**A-**55**C represent an embodiment of the apparatus and a method of using the apparatus.

FIGS. **56**A-**56**C are views of a further embodiment of the apparatus of the invention that employs a tissue connector with a releasable one-way cord lock.

FIGS. **57**A-**57**C are views of the tissue connector apparatus of FIGS. **56**A-**56**C but rotated 90°. FIGS. **58**A-**58**C are views of the tissue connector apparatus similar to those of FIGS. **56**A-**56**C, but with the releasable one-way cord lock moved to an unlocked position.

FIGS. **59**A-**59**C are views of the surgical tissue connector apparatus shown in FIGS. **58**A-**58**C, but rotated 90°.

FIGS. **60**A-**60**C show a further embodiment of the surgical tissue connector apparatus with a releasable one-way cord lock.

FIGS. **61**A-**61**C are views of the tissue connector apparatus of FIGS. **60**A-**60**C, but rotated 90°.

FIGS. **62**A-**62**C are views of the tissue connector apparatus similar to those of FIGS. **60**A-**60**C, but with the releasable one-way cord lock moved to the unlocked position.

FIGS. **63**A-**63**C are views similar to those of FIGS. **62**A-**62**C, but rotated 90°.

FIGS. **64**-**67** are representations of a method of using either of the embodiments of the surgical tissue connector apparatus shown in FIG. **56**A-**56**C or **60**A-**60**C.

FIG. **68** is a view of a still further embodiment of the apparatus comprising two cord lengths and four tissue connectors.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. **1** shows one embodiment 12 of the apparatus for intra-abdominally moving a first internal organ to a position away from a second internal organ and then holding the first internal organ in the position without manual input. As stated earlier, the apparatus **12** is constructed of component parts that are often used in laparoscopic instruments and procedures as well as other types of surgical instruments and procedures. Because such component parts are known, the component parts that make up the apparatus **12** of the invention will be described herein using their common understood names and functions, without going into the details of the particular constructions of the component parts. As is conventional with laparoscopic apparatus, the component parts of the apparatus are dimensioned to be inserted through an incision in the abdominal wall or through a cannula extending through the abdominal wall to position the apparatus in the abdominal cavity.

The basic construction of the apparatus **12** of the invention includes a length of cord. In the example of FIG. **1** the cord length is 10 inches, but the size of the apparatus **12** could change depending on the size of the patient in which the apparatus is used. In the embodiment shown in FIG. **1**, the cord is comprised of a first cord segment **14** having a flexible length with opposite first **16** and second **18** ends, and a second cord segment **22** having a flexible length with opposite first **24** and second **26** ends.

The cord segments **14**, **22** could be provided by lengths of suture, lengths of tubing such as IV tubing, lengths of umbilical tape or elastic strips, or other equivalent cord constructions. The tubing or tape configurations of the cord segments have the advantage of being less likely to dig into or cut into the first internal organ in use of the apparatus to be described. The first **14** and second **22** cord segments could be separate cord segments that are attached directly together, or separate cord segments that are attached by way of a further cord segment **28** or some other component part of the apparatus, or two cord segments of a single continuous length of cord such as the two cord segments **14***a*, **22***a* shown in FIG. **2**.

First **32**, second **34**, and third **36** separate tissue connectors are attached to the first **14** and second **22** cord segments. The tissue connectors **32**, **34**, **36** can be any type of known tissue connector that can be manually manipulated to connect to body tissue, and then manually manipulated to be removed from the body tissue **12** without leaving any significant damage to the body tissue. In addition, the tissue connectors **32**, **34**, **36** could be biocompatible tissue connectors that are designed to be left in the abdominal cavity after the surgical procedure is completed. Some examples of tissue connectors include suture needles, T bars, surgical graspers, barbed needles, hooks, clasps, rivet assemblies, or any other equivalent type of connector. In the apparatus of the invention, it is not necessary that all three tissue connectors **32**, **34**, **36** be the same type of tissue connector. Because various different types of tissue connectors may be employed with the apparatus **12** of the invention, the three tissue connectors **32**,**34**,**36** of the apparatus **12** are represented schematically in the drawing figures. The first **32** and third **36** tissue connectors are attached to the opposite ends of the first cord segment **14**. The third tissue connector **36** is also attached to one end of the second cord segment **22**, with the second tissue connector **34** being connected to the opposite end of the second cord segment **22**. This positions the first **32** and second **34** tissue connectors at the opposite ends of the combined lengths of the first **14** and second **22** cord segments, and positions the third tissue connector **36** at an intermediate position of the combined length of the first **14** and second **22** cord segments. In FIG. **1**, the first **32** and second **34** tissue connectors are shown connected to the respective first end **16** of the first cord segment i4 and the first end **24** of the second cord segment **22** through the intermediary of additional cord segments **38**, **40**. The third tissue connector **36** is shown connected to the second end **18** of the first cord segment **14** and the second end **26** of the second cord segment **22** through the intermediary of a further cord segment **28**. FIG. **2** shows the apparatus **12** with the first **32** and second **34** tissue connectors connected directly to the respective first end **16** of the first cord segment **14** and the first end **24** of the second cord segment **22**. FIG. **2** also shows the third tissue connector **36** connected directly to the second ends **18**, **26** of the first cord segment **14** and the second cord segment **22**.

FIGS. **4** and **5** illustrate an example of the use of the apparatus **12** of FIG. **1** according to the method of the invention. In use, the apparatus **12** is first manually passed through the abdominal wall **42**, for example through an incision or a cannula **44** in the abdominal wall **42**, and is positioned in the abdominal cavity **46** in the area of the first **48** and second **50** internal organs. In FIG. **4**, the first internal organ **48** represented is the human liver, and the second internal organ **50** represented is the human stomach.

The third tissue connector **36** of the apparatus is then manually connected to tissue **52** adjacent the first internal organ **48** and between the first **48** and second **50** internal organs. In the example shown in FIG. **4**, the tissue **52** is the crus of the diaphragm. Connection of the third tissue connector **36** to the tissue **52** positions the second ends **18**, **26** of the first **14** and second **22** cord segments connected to the third tissue connector **32** between the first **48** and second **50** internal organs and on an opposite side of the first internal organ **48** from the abdominal wall **42**.

The first tissue connector **32** attached to the opposite end **16** of the first cord segment **14** from the third tissue connector **36** is then manually moved causing the length of the first cord segment **14** to move and engage across the first internal organ **48**. Continued movement of the first tissue connector **32** causes the first cord segment **14** engaging across the first internal organ **48** to move the first internal organ toward a position away from the second internal organ **50**. The first tissue connector **32** is then manually connected to the inner abdominal wall **42**.

The second tissue connector **34** attached to the opposite end **24** of the second cord segment **22** from the third tissue connector **36** is then manually moved causing the second cord segment **22** to move and engage across the first internal organ **48**. Continued movement of the second tissue connector **34** causes the second cord segment **22** engaging across the first internal organ **48** to move the first internal organ **48** toward the position away from the second internal organ **50**. The second tissue connector **34** is then manually connected to the inner abdominal wall **42**.

With the apparatus **12** connected between the tissue **52** and the inner abdominal wall **42** in the manner discussed above, the first cord segment **14** and the second cord segment **22** engage across the first internal organ **48** and hold the first internal organ **48** at the position away from the second internal organ **50** without further manual input. This provides surgical access to the second internal organ **50**. Without requiring manual holding or restraining of the first internal organ **48** in the position away from the second internal organ **50**.

FIG. **6** is a representation of the apparatus of FIG. **2** that has been connected between the tissue **52** and the inner abdominal wall **42** according to the same method as the apparatus of FIG. **1** described above.

In a further embodiment of the apparatus of the invention shown in FIG. **3**, the apparatus **54** is comprised of a single cord **56** having a continuous flexible length with opposite first **58** and second **60** ends. A tissue connector in the form of a needle **62** is attached to the first end **58** of the length of cord **56**. At the opposite second end **60** of the length of cord **56**, the cord is formed in a knot **64**.

The method of using the embodiment of the apparatus **54** shown in FIG. **3** is illustrated in FIG. **7**. The apparatus **54** is first positioned inside the abdominal cavity in the same manner as the previously described embodiments. The knotted end **64** of the length of cord is then connected to the tissue **52** adjacent the first internal organ **48** by first passing the needle **62** through the tissue **52** and then manually pulling the needle **62** and the attached length of cord **56** through the tissue **52**. This attaches the knotted second end **64** of the length of cord **56** to the tissue **52** between the first **48** and second **50** internal organs.

The needle **62** is then passed through the inter-abdominal wall **42** and the needle **62** and the attached length of cord **56** are pulled from the insertion site **72** back into the abdominal cavity **46**. This causes a first segment **74** of the cord length **56** to move into engagement with and across the first internal organ **48**. The engagement of the first cord segment **74** with the first internal organ **48** moves the first internal organ **48** toward the position away from the second internal organ **50**.

The needle **62** is then again inserted through the inter-abdominal wall **42** at a second insertion location **76** spaced from the first insertion location **72**. The needle **62** and the attached length of cord **56** are pulled manually through the second insertion **76** into the abdominal cavity **46** until an intermediate section of cord **78** extends between the two insertion sites **72**,**76**.

The needle **62** and the attached length of cord **56** are then passed through the knot **64** formed at the opposite end of the length of cord **56** and are pulled tight. This causes a second cord segment **82** of the length of cord **56** to engage across and move the first internal organ **48** toward the position away from the second internal organ **50**. The length of cord **56** is pulled tight and a knot is tied between the opposite ends of the cord at the knot **64** on the cord second end **60**. The portion of the length of cord **54** extending from the knot **64** to the needle **62** is then cut and removed from the abdominal cavity. The length of cord **54** left in the abdominal cavity forms a triangular loop with the first **56** and second **82** cord segments extending across the first internal organ **48** and holding the first internal organ in the position away from the second internal organ **50** without manual input. In this manner, surgical access is provided to the second internal organ **50** without manually holding the first internal organ **48** in its retracted position.

FIGS. **8**A-**8**E represent one method of inserting the apparatus of the invention into the abdominal cavity and the method of using the apparatus. The embodiment of the apparatus **12** shown in these drawing figures has a pair of keith needles **80**, **82** as the first and second tissue connectors, and a T bar **84** as the third tissue connector. The apparatus **12** is first positioned inside an insertion device **86** in the form of a hollow narrow tube. The insertion device **86** is then inserted through a trocar or cannula **44** that has been positioned in the abdominal wall **42** in a conventional manner. Once inside the abdominal cavity **46**, the apparatus **12** is removed from the interior of the insertion device **86** and the insertion device is removed from the abdominal cavity through the cannula **44**. The T bar **84** or the third tissue connector is then passed through the body tissue **52**, i.e., the right diaphragm crus as described earlier. Once the T bar **84** is passed through the tissue **52**, it is rotated to its substantially 90-degree position relative to its pathway through the tissue **52** as shown in FIG. **8**C. The apparatus **12** is then pulled from the keith needles **80**, **82**. As represented in FIG. **80**, the keith needles **80**, **82** are then passed through the abdominal wall **42** and the apparatus is pulled tight against the first internal organ **48**, i.e., the liver. The needles **80**, **82** are then pulled at the exterior of the abdominal wall **42**, causing the apparatus to move the first internal organ **48** away from the second internal organ, i.e., the stomach. A pair of tension clasps **88**, **90** are attached to the respective first **14** and second **22** cord segments of the apparatus on the exterior of the abdominal wall **42** to hold the apparatus in its position across the first internal organ **48** in the abdominal cavity **46**.

FIGS. **9**A-**9**E represent a method of using an embodiment of the apparatus **12** that is similar to that shown in FIGS. **8**A-**8**E and described above. In this example, the apparatus **12** also employs the T bar **84** as its third tissue connector. However, there is no needle provided on the first cord segment **14** and there is no needle provided on the second cord segment **22**. In this embodiment of the apparatus **12**, the first cord segment **14** is a length of suture having a free end **92** opposite the T bar **84** and the second cord segment **22** is a length of suture also having a free end **94** opposite the T bar **84**. The apparatus **12** is shown in FIG. **9**A as being positioned in the abdominal cavity **46** using the insertion device **86** in the same manner described earlier with reference to the method of FIGS. **8**A-**8**E. The apparatus **12** of FIG. **9**A is also initially used according to the same method of FIGS. **8**A-**8**E in that the "T" bar **84** is passed through the body tissue **52** and is positioned substantially 90° relative to the pathway through the tissue. A pair **18** of GraNee needles **96**, **98** are then passed through the abdominal wall **42**. One of the GraNee needles **96** grabs the suture free end **92** of the first cord segment **14** and the other GraNee needle **98** grabs the suture free end **94** of the second cord segment **22**. The GraNee needles **96**, **98** are then withdrawn through the abdominal wall **42** pulling the suture free ends **92**, **94** through the abdominal wall. The suture free ends **92**, **94** are then secured to the abdominal wall using a pair of clamps **88**, **90** as was done in the previously-described embodiment of FIGS. **8**A-**8**E.

FIGS. **10**A and **10**B are a representation of the method of the invention practiced using an ENDO STITCH® device marketed by United States Surgical Corporation. FIG. **10**A represents the distal end of the ENDO STITCH® **102** being inserted through the cannula **44** in the abdominal wall **42** to a position adjacent the diaphragm crus **52**. As is conventional, the pair of jaws **104**, **106** at the ENDO STITCH® distal end **102** hold a needle **108** and a length of suture **110**. The ENDO STITCH® **102** is manually actuated to pass the needle **108** through the tissue **52** of the crus from one jaw **104** of the ENDO STITCH® to the opposite jaw **106** of the ENDO STITCH®. The length of suture **110** is then removed from the abdominal cavity **46** through the cannula **44** and is pulled tight, causing the length of suture **110** to move and hold the first internal organ away from the second internal organ in substantially the same manner as described earlier.

FIGS. **11**A and **11**B represent a further embodiment of the apparatus **12** and its method of use. The embodiment of the apparatus **12** shown in FIGS. **11**A and **11**B and its method of use are substantially the same as that of earlier-described embodiments, except that the T bar of the previously-described embodiments is replaced by a "J" hook locking clasp **112**. FIG. **11**A shows the locking clasp **112** in its open position prior to the hook portion of the clasp being passed through the tissue **52** of the diaphragm crus. FIG. **11** B shows the locking clasp **112** after the hook of the clasp has been passed through the tissue **52** and the clasp has been locked. The method of further using the apparatus to move and hold an internal organ is substantially the same as that of earlier-described embodiments.

FIGS. **12**A and **12**B show a further embodiment of the apparatus **12** and its method of use. The construction of the embodiment of the apparatus **12** shown in FIGS. **12**A and **12**B is substantially the same as earlier described embodiments, except that the bar or locking clasp is replaced by a barbed needle **114**. The method of using the embodiment of the apparatus shown in FIGS. **12**A and **12**B is substantially the same as that of earlier described embodiments, except that the barbed needle **114** is passed through the tissue **52** of the diaphragm crus until the barb of the needle emerges from the tissue as shown in FIG. **12**B. This secures the apparatus to the tissue **52**. Further use of the apparatus to move and hold an internal organ is substantially the same as that of earlier-described embodiments.

FIGS. **13**A and **13**B show a further embodiment of the apparatus **12** of the invention that is substantially the same as that as earlier-described embodiments except that the third tissue connector or T bar is replaced by a resilient biased clasp **116**. In the method of using the apparatus of FIGS. **13**A and **13**B, the opposite arms **118**, **120** of the clasp **16** are compressed to open the jaws **122**, **124** of the clasp as shown in FIG. **13**A. The jaws **122**, **124** are then positioned around the tissue **52** of the diaphragm crus and are allowed to close, thereby securing the clasp **116** to the tissue **52**. The subsequent method of using the apparatus shown in FIGS. **13**A and **13**B is substantially the same as that of previously-described embodiments of the apparatus.

FIG. **14**A-**14**C show a further embodiment of the apparatus **12** that is substantially the same as that of previously-described embodiments except that the third tissue connector is a two-piece rivet assembly. The assembly is comprised of a pin **126** having an enlarged point **128** and a cap **130** having a circular center opening **132**. In the method of using the apparatus of FIGS. **14**A-**14**C, the pin **126** is first inserted through the tissue **52** of the diaphragm crus until the point **128** projects from the opposite side of the tissue. The point **128** is then inserted through the center opening **132** of the cap **130**, thereby securing the pin **126** and the cap **130** to the tissue **152**. The subsequent steps of using the apparatus of FIGS. **14**A-**14**C is substantially the same as that of earlier-described embodiments of the apparatus.

FIGS. **15**A and **15**B show a further embodiment of the apparatus **12** that has substantially the same construction of earlier-described embodiments of the apparatus except for the first and second tissue connectors being a pair of "J" shaped hooks **134**, **136**. In the method of using the embodiment of the apparatus shown in FIGS. **15**A and **15**B, the first cord segment **14** and the second cord segment **22** are secured to the inner abdominal wall **42** by passing the hooks **134**, **136** through the tissue of the inner abdominal wall. Apart from this, the method of using the apparatus shown in FIGS. **15**A and **15**B is substantially the same as that of earlier-described embodiments of the apparatus.

FIGS. **16**A and **16**B represent a further embodiment of the apparatus and its method of use that are substantially the same as that of previously-described embodiments, except for the first and second tissue connectors being a pair of "J" hook locking clasps **138**, **140**. In the method of using the apparatus of FIGS. **16**A and **16**B, the hook portions of the locking clasps **138**, **140** are passed through the tissue of the inner abdominal wall **42** and then are locked closed. This secures the first cord segment **14** and the second cord segment **22** to the inner abdominal wall. Apart from this, the method of using the apparatus of the invention shown in FIGS. **16**A and **16**B is substantially the same as that of earlier-described embodiments of the apparatus.

FIG. **17** shows a representation of an embodiment of the apparatus where the first and second tissue connectors are provided as a pair of resilient, biased clasps **142**, **144** that have substantially the same construction of the earlier described clasp **116**. The clasps **142**, **144** are secured to the inner abdominal wall **42** by first opening the clasps and positioning tissue of the inner abdominal wall between the open jaws of the clasps, and then allowing the jaws of the clasps to close over the tissue. This secures the first cord segment **14** and the second cord segment **22** to the inner abdominal wall. Apart from this, the method of using the apparatus represented in FIG. **17** is substantially the same as that as earlier described embodiments of the apparatus.

FIGS. **18**A and **18**B show an embodiment of the apparatus and its method of use that is substantially the same as that of FIG. **7**. The embodiment of FIGS. **18**A and **18**B differs from that of the FIG. **7** embodiment in that the free ends **146**, **148** of the length of suture **150** are tied in a knot completing the triangular loop configuration of the length of suture **150** at a location that is displaced from the portion of the suture **150** passed through the tissue **52** of the diaphragm crus. Apart from this, the method of using the apparatus of the invention shown in FIGS. **18**A and **18**B is substantially the same as that of the embodiment of the apparatus shown in FIG. **7**.

FIGS. **19**A and **19**B show a further embodiment of the apparatus and its method of use. The apparatus shown in these drawing figures is comprised of a length of cord **152** with a circular pledget **154** secured at one end of the cord and a needle, for example a keith needle **156**, secured to the opposite end of the cord. The cord **152** could be a length of suture or other similar material. In the method of using the apparatus shown in FIGS. **19**A and **19**B, the needle **156** is first passed through the abdominal wall **42** and into the abdominal cavity **46**. The needle **156** is then passed through the tissue **52** of the diaphragm crus. The needle **156** is then again passed through the abdominal wall **42** to the exterior of the abdomen and is pulled tight. This results in the length of cord **152** engaging against and moving the first internal organ away from the second internal organ in substantially the same manner as previously-described embodiments. The tight length of cord **152** is then secured in place by a clasp **158** attached to the length of cord **152** against the exterior of the abdominal wall **42**.

FIGS. **20**A and **20**B show a representation of a further embodiment of the apparatus and its method of use. In FIG. **20**A, the apparatus is shown comprised of a length of cord **160** having a circular pledget **162** at one end and a needle, for example a keith needle **164**, at the opposite end. The apparatus also includes a second shorter length of cord **166** with a T bar **168** at one end and a loop **170** formed in the opposite end. In the embodiment, the cords **160**, **166** may be suture or other similar materials. The method of using the apparatus is represented in FIG. **20**B. The T bar **168** is first secured to the tissue **52** of the diaphragm crus. The needle **164** is then passed through the tissue of the inner abdominal wall **42**, through the loop **170** and then through the abdominal wall **42** to the exterior of the abdomen. Pulling the needle **164** on the exterior of the abdomen pulls the cord **160** tight across the internal organ to move and hold the internal organ in substantially the same manner as that of previously-described embodiments of the apparatus.

FIGS. **21**A and **21** B show a further embodiment of the apparatus that is substantially the same as that of the embodiment of FIGS. **20**A and **20**B, except that the needle **164** is removed from the end of the length of cord **160**, leaving a free end **172** of the cord. The method of using this embodiment of the apparatus is substantially the same as that of the previously-described embodiment except for the step of passing the cord free end **172** through the abdominal wall **32**. A GraNee needle (not shown) may be used to perform this step of the method.

FIGS. **22**A and **22**B show a further embodiment of the apparatus that is substantially the same as that of the previously-described embodiment, except that it is comprised of only the length of cord **160** having the circular pledget **162** at one end and a free end **172** of the cord at the opposite end. In the method of using this embodiment of the apparatus, the suture free end **172** is first passed through the inner abdominal wall **42**, then through the tissue **52** of the diaphragm crus, and then through and out of the abdominal wall **42**. As in the previously-described embodiment, the suture free end **172** can be passed through the tissue of the abdominal wall **42** and the crus **52** using a GraNee needle or other similar instrument. The length of cord **160** is pulled tight to move and hold the first internal organ relative to the second internal organ in substantially the same manner as previously-described method embodiments of the apparatus.

FIG. **23** shows a further embodiment of the apparatus that is substantially the same as that of earlier-described embodiments except for the first and second tissue connectors being "J" hook locking clasps **174**, **176** that incorporate one-way clutch mechanisms. The ends of the cord segments **14**, **22** can be pulled through the clutch mechanisms of the clasps **174**, **176** in one direction, but are prevented by the clutch mechanisms from being pulled through the clasps **174**, **176** in the opposite directions.

FIG. **24**A-**24**C show representations of a "J" hook locking clasp such as that shown in FIG. **23**, with a one-way clutch mechanism. The one-way clutch mechanism is comprised of a rotatable pulley **178** and a "V" shaped groove **180** positioned adjacent the pulley **178**. An end portion of the cord **182** is threaded through the "V" shaped groove **180** and then around the pulley **178**. When the end of the cord **182** extending from the pulley **178** is pulled tight, the relative positions of the pulley **178** and the groove **180** cause the portion of the cord **182** to wedge and become locked in the bottom of the groove **180**.

FIG. **25** shows a further representation of the embodiment of the apparatus employing a "J" hook locking clasp **184** with a one-way clutch mechanism. The one-way clutch mechanism is comprised of a pair of pivoting cams **186**, **188** having opposing ratchet tooth surfaces **190**, **192**. A portion of the apparatus cord **194** is threaded between the opposed tooth surfaces. The portion of cord **194** can be pulled through the spacing between the cam ratchet tooth surfaces **190**, **192** in one direction, for example to the left in FIG. **25**, but the cams **186**, **188** pivot toward each other and their ratchet tooth surfaces **190**, **192** clamp the cord portion **194** between the surfaces when the cord portion is pulled in the opposite direction, for example to the right as shown in FIG. **25**.

FIG. **26** shows a representation of a further embodiment of the "J" hook clasp **196** having a one-way clutch mechanism. In this embodiment, the one-way clutch mechanism is comprised of a toothed wheel **198** that engages with the cord portion **20** pulled through the claps **196**. The tooth wheel **198** also has a smaller ratchet wheel **202** at its center. The ratchet wheel **202** engages against a resilient pawl **204**. The ratchet wheel **202** and resilient pawl **204** function in the conventional manner allowing the toothed wheel **198** to rotate in one direction n when the cord portion **200** is pulled through the clutch mechanism, for example to the right as shown in FIG. **26**, but prevent the rotation of the toothed wheel **198** and the movement of the cord portion **200** when the cord portion is pulled in the ' opposite direction, for example to the left as shown in FIG. **26**.

FIGS. **27-32** show several different representations of the possible constructions of the cord segments **14**, **22**, **38** of the apparatus of the invention. In FIGS. **27-32** the first and second tissue connectors are represented by needles, for example keith needles **80**, **82**. The third tissue connector is represented by a T bar **84**. It should be understood that these are only examples of only three tissue connectors that could possibly be used with the apparatus of the invention, and that other forms of tissue connectors, for example the types described herein could be used as the three tissue connectors on the apparatus. FIG. **27** shows the first **14**, second **22** and third **38** cord segments as being constructed of suture material.

FIG. **28** shows the first **14** and second **22** cord segments being part of a single length of surgical tape or strap, and the third cord segment **38** being constructed of suture.

FIG. **29** shows the first **14** and second **22** cord segments being constructed of lengths of suture inserted through lengths of surgical tubing. The third cord segment **38** is constructed of suture.

FIG. **30** shows the apparatus as having first **14** and second **22** cord segments constructed of combinations of surgical tape and suture connected end to end. The third cord segment **38** is constructed of suture material.

FIG. **31** shows the apparatus being constructed of first **14** and second **22** cord segments formed from a single length of suture material inserted through a single length of surgical tubing. The third cord segment **38** is constructed of suture material.

FIG. **32** shows the apparatus as having the first **14** and second **22** cord segments constructed of a single continuous length of surgical tape having lengths of suture at opposite ends. The third cord segment **38** is constructed of suture material.

FIGS. **33**-**45** show examples of some of the various different types of tissue connectors that could be used as anyone of the tissues connectors **32**, **34**, **36** of the apparatus. These are only some of the possible types of tissue connectors, and the connectors shown in FIGS. **33**-**45** should not be interpreted as limiting the apparatus to the particular tissue connectors shown.

FIG. **33** shows a T bar **84** as one example of anyone of the three tissue connectors **32**, **34**, **36**.

FIG. **34** shows a barbed needle **114** as anyone of the three tissue connectors **32**, **34**, **36**.

FIG. **35** shows the two-piece rivet pin **126** and cap **130** connector that can be used as anyone of the three tissue connectors **32**, **34**, **36**.

FIG. **36** shows the "j" hook locking clasp **112** that can be used as anyone of the three tissue connectors **32**, **34**, **36**.

FIG. **37** shows the resilient, biased clasp **116** that could be used as any one of the three tissue connectors **32**, **34**, **36**.

FIG. **38** shows a cross-section of an embodiment of a "j" hook locking clasp. The embodiment shown is comprised of a cylindrical housing **206** that contains the "j" hook **208** and a coil spring **210** that biases the "j" hook **208** to its closed position.

FIGS. **39**A-**39**C show a variation of the "j" hook locking clasp of FIG. **38** where the coil spring **210** is replaced by a spiral band spring **212**. FIG. **39**B shows the spiral and spring **212** in its extended configuration, and FIG. **39**C shows the spring in its compressed configuration.

FIGS. **40**A and **40**B show a tissue connector clasp that is comprised of a pair of resilient jaws **214**, **216** that project from one end of a hollow housing **218**, and a pin **220** connected to the jaws that projects from the opposite end of the housing. A spring **22** contained in the housing **218** biases the pin **220** and the jaws **214**, **216** to the left as shown in FIG. **40**A. This causes the resilient jaws to move to their open position shown in FIG. **40**A. Pulling the pin **220** to the right against the bias of the spring **222** causes the housing to slide against the opposite sides of the jaws **214**, **216** and move the jaws to their closed position.

FIG. **41** shows a side view of the resilient biased clasp **116** described earlier. Compressing the opposite arms **118**, **120** of the clasp **116** causes the jaws **122**, **124** to separate. Releasing the compression force causes the jaws **122**, **124** to move together under the bias of the resilience of the clasp **116**.

FIG. **42** shows an embodiment of a clasp comprised of a first jaw **224** and first arm **226** connected by a pivot connection **228** to a second jaw **230** and second arm **232**. An oblong cam **234** on a toothed cam wheel **236** is positioned between the pair of arms **226**, **232**. A toothed actuator wheel **238** meshes with the toothed cam wheel **236**. Rotation of the actuator wheel **238** will cause rotation of the cam wheel **236** and the cam **238**. Rotation of the cam **234** to its position shown in FIG. **42** pushes the pair of arms **226**, **232** away from each other which in turn causes the pair of jaws **224**,**230** to move toward each other. Rotation of the cam **234** 90° or one-quarter turn from its position shown in FIG. **2** will cause the jaws **242**, **230** to move away from each other.

FIG. **43** shows an embodiment of a clasp comprised of a first jaw **240** and first arm **242** connected by a pivot connection **244** to a second jaw **246** and second arm **248**. A spring **250** is positioned between the pair of arms **240**, **248** and biases the arms away from each other. This in turn biases the first jaw **242** and second jaw **246** toward each other. The jaws **242**, **246** are opened by applying a compression force to the opposite sides of the first arm **240** and second arm **248** that compresses the spring **250**.

FIGS. **44**A-**44**B show a side-sectioned view of a construction of the rivet assembly described earlier. As seen in the drawing figures, the pin head **128** is slightly larger in diameter than the cap hole **132**. When the pin **126** is attached to the cap **130**, there is a fixed gap or maximum distance between a circular head **252** of the pin **126** and the cap **130**.

FIGS. **45**A-**45**E show a further embodiment of a rivet assembly. In this assembly, the rivet pin **254** has several notches **256** along its length between the pin head **258** and the pin point **260**. The rivet cap **262** is similar in construction to that of the previously-described embodiment with a center opening or hole **264** extending through the cap. However, the cap **262** is also formed with a transverse slot **266** that intersects the center hole **264** and a parallel slot **268** that extends into the cap **262** parallel to the center hole **264** and intersects the transverse slot **266**. A locking tab **270** with a pin hole **272** and a spring hole **274** is inserted in the transverse slot **266** for sliding movement therein. A resilient wire spring **276** is inserted downwardly into the parallel slot **268** and through the tab pin hole **272**. Inserting the rivet pin **254** into the cap center hole **264** and through the tab pin hole **272** causes the pin to slide the **30** tab to the left as shown in FIG. **45**A against the bias of the wire spring **276**. As a pin notch **256** passes through the tab hole **272**, the bias of the spring **276** causes the tab **270** to move to the right and into the notch **256**. This locks the pin **254** in place relative to the cap **262**. With the pin **254** having a number of notches, and in the example of FIG. **45**A having three notches, the position of the pin head **258** relative to the cap **262** can be adjusted between three positions. This provides an adjustable gap or an adjustable distance between the pin head **258** and the cap **262**.

FIGS. **46**A-**46**E represent a further embodiment of the apparatus of the invention. This embodiment is comprised of a length of cord **278** having a needle **280** at one end and a loop **282** formed at the opposite end. A circular pledget **284** is provided on the length of cord **278** toward the loop end of the cord. The apparatus also includes a locking collar having a hollow cylindrical housing **286** that contains a tubular one-way suture lock **288**. The suture lock **288** is basically cylindrical but is formed with a resilient tab **290** that projects toward the center of the cylindrical configuration of the suture lock. FIG. **46**E shows a cross-section representation of the collar cylindrical housing **286** containing the one-way suture lock **288** and a portion of the length of cord **278** extending through the collar. The method of using this embodiment of the apparatus is shown in FIG. **46**C. In use in the abdominal cavity **46**, the needle **280** is first passed through the tissue **52** in the area of the diaphragm crus, and then is passed a first time through the inner abdominal wall **42**. The needle **280** is then moved across the inner abdominal wall **42** and is again passed a second time through the inner abdominal wall. The needle is then inserted through the loop **282** and is pulled tight. This causes the length of cord **278** to form a triangular loop in the abdominal cavity that moves the first internal organ away from the second internal organ and holds the first internal organ in the displaced position in the same manner as previously-described methods of using the apparatus of the invention. The needle **280** is then passed through the collar cylindrical housing **286** and the housing **286** is moved tight against the cord loop **282**. The cord loop **282** is smaller than the housing **286** so that the housing cannot pass through the loop **282**. As the length of cord **278** is pulled through the collar housing **286**, the locking tab **290** engages against the side of the cord **278** as shown in FIG. **46**E. This allows the cord **278** to move through the collar housing **286** in the direction to the right shown in FIG. **46**E, but prevents movement of the cord to the left as shown in the figure. In this manner, the apparatus of FIGS. **46**A-**46**E holds the length of cord tight in its triangular loop configuration.

FIGS. **47**A and **47**B show a further embodiment of the apparatus of the invention and its method of use. The apparatus is comprised of a length of cord **294** having a pledget **296** secured at one end and a needle **298** secured at the opposite end. The apparatus also includes a one-way locking mechanism **300** having a pair of channels **302**, **304** through the mechanism dimensioned to receive the length of cord **294**. One of the channels **302** allows the length of cord **294** to move through the channel in one direction, but prevents the opposite direction of movement. The other channel **304** allows the length of cord **294** to move through the channel in one direction, but also prevents the opposite direction of movement of the cord **294**. As represented in FIG. **47**A, the method of using the apparatus first involves the needle **298** passing through the inner abdominal wall until the pledget **296** is positioned up against the wall. The needle **298** then passes through the tissue **52** in the area of the diaphragm crus. The needle **298** is then inserted through the first channel **302** of the one-way locking mechanism **300**. The needle **298** is then again passed through the inner abdominal wall at a location spaced from the first insertion site and is then passed through the second channel **304** of the one-way locking mechanism **300**. The needle **298** with the length of cord **294** are then pulled tight and the locking mechanism **300** is moved up against the inner abdominal wall at the second needle insertion site. This causes the length of cord **294** to move the first internal organ and hold the first internal organ in its moved position away from the second internal organ in a similar manner to that of earlier-described embodiments.

FIGS. **47**C and **47**D show the interior of one embodiment of the one-way locking mechanism **300**. The mechanism **300** includes a housing first half **306** and a second half **308** that are connected together by a living hinge **310**. The open position of the locking mechanism is shown in FIG. **47**D. The interior of the two halves **306**,**308** of the locking mechanism are formed with grooves **312**,**314** that form the two channels **302**,**304** through the locking mechanism when the two halves **306**, **308** of the locking mechanism are pivoted about the living hinge **310** and snapped together. A "U" shaped spring member **316** is positioned in the first locking mechanism half **306**. The spring member **316** has a pair of arms **318**,**320** that project from opposite sides of the spring member. Each arm **318**, **320** in turn has a resilient locking tab **322**, **324** that projects outwardly at an angle from its respective arm **318**, **320**. The resilient tabs **322**, **324** are positioned to engage in sliding engagement along portions of the cord **294** that pass through the channels **302**, **304**. As shown in FIG. **47**D, the one tab **322** will allow the cord **294** to slide across the tab in a direction from right to left as shown in the drawing figure, but will prevent the reverse sliding movement of the cord. The other tab **324** will allow sliding movement of the cord **294** across the tab **324** in a left to right direction as shown in FIG. **47**D, but will prevent the reverse movement of the length of cord **294**.

FIGS. **48**A-**48**D show a variant embodiment of the one-way locking mechanism **300**. As shown in FIG. **48**A, the length of cord is passed through the locking mechanism **328** in much the same manner as the earlier-described locking mechanism **300**. However, the second channel **330** of the locking mechanism **328** of FIG. **48**A has a block **332** with a hole **334** positioned along the channel. An inclined tooth **336** is positioned in the block hole **334**. The portion of the cord length **338** that extends through the locking mechanism channel **330** also extends through the block hole **334**. A spring **340** in the locking mechanism **328** biases the block **332** and the tooth **336** toward the portion of cord **338** extending through the locking mechanism channel **330**. Due to the inclination of the tooth **336**, with the spring **340** biasing the tooth **336** into engagement with the cord portion **338**, the cord portion **338** can slide over the tooth **336** as it is moved in a left to right direction as shown in FIG. **48**C, but is prevented from moving in the opposite direction. Pressing the block **332** into the locking mechanism **328** against the bias of the spring **340** disengages the tooth **336** from the cord portion **338** and permits the cord portion to move in either direction through the locking mechanism **328**.

FIGS. **49**A and **49**B show a further embodiment of a cord locking mechanism **344** that is similar to that of FIG. **48**A. A cross-section of a channel **346** extending through the locking mechanism **344** is shown in FIG. **49**A. The channel **346** is formed with pairs of ridges **348**, **350** on opposite sides of the channel. A wave form spring **352** is positioned in the channel **346**. The spring **352** has grooves **354** formed through peaks formed in the wave form spring. The portion of the cord **356** passing through the locking mechanism channel **346** also passes through the grooves **354** in the wave form spring **352**. A button hole **358** is provided in the top of the cord locking mechanism **344** and a release button **360** is positioned in the hole. When the release button **360** is pressed in the hole **358**, it engages with the wave form spring **352** and compresses the spring to the position shown in FIG. **49**A. In this position of the spring **352** the cord **356** is free to move in opposite directions through the locking mechanism **344**. When the button **360** is released, the spring **352** moves upwardly from its position shown in FIG. **49**A and portions of the spring **362** engage with the cord portion **356** extending through the lock mechanism channel **346** and hold the cord portion against the ridges **348** at the top of the channel **346**. This locks the cord portion **356** in the locking mechanism **344**.

FIGS. **50**A and **50**B show a further embodiment of a one-way cord locking mechanism. The mechanism includes a housing **364** having a hole **366** extending through the housing that is defined by a cone-shaped interior surface **368**. A pair of lock members **370**,**372** are positioned in the housing hole **366**. Each of the lock members **370**, **372** have exterior surfaces **374**,**376** that when the locking members are positioned together, define a truncated cone shape that fits within the cone-shaped interior surface **368** of the housing **364**. The opposing interior surfaces **378**, **380** of the lock members **370**, **372** are formed with mating peaks and valleys. As shown in FIG. **50**B, a spring **382** biases the two lock members **370**, **372** into the cone-shaped interior surface **368** of the housing **364**, thereby causing the lock member interior surfaces **378**, **380** to move toward each other. A portion of a cord length **384** extending through the opposing interior surfaces **378**, **380** of the lock members **370**, **372** is prevented from moving in the upward direction as shown in FIG. **50**B due to the bias of the spring **382**. However, when the cord portion **384** is moved in the opposite downward direction as shown in FIG. **50**B, the movement of the cord portion **384** causes the lock members **370**, **372** to compress the spring **382**. This allows the lock member interior surfaces **378**, **380** to move away from each other and release the portion of the cord **384** for movement through the lock mechanism.

FIGS. **51**A-**51**E show one method of inserting the apparatus of the invention into the tubular insertion device **86** described earlier. As shown in these drawing figures, a length of suture **386** is looped around the apparatus and is then pulled through the interior of the insertion device **86**. The first **14** and second **22** cord segments are folded flat against each other and the additional cord segment **38** is folded over parallel with the first cord segment **14** and second cord segment **22**. The apparatus is then pulled by the suture loop **386** into the interior of the insertion device **86** to the position shown in FIG. **51** E.

FIGS. **52**A and **52**B show a further embodiment of an insertion device **390**. The insertion device **390** has the configuration of an elongate narrow rod with a pair of opposed grooves **392**, **394** extending up one side of the rod from a distal end **396** of the rod. A third groove **398** is formed in a side of the rod toward a proximal end of the rod. The third groove **398** is positioned between the opposed pair of grooves **392**, **394**. According to the method of using the insertion device **390**, the first cord segment **14** and second cord segment **22** of the apparatus **12** are positioned in the opposed pair of grooves **392**, **394** that extend from the insertion device distal end **396**. The additional cord segment **38** of the apparatus **12** is positioned in the third groove **398** in the side of the rod. With the cords of the apparatus held in these grooves, the insertion device **390** is then inserted through a cannula **44** to insert the apparatus **12** into the abdominal cavity.

FIG. **53** shows a representation of a further embodiment of the insertion device **402** that is similar in construction to the previously-described embodiment of the insertion device **390**. The insertion device **402** of FIG. **53** is also comprised of a pair of opposed grooves **404**, **406** that receive the first **14** and second **22** cord segments of the apparatus **12**, and a third groove **408** that receives the additional cord segment **38** of the apparatus.

FIG. **54** shows a still further embodiment of an insertion device **410**. The insertion device **410** has a rod-shaped length with a hollow distal end. The rod distal end is comprised of a first half **412** and a second half **414** that are connected together by a living hinge assembly **416**. According to the method of using the insertion device **410** of FIG. **54**, the apparatus **12** is positioned in the interior of the first half **412** with the first cord segment **14** and second cord segment **22** extending parallel to each other, and the third cord segment **38** folded over the first cord segment **14** and second cord segment **22**. The second half **414** of the insertion device is then folded over the hinge assembly **416** and snapped closed to prepare the insertion device **410** for insertion of the apparatus **12**.

FIGS. **55**A-**55**C show a mesh apparatus **420** that is designed to be used as a part of the apparatus of the invention. The mesh apparatus **420** is basically comprised of a generally rectangular or trapezoidal-shaped panel of surgical mesh **422** with a pair of axially aligned tubes **424** at one side and a pair of axially aligned tubes **426** at the opposite side. As shown in FIG. **55**B, the mesh apparatus **420** can be rolled up around the pairs of tubes **424**, **426** to reduce the size of the apparatus for insertion through a cannula and into the abdominal cavity. FIG. **55**C shows the mesh apparatus **420** positioned in the abdominal cavity **46** and held in place against the first internal organ **48** by one of the previously-described embodiments of the apparatus. It should be understood that any of the previously described embodiments of the apparatus may be employed according to the method of the invention to hold the surgical mesh **420** in its position as shown in FIG. **55**C.

FIGS. **56**A-**56**C, **57**A-**57**C, **58**A-**58**C and **59**A-**59**C show an embodiment of the apparatus of the invention **500** that employs a surgical tissue connector with a releasable one-way cord lock. The apparatus **500** is basically designed to be attached between body tissue (or the first internal organ) and the abdomen wall with a cord of the apparatus extending across the first internal organ as in previously described embodiments, but also includes a feature for shortening the portion of the cord extending across the first internal organ to thereby cause the portion of the cord to move the first internal organ away from the second internal organ and to hold the first internal organ in the displaced position. Thus, the apparatus **500** enables the use of only one cord to move the first internal organ to a position away from the second internal organ and then hold the first internal organ at the position.

The apparatus **500** is comprised of a base **502** having a tubular configuration. More specifically the base **502** is formed as a cylindrical housing wall having a hollow interior bore extending entirely through the length of the base housing. A center axis **506** of the interior bore defines mutually perpendicular axially and radial directions relative to the base. The base cylindrical housing **502** has axially opposite first **508** and second **510** ends.

A first rod **512** and a second rod **514** are secured to the base. As shown in the drawing figures, the first rod **512** extends radially across the base interior bore adjacent the base second end **508**. Opposite ends of the first rod **512** are secured to the base cylindrical housing **502**. The second rod **514** extends radially across the base interior bore adjacent the base second end **510**. Opposite ends of the second rod are secured to the base cylindrical housing **502**.

A first tissue connector **516** extends from the base **502** at the base first end **508**. In the example shown in the drawings, the tissue connector **516** has a hook **518** formed at one end and a ring **520** formed at the opposite end. The first rod **512** extends through the ring **520** and thereby connects the tissue connector **516** to the base **502**. The hook **518** is employed in connecting the apparatus **500** to body tissue. The tissue connector shown in the drawing figures is only one example of a known type of tissue connector that could be employed with the apparatus **500**. Any other type of known tissue connector could replace the tissue connector **516** shown in the drawing figures. Additionally, the first tissue connector could be an integral extension of the base.

A flexible cord **522** having a length with opposite first **524** and second **526** ends is attached to the base **502** at the base second end **510**. An intermediate portion **528** of the cord is wrapped around the second rod **514** thereby attaching the cord **522** to the base **502**. A first portion or first percentage **530** of the cord length extends from the intermediate portion **528** and from the base second end **510** to the cord first end **524**. A second portion or second percentage **532** of the cord length extends from the intermediate portion **528** and from the base second end **510** to the cord second end **526**.

The cord intermediate portion **528** is wrapped around the second rod **514** by being tied in a Munter hitch or Italian hitch knot **534** around the second rod **514**. In FIG. **56**C the Munter hitch knot **534** is shown on a first radial side of the second rod **514**. When the knot **534** is maintained in this position, the first cord portion **530** can be pulled from the knot **534** increasing the length of the cord first portion **530** (or increasing the first percentage of the overall cord length) while decreasing the length of the cord second portion **532** (or decreasing the second percentage of the overall cord length). The cord second portion **532** is braked by the knot **534** with the knot in the first position shown in FIG. **56**C and the cord second portion cannot be pulled from the knot to increase its length. In FIG. **57**C the Munter hitch knot **534** is shown positioned on a second radial side of the second rod **514**, which is on an opposite side of the second rod **514** from the first radial side. When the knot **534** is maintained in this position, the second cord position **532** can be pulled from the knot increasing the length of the cord second portion **532** (or increasing the second percentage of the cord overall length) while decreasing the length of the cord first portion **530** (or decreasing the first percentage of the cord overall length). The cord first portion **530** is braked by the knot **534** with the knot in the second position shown in FIG. **57**C and the cord first portion cannot be pulled from the knot to increase its length. The Munter hitch knot **534** is a continuously sliding knot. When the knot **534** is free to move between its first position on the first radial side of the second rod **514** shown in FIG. **56**C and its second position on the second radial side of the second rod **514** shown in FIG. **57**C, pulling on the cord first portion **530** will cause the knot **534** to move to the first radial side of the rod **512** shown in FIG. **56**C. Further pulling on the cord first portion **530** will cause the length of the cord first portion to increase, while the length of the cord second portion **532** decreases. The cord intermediate portion **528** wrapped around the second rod **514** in the Munter hitch knot **534** is continuously wrapped around the rod as the cord first portion is pulled. Pulling on the cord second portion **532** will cause the Munter hitch knot **534** to move across the second rod **514** to the second radial side of the rod as shown in FIG. **57**C. Continuing to pull on the cord second portion **532** will cause the length of the cord second portion **532** to increase while the length of the cord first portion decreases. The cord intermediate portion **528** wrapped around the second rod **514** in the Munter hitch knot **534** is continuously wrapped around the second rod **514** as the cord second portion **532** is pulled.

A second tissue connector **540** is provided on the cord second end **526**. The second tissue connector **540** can be any known type of tissue connector used to attach to body tissue and is therefore shown only schematically in the drawing figures. A percentage of the cord length (the second percentage) extends between the first tissue connector and the second tissue connector. The percentage of the cord length extending between the first and second tissue connectors is intra-abdominally adjustable to increase the percentage of the cord length and to decrease the percentage of the cord length.

The apparatus **500** also includes a releasable one-way cord lock **542**. The lock **542** has a cylindrical exterior surface and engages in sliding engagement with the interior surface of the base cylindrical housing **502**. The lock **542** moves in axially reciprocating movements through the base interior bore between a first position of the lock shown in FIG. **56**C and a second position of the lock shown in FIG. **57**C. A half cylinder protrusion **544** is formed on the end of the lock adjacent the Munter hitch knot **534**. As seen in the drawing Figures, the protrusion **544** is positioned on the second radial side of the second rod **514**. Axial slots **546** are formed in the opposite sides of the base cylindrical housing **502** and a pin **548** extends radially through the lock **542** with opposite ends of the pin engaging in sliding engagement in the axial slots **546** of the base **502**. The ends of the pin **548** extending into the axial slots **546** allow the lock **542** to axially reciprocate through the interior bore of the base but prevent the lock **532** from rotating around the interior bore of the base. This maintains the lock protrusion **544** on the second radial side of the second rod **514**.

An actuator **550** is mounted on the base **502** and is operatively connected to the reversible one-way cord lock **542**. The actuator **550** is formed as a cylindrical sleeve that surrounds the base cylindrical housing **502**. The opposite ends of the lock pin **548** project beyond the axial slots **546** in the base cylindrical housing **502** and are secured in opposite sides of the actuator **550**. This operatively connects the actuator with the lock **542**. The actuator **550** is mounted on the cylindrical housing of the base **502** for axially reciprocating movements between first and second positions of the actuator relative to the base. Moving the actuator **550** to its first position relative to the base **502** moves the one-way cord lock **542** to its first position relative to the base shown in FIG. **56**C. Moving the actuator **550** to its second position relative to the base **502** moves the cord lock **542** to its second position relative to the base shown in FIG. **58**C.

A biasing device urges the one-way cord lock **542** to its first position shown in FIG. **56**C. In the embodiment of the apparatus shown in the drawing figures the biasing device **552** is a coil spring. As shown in FIG. **56**C, with the knot **534** positioned on the first radial side of the second rod **514**, the spring **552** biases the lock **542** toward the knot **534** until the lock protrusion **544** engages against the cord intermediate portion **528** adjacent the knot **534**. In this position of the protrusion **544** the protrusion prevents the knot **534** from moving around the second rod **514** to the second radial side of the rod. With the knot **534** maintained on the first radial side of the second rod **514** by the lock protrusion **534**, exerting a pulling force on the cord first portion **530** will increase the length of the cord first portion while decreasing the length of the cord second portion **532**. With the knot **534** maintained on the first radial side of the second rod **514** by the lock protrusion **544**, exerting a pulling force on the cord second portion **532** will not result in increasing the length of the cord second portion **532** and decreasing the length of the cord first portion **530**. The friction of the knot **534** held in the position shown in FIG. **56**C will resist the cord second portion **532** from being pulled from the base second end **510**.

With the actuator **550** being moved to its second position and in turn the one-way cord lock **542** being moved to its second position shown in FIG. **57**C, the knot **534** is free to move between the first radial side of the second rod **514** as shown in FIG. **56**C and the second radial side of the second rod **514** as shown in FIG. **57**C. With the lock protrusion **544** moved away from the knot, exerting a pulling force on the cord second portion **532** will cause the knot **534** to move from its position on the first radial side of the second rod **514** shown in FIG. **56**C to its position on the second radial side of the second rod **514** shown in FIG. **57**C. In this position of the knot, the pulling force exerted on the cord second portion **532** will result in the length of the cord second portion **532** increasing while the length of the cord first portion **530** decreases. When the actuator **550** is released and the spring **552** biases the one-way cord lock **542** back toward its first position, exerting a pulling force on the cord first portion **530** will cause the knot **532** to move from its position on the second radial side of the second rod **514** shown in FIG. **57**C to its position on the first radial side of the second rod **514** shown in FIG. **56**C. The biasing force of the spring **552** is not sufficient to hold the knot **534** on the second radial side of the second rod **514**. With the knot **534** positioned on the first radial side of the second rod **514** as shown in FIG. **56**C, again exerting a pulling force on the cord first portion **530** will result in increasing the length of the cord first portion while decreasing the length of the cord second portion **532**. Again, the friction of the knot **534** held at the position on the first radial side of the second rod **514** shown in FIG. **56**C will resist the cord second portion **532** from being pulled from the base housing second end **510**.

FIGS. **60**A-**60**C, **61**A-**61**C, **62**A-**62**C and **63**A-**63**C show a variant embodiment of the tissue connector apparatus with a releasable one-way cord lock just described. In this further embodiment of the apparatus **554**, many of the component parts of the apparatus **554** are the same as those of the previously described apparatus **500**. Therefore, these component parts will not be described again. The reference numbers used to identify the component parts in this further embodiment are the same as those used in identifying the component parts of the previous embodiment of the apparatus **500**. These component parts include the base cylindrical wall housing **502**, the first rod **512**, the second rod **514**, the first tissue connector **516**, the second tissue connector **540**, the cord **552**, the Munter hitch knot **534** and the biasing device or coil spring **552**.

The construction of the further embodiment of the apparatus **554** differs from that of the previous embodiment basically in the construction of the releasable one-way cord lock **556**. The lock **556** has a lock protrusion **544** that functions in the same manner as the previous embodiment. However, the cylindrical configuration of the lock **556** extends beyond the base cylindrical housing first end **508** to an annular flange or rim **558** on an opposite end of the lock from the protrusion **554**. This rim **558** functions as the actuator of the lock **556**. The rim **558** surrounds a hollow center bore **560**. The bore extends from the rim down into the lock **556** and ends short of the lock protrusion **544**. A pair of axially extending slots **562** are formed in the opposite sides of the lock **556** and communicate the interior bore **560** with the exterior of the lock **556**. The first rod **508** extends through the pair of slots **562**. The engagement of the first rod **512** through the slots **562** enables the lock **556** to reciprocate between its first and second positions relative to the base **502**, but prevents the lock **556** from rotating relative to the base. This maintains the protrusion **544** on the second radial side of the second rod **514**.

The first tissue connector **516** is connected to the first rod **512** just as in the previous embodiment. The first tissue connector **515** extends from the first rod **512** to the hook **518** of the connector.

The biasing device in the form of the coil spring **522** is positioned in the interior bore **560** of the lock **556**. The spring **552** is positioned between the first tissue connector ring **520** and the lock **556** and exerts a biasing force on the lock pushing the lock toward its first position relative to the base **502**.

The releasable one-way cord lock **556** of the apparatus **554** functions in the same manner as the previously described apparatus in maintaining the Munter hitch knot **534** on the first radial side of the second rod **514** when the lock is in its first position relative to the base, and allowing the knot **534** to move to the second side of the second rod **514** when the lock is moved to its second position on the base.

Both embodiments of the apparatus have the same method of use. Basically, a portion of the cord is attached to body tissue on an opposite side of the abdominal cavity from the abdominal wall, an additional portion of the cord is attached to the abdominal wall positioning a length or percentage of the cord across the first internal organ, and then the length or percentage of the cord extending across the first organ is decreased thereby causing the decreasing percentage of the cord length to engage across and move the first internal organ away from the second internal organ. This is illustrated schematically in FIG. **64**. As in the previously described embodiments, the apparatus **554** is first manually passed through the abdomen wall **42**, for example through an incision or a cannula **44** in the abdomen wall and is positioned in the abdominal cavity **46** in the area of the first **48** and second **50** internal organs. In the example shown, the first internal organ **48** represented is the human liver and the second internal organ **50** represented is the human stomach.

The second tissue connector **540** of the apparatus **554** is then manually connected to tissue **52** adjacent to the first internal organ **48** and between the first **48** and second **50** internal organs. In the example shown in FIG. **65**, the tissue **52** is the crus of the diaphragm. Alternatively, the second tissue connector **540** could be connected to the tissue of the first internal organ **48** itself, as shown in FIG. **66**. The apparatus **554** is then grasped by its actuator **558** and moved toward the abdominal wall **42**. This movement causes the actuator **558** and its associated releasable one-way cord lock to move to their second positions. The movement of the lock allows the knot to move to the second side of the second rod **514** when the cord second portion **532** is pulled in tension. The movement of the knot to the second side of the second rod **514** allows the cord second portion **532** to be pulled from the base second end **510** and increase in length (or increase in percentage) as the apparatus **554** is moved toward the abdominal wall **42**. When at the abdominal wall, the tissue connector **516** of the apparatus **500**/**554** is then connected to the inner abdominal wall **42**. This positions the cord second portion **532** extending from the second tissue connector **540** across the first internal organ **48** to the first tissue connector **516** attached to the abdominal wall **42**.

The actuator **558** of the apparatus **554** is then released. This results in the spring of the apparatus moving the releasable one-way cord lock to its first position relative to the base **502**.

The cord first portion **530** is then grasped and pulled from the base second end **510**. This causes the knot to move to the first side of the second rod **514** and causes the length of the cord first portion **530** to increase (or increase in percentage) while decreasing the length of the cord second portion **532** (or decreasing the percentage of the cord second portion). The decreasing length of the cord second portion **532** is pulled tight across the first internal organ **48**.

Continuing the pulling force on the cord first portion **530** continues to decrease the length of the cord second portion **532** causing the cord second portion to move the first internal organ **48** toward the position away from the second internal organ **50**. When the first internal organ **58** is in the desired position, the grasping and pulling force on the court first portion **530** is released. With the pulling force on the cord first portion **530** having moved the knot to the first radial side of the second rod **514**, the lock protrusion prevents the knot from moving back to the second radial side of the second rod **514**. With the knot maintained on the first radial side of the second rod **514**, the length of the cord second portion cannot be increased. Therefore, the cord second portion **532** holds the first internal organ **48** in its position away from the second internal organ **50** as shown in FIG. **67**.

When it is desired to remove the apparatus **554** from the abdominal cavity the actuator **558** is again grasped and moved toward its second position on the base **502**. This causes the lock to move to its second position and moves the lock protrusion away from the knot. This again allows the knot to move to the second side of the second rod **514** and allows the cord second portion **532** to be pulled from the base second end **510**. This in turn allows the first internal organ **48** to return to its original position relative to the second internal organ **50**. The increased length of the cord second portion **532** enables the first tissue connector **516** and second tissue connector **540** to be removed from their connections to the body tissue.

FIG. **68** shows a still further embodiment of the apparatus of the invention. The apparatus in FIG. **68** comprises a first tissue connector **572**, a cord **574** and a second tissue connector **576** that are the same as those of the previously discussed embodiment of the apparatus. In addition, the apparatus of FIG. **68** includes a third tissue connector **578** that is the same as the first tissue connector **572**, and a second length of cord **582** that is the same as the first length of cord **574**. The apparatus of FIG. **68** also includes a fourth tissue connector **584** that is mounted to the portion of the cord **574** extending between the first tissue connector **572** and the second tissue connector **576** for sliding movement of the fourth tissue connector **584** along the length of cord.

The method of using the apparatus shown in FIG. **68** is similar to that of previously described embodiments. The second tissue connector **576** is connected to body tissue adjacent to the first internal organ or to the first internal organ, and then the first tissue connector **572** is moved intra-abdominally toward the abdominal wall and is connected to the abdominal wall. This causes the first cord **574** to extend across the first internal organ. The third tissue connector **578** is then moved intra-abdominally toward the abdominal wall and is connected to the abdominal wall in a position spaced from the first tissue connector **572**. This causes the second cord **582** to extend across the first internal organ. Shortening first **574** and second **582** cords causes the cords to engage with and move the first internal organ upwardly and away from the second internal organ in a manner similar to that of previously described embodiments.

In addition to the above, the fourth tissue connector **584** can be used to laterally displace or move the first internal organ in a sideways direction. This is accomplished by grasping the fourth tissue connector **584** with a surgical grasper and then pushing the first internal organ to one side or the other before securing the fourth tissue connector **584** to body tissue. This results in the fourth tissue connector **584** holding the first internal organ in its sideways displaced position.

As various modifications could be made in the constructions of the apparatus and the methods herein described and illustrated without departing from the scope of the invention, it is intended that all matter contained in the foregoing description or shown in the accompanying drawings shall be interpreted as illustrative rather than limiting. Thus, the breadth and scope of the present invention should not be limited by any of the above-described exemplary embodiments, but should be defined only in accordance with the following claims appended hereto and their equivalents.

We claim:

1. A method of retracting an organ within the abdomen of a patient with a retractor system comprising:

a first tissue connector;

a base comprising a first end secured to the first tissue connector, a second end, and a bore extending within the base;

a rod extending through the bore of the base; a lock slidably disposed within the bore of the base;

a cord extending from the base secured to said first tissue connector, said cord characterized by a first end, a second end, a first portion extending from the rod and out of the base second end, a second portion extending from the rod and out of the base at the second end, and an intermediate portion comprising a sliding knot wrapped around and engaging the rod; and

an actuator connected to the lock, and operable to move the lock within the bore of the base;

the method comprising the steps of:

using a grasper to attach the first tissue connector to a first body tissue;

routing the cord second portion proximate the organ;

with the actuator in a first position, pulling the cord first portion from the base second end, thereby shortening the cord second portion extending from the base second end and retracting the organ;

forcing the actuator toward the first tissue connector to a second position; and

with the actuator held in the second position, pulling the cord second portion from the base second end, thereby lengthening the cord second portion extending from the base second end.

2. The method of claim **1**, wherein the retractor system is further characterized by:

a first configuration, wherein the knot is disposed on a first side of the bore opposite, relative to the rod, an impinging structure of the lock, and is free to slide in a first direction away from the impinging structure when the cord first portion is pulled, and the knot is prevented from sliding in a second direction toward the impinging structure when the cord second portion is pulled; and

a second configuration, wherein the knot is disposed on a second side of the bore, relative to the rod, and on the same side of the bore as the impinging structure of the lock, and the knot is free to slide in a second direction away from the impinging structure when the cord second portion is pulled;

wherein the step of forcing the actuator toward the tissue connector moves the lock away from the rod, thereby permitting the knot to move from the first side of the bore to the second side of the bore.

3. The method of claim **2** further comprising the step of pulling the cord second portion to move the knot from the first side of the bore to the second side of the bore.

4. The method of claim **3** further comprises the step of: after the step of forcing the actuator toward the second position, moving the actuator to the first position, to move the lock toward the rod, and inhibit the knot, when on the second side of the bore, from moving to the first side of the bore.

5. The method of claim **3** further comprises the step of: after the step of forcing the actuator toward the second position, moving the actuator to the first position, to move the lock toward the rod, and prevent the knot, when on the second side of the bore, from moving to the first side of the bore.

6. The method of claim **3**, wherein the actuator is biased toward the first position, and the method further comprises the step of:

after the step of forcing the actuator toward the second position, releasing the actuator to allow the to move to the first position, to move the lock toward the rod, and inhibit the knot, when on the second side of the bore, from moving to the first side of the bore.

7. The method of claim **3**, wherein the actuator is biased toward the first position, and the method further comprises the step of:

after the step of forcing the actuator toward the second position, releasing the actuator to allow the actuator to move to the first position, to move the lock toward the rod, and prevent the knot, when on the second side of the bore, from moving to the first side of the bore.

8. The method of claim **2** further comprises the step of: after the step of forcing the actuator toward the second position, moving the actuator to the first position, to move the lock toward the rod, and inhibit the knot, when on the second side of the bore, from moving to the first side of the bore.

9. The method of claim **2** further comprises the step of: after the step of forcing the actuator toward the second position, moving the actuator to the first position, to move the lock toward the rod, and prevent the knot, when on the second side of the bore, from moving to the first side of the bore.

10. The method of claim **2**, wherein the actuator is biased toward the first position, and the method further comprises the step of:

after the step of forcing the actuator toward the second position, releasing the actuator to allow the actuator to move to the first position, to move the lock toward the rod, and inhibit the knot, when on the second side of the bore, from moving to the first side of the bore.

11. The method of claim **2**, wherein the actuator is biased toward the first position, and the method further comprises the step of:

after the step of forcing the actuator toward the second position, releasing the actuator to allow the actuator to move to the first position, to move the lock toward the rod, and prevent the knot, when on the second side of the bore, from moving to the first side of the bore.

12. The method of claim **1**, the first body tissue is an abdominal wall of the patient.

13. The method of claim **1**, further comprising the steps of connecting the cord second end to a second body tissue with a second tissue connector.

14. The method of claim **13**, the second body tissue is a crus or a liver of the patient.

15. The method of claim **1**, wherein the actuator comprises a sleeve slidably disposed about the base.

16. The method of claim **1**, wherein the actuator comprises a flange disposed on the lock.

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