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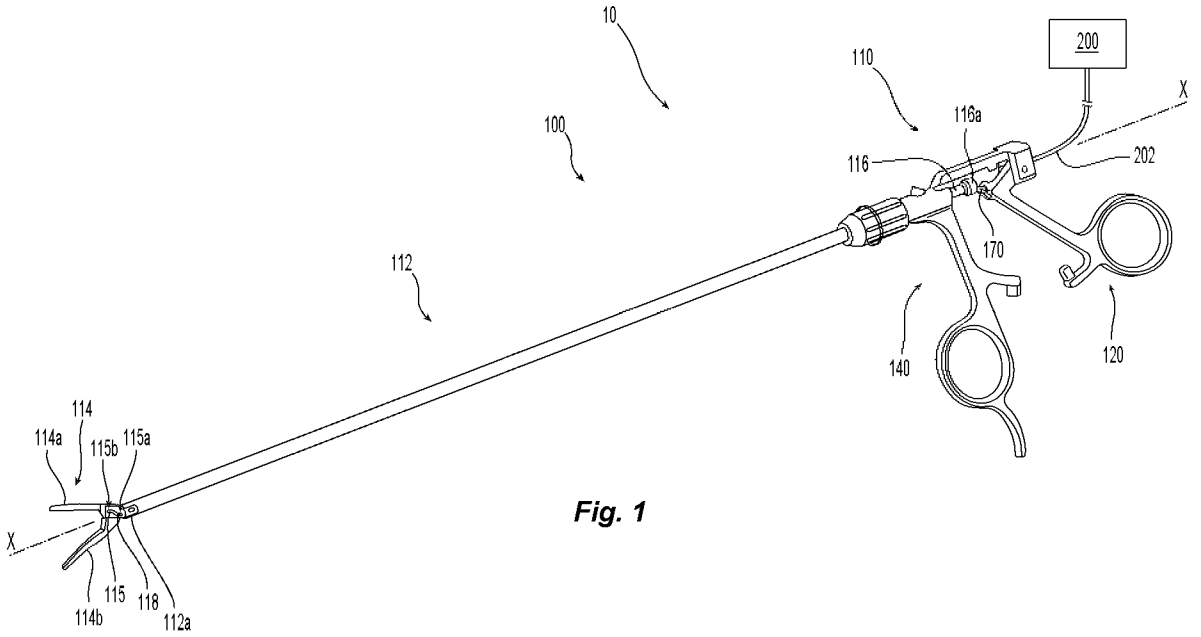

Fig. 1

(57) Abstract: An electrosurgical forceps includes a handle assembly including a movable handle pivotably connected to a fixed handle, an elongated shaft extending distally from the fixed handle, an end effector disposed at a distal end of the elongated shaft, and a drive member slidably disposed within the elongated shaft. The drive member includes a proximal end pivotably coupled to the movable handle and a distal end operably coupled to the end effector. A first movement of the movable handle relative to the distal handle causes a first distal movement of the drive member to effect a first function of the end effector, and a second movement of the movable handle relative to the fixed handle causes a second distal movement of the drive member to effect a second function of the end effector.

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VESSEL SEALING AND DIVIDING LAPAROSCOPIC DEVICE

BACKGROUND

1. *Background of Related Art*

[0001] The present disclosure relates to energy-based surgical instruments and, more particularly, to energy-based surgical forceps configured for sealing and cutting tissue.

2. *Technical Field*

[0002] A forceps or hemostat is an instrument which relies on mechanical action between its jaws to grasp, clamp, and constrict tissue and/or vessels. "Open forceps" are commonly used in open surgical procedures, whereas "endoscopic forceps" or "laparoscopic forceps" are used for less invasive or minimally invasive surgical procedures. Electrosurgical or energy-based forceps (open or endoscopic/laparoscopic) utilize both mechanical clamping action and energy, e.g., electrosurgical energy, ultrasonic energy, light energy, microwave energy, heat, etc., to affect hemostasis by heating tissue to coagulate and/or cauterize tissue.

[0003] Current energy-based forceps require a surgeon to close the handles of the forceps to clamp tissue between its jaws and to activate sealing. Once the tissue is sealed, the surgeon has to accurately sever the tissue along the newly formed tissue seal. Accordingly, many energy-based forceps have been designed to incorporate a blade that is movable with respect to a blade slot disposed in one of the jaws of the forceps to sever the tissue after forming the tissue seal. To move the blade, the surgeon actuates a trigger on the forceps to cut the tissue. Once cutting is complete, the surgeon then opens the handles of the forceps to

release the tissue.

SUMMARY

[0004] The present disclosure is directed to energy-based surgical instruments having movable, opposed jaw members that are configured for grasping, sealing, dividing, and releasing tissue and/or vessel(s) using a two-step handle movement. The two-step handle movement allows an operator to grasp, seal, divide, and release tissue quickly and efficiently, and can reduce the likelihood of bleeding which can interrupt a surgical procedure.

[0005] In accordance with aspects of the present disclosure, an electrosurgical forceps includes a handle assembly having a movable handle pivotably connected to a fixed handle, an elongated shaft extending distally from the fixed handle, an end effector disposed at a distal end of the elongated shaft, and a drive member slidably disposed within the elongated shaft. The drive member includes a proximal end pivotably coupled to the movable handle and a distal end operably coupled to the end effector. A first movement of the movable handle relative to the fixed handle causes a first distal movement of the drive member to effect a first function of the end effector, and a second movement of the movable handle relative to the fixed handle causes a second distal movement of the drive member to effect a second function of the end effector.

[0006] In some aspects, a cross pin interconnects the movable handle and the fixed handle. The cross pin may include a first pin portion extending along a first axis, and a second pin portion intersecting the first pin portion and extending along a second axis. The first movement of the movable handle may be rotation about the second pin portion, and the second movement of the movable handle may be rotation about the first pin portion.

[0007] In certain aspects, the cross pin is disposed within a proximal recess

of a connector of the movable handle, with the first pin portion rotatably disposed within opposed openings defined in the connector, and the connector is disposed within a coupler of the fixed handle, with the second pin portion rotatably disposed within opposed openings defined in first and second walls of the coupler, such that the movable handle is rotatable about the first and second pin portions. The first wall of the coupler of the fixed handle may include a sloped inner wall and the second wall of the coupler may include a substantially planar wall portion such that the movable handle is rotatable about the second pin portion within a range defined by the sloped inner wall and the substantially planar wall portion.

[0008] In some aspects, a ball rod interconnects the movable handle and the drive member. The ball rod may include a rod body having first and second balls disposed at opposed ends thereof. The first ball may be securely retained and rotatable within a distal recess defined in a connector of the movable handle, and/or the second ball may be securely retained and rotatable within a socket defined in the proximal end of the drive member.

[0009] In certain aspects, the rod body extends through an opening defined in the connector of the movable handle. The first movement of the movable handle may move the rod body from an upper portion to a lower portion of the opening defined in the connector of the movable handle to drive the drive member to a first distal position, and/or the second movement of the movable handle may move the rod body laterally within the lower portion of the opening defined in the connector of the movable handle to drive the drive member to a second distal position.

[0010] In some aspects, the end effector includes first and second jaw members pivotably coupled to each other. The first function of the end effector

may be closing of the first and second jaw members to a sealing position, and/or the second function of the end effector may be closing of the first and second jaw members to a cutting position.

[0011] In accordance with aspects of the present disclosure, a method of treating tissue includes: positioning first and second jaw members of an electrosurgical forceps at a surgical site, the electrosurgical forceps including a handle assembly having a movable handle pivotably connected to a fixed handle, an elongated shaft extending distally from the fixed handle, and a drive member slidably disposed within the elongated shaft, the drive member including a proximal end pivotably coupled to the movable handle and a distal end operably coupled to the first and second jaw members; moving the movable handle relative to the fixed handle to cause a first distal movement of the drive member to close the first and second jaw members and grasp tissue therebetween; applying electrosurgical energy to the tissue grasped between the first and second jaw members to seal the tissue; and moving the movable handle relative to the fixed handle to cause a second distal movement of the drive member to further close the first and second jaw members and cut the tissue disposed therebetween. The method may further include moving the movable handle member relative to the fixed handle to cause a proximal movement of the drive member to open the first and second jaw members and release the tissue disposed therebetween.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] Various aspects and features of the present disclosure are described herein with reference to the drawings wherein corresponding reference characters indicate corresponding parts throughout the drawings, and wherein:

[0013] FIG. 1 is a side, perspective view of an energy-based surgical system including a forceps connected to a source of electrosurgical energy in accordance with the present disclosure;

[0014] FIG. 2 is a side, perspective view of a handle assembly of the forceps of FIG. 1;

[0015] FIG. 3 is a side, exploded perspective view of the handle assembly of FIG. 2, with parts separated;

[0016] FIG. 4A is a side, perspective view of a fixed handle of the handle assembly of FIG. 3;

[0017] FIG. 4B is an enlarged, perspective view of a portion of the fixed handle of FIG. 4A, shown along the area of detail 4B identified in FIG. 4A;

[0018] FIG. 5A is a side, perspective view of a handle assembly of the forceps of FIG. 1, shown in an open position;

[0019] FIG. 5B is an enlarged, perspective view of a portion of the handle assembly of FIG. 5A, shown along the area of detail 5B identified in FIG. 5A;

[0020] FIG. 6 is a side view of the handle assembly of FIG. 5A;

[0021] FIG. 7A is a rear end view of the handle assembly of FIG. 5A;

[0022] FIG. 7B is an enlarged, end view of a portion of the handle assembly of FIG. 7A, shown along the area of detail 7B identified in FIG. 7A;

[0023] FIG. 8 is a top view of the handle assembly of FIG. 5A;

[0024] FIG. 9A is a side, perspective view of a handle assembly of the forceps of FIG. 1, shown in a sealing position;

[0025] FIG. 9B is an enlarged, perspective view of a portion of the handle assembly of FIG. 9A, shown along the area of detail 9B identified in FIG. 9A;

[0026] FIG. 10A is a side view of the handle assembly of FIG. 9A;

[0027] FIG. 10B is an enlarged, side view of a portion of the handle assembly of FIG. 10A, shown along the area of detail 10B identified in FIG. 10A;

[0028] FIG. 11A is a rear end view of the handle assembly of FIG. 9A;

[0029] FIG. 11B is an enlarged, end view of a portion of the handle assembly of FIG. 11A, shown along the area of detail 11B identified in FIG. 11A;

[0030] FIG. 12 is a top view of the handle assembly of FIG. 9A;

[0031] FIG. 13A is a side, perspective view of a handle assembly of the forceps of FIG. 1, shown in a cutting position;

[0032] FIG. 13B is an enlarged, perspective view of a portion of the handle assembly of FIG. 13A, shown along the area of detail 13B identified in FIG. 13A;

[0033] FIG. 14 is a side view of the handle assembly of FIG. 13A;

[0034] FIG. 15A is a rear end view of the handle assembly of FIG. 13A;

[0035] FIG. 15B is an enlarged, end view of a portion of the handle assembly of FIG. 15A, shown along the area of detail 15B identified in FIG. 15A;

[0036] FIG. 16 is a top view of the handle assembly of FIG. 13A; and

[0037] FIG. 17 is a schematic illustration of a work station configured for use with a forceps of the present disclosure.

DETAILED DESCRIPTION

[0038] In this disclosure, the term "proximal" refers to a portion of a structure closer to an operator, while the term "distal" refers to a portion of the

same structure further from the operator. As used herein, the term "subject" refers to a human patient or animal. The term "operator" refers to a doctor (e.g., a surgeon), a nurse, and other clinicians or care providers, and may include support personnel. Directional reference terms, such as "upper" and "lower," and the like, are intended to ease description of the embodiments and are not intended to have any limiting effect on the ultimate orientations of the surgical instruments, or any parts thereof.

[0039] Referring now to FIG. 1, an energy-based surgical system 10 in accordance with the present disclosure is configured for grasping, electrically sealing, and mechanically cutting/dividing/dissecting tissue and/or vessel(s) in endoscopic or laparoscopic surgical procedures. The energy-based surgical system 10 includes a forceps 100 releasably connected to a source of electrosurgical energy 200 via cable 202.

[0040] The forceps 100 includes a handle assembly 110, an elongated shaft 112 extending distally from the handle assembly 110, and an end effector 114 disposed at a distal end of the elongated shaft 112. The elongated shaft 112 extends along a longitudinal axis "X" and includes a longitudinal opening 112a defined therethrough for slidable receipt of a drive member 116 therein. The end effector 114 is operably coupled to the drive member 116 and includes first and second jaw members 114a, 114b pivotably coupled, in opposed relation, to each other, that are configured to grasp, seal, cut, and/or dissect tissue therebetween. A drive pin 118 extends through opposed slots 115 defined in the first and second jaw members 114a, 114b such that longitudinal movement of the drive member 116, with respect to the elongated shaft 112, causes the drive pin 118 to travel through the slots 115 of the first and second jaw members 114a, 114b to effect a function of the end effector 114, e.g., opening or closing of the first and

second jaw members 114a, 114b relative to each other, as described in further detail below.

[0041] As shown in FIGS. 1-3, the handle assembly 110 includes a movable handle 120 and a fixed handle 140. The movable handle 120 is pivotably coupled to the fixed handle 140 by a cross pin 160 (FIG. 3), and is pivotably coupled to the drive member 116 (FIG. 1) via a ball rod 170 (FIG. 3).

[0042] Referring now to FIG. 3, an upper portion 120a of the movable handle 120 includes a connector 122, and a lower portion 120b of the movable handle 120 includes a movable handle member 124. The connector 122 of the movable handle 120 includes a body portion 122a defining a proximal recess 122b between upper and lower legs 125a, 125b extending proximally from the body portion 122a of the connector 122. Each of the upper and lower legs 125a, 125b defines an opening 125c therethrough. The cross pin 160 includes a first pin portion 162 extending along a first axis, "Y," and a second pin portion 164 extending along a second axis, "Z," that intersects and is perpendicular to the first axis, "Y." The cross pin 160 is positioned within the proximal recess 122b of the connector 122 with the first pin portion 162 extending through the openings 125c defined in the upper and lower legs 125a, 125b of the connector 122 such that the movable handle 120 is rotatable, as indicated by arrow "Y_1," about the first axis, "Y."

[0043] The connector 122 includes a distal recess 122c defined between a cover 126 that is releasably connected to a distal end 122d of the body portion 122a of the connector 122. The ball rod 170 includes a rod body 172 including first and second balls 174, 176 disposed at opposed ends of the rod body 172. The distal recess 122c of the connector 122 has a substantially spherical shape to rotatably retain the first ball 174 of the ball rod 170 therein. The rod body 172

of the ball rod 170 extends through an opening 123 (see e.g., FIG. 2) defined by a perimeter formed by the cover 126 and the distal end 122d of the connector 122. As shown in FIGS. 1 and 2, the second ball 176 of the ball rod 170 is disposed within a socket 116a defined in a proximal end of the drive member 116. The second ball 176 of the ball rod 170 is secured within the socket 116a of the drive member 116, and is configured to rotate within the socket 116a and to move (e.g., push or pull) the drive member 116 along the longitudinal axis "X."

[0044] With continued reference to FIG. 3, an upper portion 140a of the fixed handle 140 includes a housing assembly 142, and a lower portion 140b of the fixed handle 140 includes a fixed handle member 144. The housing assembly 142 includes a substantially cylindrical body 146 defining a bore 146a therethrough through which the drive member 116 (FIG. 1) is slidably disposed. A distal end 146b of the cylindrical body 146 includes a knob 148 rotatable about the cylindrical body 146. As shown, for example, in FIG. 8, in conjunction with FIG. 1, the knob 148 includes a proximal portion 148a and a distal portion 148b connected together via thread 148c. A proximal pin 149a extends through the proximal portion 148a of the knob 148 and through a cylindrical slot (not shown) of the cylindrical body 146, such that rotation of the drive member 116 causes a corresponding rotation of the proximal portion 148a of the knob 148, and vice versa. A distal pin 149b extends through the distal portion 148b of the knob 148 and into operative engagement with the elongated shaft 112, such that rotation of the distal portion 148b of the knob 148 results in a rotation of the first and second jaw members 114a, 114b about longitudinal axis "X.".

[0045] An extension 150 extends proximally from the cylindrical body 146 of the housing assembly 142. The extension 150 includes a coupler 152

disposed at a proximal end thereof. The coupler 152 includes a body portion 152a defining a recess 152b therein, the recess 152b is partially defined by first and second walls 154, 156 of the coupler 152. The recess 152b is dimensioned to receive a proximal portion of the connector 122 of the movable handle 120. The first and second walls 154, 156 include openings 154a, 156a, respectively, defined therethrough that are configured to receive the second pin portion 164 of the cross pin 160 such that the movable handle 120 is rotatable, as indicated by arrow "Z_1," about the second axis, "Z." As shown in FIGS. 4A and 4B, the first wall 154 includes a sloped inner wall 154b and the second wall 156 includes a substantially planar inner wall portion 156b such that the movable handle 120 is rotatable relative to the fixed handle 140 about the first axis, "Y" (FIG. 3), in the limited range defined between the substantially planar wall portion 156b and the sloped inner wall 154b of the coupler 152 of the fixed handle 140.

[0046] Referring again to FIG. 3, the movable and fixed handle members 124, 144 of the movable and fixed handles 120, 140 are configured to allow an operator to effect movement of the movable handle 120 relative to the fixed handle 140. The movable and fixed handle members 124, 144 each define a finger hole 124a, 144a, respectively, therethrough for receiving a finger of an operator. The movable and fixed handle members 124, 144 are each monolithically formed with its respective movable and fixed handle 120, 140. Alternatively, the movable and fixed handle members 124, 144 may each be engaged with its respective movable and fixed handle 120, 140 in any suitable configuration, e.g., via mechanical engagement, molding, adhesion, etc.

[0047] The movable handle member 124 includes a first guide member 128 extending from an inner surface 124b of the movable handle member 124 towards the fixed handle member 144, and the fixed handle member 144

includes a second guide member 158 extending from an inner surface 144b of the fixed handle member 144 towards the movable handle member 124. The first and second guide members 128, 158 have a general L-shaped configuration including respective body portions 128a, 158a and respective leg portions 128b, 158b extending substantially perpendicularly from the body portions 128a, 158a. The leg portions 128b, 158b include substantially flat inner surfaces 128c, 158c, and convex outer surfaces 128d, 158d, respectively.

[0048] When the forceps 100 are in an open position, as shown in FIG. 1, in conjunction with FIGS. 5A-8 in which the elongated shaft 112, the end effector 114, and the drive member 116 are removed for ease of description of the handle assembly 110, the movable and fixed handle members 124, 144 of the movable and fixed handles 120, 140 are spaced from each other. The drive member 116 is disposed in a proximal-most position with the first and second jaw members 114a, 114b of the end effector 14 open and in spaced relation relative to each other. As shown in FIGS. 5B and 6, the first ball 174 of the ball rod 170 is rotated such that the rod body 172 extends distally upwards through an upper portion 123a of opening 123 defined in the connector 122 of the movable handle 120 towards the drive member 116 (FIG. 1) at about a 90° angle, "α," with respect to the body portion 122a of the connector 122 of the movable handle 120. The dimension of the upper portion 123a of the opening 123 limits the rotation of the movable handle 120 about the first axis, "Y" (FIG. 3). As shown in FIG. 8, to move to a first approximated, or sealing, position, the operator moves the movable handle member 124 towards the fixed handle member 144, in the direction of arrow "A," to rotate the movable handle 120 about the second pin portion 164 of the cross pin 160 (see e.g., FIG. 7B) about the second axis, "Z" (FIG. 3).

[0049] With reference now to FIGS. 9A-12, as the movable handle 120 is rotated towards the fixed handle 140, the first ball 174 of the ball rod 170 rotates within the connector 122 of the movable handle 120 such that the rod body 172 extends through a lower portion 123b of the opening 123 defined in the connector 122 (see e.g., FIG. 9B). The second ball 176 of the ball rod 170 rotates within the socket 116a of the drive member 116 (FIG. 1) such that the rod body 172 extends distally along longitudinal axis "X" at about a 180° angle "β" (FIG. 10A) with respect to the body portion 122a of the connector 122 of the movable handle 120, thereby pushing the drive member 116 (FIG. 1) distally to a first distal position, which in turn, causes distal movement of the drive pin 118 through a proximal section 115a of the slots 115 of the first and second jaw members 114a, 114b to effect closing of the first and second jaw members 114a, 114b of the end effector 114 (FIG. 1). As shown in FIGS. 10A and 10B, the inner surfaces 128c, 158c of the leg portions 128b, 158b of the first and guide members 128, 158 of the movable and fixed handle members 124, 144 slidingly touch as they pass each other to limit the rotation of the movable handle 120 about the first axis, "Y" (FIG. 3). As shown in FIG. 12, to begin movement to a second approximated, or cutting, position, the operator moves the movable handle member 124 laterally, in the direction of arrow B, to rotate the movable handle 120 about the first pin portion 162 of the cross pin 160 about the first axis, "Y" (FIG. 3), until the connector 122 of the movable handle 120 contacts the sloped inner wall 154b of the coupler 152 of the fixed handle 140 (see e.g., FIG. 4B).

[0050] Turning now to FIGS. 13A-16, as the movable handle 120 is rotated laterally with respect to the fixed handle 140, the first ball 174 of the ball rod 170 rotates within the connector 122 of the movable handle 120 such that the rod

body 172 moves laterally within the lower portion 123b of the opening 123 defined in the connector 122 (see e.g., FIG. 13B) which, in turn, drives the rod body 172 distally such that the second ball 176 rotates and drives the drive member 116 (FIG. 1) distally to a second distal position, which in turn, causes distal movement of the drive pin 118 (FIG. 1) through a distal section 115b of the slots 115 of the first and second jaw members 114a, 114b, which is disposed at an angle with respect to the proximal section 115a, to stagger the first and second jaw members 114a, 114b of the end effector 114 with respect to the longitudinal axis "X." As shown in FIG. 14, during the cutting motion, the first guide member 128 of the movable handle member 124 is rotated such that the outer surface 128d of the first guide member 128 opposes the outer surface 158d of the second guide member 158 of the fixed handle member 144. As the operator moves the movable handle 120 in the direction of arrow "C," shown in FIG. 16, the cutting motion is completed and the movable and fixed handle members 120, 140 return to the open position of FIG. 1 to reset the forceps 100. Accordingly, cutting with the forceps is defined by one continuous motion following a generally L-shaped path, so that cutting and resetting merge as one action.

[0051] For a detailed discussion of the articulation of the first and second jaw members with respect to one another, reference may be made to commonly owned U.S. Patent Application Serial No. XX/XXX,XXX (Attorney Docket No. 356613 (203-11066)), entitled "Articulation Assemblies For Use with Endoscopic Surgical Instruments," the entire contents of which are incorporated by reference herein.

[0052] In an exemplary method of using the energy based surgical system 10 of FIG. 1, the forceps 100 is placed at a desired surgical site and the first and

second jaw members 114a, 114b are positioned in an open position around desired tissue and/or vessel(s) (not shown). As shown in FIG. 6, for example, in the open position, the movable and fixed handle members 124, 144 of the movable and fixed handles 120, 140 are spaced apart from each other.

[0053] The handle assembly 110 is moved to a sealing position by moving the movable handle member 124 towards the fixed handle member 144, in the direction of arrow "A" shown in FIG. 8, such that the ball rod 170 is moved to an extended position, as shown, for example, in FIG. 10A, thereby driving the drive member 116 (FIG. 1) distally to effect a first function of the end effector 114 (FIG. 1), e.g., closing the first and second jaw members 114a, 114b (FIG. 1) to grasp tissue therebetween. The source of electrosurgical energy 200 (FIG. 1) may then be activated to apply electrosurgical energy to tissue grasped between the first and second jaw members 114a, 114b of the end effector 114.

[0054] When sealing is complete and the source of electrosurgical energy 200 is shut off, the handle assembly 110 may be returned to the open position (FIG. 1) to release tissue held between the first and second jaw members 114a, 114b, or the handle assembly 110 may be moved to a cutting position to cut the sealed tissue disposed between the first and second jaw members 114a, 114b.

[0055] To cut tissue, the movable handle member 124 is moved laterally with respect to the fixed handle member 144, as shown for example, in FIG. 12, in the direction of arrow "B," such that the ball rod 170 is moved to a further extended position, thereby further driving the drive member 116 (FIG. 1) distally to effect a second function of the end effector 114 (FIG. 1), e.g., staggering the first and second jaw members at an angle with respect to each other to cut tissue disposed therebetween. The movable handle member 124 is then moved proximally in the direction of arrow "C," shown in FIG. 16, to complete the

cutting motion, thereby releasing the sealed and divided tissue, and re-setting the forceps 100 to the open position.

[0056] The embodiments disclosed herein may also be configured to work with robotic surgical systems and what is commonly referred to as "Telesurgery." Such systems employ various robotic elements to assist the operator and allow remote operation (or partial remote operation) of surgical instrumentation. Various robotic arms, gears, cams, pulleys, electric and mechanical motors, etc. may be employed for this purpose and may be designed with a robotic surgical system to assist the operator during the course of an operation or treatment. Such robotic systems may include remotely steerable systems, automatically flexible surgical systems, remotely flexible surgical systems, remotely articulating surgical systems, wireless surgical systems, modular or selectively configurable remotely operated surgical systems, etc.

[0057] The robotic surgical systems may be employed with one or more consoles that are next to the operating theater or located in a remote location. In this instance, one team of surgeons or nurses may prep a subject (e.g., a patient) for surgery and configure the robotic surgical system with one or more of the instruments disclosed herein while another surgeon (or group of surgeons) remotely control the instruments via the robotic surgical system. As can be appreciated, a highly skilled surgeon may perform multiple operations in multiple locations without leaving his/her remote console which can be both economically advantageous and a benefit to the patient or a series of patients.

[0058] The robotic arms of the surgical system are typically coupled to a pair of master handles by a controller. The handles can be moved by the surgeon to produce a corresponding movement of the working ends of any type of surgical instrument (e.g., end effectors, graspers, knifes, scissors, etc.) which

may complement the use of one or more of the embodiments described herein. The movement of the master handles may be scaled so that the working ends have a corresponding movement that is different, smaller or larger, than the movement performed by the operating hands of the surgeon. The scale factor or gearing ratio may be adjustable so that the operator can control the resolution of the working ends of the surgical instrument(s).

[0059] The master handles may include various sensors to provide feedback to the surgeon relating to various tissue parameters or conditions, e.g., tissue resistance due to manipulation, cutting or otherwise treating, pressure by the instrument onto the tissue, tissue temperature, tissue impedance, etc. As can be appreciated, such sensors provide the surgeon with enhanced tactile feedback simulating actual operating conditions. The master handles may also include a variety of different actuators for delicate tissue manipulation or treatment further enhancing the surgeon's ability to mimic actual operating conditions.

[0060] As shown in FIG. 17, a medical work station is shown generally as work station 1000 and generally may include a plurality of robot arms 1002 and 1003; a control device 1004; and an operating console 1005 coupled with control device 1004. Operating console 1005 may include a display device 1006, which may be set up in particular to display three-dimensional images; and manual input devices 1007 and 1008, by means of which an operator (not shown), for example a surgeon, may be able to telemanipulate robot arms 1002 and 1003 in a first operating mode.

[0061] Each of the robot arms 1002 and 1003 may include a plurality of members, which are connected through joints, and an attaching device 1009 and 1011, to which may be attached, for example, a surgical tool "ST" supporting an end effector 1100, in accordance with any one of the embodiments disclosed

herein.

[0062] Robot arms 1002 and 1003 may be driven by electric drives (not shown) that are connected to control device 1004. Control device 1004 (e.g., a computer) may be set up to activate the drives, in particular by means of a computer program, in such a way that robot arms 1002 and 1003, their attaching devices 1009 and 1011 and thus the surgical tool (including end effector 1100) execute a desired movement according to a movement defined by means of manual input devices 1007 and 1008. Control device 1004 may also be set up in such a way that it regulates the movement of robot arms 1002 and 1003, and/or of the drives.

[0063] Medical work station 1000 may be configured for use on a patient 1013 lying on a patient table 1012 to be treated in a minimally invasive manner by means of end effector 1100. Medical work station 1000 may also include more than two robot arms 1002 and 1003, the additional robot arms likewise being connected to control device 1004 and being telemanipulatable by means of operating console 1005. A medical instrument or surgical tool (including an end effector 1100) may also be attached to the additional robot arm. Medical work station 1000 may include a database 1014, in particular coupled to with control device 1004, in which are stored, for example, pre-operative data from patient/living being 1013 and/or anatomical atlases.

[0064] While several embodiments of the disclosure have been shown in the drawings and described herein, it is not intended that the disclosure be limited thereto, as it is intended that the disclosure be as broad in scope as the art will allow and that the specification be read likewise. Therefore, the above description should not be construed as limiting, but merely as examples of particular embodiments. Those skilled in the art will envision other

modifications within the scope and spirit of the claims appended hereto.

WHAT IS CLAIMED IS:

1. An electrosurgical forceps, comprising:

a handle assembly including a movable handle pivotably connected to a fixed handle;

an elongated shaft extending distally from the fixed handle;

an end effector disposed at a distal end of the elongated shaft; and

a drive member slidably disposed within the elongated shaft, the drive member including a proximal end pivotably coupled to the movable handle and a distal end operably coupled to the end effector, wherein a first movement of the movable handle relative to the fixed handle causes a first distal movement of the drive member to effect a first function of the end effector, and a second movement of the movable handle relative to the fixed handle causes a second distal movement of the drive member to effect a second function of the end effector.

2. The electrosurgical forceps of claim 1, further comprising a cross pin interconnecting the movable handle and the fixed handle.

3. The electrosurgical forceps of claim 2, wherein the cross pin includes a first pin portion extending along a first axis, and a second pin portion intersecting the first pin portion and extending along a second axis.

4. The electrosurgical forceps of claim 3, wherein the first movement of the movable handle is rotation about the second pin portion, and the second movement of the movable handle is rotation about the first pin portion.

5. The electrosurgical forceps of claim 3, wherein the cross pin is disposed within a proximal recess of a connector of the movable handle, with the first pin portion rotatably disposed within opposed openings defined in the connector, the connector disposed within a coupler of the fixed handle, with the second pin portion rotatably disposed within opposed openings defined in first and second walls of the coupler, such that the movable handle is rotatable about the first and second pin portions.

6. The electrosurgical forceps of claim 5, wherein the first wall of the coupler of the fixed handle includes a sloped inner wall, and the second wall of the coupler includes a substantially planar wall portion such that the movable handle is rotatable about the second pin portion within a range defined by the sloped inner wall and the substantially planar wall portion.

7. The electrosurgical forceps of claim 1, further comprising a ball rod interconnecting the movable handle and the drive member.

8. The electrosurgical forceps of claim 7, wherein the ball rod includes a rod body having first and second balls disposed at opposed ends thereof.

9. The electrosurgical forceps of claim 8, wherein the first ball is securely retained and rotatable within a distal recess defined in a connector of the movable handle.

10. The electrosurgical forceps of claim 9, wherein the second ball is

securely retained and rotatable within a socket defined in the proximal end of the drive member.

11. The electrosurgical forceps of claim 10, wherein the rod body extends through an opening defined in the connector of the movable handle.

12. The electrosurgical forceps of claim 11, wherein the first movement of the movable handle moves the rod body from an upper portion to a lower portion of the opening defined in the connector of the movable handle to drive the drive member to a first distal position.

13. The electrosurgical forceps of claim 11, wherein the second movement of the movable handle moves the rod body laterally within the lower portion of the opening defined in the connector of the movable handle to drive the drive member to a second distal position.

14. The electrosurgical forceps of claim 1, wherein the end effector includes first and second jaw members pivotably coupled to each other.

15. The electrosurgical forceps of claim 14, wherein the first function of the end effector is closing of the first and second jaw members to a sealing position.

16. The electrosurgical forceps of claim 15, wherein the second function of the end effector is closing of the first and second jaw members to a cutting position.

17. A method of treating tissue comprising:

positioning first and second jaw members of an electrosurgical forceps at a surgical site, the electrosurgical forceps including a handle assembly having a movable handle pivotably connected to a fixed handle, an elongated shaft extending distally from the fixed handle, and a drive member slidably disposed within the elongated shaft, the drive member including a proximal end pivotably coupled to the movable handle and a distal end operably coupled to the first and second jaw members;

moving the movable handle relative to the fixed handle to cause a first distal movement of the drive member to close the first and second jaw members and grasp tissue therebetween;

applying electrosurgical energy to the tissue grasped between the first and second jaw members to seal the tissue; and

moving the movable handle relative to the fixed handle to cause a second distal movement of the drive member to further close the first and second jaw members and cut the tissue disposed therebetween.

18. The method of claim 17, further including moving the movable handle relative to the fixed handle to cause a proximal movement of the drive member to open the first and second jaw members and release the tissue disposed therebetween.

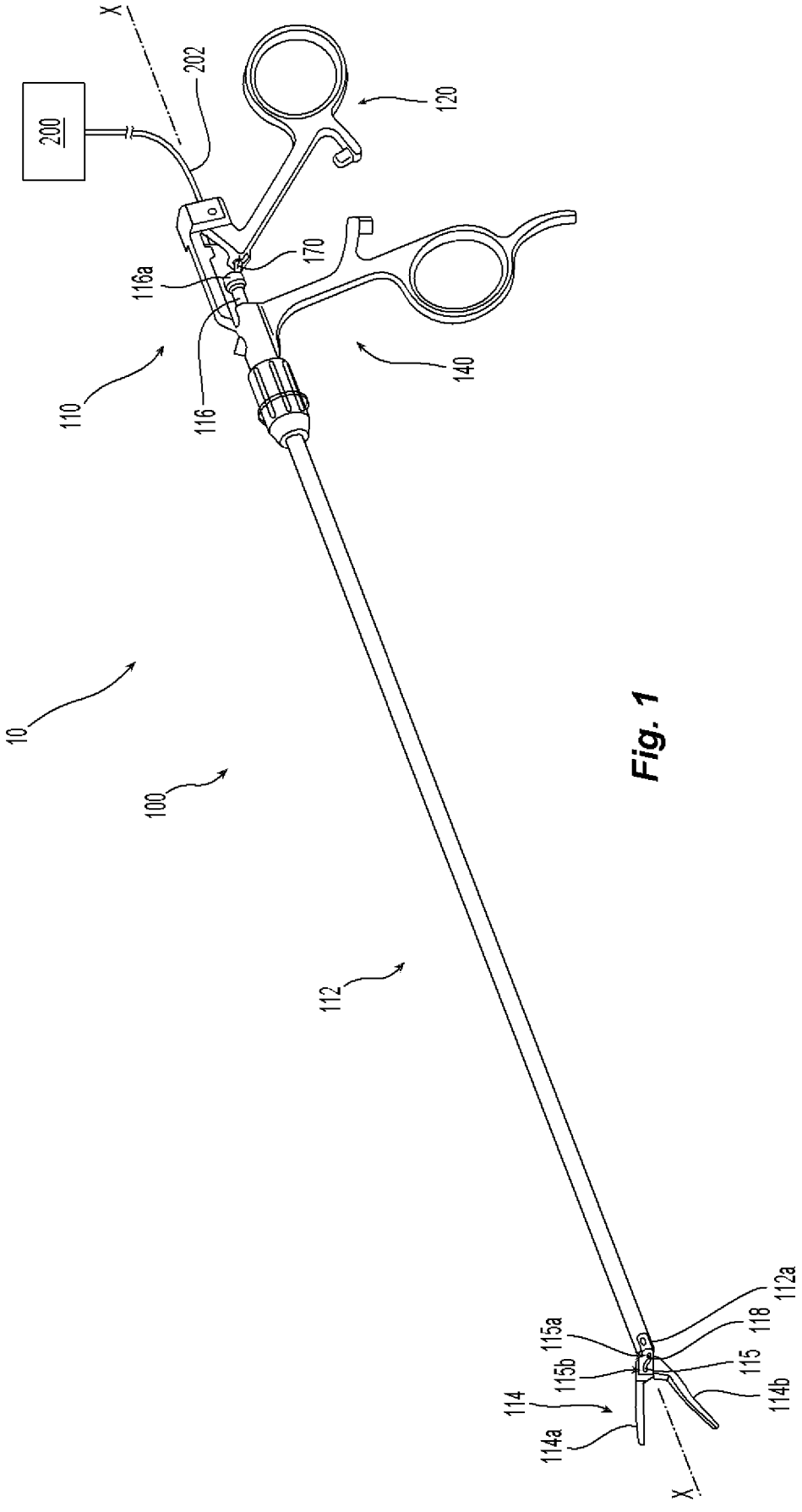
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Fig. 1

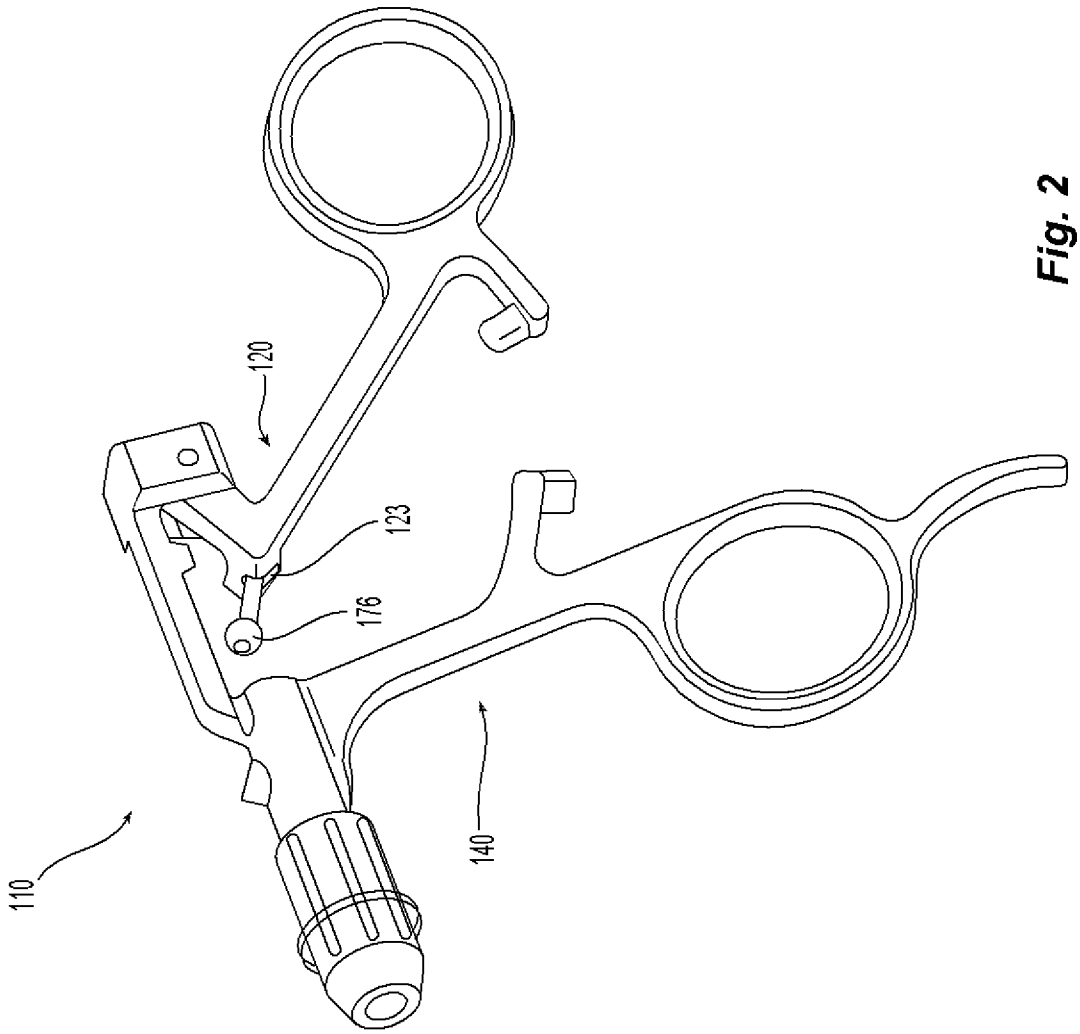

Fig. 2

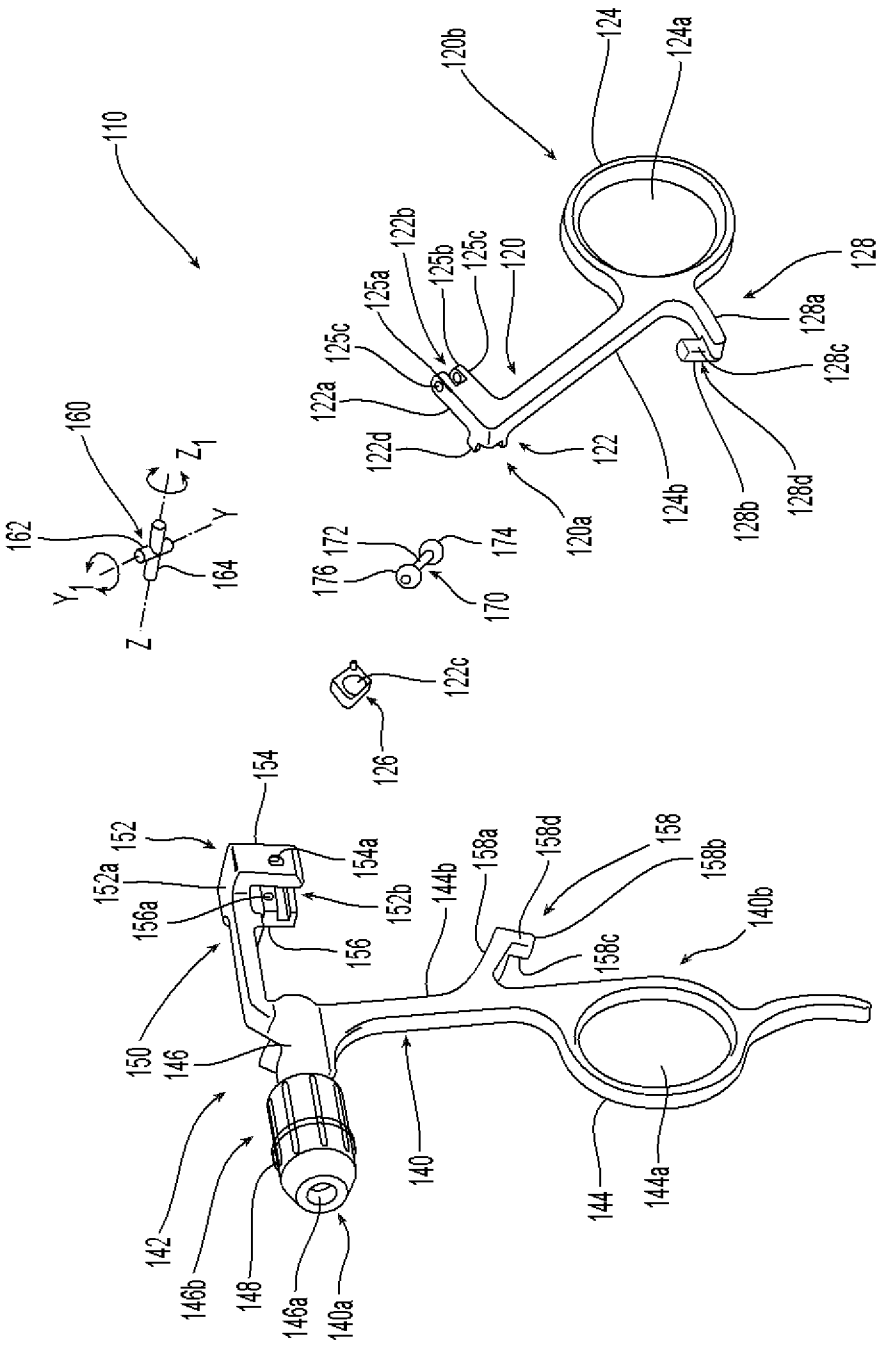
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Fig. 3

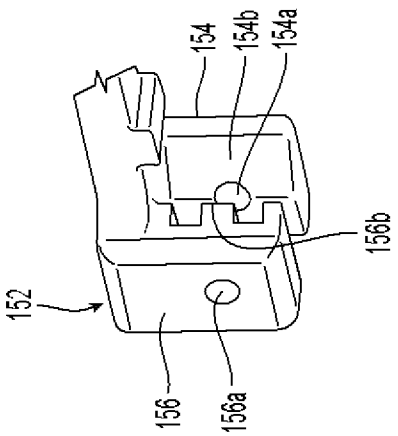


Fig. 4B

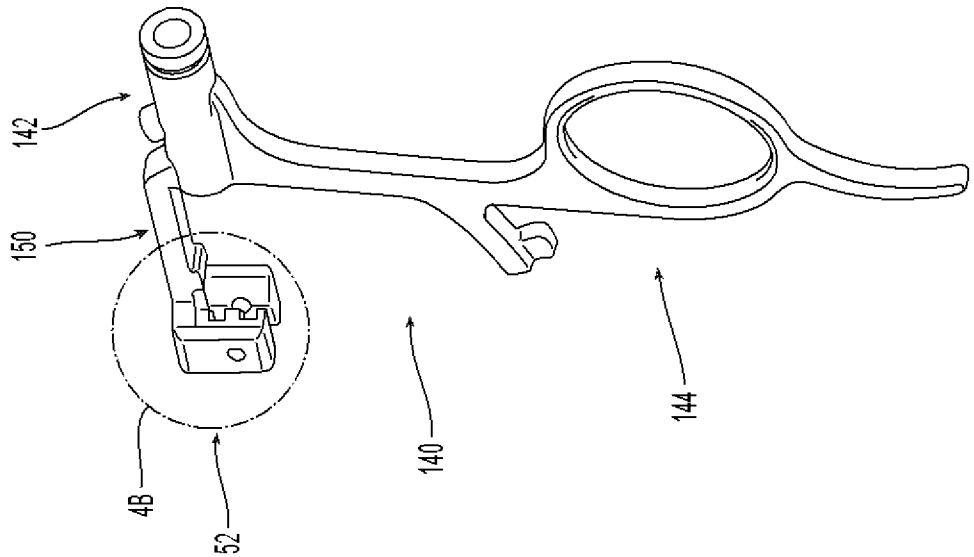


Fig. 4A

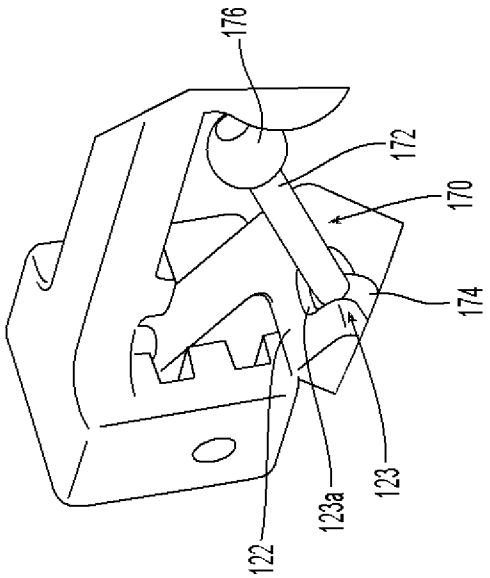


Fig. 5B

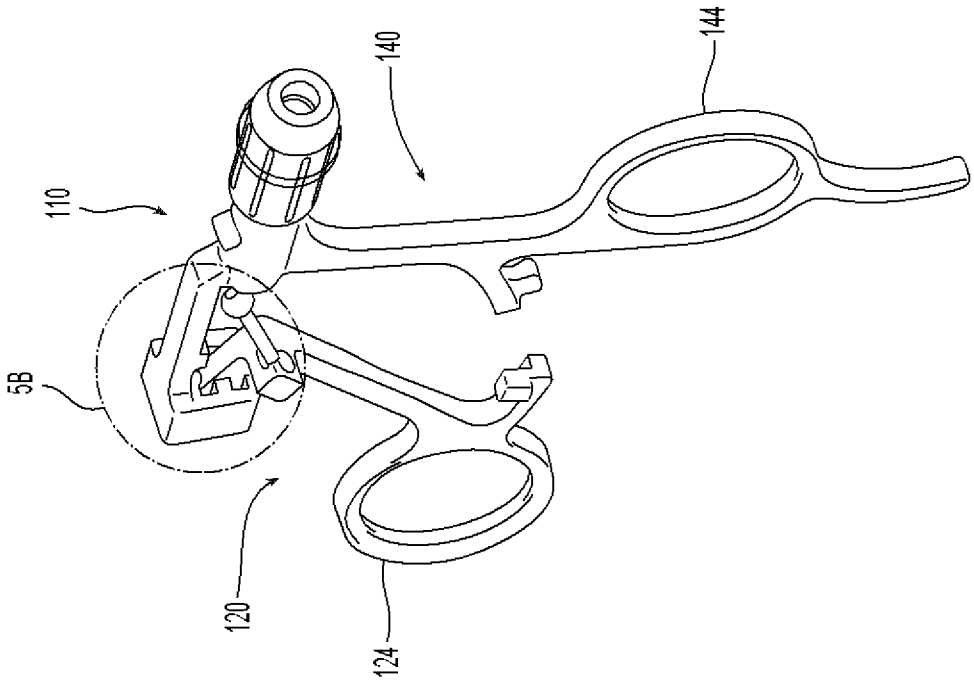


Fig. 5A

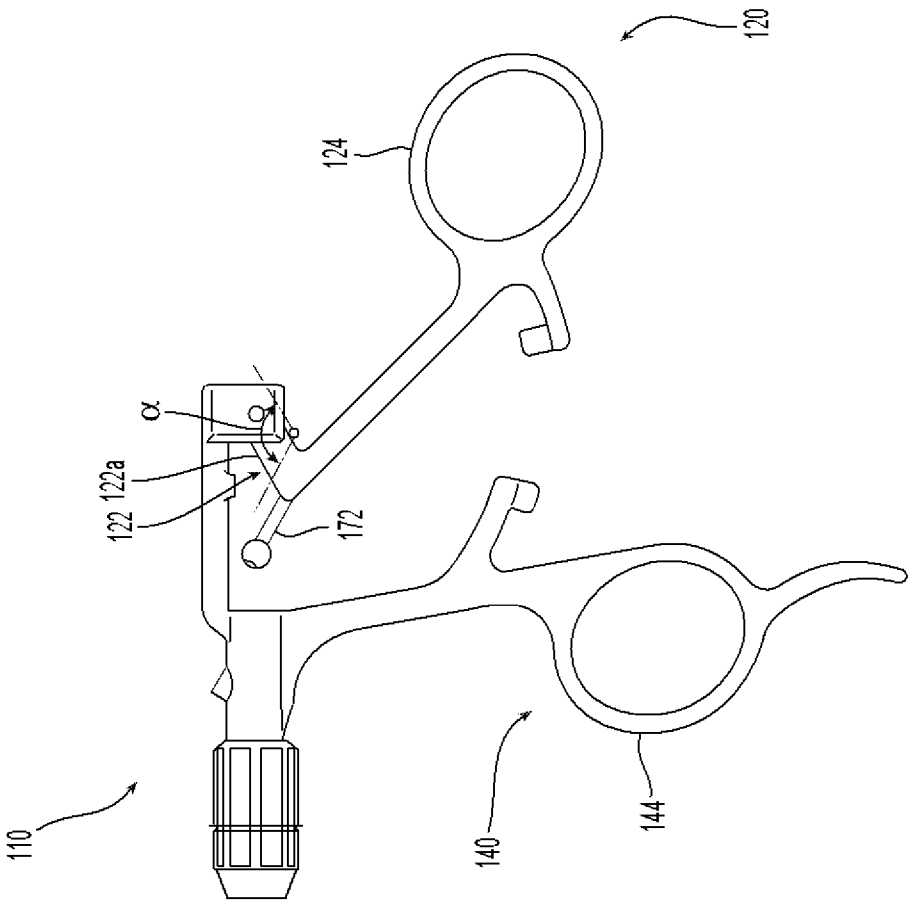


Fig. 6

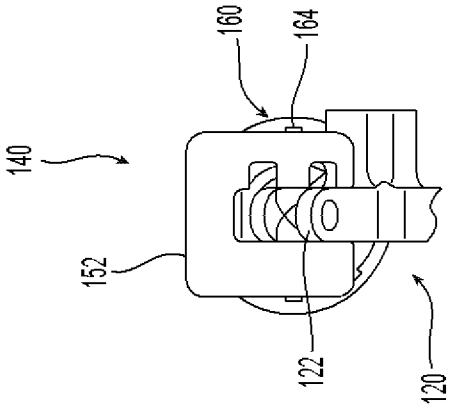


Fig. 7B

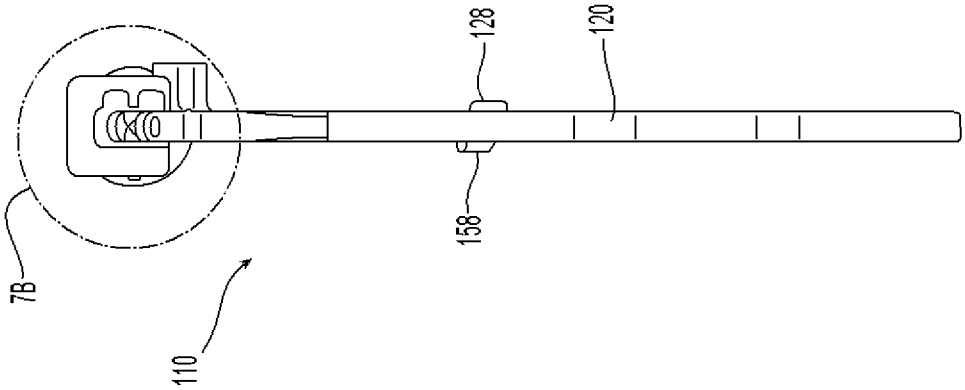
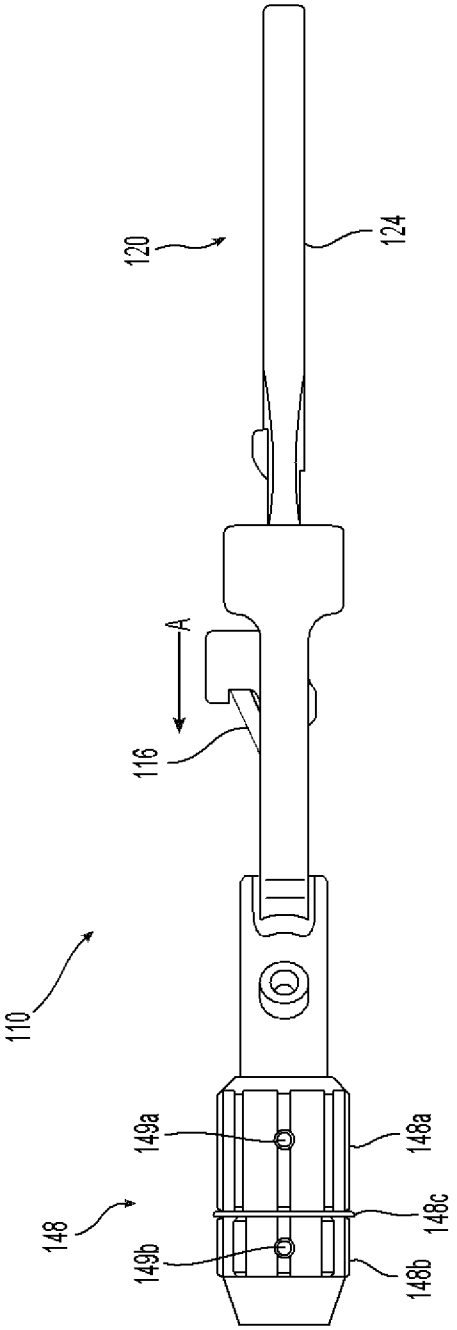


Fig. 7A



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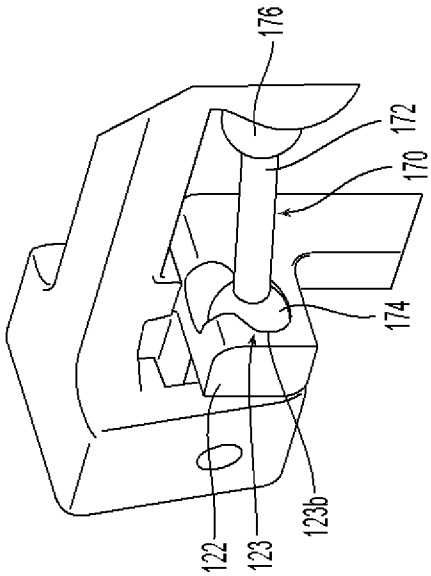


Fig. 9B

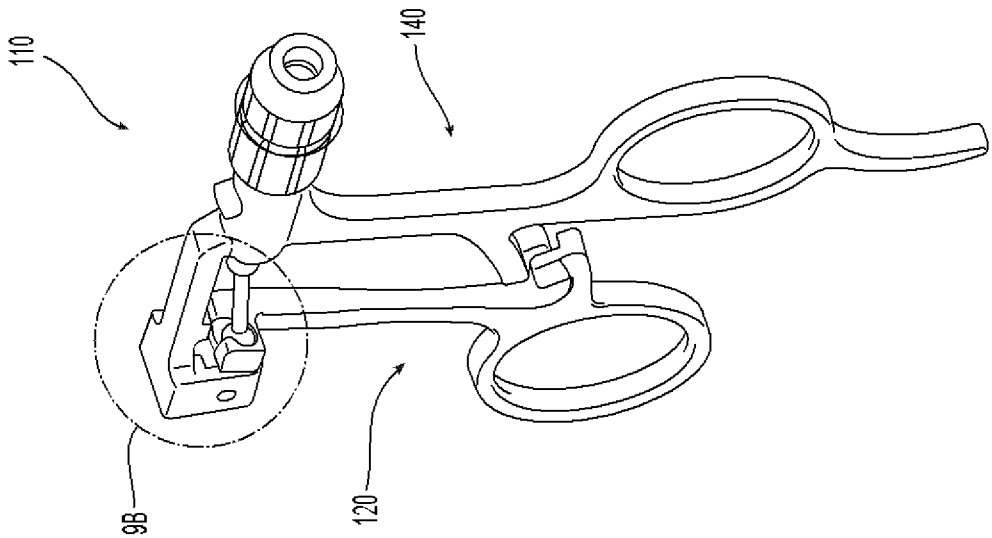


Fig. 9A

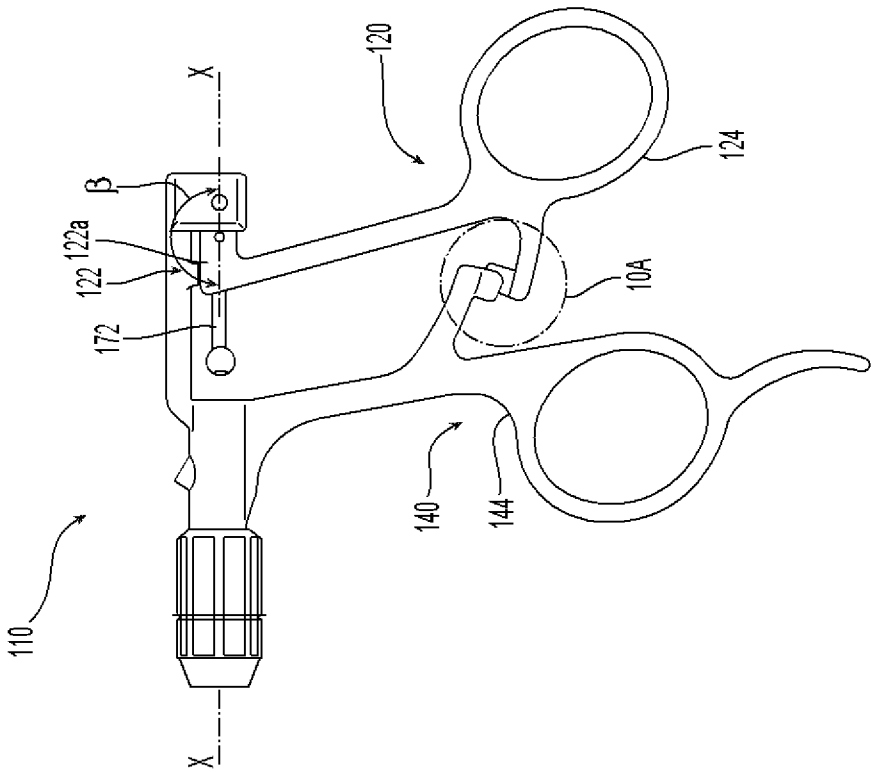


Fig. 10A

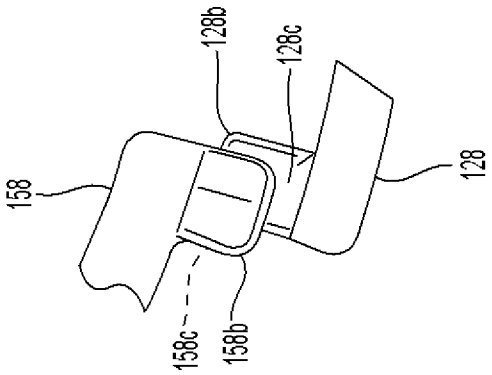


Fig. 10B

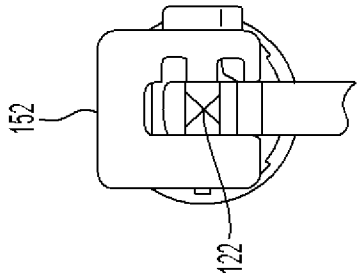


Fig. 11B

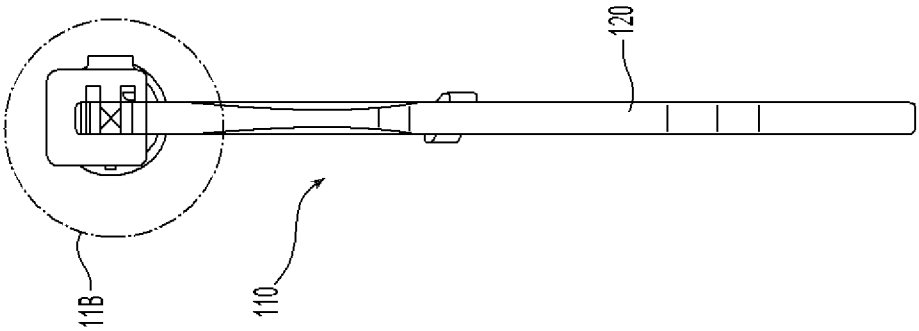
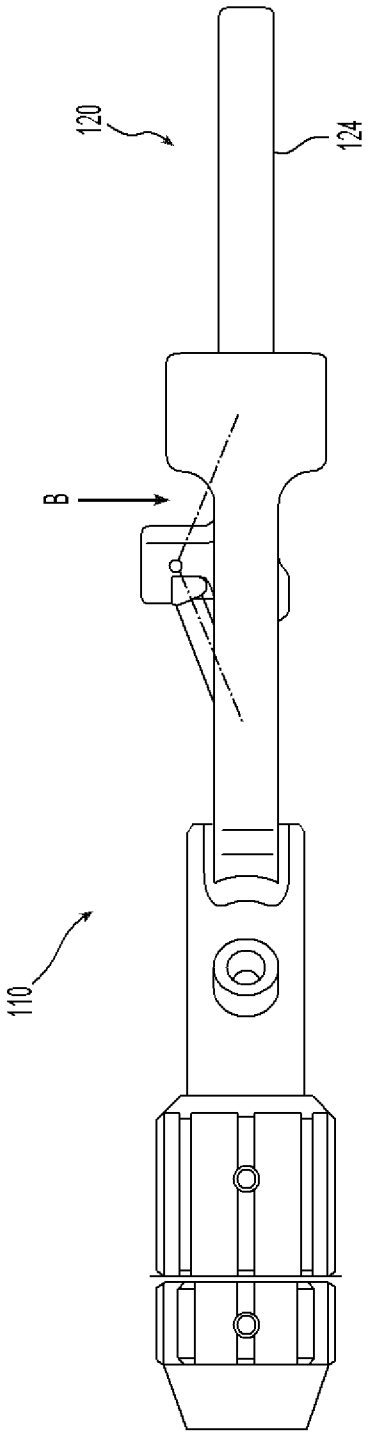


Fig. 11A



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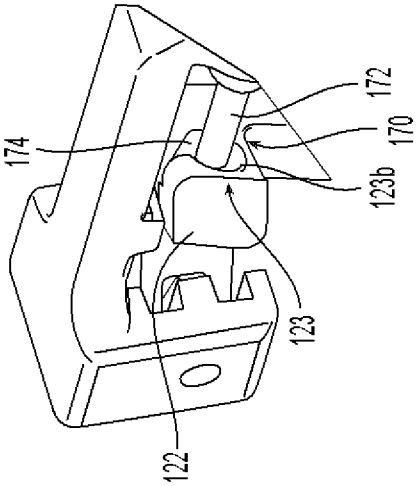
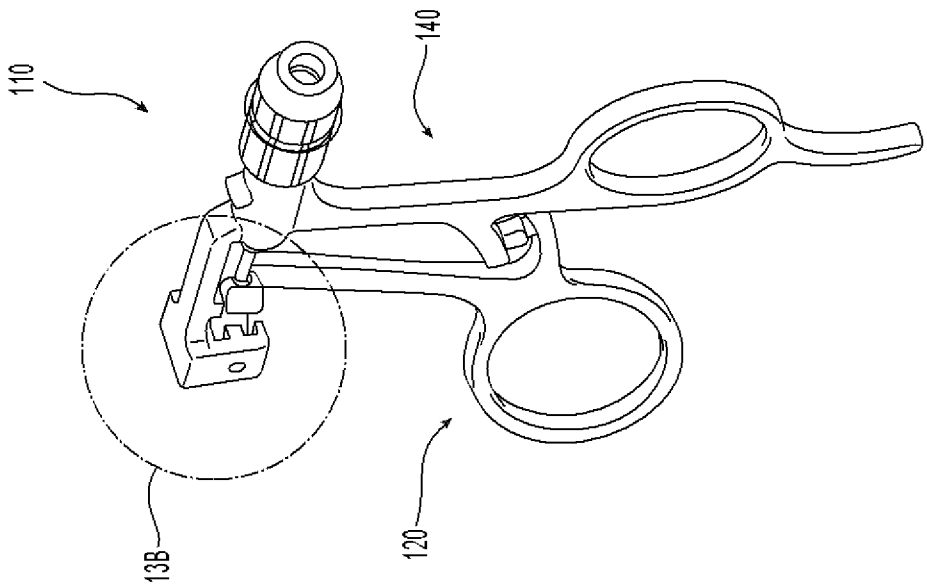


Fig. 13B



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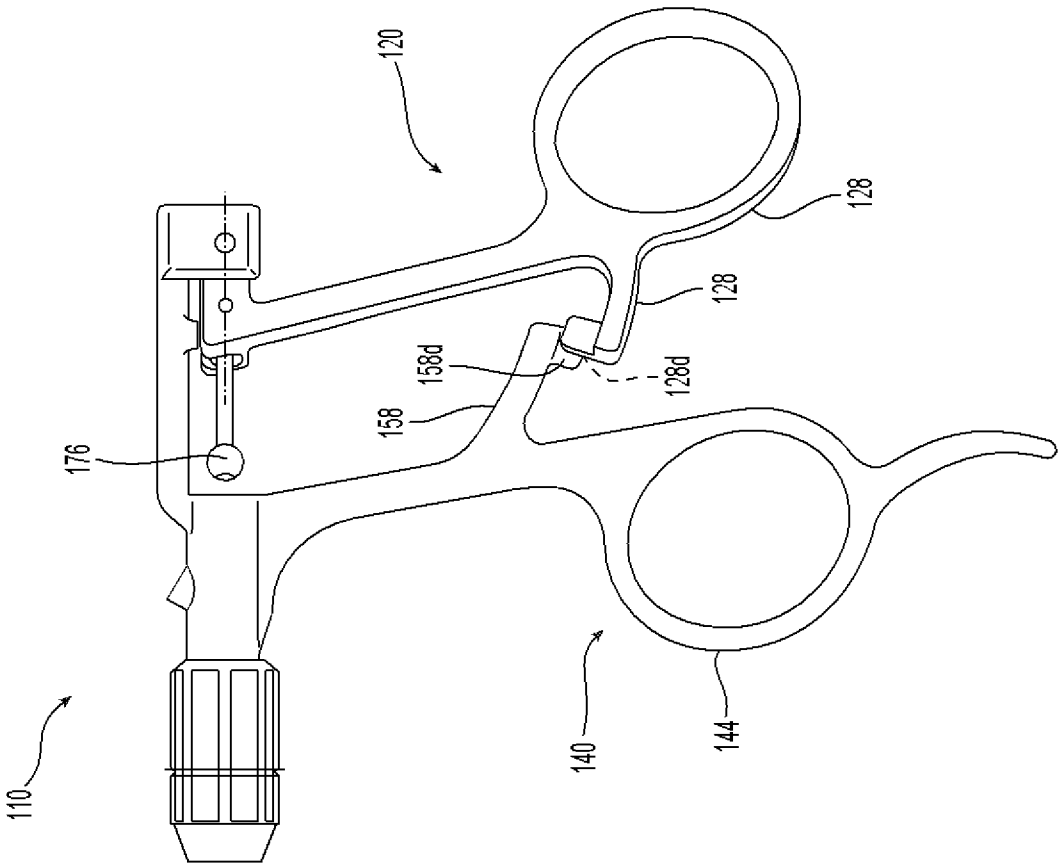

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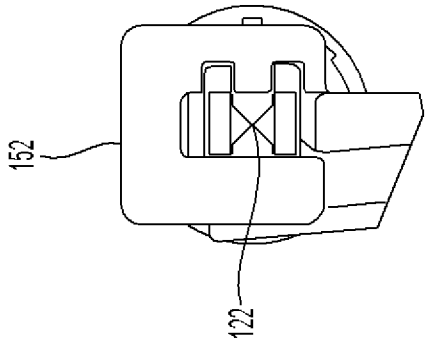


Fig. 15B

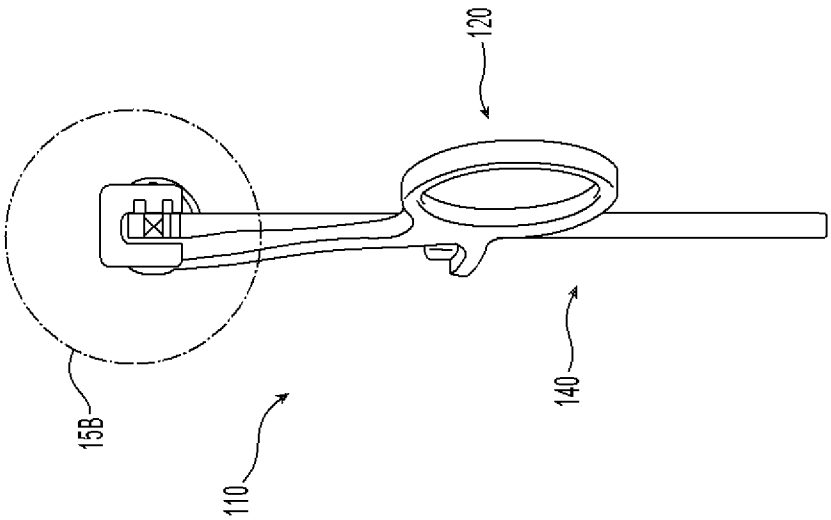
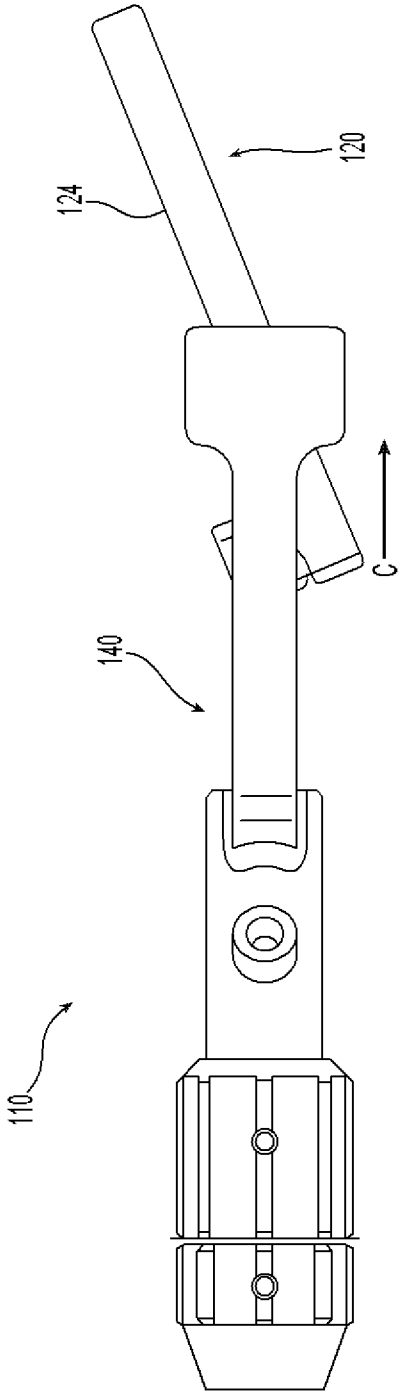


Fig. 15A



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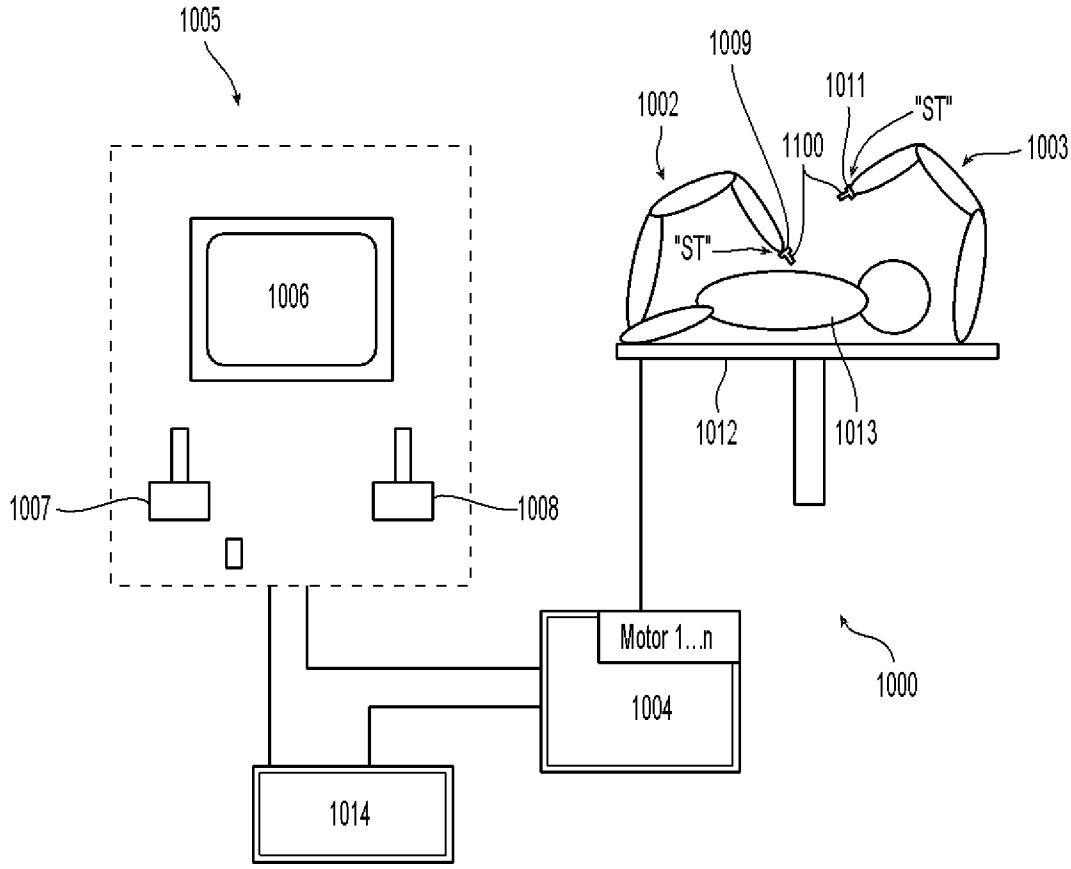
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Fig. 17

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CN2016/081087

A. CLASSIFICATION OF SUBJECT MATTER

A61B 18/14(2006.01)i; A61B 18/12(2006.01)i; A61B 17/28(2006.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

A61B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNABS, CNKI, EPODOC, WPI: electrosurgical, forcep?, handle?, shaft, driv+

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	CN 102119010 A (SURGRX INC) 06 July 2011 (2011-07-06) description, paragraphs [0040]-[0057] and figures 1-4E	1, 14-18
A	US 7232440 B2 (SHERWOOD SERV AG) 19 June 2007 (2007-06-19) the whole document	1-18
A	CN 204106126 U (UNIV HUAQIAO) 21 January 2015 (2015-01-21) the whole document	1-18
A	CN 103211647 A (TYCO HEALTHCARE) 24 July 2013 (2013-07-24) the whole document	1-18

☐ Further documents are listed in the continuation of Box C. ☑ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
29 December 2016	**16 February 2017**
Name and mailing address of the ISA/CN **STATE INTELLECTUAL PROPERTY OFFICE OF THE P.R.CHINA** **6, Xitucheng Rd., Jimen Bridge, Haidian District, Beijing 100088** **China**	Authorized officer **ZHANG,Xian**
Facsimile No. **(86-10)62019451**	Telephone No. **(86-10)62085801**

Form PCT/ISA/210 (second sheet) (July 2009)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/CN2016/081087

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