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(54) LAPAROSCOPIC BIPOLAR ELECTROSURGICAL INSTRUMENT

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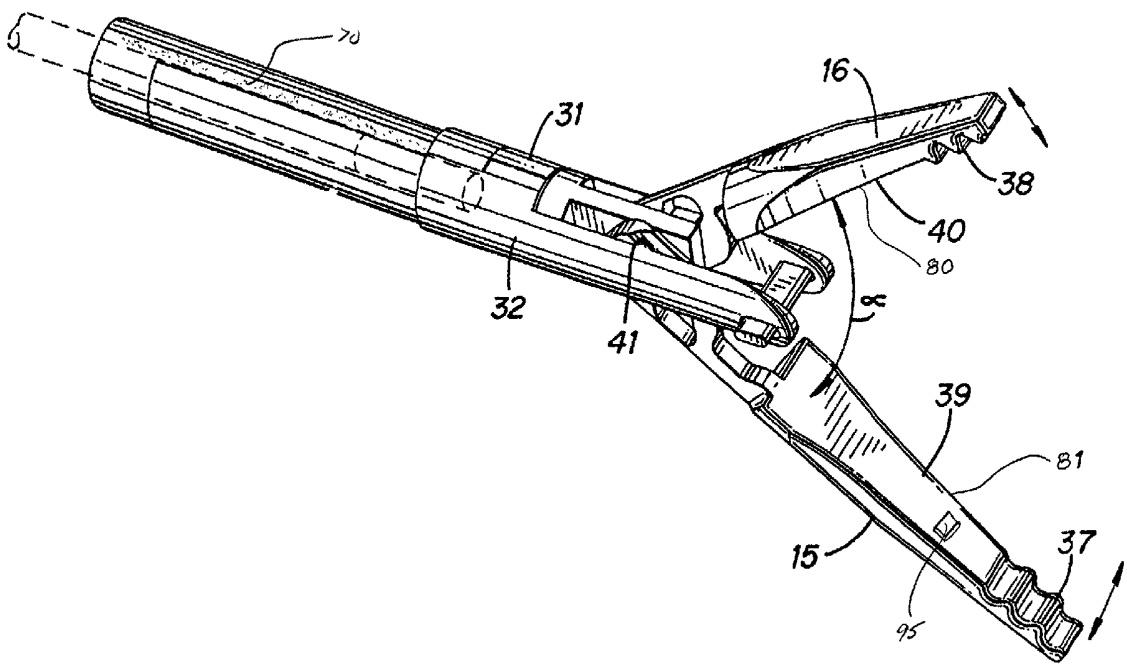
(57) **ABSTRACT**

A laparoscopic bipolar electrosurgical instrument for sealing tissue includes a handle having an elongated tube affixed thereto. The tube includes first and second jaw members having electrically conductive sealing surfaces attached to a distal end thereof which are movable from a first position for approximating tissue to a second position for grasping tissue therebetween. The handle includes a fixed handle and a handle which is movable relative to the fixed handle to effect movement of the jaw members from the first position to the second position for grasping tissue. The jaw members connect to a source of electrosurgical energy such that the opposable sealing surfaces are capable of conducting electrosurgical energy through tissue held therebetween. A stop is included for maintaining a minimum separation distance between opposing sealing surfaces. A ratchet is also included to maintain a closure force in the range of about 7 kg/cm^2 to about 13 kg/cm^2 between opposing sealing surfaces.



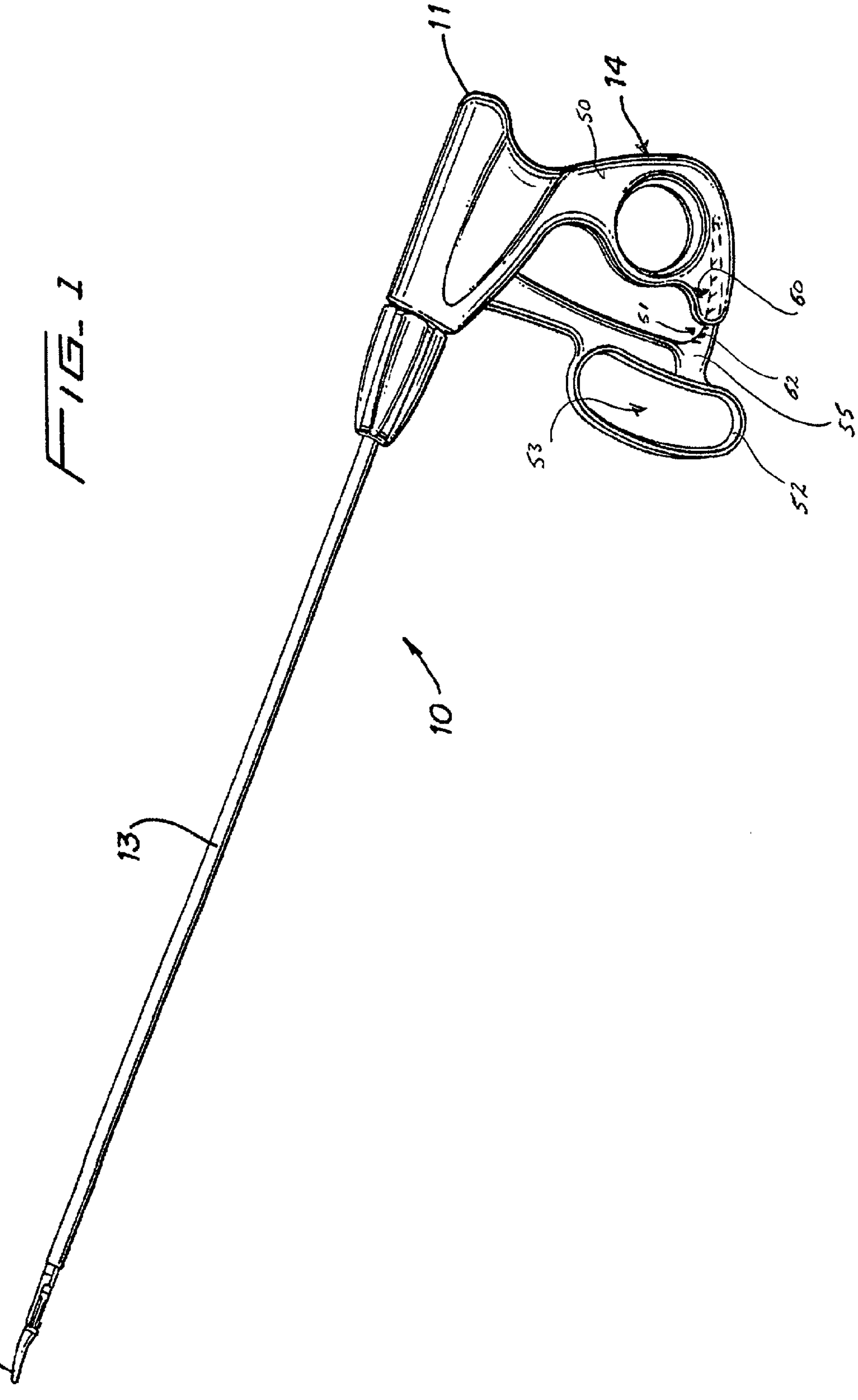


FIG. 1

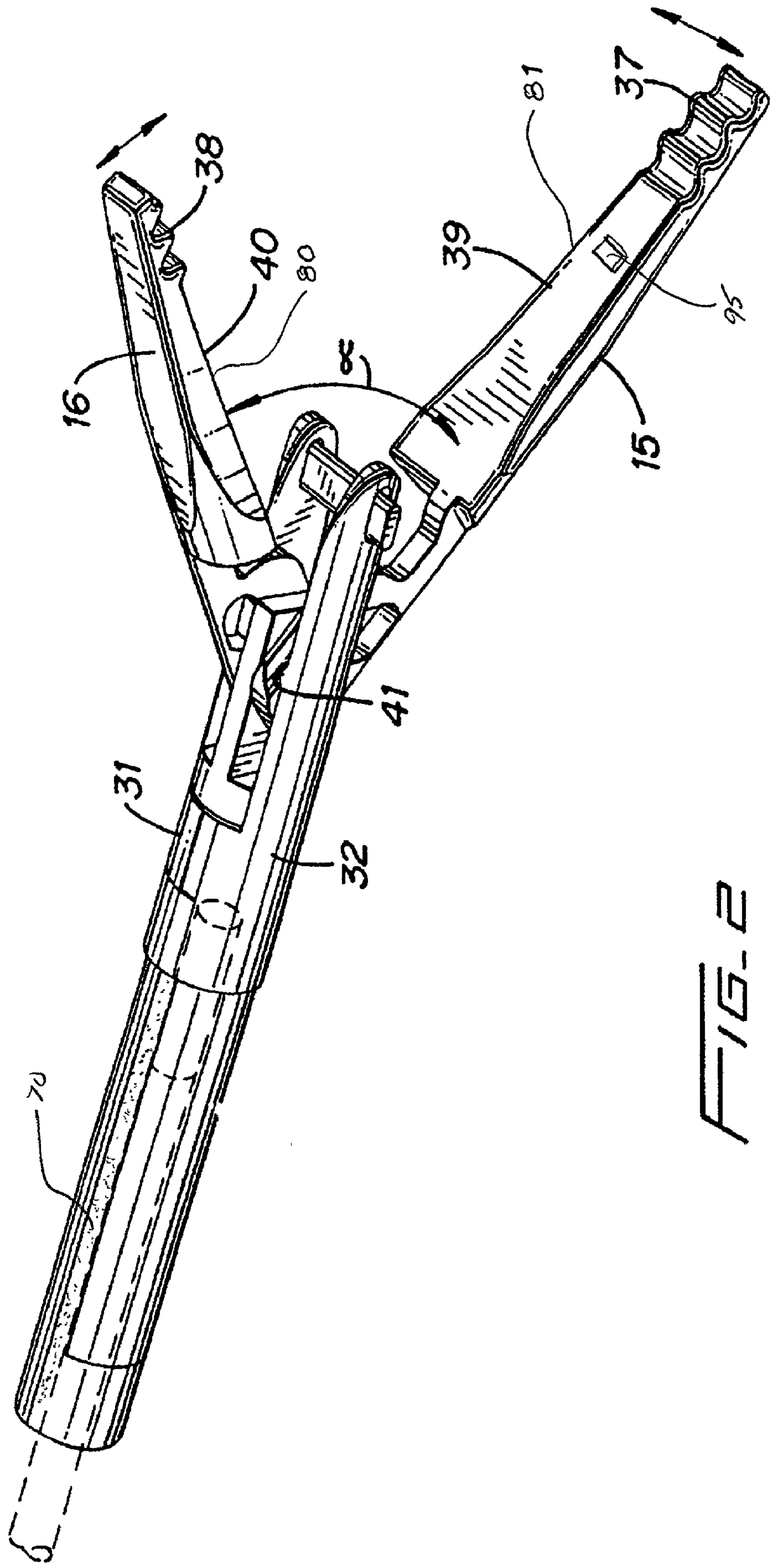


FIG. 2

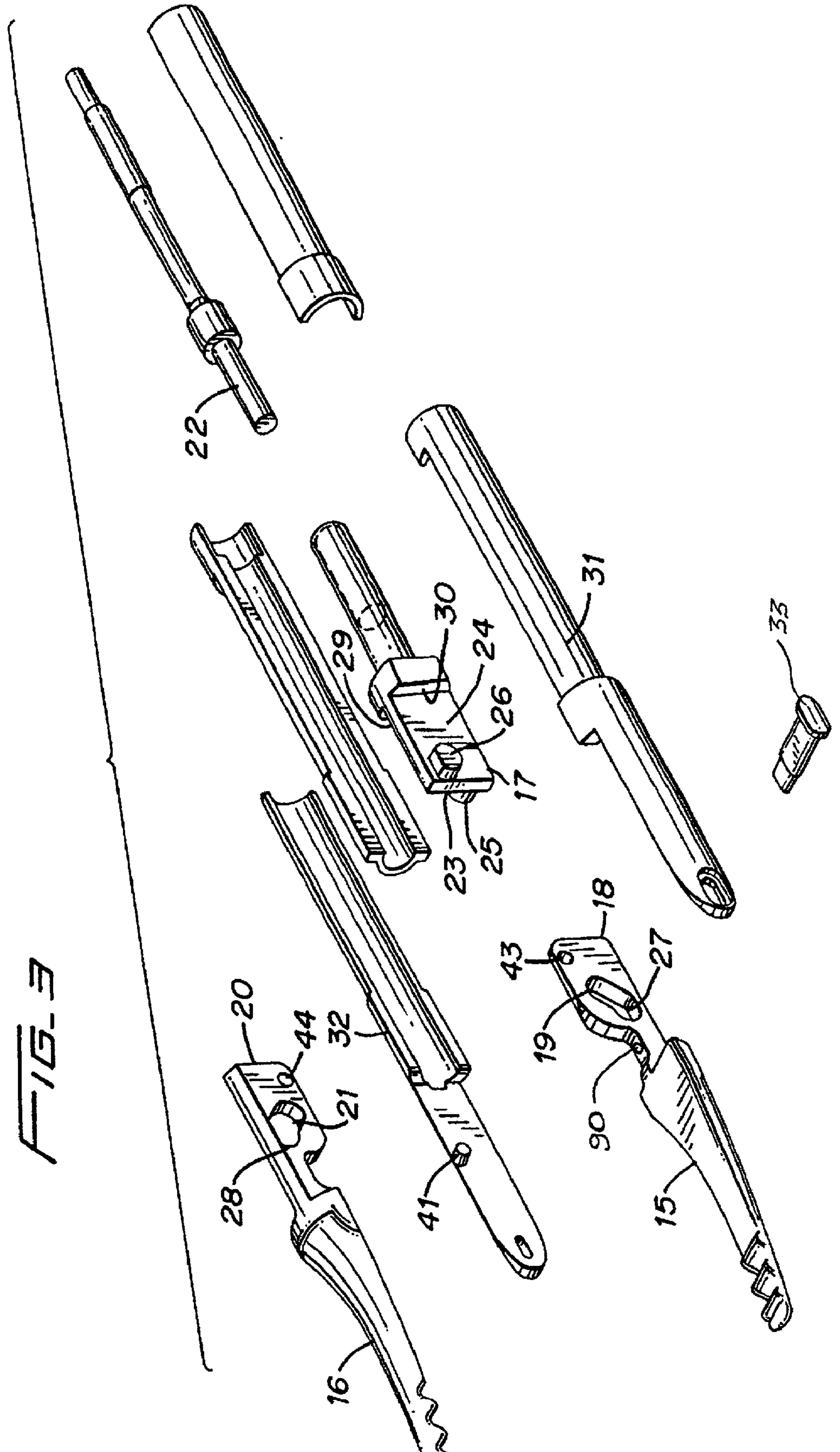


FIG. 3

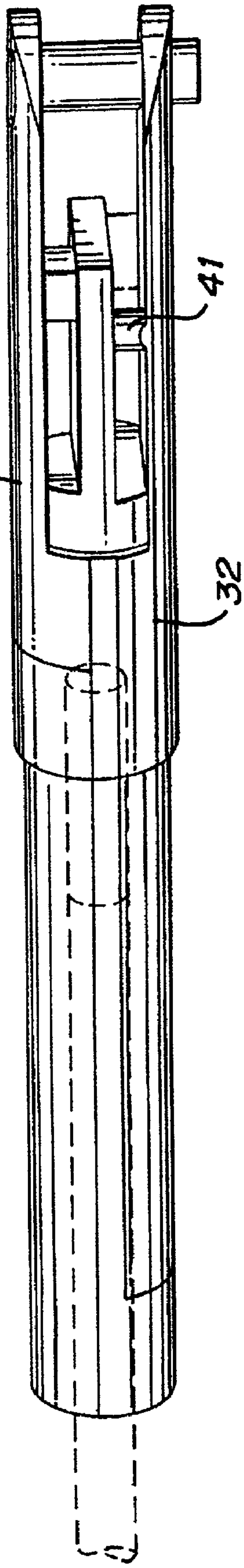


FIG. 4

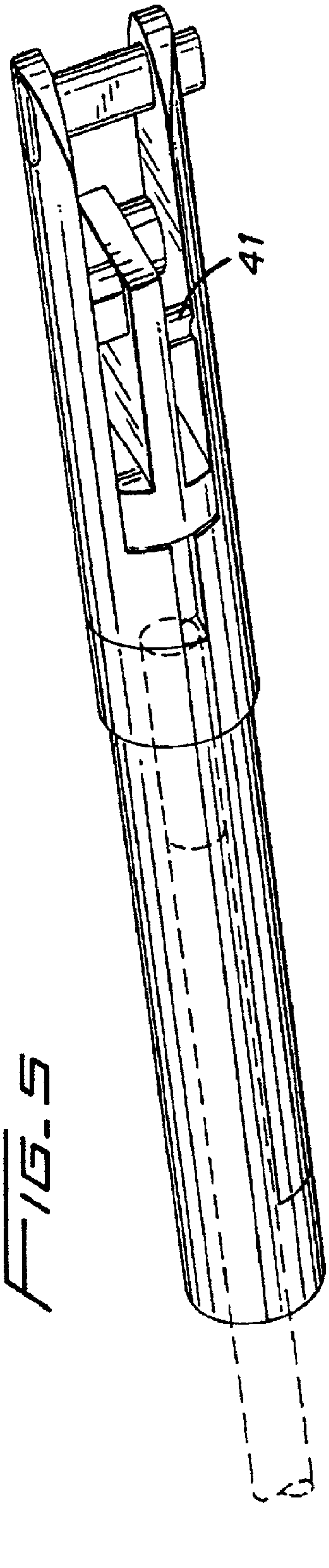


FIG. 5

FIG. 6

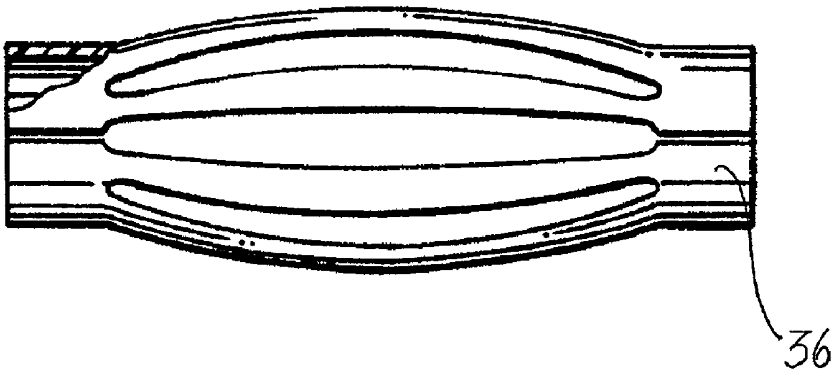
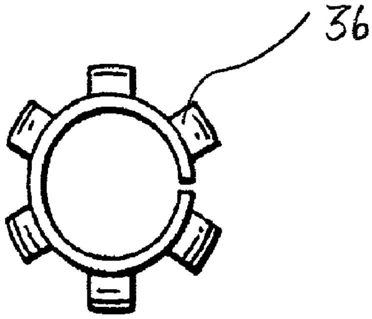


FIG. 7



LAPAROSCOPIC BIPOLAR ELECTROSURGICAL INSTRUMENT

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application is a continuation-in-part of U.S. application Ser. No. 09/591,330 filed on Jun. 9, 2000 by Lands et al. entitled "LAPAROSCOPIC BIPOLAR ELECTROSURGICAL INSTRUMENT" which is a continuation of U.S. application Ser. No. 08/970,472 filed on Nov. 14, 1997 by Lands et al. entitled "LAPAROSCOPIC BIPOLAR ELECTROSURGICAL INSTRUMENT", the entire contents of both of these applications are incorporated by reference herein in their entirety.

BACKGROUND

[0002] 1. Field of the Invention

[0003] This disclosure relates to an electrosurgical instrument for performing laparoscopic surgical procedures, and more particularly to a laparoscopic electrosurgical instrument that is capable of grasping vessels and vascular tissue with sufficient force between two bipolar jaws to seal the vessel or vascular tissue.

[0004] 2. Background of Related Art

[0005] Laparoscopic surgical instruments are used to perform surgical operation without making large incisions in the patient. The laparoscopic instruments are inserted into the patient through a cannula, or port, that has been made with a trocar. Typical sizes for cannulas range from three millimeters to twelve millimeters. Smaller cannulas are usually preferred, and this presents a design challenge to instrument manufacturers who must find ways to make surgical instruments that fit through the cannulas.

[0006] Certain surgical procedures require cutting blood vessels or vascular tissue. This sometimes presents a problem for surgeons because it is difficult to suture blood vessels using laparoscopic tools. Very small blood vessels, in the range below two millimeters in diameter, can often be closed using standard electrosurgical techniques. If a larger vessel is severed, it may be necessary for the surgeon to convert the laparoscopic procedure into an open-surgical procedure and thereby abandon the benefits of laparoscopy.

[0007] Several journal articles have disclosed methods for sealing small blood vessels using electrosurgery. An article entitled Studies on Coagulation and the Development of an Automatic Computerized Bipolar Coagulator, J. Neurosurg., Volume 75, July 1991, describes a bipolar coagulator which is used to seal small blood vessels. The article states that it was not possible to safely coagulate arteries with a diameter larger than 2 to 2.5 mm. A second article is entitled Automatically Controlled Bipolar Electrocoagulation—"COA-COMP", Neurosurg. Rev. (1984), pp. 187-190. This article describes a method for terminating electrosurgical power to the vessel so that charring of the vessel walls can be avoided.

[0008] It has been recently determined that electrosurgical methods may be able to seal larger vessels using an appropriate electrosurgical power curve, coupled with an instrument capable of applying a large closure force to the vessel walls. It is thought that the process of coagulating small vessels is fundamentally different than electrosurgical vessel sealing. Coagulation is defined as a process of desiccating tissue wherein the tissue cells are ruptured and dried. Vessel sealing is defined as the process of liquefying the collagen in the tissue so that it cross-links and reforms into a fused mass. Thus, coagulation of small vessels is sufficient to permanently close them. Larger vessels need to be sealed to assure permanent closure.

[0009] It would be desirable to have a surgical tool capable of applying electrosurgical energy, capable of applying a large closure force to the vessel walls, and also capable of fitting through a cannula. A large closure force between the jaws typically requires a large moment about the pivot for each jaw. This presents a challenge because the first and second pins have a small moment arm with respect to the pivot of each jaw. A large force, coupled with a small moment arm, is undesirable because the large forces may shear the first and second pins. It is also undesirable to increase the moment arm of the first and second pins because the physical size of the yoke might not fit through a cannula.

[0010] Several bipolar laparoscopic instruments are known. For example, U.S. Pat. No. 3,938,527 discloses a bipolar laparoscopic instrument for tubal cauterization. U.S. Pat. No. 5,250,047 discloses a bipolar laparoscopic instrument with a replaceable electrode tip assembly. U.S. Pat. No. 5,445,638 discloses a bipolar coagulation and cutting forceps with first and second conductors extending from the distal end. U.S. Pat. No. 5,391,166 discloses a bipolar endoscopic instrument having a detachable working end. U.S. Pat. No. 5,342,359 discloses a bipolar coagulation device.

[0011] The present invention solves the problem of providing a large closure force between the jaws of a laparoscopic bipolar electrosurgical instrument, using a compact design that fits through a cannula, without risking structural failure of the instrument yoke.

SUMMARY OF THE INVENTION

[0012] The present disclosure relates to a laparoscopic bipolar electrosurgical instrument for sealing tissue and includes a handle having an elongated tube affixed thereto. The tube includes first and second jaw members attached to a distal end thereof which are movable from a first position for approximating tissue to at least one subsequent position for grasping tissue therebetween. Each of the jaw members includes an electrically conductive sealing surface. The handle has a fixed handle and a handle which is movable relative to the fixed handle to effect movement of the jaw members from the first position to the at least one subsequent position for grasping tissue. The jaw members are connected to a source of electrosurgical energy such that the jaw members are capable of conducting bipolar electrosurgical energy through the tissue held therebetween. A stop is included for maintaining a minimum separation distance between opposing sealing surfaces and a ratchet is included for maintaining a closure force in the range of about 3 kg/cm^2 to about 16 kg/cm^2 between opposing sealing surfaces.

[0013] Preferably, the stop maintains a minimum separation distance of at least about 0.03 millimeters between opposing sealing surfaces. The stop may be disposed on at least one of the electrically conductive sealing surfaces, or alternatively, the stop may be located adjacent one of the electrically conductive sealing surfaces.

[0014] In one embodiment according to the present disclosure, the first jaw member is connected to the bipolar electrosurgical energy source by a pushrod and the second jaw member is connected to the bipolar electrosurgical source by a conductive tube.

[0015] In another embodiment, the ratchet is disposed within the fixed handle and at least one complimentary interlocking mechanical interface is disposed on the movable handle. Preferably, the ratchet and the complimentary interlocking mechanical interface provide at least one interlocking position for maintaining a closure force within the range of about 7 kg/cm^2 to about 13 kg/cm^2 between opposing sealing surfaces. Ideally, the closure force is in the range of about 4 kg/cm^2 to about 6.5 kg/cm^2.

[0016] In yet another embodiment according the present disclosure, the laparoscopic bipolar electrosurgical instrument includes a handle having an elongated tube affixed thereto with first and second jaw members attached to a distal end thereof which each include electrically conductive sealing surfaces. The jaw members are movable from a first position for approximating tissue to at least one subsequent position for grasping tissue therebetween. The handle has a fixed handle and a handle which is movable relative to the fixed handle to effect movement of the jaw members from the first position to the at least one subsequent position for grasping tissue. The sealing surfaces include a non-stick material for reducing tissue adhesion during the sealing process. The first and second jaw members are coupled to a source of bipolar electrosurgical energy and a stop is disposed on at least one of the electrically conductive sealing surfaces to maintain a minimum separation distance between the opposable seal surfaces during sealing. A ratchet is disposed on one of the fixed and movable handles and at least one complimentary interlocking mechanical interface is disposed on the other of the fixed and movable handles. Preferably, the ratchet and the complimentary interlocking mechanical interface include at least one interlocking position which maintains a closure force in the range of about 7 kg/cm^2 to about 13 kg/cm^2 between opposable seal surfaces.

[0017] In one embodiment, the non-stick material is a coating which is deposited on the opposable sealing surfaces. The non-stick coating may be selected from a group of materials consisting of: nitrides and nickel/chrome alloys. Preferably, the non-stick coating includes one of: TiN; ZrN; TiAIN; CrN; nickel/chrome alloys with a Ni/Cr ratio of approximately 5:1; Inconel 600; Ni200; and Ni201.

[0018] In one embodiment according to the present disclosure, the opposable sealing surfaces are manufactured from a non-stick material which is a nickel/chrome alloy. For example, the non-stick material may include nickel/chrome alloys with a Ni/Cr ratio of approximately 5:1, Inconel 600, Ni200and Ni201.

[0019] Preferably, at least one of the jaw members, handles and elongated tube includes an insulative material disposed thereon which may be an insulative coating or an insulative sheath.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] **FIG. 1** is a perspective view of a laparoscopic bipolar electrosurgical instrument according to the present disclosure;

[0021] **FIG. 2** is a perspective view of the distal end and jaws of the instrument in **FIG. 1**;

[0022] **FIG. 3** is an exploded view of the distal end shown in **FIG. 2**;

[0023] **FIG. 4** is perspective view of the distal end of the instrument with the jaws removed;

[0024] **FIG. 5** is another perspective of **FIG. 4**;

[0025] **FIG. 6** is a side view of an electrical spring contact; and

[0026] **FIG. 7** is a front view of the spring contact shown in **FIG. 6**.

DETAILED DESCRIPTION OF THE INVENTION

[0027] A laparoscopic bipolar electrosurgical instrument **10** is shown in **FIG. 1**. The instrument **10** has a proximal end **11** with a handle **14** for holding and manipulating the instrument **10**. A distal end **12** on the instrument **10** is used for surgical manipulation of tissue. The instrument **10** comprises an elongate tube **13** that is sized to fit through a cannula for laparoscopic operations, and in different embodiments may be sized to fit through a five to ten millimeter cannulas.

[0028] A portion of the distal end **12** of the instrument **10** is shown in **FIG. 2**. A first jaw **15** and a second jaw **16** are shown in an open position. An angle α is subtended by the jaws **15** and **16**. Closing of the jaws **15** and **16** is defined as a reduction of the angle α subtended by the jaws **15** and **16**. Similarly, opening of the jaw **15** and **16** is defined as an enlargement of the angle α. The angle α is zero when the jaws **15** and **16** are closed together. The center of rotation for the first jaws **15** is at the first pivot **41**, and the center of rotation for the second jaw **16** is at the second pivot **42**. The first pivot **41** is located on an outer nose piece **32**, and fits in a first pivot hole **43** located on the first flange **18**. The second pivot **42** is located on an inner nose piece **31**, and fits in a second pivot hole **44** located on the second flange **20**.

[0029] Pieces that comprise the distal end **12** of the instrument **10** are shown in an exploded view in **FIG. 3**. The first jaw **15** and the second jaw **16** are shown separated from a yoke **17**. The first jaw **15** has a first flange **18** and a first slot **19** therewithin. The second jaw **16** has a second flange **20** and a second slot **21** therewithin. Each jaw **15** and **16** is preferably formed from a single piece of stainless steel or other electrically conductive material.

[0030] Referring again to **FIG. 3**, the yoke **17** is attached to a pushrod **22**. The yoke **17** is preferably formed from an electrically insulative material such as plastic. A first side **23** of the yoke **17** faces the first flange **18**. A second side **24** of the yoke **17** faces the second flange **20**. When the yoke **17** is positioned between the flanges **18** and **20**, the yoke **17** also acts to electrically insulate the first jaw **15** from the second jaw **16**. In this manner, bipolar electrosurgical current can be conducted through tissue grasped by the jaws **15** and **16** without short circuiting between the flanges **18** and **20**.

[0031] A first pin **25** is located on the first side **23** which movably engages the first slot **19**. Similarly, a second pin **26** is located on the second side **24** to movably engage the second slot **21**. Each pin and slot combination works as a cam-follower mechanical linkage. Motion of the pushrod **22** moves the yoke **17** causing pins **25** and **26** to slide within their respective slots **19** and **21**. The slots **19** and **21** are angled with respect to the distal ends of the jaws **15** and **16** such that the jaws **15** and **16** move in an arcuate fashion toward and away from each other. The pins **25** and **26** are different from the pivots **41** and **42**. The pins **25** and **26** provide a force against the walls of the slots **19** and **21**, creating a moment about the pivots **41** and **42**.

[**0032**] The slots **19** and **21** are arranged such that distal motion of the pushrod **22** causes the jaws **15** and **16** to move together. Distal motion of the pushrod **22** is defined as motion in the direction of the distal end **12** of the instrument **10**. Once the jaws **15** and **16** are closed together, the present invention holds the jaws **15** and **16** together with a compressive force on the pushrod **22**.

[**0033**] One of the advantages of this invention is that shear forces on the pins **25** and **26** can be offloaded to prevent mechanical failure when large forces are being transmitted to the jaws **15** and **16**. Each slot **19** and **20** has a cul-de-sac **27** and **28**, respectively, as shown in **FIG. 3**. The first cul-de-sac **27** is an enlargement of the first slot **19** near its distal end. The second cul-de-sac **28** is an enlargement of the second slot **21** near its distal end. The cam-follower motion of the pins **25** and **26** in the slots **19** and **21** will bring the pins **25** and **26** into their respective cul-de-sac **27** and **28**. This position of the pins **25** and **26** leaves a very small moment arm between the pins **25** and **26** and the pivots **41** and **42**. The yoke **17** has shoulders **29** and **30** that can provide a relatively large moment about the pivots **41** and **42** to effect a high closure force between the jaws **15** and **16** without a high shear forces on the pins **25** and **26**, as described below.

[**0034**] Once the pins **25** and **26** are in the cul-de-sacs **27** and **28**, the force from the yoke is transmitted to the flanges **18** and **20** by a first shoulder **29** and a second shoulder **30**. The shoulders **29** and **30** abut the proximal end of the flanges **18** and **20** to cause the jaws **15** and **16** to close together. The pivots **41** and **42** are preferably made of metal and can withstand relatively high shear forces. In contrast, pins **25** and **26** are preferably made of plastic and will break under relatively high shear forces. Thus, the shoulders **29** and **30** provide a moment about the pivots **41** and **42**, thereby avoiding the necessity of applying high shear forces to the pins **25** and **26** wherein the moment arm from the pins **25** and **26** would be small. There is an angle α at which the pins **25** and **26** enter their respective cul-de-sacs **27** and **28** and the shoulders **29** and **30** abut the flanges **18** and **20**. The angle α at which the forgoing occurs is preferably around three degrees.

[**0035**] The bipolar electrosurgical instrument **10** has first and second poles of alternating potential that are conducted along the instrument **10** and through tissue that is grasped between the jaws **15** and **16**. The first pole is conducted from the proximal end **11** toward the distal end **12** along the pushrod **22**. The second pole is conducted from the proximal end **11** toward the distal end **12** along the tube **13**. The outer surface of the tube **13** is preferably coated with an electrically insulative material. There is also preferably an electrically insulative barrier between the pushrod **22** and the tube **13** to prevent short circuits in the instrument **10**.

[**0036**] In the preferred embodiment, the distal end of the instrument **10** comprises an inner nose piece **31** and an outer nose piece **32**, as shown in **FIG. 2**. The inner nose piece **31** is electrically connected with the pushrod **22**, while the outer nose piece is electrically connected with the tube **13**. The inner nose piece **31** and the outer nose piece **32** capture the yoke **17**, along with the first and second flanges **18** and **20**, as shown in **FIG. 2**. The yoke **17** moves axially, along an axis defined by the tube **13**, in a space between the inner and outer nose pieces **31** and **32**. A spacer stake **33** maintains the separation of the nose pieces **31** and **32** at their distal ends. The nose pieces **31** and **32** provide lateral support for the flanges **18** and **20** to help ensure that the pins **25** and **26** remain within the slots **19** and **21**, respectively.

[**0037**] The preferred embodiment also comprises an inner insulator **34** and an outer insulator **35** for maintaining electrical insulation between the poles. The outer insulator **35** is seated between the tube **13** and the inner nose **31**, as shown in **FIGS. 2 and 4**. The inner insulator **34** is seated between the tube **13** and the pushrod **22**. In this manner, the outer nose piece **32** can provide electrical continuity between the tube **13** and the second jaw **16**, while the inner nose piece **34** can provide electrical continuity between the pushrod **22** and the first jaw **15**. Since the pushrod **22** is slidably mounted within the tube **13**, the preferred embodiment has a spring contact **36**, as shown in **FIGS. 6 and 7**, which is mounted on the pushrod **22** to maintain an electrical connection with the inner nose piece **34** during axial motion.

[**0038**] The first and second jaws **15** and **16** each have ridges **37** and **38** at their distal ends that preferably nest together. The jaws **15** and **16** also have seal surfaces **39** and **40**, as shown in **FIG. 2**. The width of the seal surfaces **39** and **40** is a parameter that affects the quality of the surgical outcome. The closure force between the jaws **15** and **16** varies along the length of the seal surfaces **39** and **40**, with the largest force at the distal tip and the smallest force at the proximal end of the seal surfaces **39** and **40**. It is known that the amount of pressure exerted on the tissue depends on the surface area of the tissue that is in contact with the seal surfaces. In the one embodiment, the width of each seal surface, e.g., **39**, is in the range of about 2 to about 5 millimeters, and preferably 4 millimeters width, while the length of each seal surface **39** and **40** is preferably in the range of about 10 to 30 millimeters.

[**0039**] It has been found through experimentation that good vessel sealing results are obtained when the closure force in grams divided by the width in millimeters is in the range of about 400 to 650 grams per millimeter of seal surface width. Since the closure force varies with the length of the seal surfaces **39** and **40**, it has been found to be advantageous to taper the width of the seal surfaces **39** and **40** along their length, with the widest width at the proximal end and the narrowest width at the distal end. For example, if the width of the seal surface **39**, **40** is 4 millimeters, the closure force is preferably in the range of about 1600 grams to about 2600 grams This design allows the jaws **15** and **16** to apply a relatively constant closure force per unit width, preferably 525 grams per millimeter width which yields a closure force of 2100 grams for a 4 millimeter width seal surface **39**, **40**.

[**0040**] In one embodiment, the handle **14** includes a fixed handle **50** having a channel **51** defined therein which slidingly receives a movable handle **52**. Movable handle **52** includes a handgrip **53** defined therein which allows a user to move handle **52** relative to fixed handle **50**. Movable handle **52** also includes a flange **55** having a series of grooves **62** defined therein which mechanically inter-engage a corresponding ratchet **60** disposed within channel **51**. Preferably, the ratchet **60** and groove **62** are dimensioned such that successive ratchet positions will yield pressures within a predetermined working range of about 7 kg/cm^2 to about 13 kg/cm^2. In one embodiment, the successive ratchet positions are two millimeters apart.

[**0041**] Experimental results in tissue studies suggest that the magnitude of pressure exerted on the tissue by the seal surfaces **39** and **40** is important in assuring a proper surgical outcome. Tissue pressures within a working range of about 3 kg/cm^2 to about 16 kg/cm^2 and, preferably, within a working range of 7 kg/cm^2 to 13 kg/cm^2 have been shown to be effective for sealing arteries and vascular bundles. Tissue pressures within the range of about 4 kg/cm^2 to about 6.5 kg/cm^2 have proven to be particularly effective in sealing arteries and tissue bundles.

[**0042**] A method of making a laparoscopic bipolar electrosurgical instrument **10** is also herein described. The method comprises the step of forming a first jaw **15** having a first flange **18** with a first slot **19**, and a second jaw **16** having a second flange **20** with a second slot **21**. The jaws **15** and **16** are preferably formed in a casting process, although it is also possible to machine the jaws **15** and **16** from stock. The casting process may include injecting powdered metal under pressure into a mold, and then applying heat.

[**0043**] Other steps in the method include attaching a yoke **17** to a pushrod **22**, and electrically insulating the first flange **18** from the second flange **20** with the yoke **17**. The yoke **17** is preferably an injection molded plastic part with features including a first shoulder **29** and a second shoulder **30**.

[**0044**] During assembly of the distal portion of the instrument **10**, steps in the method include engaging a first pin **25** with the first slot **19**, and engaging a second pin **26** with the second slot **21**. The slots **19** and **21** are shaped such that a subtended angle α between the first and second jaws **15** and **16** decreases with distal motion of the pushrod **17**. The slots **19** and **20** are formed with cul-de-sacs **27** and **28** positioned to relieve shear stresses on the first and second pins **25** and **26** at the subtended angle α approximately where the first and second shoulders **29** and **30** engage the first and second flanges **18** and **20**.

[**0045**] Further steps in the method comprise: surrounding at least a portion of the pushrod **22** with an electrically conductive tube **13**; electrically insulating the tube **13** from the pushrod **22**; electrically connecting an inner nose piece **31** to the pushrod **22**, and electrically connecting an outer nose piece **32** to the tube **13**, wherein the inner nose piece **31** and the outer nose piece **32** capture the yoke **17** along with the first and second flanges **18** and **20** to conduct bipolar electrosurgical current to the first and second jaws **15** and **16**. In the preferred embodiment, there is a step of electrically connecting the pushrod **22** and the inner nose piece **31** with a spring contact **36**.

[**0046**] The method of making the instrument **10**, in some embodiments, includes the steps of tapering the width of the seal surfaces **39** and **40** along the length of each of the first and second jaws **15** and **16**.

[**0047**] An electrically insulative coating **70** may be included to substantially cover the elongated tube **13** to protect the surgeon against electrical arcs. Other parts of the instrument may also be protected by the insulative coating **70**. An insulative sheath may also be used to cover tube **13** or other components of the instrument **10**, e.g., the proximal end **11**, handles **50, 52** and the outer surfaces (non-opposing surfaces) of the jaw members **15, 16**.

[**0048**] It is envisioned that the outer surface of the jaw members **15** and **16** may include a nickel-based material, coating, stamping, metal injection molding which is designed to reduce adhesion between the jaw members (or components thereof) with the surrounding tissue during activation and sealing. Moreover, it is also contemplated that other components such as the tube **13** and handles **50, 52** may also be coated with the same or a different "non-stick" material. Preferably, the non-stick materials are of a class of materials that provide a smooth surface to prevent mechanical tooth adhesions.

[**0049**] It is also contemplated that the tissue sealing surfaces **39** and **40** of the jaw members **15** and **16**, respectively, may be manufactured from one (or a combination of one or more) of the following "non-stick" materials: nickel-chrome, chromium nitride, MedCoat 2000 manufactured by The Electrolizing Corporation of OHIO, Inconel 600 and tin-nickel. For example, high nickel chrome alloys and Ni200, Ni201 (~100% Ni) may be made into electrodes or sealing surfaces by metal injection molding, stamping, machining or any like process.

[**0050**] In addition these materials preferably include an optimal surface energy for eliminating sticking due in part to surface texture and susceptibility to surface breakdown due electrical effects and corrosion in the presence of biologic tissues. It is envisioned that these materials exhibit superior non-stick qualities over stainless steel and should be utilized on the instrument in areas where the exposure to pressure and RF energy can create localized "hot spots" more susceptible to tissue adhesion. As can be appreciated, reducing the amount that the tissue "sticks" during sealing improves the overall efficacy of the instrument.

[**0051**] The tissue sealing surfaces **39** and **40** may also be "coated" with one or more of the above materials to achieve the same result, i.e., a "non-stick surface". For example, Nitride coatings (or one or more of the other above-identified materials) may be deposited as a coating on another base material (metal or nonmetal) using a vapor deposition manufacturing technique.

[**0052**] One particular class of materials disclosed herein has demonstrated superior non-stick properties and, in some instances, superior seal quality. For example, nitride coatings which include, but not are not limited to: TiN, ZrN, TiAlN, and CrN are preferred materials used for non-stick purposes. CrN has been found to be particularly useful for non-stick purposes due to its overall surface properties and performance. Other classes of materials have also been found to reducing overall sticking. For example, high nickel/chrome alloys with a Ni/Cr ratio of approximately 5:1 have been found to significantly reduce sticking in bipolar instrumentation. One particularly useful non-stick material in this class is Inconel 600. Bipolar instrumentation having electrodes made from or coated with Ni200, Ni201 (~100% Ni) also showed improved non-stick performance over typical bipolar stainless steel electrodes.

[0053] It has been found experimentally that local current concentrations can result in an uneven tissue effect, and to reduce the possibility of this outcome, each seal surface **39** and **40** may include a radiused edge **80**, **81**. As mentioned above, a tapered seal surface **39** and **40** has been shown to be advantageous in certain embodiments because the taper allows for a relatively constant pressure on the tissue along the length of the seal surfaces **39** and **40**. The width of the seal surfaces **39** and **40** may be adjusted to assure that the closure force divided by the width is approximately constant along the length.

[0054] In one embodiment, a stop **90**, made from insulative material, is located in the instrument to maintain a minimum separation of at least about 0.03 millimeters between the seal surfaces **39** and **40**, as shown in **FIG. 3**. Preferably, the stop maintains a minimum separation distance in the range of about 0.03 millimeters to about 0.16 millimeters. The stop **90** reduces the possibility of short circuits between the seal surfaces **39** and **40**. It is envisioned that stop **90** may be positioned proximate the pivots **41** and **42**, proximate the stake **33** or adjacent the opposable seal surfaces **39** and **40**.

[0055] In another embodiment, the instrument **10** includes a second or alternative stop **95** which is designed to maintain a minimum separation of at least about 0.03 millimeters between the seal surfaces **39** and **40**, as shown in **FIG. 2**. Preferably, the stop **90** and/or the stop **95** maintains a separation distance within range of about 0.03 millimeters to about 0.16 millimeters. A plurality of stops and/or **95** (or various patterns of stops **90**, **95**) may also be utilized to accomplish this purpose.

[0056] It is to be understood that the above described embodiments are only illustrative of the application of the principles of the present invention. Numerous modification and alternative arrangements may be devised by those skilled in art without departing from the spirit and scope of the present invention. The ended claims are intended to cover such modifications and arrangements.

What is claimed is:

1. A laparoscopic bipolar electrosurgical instrument for sealing tissue, comprising:

a handle having an elongated tube affixed thereto, the tube including first and second jaw members attached to a distal end thereof, the jaw members being movable from a first position for approximating tissue to at least one subsequent position for grasping tissue therebetween, each of the jaw members including an electrically conductive sealing surface, the handle including a fixed handle and a movable handle, the movable handle being movable relative to the fixed handle to effect movement of the jaw members from the first position to the at least one subsequent position for grasping tissue;

means for connecting the jaw members to a source of electrosurgical energy such that the opposable seal surfaces are capable of conducting electrosurgical energy through tissue held therebetween;

a stop for maintaining a minimum separation distance of at least about 0.03 millimeters between opposable sealing surfaces; and

means for maintaining a closure force in the range of about 3 kg/cm^2 to about 16 kg/cm^2 between opposable sealing surfaces.

2. A laparoscopic bipolar electrosurgical instrument according to claim 1 wherein the connecting means includes:

a pushrod for connecting the first jaw member to a source of electrosurgical energy; and

a conductive tube for connecting the second jaw member to the source of electrosurgical energy.

3. A laparoscopic bipolar electrosurgical instrument according to claim 1 wherein the maintaining means includes a ratchet disposed within the fixed handle and at least one complimentary interlocking mechanical interface disposed on the movable handle, the ratchet and the complimentary interlocking mechanical interface providing at least one interlocking position for maintaining a closure force within the range of about 7 kg/cm^2 to about 13 kg/cm^2 between opposable sealing surfaces.

4. A laparoscopic bipolar electrosurgical instrument according to claim 1 wherein the closure force is in the range of about 4 kg/cm^2 to about 6.5 kg/cm^2.

5. A laparoscopic bipolar electrosurgical instrument according to claim 1 wherein the stop is disposed on at least one of the sealing surfaces.

6. A laparoscopic bipolar electrosurgical instrument according to claim 1 wherein the stop is disposed adjacent to at least one of the sealing surfaces.

7. A laparoscopic bipolar electrosurgical instrument according to claim 1 wherein the stop maintains a minimum separation distance between sealing surfaces in the range of about 0.03 millimeters to about 0.16 millimeters.

8. A laparoscopic bipolar electrosurgical instrument for sealing tissue, comprising:

a handle having an elongated tube affixed thereto, the tube including first and second jaw members attached to a distal end thereof, the jaw members being movable from a first position for approximating tissue to at least one subsequent position for grasping tissue therebetween, each of the jaw members including an electrically conductive sealing surface, the handle including a fixed handle and a movable handle, the movable handle being movable relative to the fixed handle to effect movement of the jaw members from the first position to the at least one subsequent position for grasping tissue, the opposable sealing surfaces including a non-stick material for reducing tissue adhesion during the sealing process;

means for connecting the jaw members to a source of electrosurgical energy such that the opposable sealing surfaces are capable of conducting electrosurgical energy through tissue held therebetween;

a stop disposed on one of the opposable sealing surfaces for maintaining a minimum separation distance between the opposable sealing surfaces; and

a ratchet disposed on one of the fixed and movable handles and at least one complimentary interlocking mechanical interface disposed on the other of the fixed and movable handles, the ratchet and the complimentary interlocking mechanical interface providing at least one interlocking position to maintain a closure force in the range of about 3 kg/cm^2 to about 16 kg/cm^2 between opposable sealing surfaces.

9. A laparoscopic bipolar electrosurgical instrument according to claim 8 wherein the non-stick material is a coating which is deposited on the opposable sealing surfaces.

10. A laparoscopic bipolar electrosurgical instrument according to claim 9 wherein the non-stick coating is selected from a group of materials consisting of: nitrides and nickel/chrome alloys.

11. A laparoscopic bipolar electrosurgical instrument according to claim 9 wherein the non-stick coating includes at least one of: TiN; ZrN; TiAlN; CrN; nickel/chrome alloys with a Ni/Cr ratio of approximately 5:1; Inconel 600; Ni200; and Ni201.

12. A laparoscopic bipolar electrosurgical instrument according to claim 8 wherein the opposable sealing surfaces are manufactured from a non-stick material.

13. A laparoscopic bipolar electrosurgical instrument according to claim 12 wherein the non-stick material is a nickel/chrome alloy.

14. A laparoscopic bipolar electrosurgical instrument according to claim 12 wherein the non-stick material includes at least one of nickel/chrome alloys with a Ni/Cr ratio of approximately 5:1, Inconel 600, Ni200 and Ni201.

15. A laparoscopic bipolar electrosurgical instrument according to claim 8 wherein at least one of the jaw members, handles and elongated tube includes an insulative material disposed thereon.

16. A laparoscopic bipolar electrosurgical instrument according to claim 15 wherein the insulative material is an insulative coating.

17. A bipolar electrosurgical instrument according to claim 15 wherein the insulative material is an insulative sheath.

* * * * *

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摘要(译)

用于密封组织的腹腔镜双极电外科器械包括手柄，手柄具有固定到其上的细长管。所述管包括第一和第二钳口构件，所述第一和第二钳口构件具有附接到其远端的导电密封表面，所述导电密封表面可从用于接近组织的第一位置移动到用于抓握其间的组织的第二位置。手柄包括固定手柄和手柄，手柄可相对于固定手柄移动，以实现钳口构件从第一位置到第二位置的移动，以抓取组织。钳口构件连接到电外科能量源，使得可相对的密封表面能够通过保持在其间的组织传导电外科能量。包括止动件以保持相对的密封表面之间的最小间隔距离。还包括棘轮以在相对的密封表面之间保持约7kg / cm 2至约13kg / cm 2范围内的闭合力。