US 20190313971A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2019/0313971 A1**

LEE (43) **Pub. Date: Oct. 17, 2019**

(54) **NERVE PROBE ATTACHABLE/DETACHABLE TO/FROM SURGICAL INSTRUMENT, AND ENERGY DEVICE SURGICAL INSTRUMENT HAVING NERVE PROBE ATTACHED THERETO**

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(21) Appl. No.: **16/319,339**

(22) PCT Filed: **Aug. 31, 2016**

(86) PCT No.: **PCT/KR2016/009737**

§ 371 (c)(1),
(2) Date: **Jan. 19, 2019**

(30) **Foreign Application Priority Data**

Aug. 31, 2016 (KR) 10-2016-0111913
Aug. 31, 2016 (KR) 10-2016-0111923

Publication Classification

(51) **Int. Cl.**

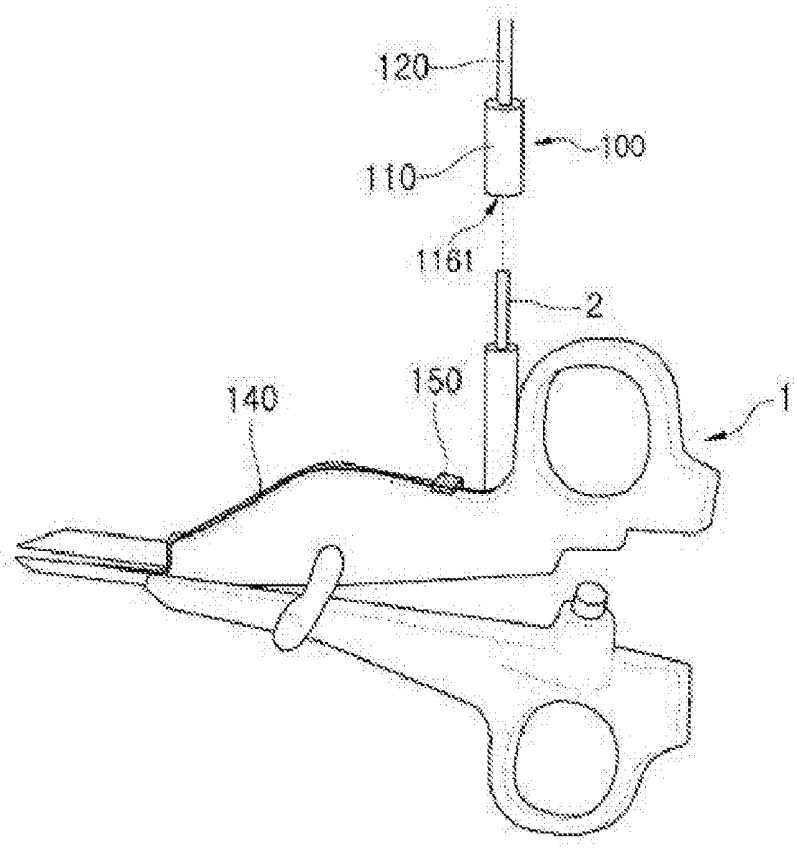
A61B 5/00	(2006.01)
A61B 5/0492	(2006.01)
A61B 18/12	(2006.01)

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

CPC .. ***A61B 5/4893*** (2013.01); *A61B 2017/00477* (2013.01); ***A61B 18/1233*** (2013.01); ***A61B 5/0492*** (2013.01)

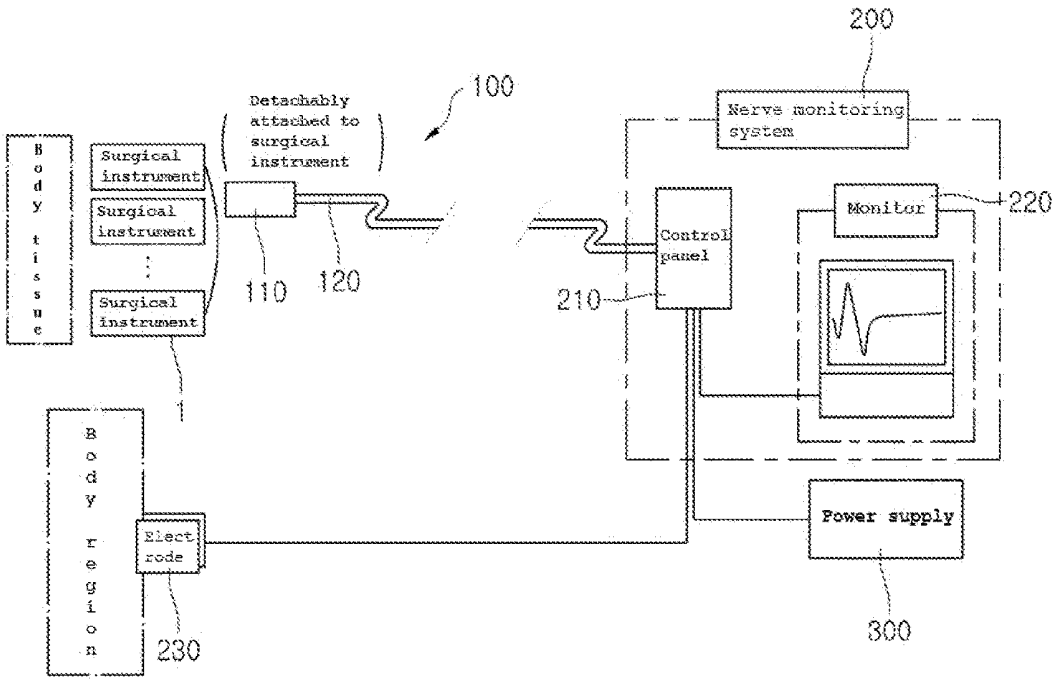
(57) **ABSTRACT**

The nerve probe attachable and detachable to and from a surgical instrument according to the present invention has a technical feature in that it is detachably mounted to a surgical instrument (a general surgical instrument, an endoscopic surgical instrument, or a robotic surgical instrument) made of an electrically conductive material to allow an electric current to be applied to body tissue by the surgical instrument so that real-time nerve identification and surgery can be performed simultaneously at body tissue coming into close contact with the surgical instrument only by use of the surgical instrument even without suffering from inconvenience of having to frequently replace a separate nerve probe and the surgical instrument, leading to promotion of rapid surgery and improvement of convenience of medical staffs.

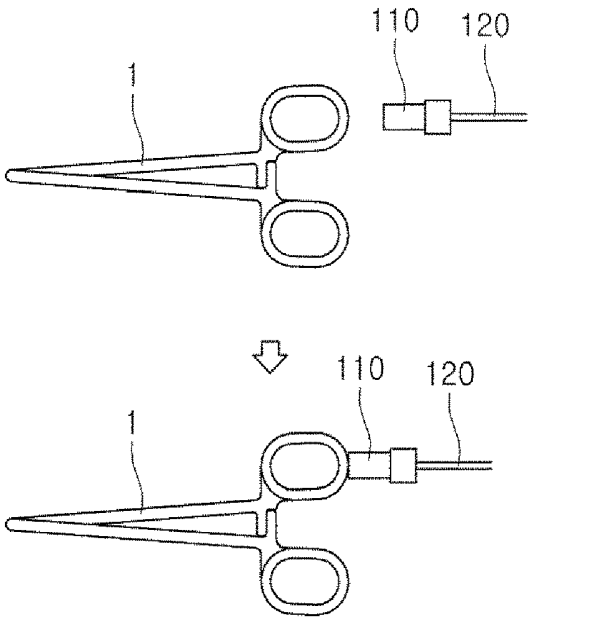


(Bipolar vessel sealing system)

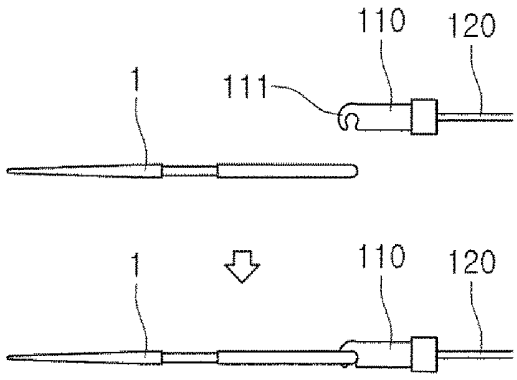
【Fig. 1】


200
Nerve monitoring system
100
Detachably attached to surgical instrument
Body tissue
Surgical instrument
Surgical instrument
Surgical instrument
110
120
Control panel
210
Monitor
220
1
Body region
Electrode
230
Power supply
300

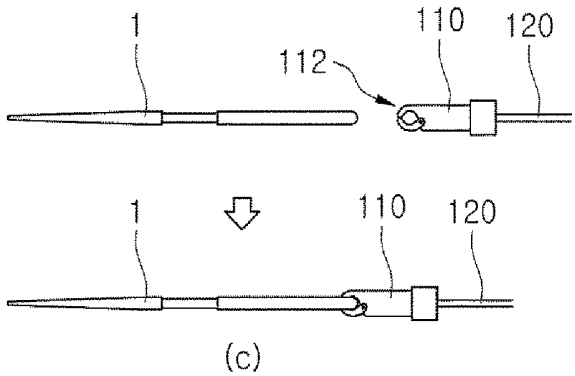
【Fig. 2】



(a)

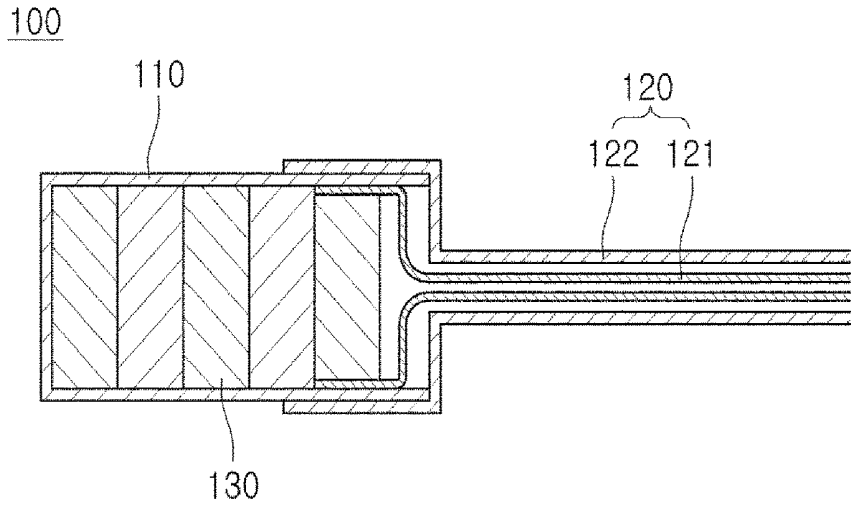


(b)

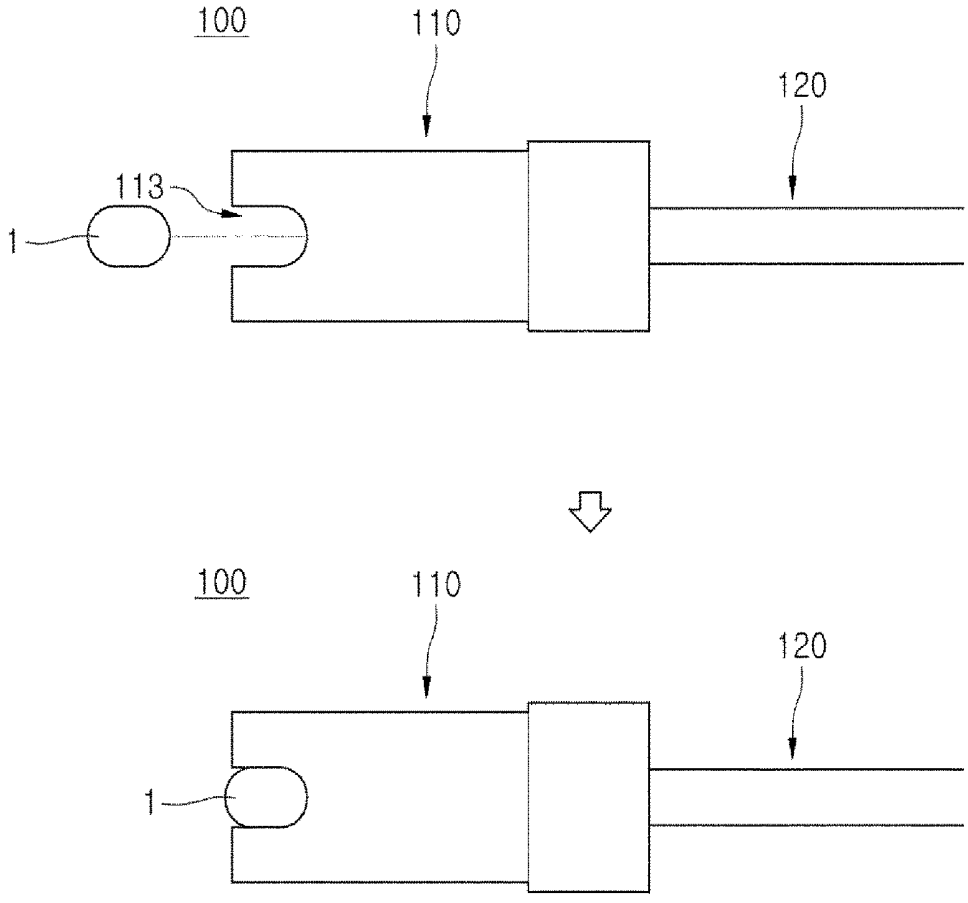


(c)

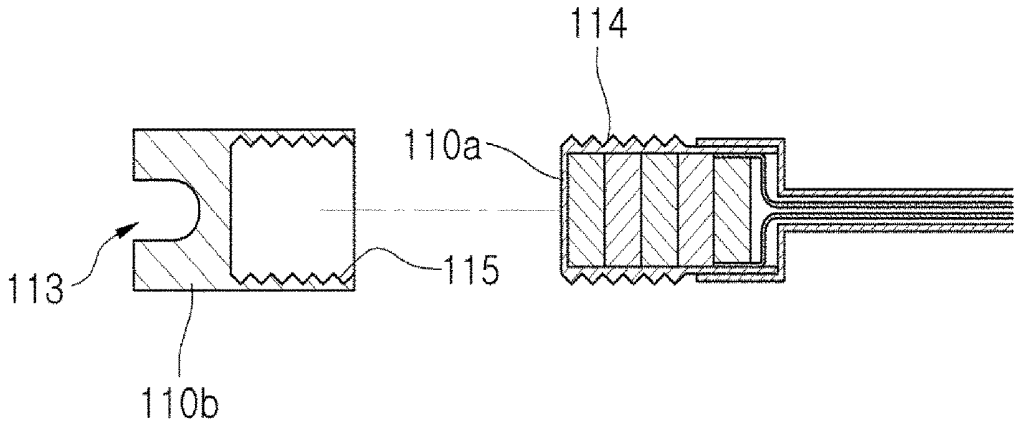
【Fig. 3】



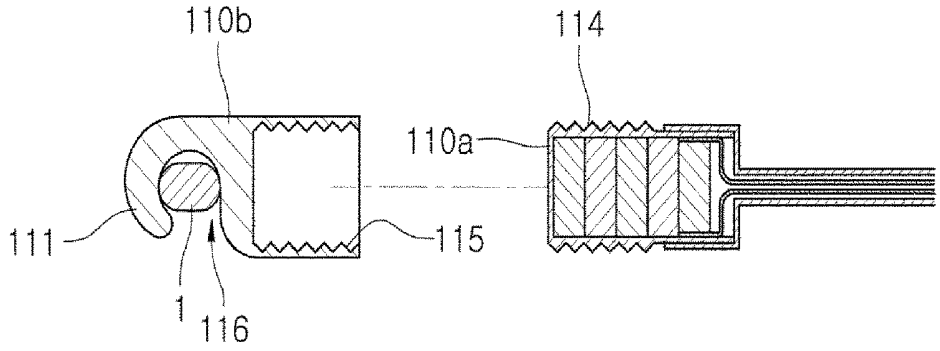
【Fig. 4】



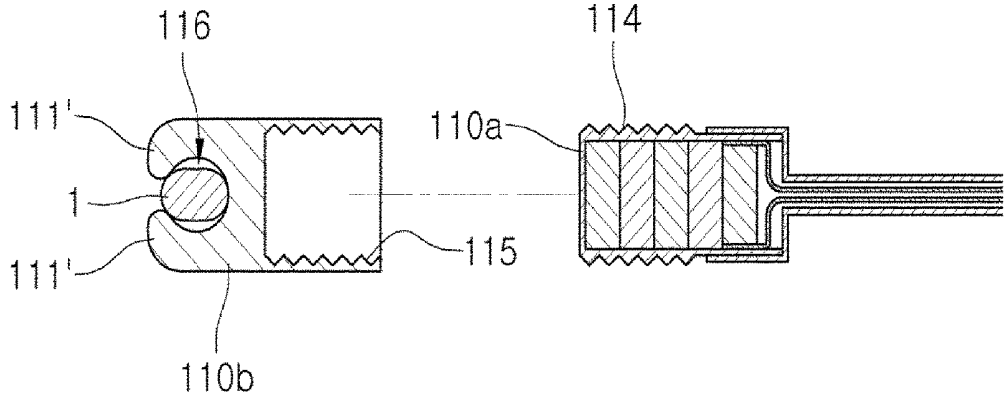
【Fig. 5】



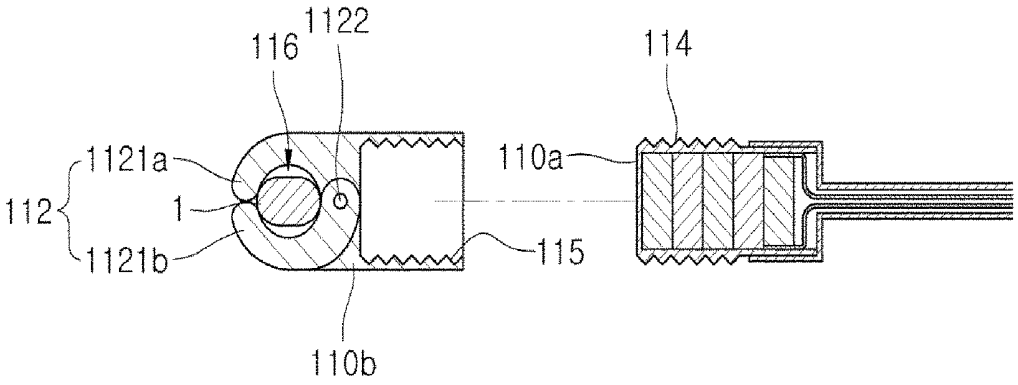
【Fig. 6】



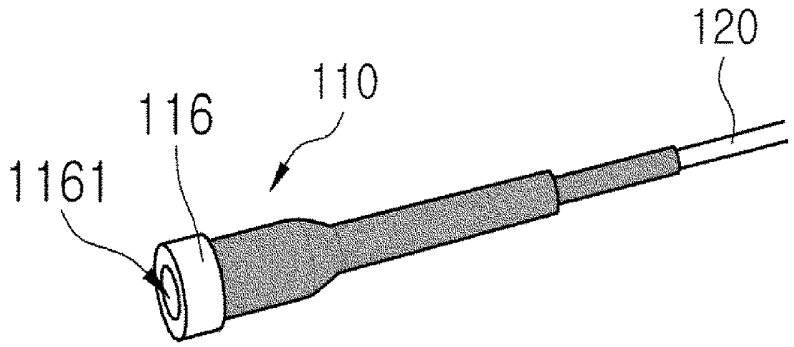
【Fig. 7】



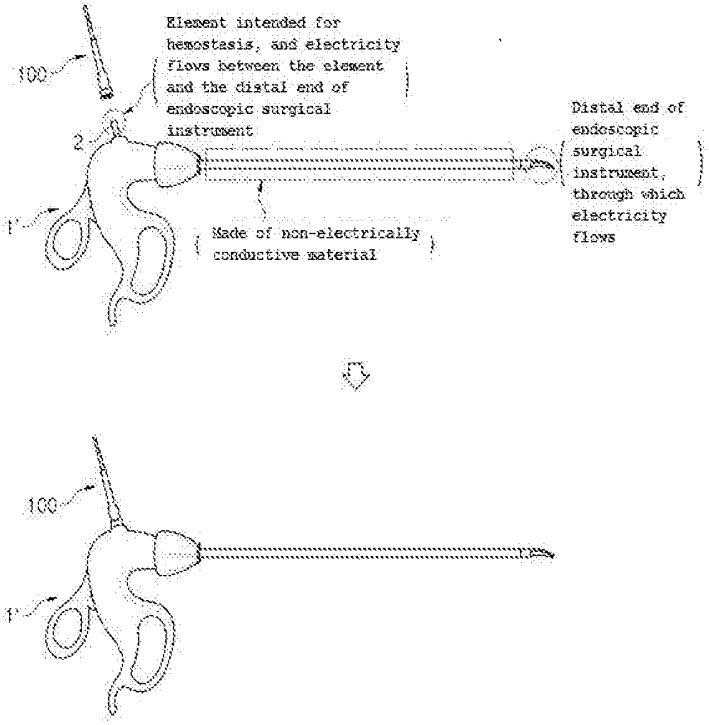
【Fig. 8】



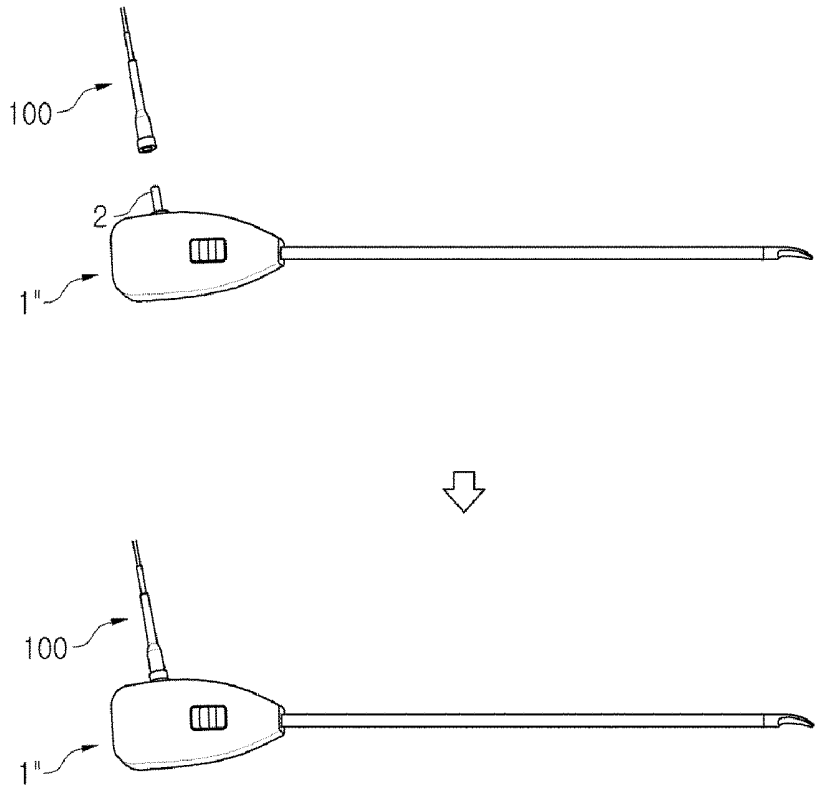
【Fig. 9】



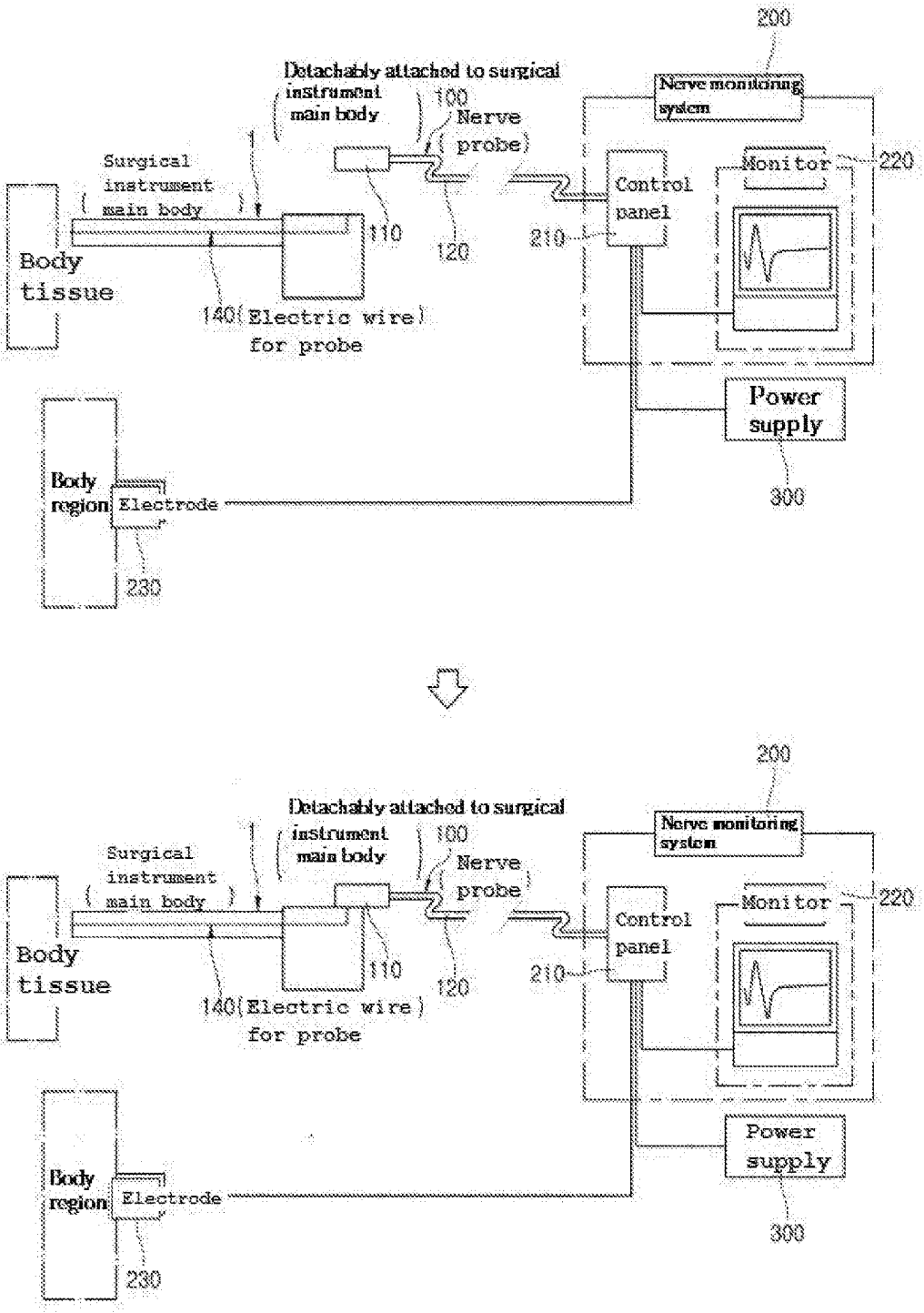
【Fig. 10】


Element intended for hemostasis, and electricity flows between the element and the distal end of endoscopic surgical instrument
Distal end of endoscopic surgical instrument, through which electricity flows
Made of non-electrically conductive material
100
2
1"
100
1"

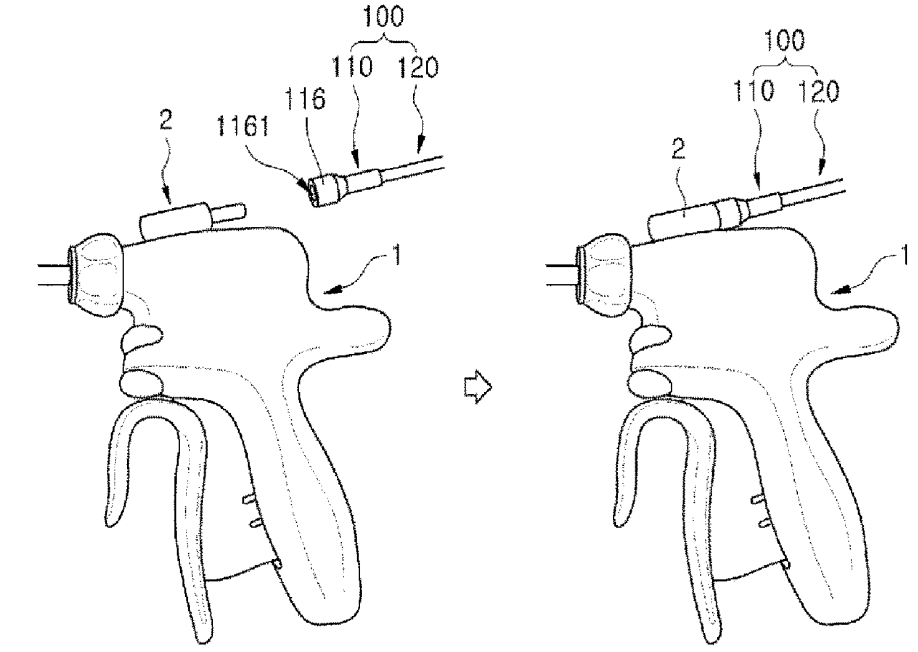
【Fig. 11】


100
2
1"
100
1"

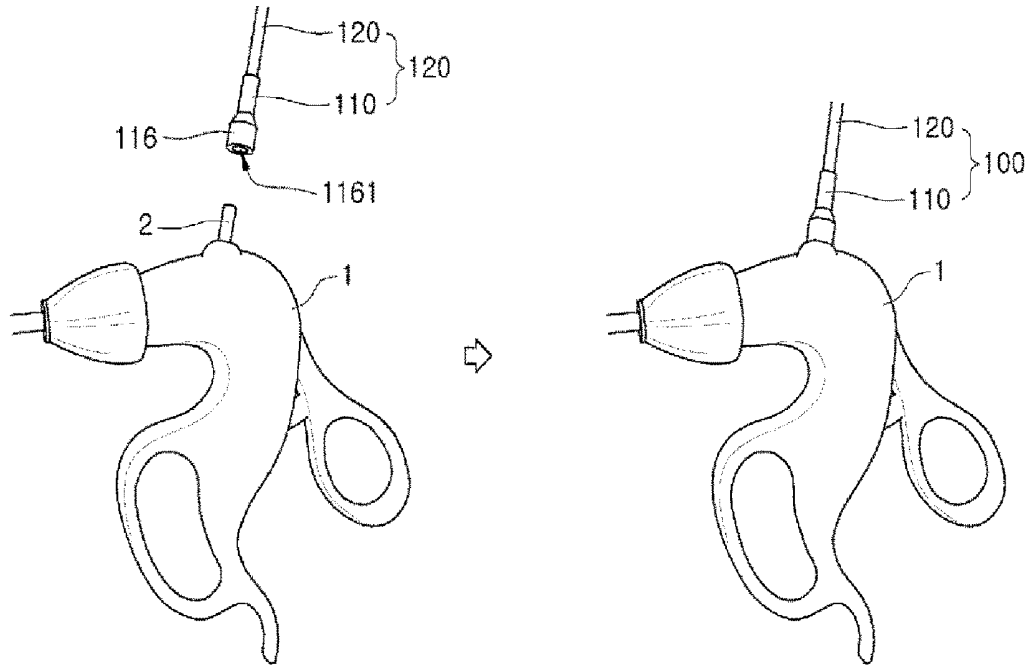
【Fig. 12】


200
Detachably attached to surgical instrument main body
100
Nerve probe
Nerve monitoring system
Surgical instrument main body
1
Monitor
220
Control panel
210
110
120
Body tissue
140(Electric wire) for probe
Power supply
300
Body region
Electrode
230

【Fig. 13】

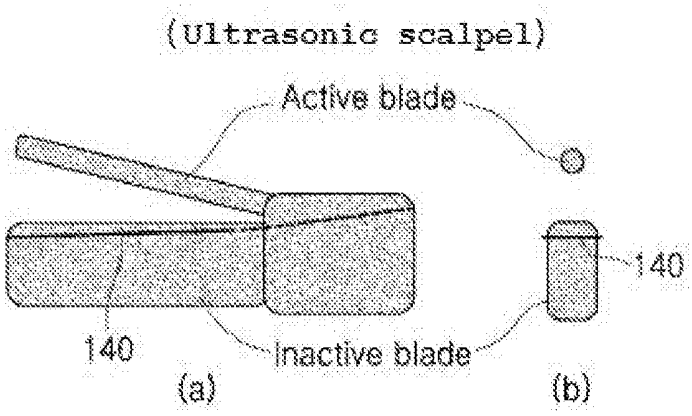

100
110
120
116
2
1161
1
100
110
120
2
1

(a)

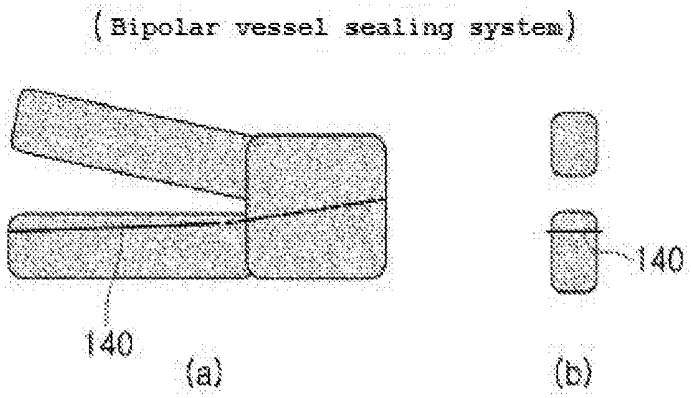

120
120
110
116
1161
2
1
120
100
110
1

(b)

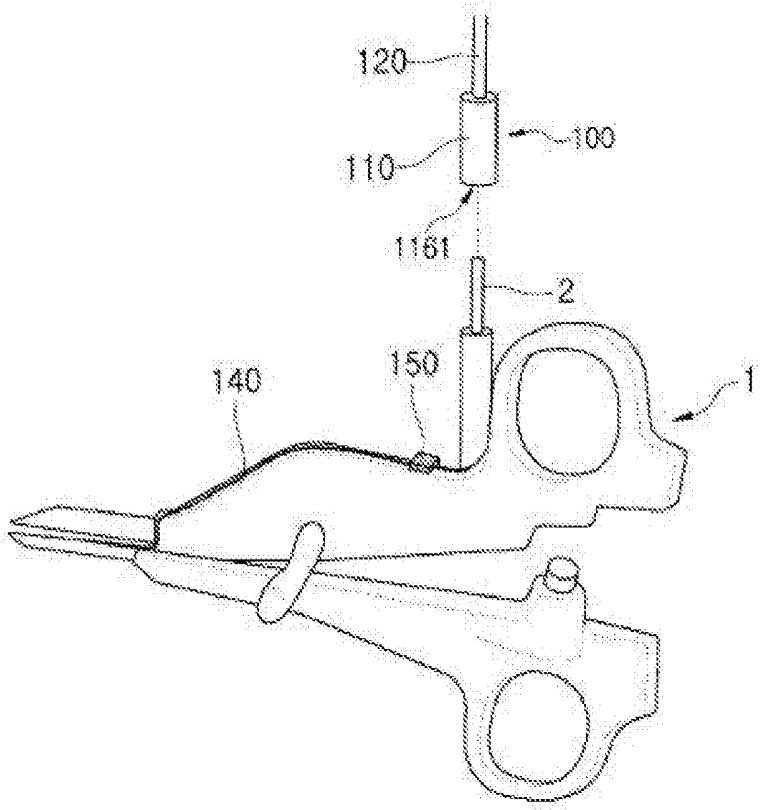
【Fig. 14】


(Ultrasonic scalpel)
Active blade
140
140
Inactive blade
(a)
(b)

【Fig. 15】


(Bipolar vessel sealing system)
140
140
(a)
(b)

【Fig. 16】



(Bipolar vessel sealing system)

NERVE PROBE ATTACHABLE/DETACHABLE TO/FROM SURGICAL INSTRUMENT, AND ENERGY DEVICE SURGICAL INSTRUMENT HAVING NERVE PROBE ATTACHED THERETO

TECHNICAL FIELD

[0001] The present invention relates to a nerve probe attachable and detachable to and from a surgical instrument in which it is detachably mounted to a surgical instrument (a general surgical instrument, an endoscopic surgical instrument, or a robotic surgical instrument) made of an electrically conductive material to allow an electric current to be applied to body tissue by the surgical instrument so that real-time nerve identification and surgery can be performed simultaneously at body tissue coming into close contact with the surgical instrument only by use of the surgical instrument even without suffering from inconvenience of having to frequently replace a separate nerve probe and the surgical instrument, leading to promotion of rapid surgery and improvement of convenience of medical staffs, in which the nerve probe can be used by being detachably attached to various forms of the surgical instruments in a simple and easy manner, leading to promotion of acquisition of universality and enhancement of utility, and in which a main body block includes a magnet body or a forceps/a hook/a fitting groove so as to be attached to a rear end of the surgical instrument so that the nerve probe can be used easily without twisting of the wire irrespective of the kind and position of and any changes in posture of the surgical instrument, thus leading to optimization of an environment of surgery that is performed simultaneously with nerve identification, and to a surgical energy device attached with a nerve probe in which an electric wire for probe formed extendedly at a distal end of the surgical instrument to which the nerve probe is detachably mounted so that real-time nerve identification and surgery can be performed simultaneously at body tissue coming into close contact with the surgical instrument only by use of the surgical instrument, leading to promotion of rapid surgery and improvement of convenience of medical staffs, and in which in particular, it is applied to an energy devices for surgical operations, which requires a special attention to be paid to nerve injury due to generation of heat so that nerve identification and early finding of nerve injury caused by heat can be performed in an accurate and smooth manner, leading to minimization of nerve injury during surgery.

BACKGROUND ART

[0002] Nerve injury occurring during a surgical operation is a critical complication in a variety of surgical operations such as otorhinolaryngological surgery, brain surgery, thoracic surgery, spinal surgery, orthopedic surgery, and the like. An intraoperative nerve monitoring system is used to prevent the nerve injury during a surgical operation. In this case, the nerve monitoring system which employs electroneuromyography evaluates the movement of relevant muscles using electromyogram by applying electrical stimulation to a site where a nerve is suspected of being located. To this end, the nerve monitoring system requires a nerve probe that can apply electrical stimulation separately from a surgical instrument.

[0003] Nerve injury may occur even though a surgical operation is performed using such a nerve monitoring system. One of causes of occurrence of nerve injury during the surgical operation is that a surgeon does not recognize a nerve located at an abnormal position as a normal nerve and cuts out the nerve. In other words, a conventional nerve monitoring system is a system which applies electrical stimulation to a site where a nerve is suspected of being located using a separate nerve probe to identify the nerve. Thus, in the case where nerve identification is not performed because a nerve is not suspected of being located at the site, a surgeon may cut out the nerve without recognizing it as a normal nerve. Therefore, the conventional nerve monitoring system has a limitation in that unpredicted nerve injury cannot be prevented.

[0004] In addition, a variety of kinds of surgical instruments are used in various steps of a surgical operation. By the way, the conventional nerve monitoring system entails a drawback in that a surgical instrument and a nerve probe are used separately from each other, and thus a user suffers from inconvenience of having to frequently replace the nerve probe in order to identify a relevant nerve during surgery.

[0005] In the meantime, an energy device for surgical operations has recently been developed and used as a surgical instrument for performing a rapid surgical operation while minimizing hemorrhage during surgery. Since such an energy device for surgical operations can perform hemostasis and detachment relatively rapidly compared to the conventional surgical instrument, it is widely used for purpose of reduction of surgery time and accurate hemostasis even in laparoscopic surgery, robotic surgery as well as general surgical operations. Examples of the energy device for surgical operations include an ultrasonic scalpel (representative product name: harmonic scalpel) using vibration of an ultrasonic wave of frequency 55,000 Hz, a bipolar vessel sealing system (representative product name: LigaSure) using a bipolar electric coagulator, and a thunderbeat having two functions, and the like.

[0006] However, a special attention must be paid to nerve injury in the use of the above-described energy device for surgical operations. Similarly to other surgical instruments, the energy device for surgical operations also has a structure in which it generates high heat at the periphery thereof along with the case where a surgeon causes an injury to nerves while cutting out body tissue, leading to the occurrence of nerve injury due to the high heat. It is reported that temporary nerve injury actually occurs frequently during the use of the energy device for surgical operations.

DISCLOSURE OF INVENTION

Technical Problem

[0007] Accordingly, the present invention has been made in order to solve the above-described problems occurring in the prior art, and it is an object of the present invention is to provide a novel type nerve probe attachable and detachable to and from a surgical instrument in which it includes a main body block and a connection cable, which are made of electrically conductive material based on a fact that many surgical instruments are made of metal and have an electrical conductivity, and by virtue of a structure in which the main body block includes a magnet body, a forceps or a hook so as to be detachably mounted to a general surgical instrument or includes a fitting groove formed therein so as to be

detachably mounted to a protruding pin formed at a handle portion of the endoscopic surgical instrument or the robotic surgical instrument, an electric current is applied to body tissue by the surgical instrument made of an electrically conductive material so that real-time nerve identification and surgery to be performed simultaneously at body tissue coming into close contact with the surgical instrument only by use of the surgical instrument even without suffering from inconvenience of having to frequently replace a separate nerve probe and the surgical instrument, leading to promotion of rapid surgery and improvement of convenience of medical staffs.

[0008] Another object of the present invention is to provide a novel type nerve probe attachable and detachable to and from a surgical instrument in which a main body block includes a magnet or a forceps/a hook/a fitting groove so as to be attached to a rear end of the surgical instrument based on a fact that many surgical instruments are made of metal and have a property of being attracted to the magnet, so that the nerve probe can be used by being detachably attached to various forms of the surgical instruments (a general surgical instrument, an endoscopic surgical instrument, and a robotic surgical instrument) in a simple and easy manner, leading to promotion of acquisition of universality and enhancement of utility, as well as the nerve probe can be used easily without twisting of the wire irrespective of the kind and position of and any changes in posture of the surgical instrument, thus leading to optimization of an environment of surgery that is performed simultaneously with nerve identification.

[0009] Still another object of the present invention is to provide a novel type surgical energy device attached with a nerve probe in which the nerve probe is detachably mounted to a surgical instrument, and an electric wire for probe attached integrally to the surgical instrument is formed extendedly at a distal end of the surgical instrument so as to be electrically connected to the nerve probe so that nerve identification is performed by a nerve monitoring system along with the application of the current to body tissue coming into close contact with the surgical instrument by the electric wire for probe, and thus real-time nerve identification and surgery can be performed simultaneously at body tissue coming into close contact with the surgical instrument only by use of the surgical instrument, leading to promotion of rapid surgery and improvement of convenience of medical staffs.

[0010] In particular, yet another object of the present invention is to provide a novel type surgical energy device attached with a nerve probe in which it is applied to an ultrasonic scalpel, a bipolar vessel sealing system, or a thunderbeat that is an energy devices for surgical operations, which requires a special attention to be paid to nerve injury due to generation of heat so that nerve identification and early finding of nerve injury caused by heat can be performed in an accurate and smooth manner, leading to minimization of nerve injury during surgery by an energy device for surgical operations.

Technical Solution

[0011] To achieve the above objects, in one aspect, the present invention provides a nerve probe **100** attachable and detachable to and from a surgical instrument, the nerve probe **100** including: a connection cable **120** connected to a power supply **300** and configured to transmit an electric current applied thereto from the power supply **300**; and a main body block **110** formed as a block body of a predetermined size at a distal end of the connection cable **120** so as to be detachably attached to a surgical instrument **1** made of an electrically conductive material, the main body block **110** being made of an electrically conductive material so as to receive the electric current from the connection cable **120** for application to the surgical instrument **1**, whereby the electric current is applied to body tissue with which the surgical instrument **1** comes into close contact during surgery through the connection cable **120**, the main body block **110**, and the surgical instrument **1**, and an electric signal generated from a muscle movement by the applied electric current is detected through a signal-detecting electrode **230** attached to a preset point of a body region and then is inputted to a nerve monitoring system **200** to allow a nerve to be identified by electromyogram analysis.

[0012] In another aspect, the present invention provides a surgical energy device attached with a nerve probe, the surgical energy device including: a surgical instrument **1** used in a surgical operation; a nerve probe **100** detachably mounted to a preset portion of the surgical instrument **1**; and an electric wire **140** for probe attached to the surgical instrument **1** so as to be electrically connected to the nerve probe **100**, and disposed at a distal end of the surgical instrument **1**, which comes into close contact with body tissue, to allow an electric current to be applied to body tissue, wherein the nerve probe **100** includes: a connection cable **120** configured to transmit the electric current applied thereto from the power supply **300**; a main body block **110** formed as a block body of a predetermined size at a distal end of the connection cable **120** so as to be detachably attached to the surgical instrument **1**, whereby the electric current transmitted from the power supply **300** through the connection cable **120** is applied to body tissue with which the surgical instrument **1** comes into close contact during surgery through the connection cable **120** of the nerve probe **100** and the electric wire **140** for probe of the surgical instrument **1**, and an electric signal generated from a muscle movement by the electric current applied to the body tissue is detected through a signal-detecting electrode **230** attached to a preset point of a body region and then is inputted to a nerve monitoring system **200** to allow a nerve to be identified by electromyogram analysis.

Advantageous Effects

[0013] The nerve probe attachable and detachable to and from a surgical instrument according to the present invention has an effect in that real-time nerve identification and surgery to be performed simultaneously at body tissue coming into close contact with the surgical instrument only by use of the surgical instrument even without suffering from inconvenience of having to frequently replace a separate nerve probe and the surgical instrument, leading to promotion of rapid surgery and improvement of convenience of medical staffs. In addition, the nerve probe attachable and detachable to and from a surgical instrument according to the present invention has an effect in that the main body block includes the magnet body or the forceps/hook/the fitting groove so as to be attached to the rear end of the surgical instrument so that the nerve probe can be used easily without twisting of the wire irrespective of the kind and position of and any changes in posture of the surgical

instrument, thus leading to optimization of an environment of surgery that is performed simultaneously with nerve identification.

[0014] Further, the nerve probe attachable and detachable to and from a surgical instrument according to the present invention has an effect in that an electric wire for probe formed extendedly at a distal end of the surgical instrument to which the nerve probe is detachably mounted so that real-time nerve identification and surgery can be performed simultaneously at body tissue coming into close contact with the surgical instrument only by use of the surgical instrument, leading to promotion of rapid surgery and improvement of convenience of medical staffs.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] The above and other objects, features and advantages of the present invention will be apparent from the following detailed description of the preferred embodiments of the invention in conjunction with the accompanying drawings, in which:

[0016] FIG. **1** is a diagrammatic view illustrating a conventional nerve probe provided and used separately from surgical instruments;

[0017] FIG. **2** is a diagrammatic view illustrating a configuration in which a nerve probe attachable and detachable to and from a surgical instrument according to an embodiment of the present invention is connected to a surgical instrument and a nerve monitoring system;

[0018] FIG. **3** is a cross-sectional view illustrating a nerve probe attachable and detachable to and from a surgical instrument according to an embodiment of the present invention, which includes a magnet body.

[0019] FIGS. **4** to **8** are views illustrating various modifications of a main body block constituting a nerve probe attachable and detachable to and from a surgical instrument according to an embodiment of the present invention;

[0020] FIG. **9** is a diagrammatic view illustrating a nerve probe attachable and detachable to and from a surgical instrument according to another embodiment of the present invention; diagrammatic view illustrating

[0021] FIG. **10** is a diagrammatic view illustrating a configuration in which a nerve probe attachable and detachable to and from a surgical instrument according to another embodiment of the present invention is attached to an endoscopic surgical instrument;

[0022] FIG. **11** is a diagrammatic view illustrating a configuration in which a nerve probe attachable and detachable to and from a surgical instrument according to another embodiment of the present invention is attached to a robotic surgical instrument;

[0023] FIG. **12** is a block diagram illustrating a configuration of a surgical energy device attached with a nerve probe according to an embodiment of the present invention;

[0024] FIG. **13** is a diagrammatic view illustrating a connection configuration between a surgical instrument and a nerve probe according to an embodiment of the present invention;

[0025] FIG. **14** is a diagrammatic view illustrating an arrangement configuration of an electric wire for probe in an ultrasonic scalpel to which a surgical energy device attached with a nerve probe according to an embodiment of the present invention is applied;

[0026] FIG. **15** is a diagrammatic view illustrating an arrangement configuration of an electric wire for probe in an bipolar vessel sealing system to which a surgical energy device attached with a nerve probe according to an embodiment of the present invention is applied; and

[0027] FIG. **16** is a diagrammatic view illustrating a circuit breaker provided at a bipolar vessel sealing system to which a surgical energy device attached with a nerve probe according to an embodiment of the present invention is applied.

BEST MODE FOR CARRYING OUT THE INVENTION

[0028] A nerve probe **100** attachable and detachable to and from a surgical instrument according to an embodiment of the present invention includes: a connection cable **120** connected to a power supply **300** and configured to transmit an electric current applied thereto from the power supply **300**; and a main body block **110** formed as a block body of a predetermined size at a distal end of the connection cable **120** so as to be detachably attached to a surgical instrument **1** made of an electrically conductive material, the main body block **110** being made of an electrically conductive material so as to receive the electric current from the connection cable **120** for application to the surgical instrument **1**, whereby the electric current is applied to body tissue with which the surgical instrument **1** comes into close contact during surgery through the connection cable **120**, the main body block **110**, and the surgical instrument **1**, and an electric signal generated from a muscle movement by the applied electric current is detected through a signal-detecting electrode **230** attached to a preset point of a body region and then is inputted to a nerve monitoring system **200** to allow a nerve to be identified by electromyogram analysis.

[0029] Herein, the main body block **110** may include a magnet body **130** so as to be detachably attached to the surgical instrument **1**. In addition, the main body block **110** may include a forceps **112** consisting of a pair of clampers **1121***a* and **1121***b* so as to be detachably attached to the surgical instrument **1**, and may include a claw-shaped hook **111** so as to be detachably attached to the surgical instrument **1**. Alternatively, the main body block **110** may include a surgical instrument-connecting terminal **116** formed at a front end thereof, and the surgical instrument-connecting terminal **116** has a fitting groove **1161** formed therein so that the surgical instrument-connecting terminal **116** is detachably attached to a protruding pin **2** formed at a preset point of a rear end of each of an endoscopic surgical instrument **1'** and a robotic surgical instrument **1"**.

[0030] In addition, the connection cable **120** includes: a conducting wire **121** along which an electric current is transmitted; and a cladding **122** configured to encircle the conducting wire **121** to insulate the conducting wire **121** from the outside, and arranged in expanded tubular form at a distal end thereof. The main body block **110** includes a main body **110***a* that is opened at a rear end thereof so that the opened rear end of the main body **110***a* constituting the main body block **110** can be inserted into the expanded distal end of the cladding **122** constituting the connection cable **120** to allow the conducting wire **121** and the main body **110***a* to be electrically connected to each other.

[0031] In addition, the main body block **110** includes: a cylindrical main body **110***a* made of an electrically conductive material, having a male thread machined face **114** formed on an outer circumferential surface thereof, and connected to the connection cable **120**; and an auxiliary cap

110*b* made of an electrically conductive material, having a female thread machined face **115** formed on an inner circumferential surface of a rear end thereof so as to be coupled with the main body **110***a*, and including any one of a forceps **112** consisting of a pair of clampers **1121***a* and **1121***b* and a claw-shaped hook **111**, which is formed at a front end thereof, so as to be retainingly secured to the surgical instrument **1**. The forceps **112** that can be formed at the auxiliary cap **110***b* consists of a pair of hooked clampers which are pin-engaged with each other, and elasticity can be imparted in a direction in which the clampers **1121***a* and **1121***b* are engaged with each other by means of a torsion spring arranged at a pin-engagement portion of the forceps.

[0032] A surgical energy device attached with a nerve probe according to an embodiment of the present invention includes: a surgical instrument **1** used in a surgical operation; a nerve probe **100** detachably mounted to a preset portion of the surgical instrument **1**; and an electric wire **140** for probe attached to the surgical instrument **1** so as to be electrically connected to the nerve probe **100**, and disposed at a distal end of the surgical instrument **1**, which comes into close contact with body tissue, to allow an electric current to be applied to body tissue, wherein the nerve probe **100** includes: a connection cable **120** configured to transmit the electric current applied thereto from the power supply **300**; a main body block **110** formed as a block body of a predetermined size at a distal end of the connection cable **120** so as to be detachably attached to the surgical instrument **1**, whereby the electric current transmitted from the power supply **300** through the connection cable **120** is applied to body tissue with which the surgical instrument **1** comes into close contact during surgery through the connection cable **120** of the nerve probe **100** and the electric wire **140** for probe of the surgical instrument **1**, and an electric signal generated from a muscle movement by the electric current applied to the body tissue is detected through a signal-detecting electrode **230** attached to a preset point of a body region and then is inputted to a nerve monitoring system **200** to allow a nerve to be identified by electromyogram analysis.

[0033] The surgical instrument **1** may be an energy device for surgical operations, which generates heat to perform hemostasis. In particular, the surgical instrument **1** may be any one selected from the group consisting of an ultrasonic scalpel using ultrasonic energy, a bipolar vessel sealing system using bipolar high frequency energy, and a thunderbeat that is a dual energy device using both ultrasonic energy and bipolar high frequency energy. In addition, the surgical instrument **1** may be any one of an endoscopic surgical instrument and a robotic surgical instrument.

[0034] In the meantime, the surgical instrument **1** includes a protruding pin **2** formed protrudingly at a preset point of a rear end thereof, and the nerve probe **100** includes a surgical instrument-connecting terminal **116** formed at a front end thereof, the surgical instrument-connecting terminal **116** having a fitting groove **1161** formed therein so that the nerve probe **100** can be detachably mounted to the surgical instrument **1**.

[0035] Further, the electric wire **140** for probe may be attached to a blade formed at a front end of the surgical instrument **1** so as to surround left and right lateral sides and a front side of the blade. Alternatively, the electric wire **140** for probe may be attached to at least one of a top side and a bottom side of the blade formed at the front end of the surgical instrument **1**.

[0036] In the surgical energy device attached with a nerve probe according to an embodiment of the present invention, the electric wire **140** for probe is installed at a blade made of an electrically conductive material and configured to be applied with the electric current, and the surgical energy device may further include a circuit breaker **150** fixedly mounted at a preset point of the surgical instrument **1** so as to be electrically connected to the nerve probe **100** and the electric wire **140** for probe and configured to interrupt the electrical connection between nerve probe **100** and the electric wire **140** for probe upon the application of the electric current to the blade to prevent reverse flow of the current.

BEST MODE

[0037] Hereinafter, preferred embodiments of the present invention will be described in further detail with reference to FIGS. **1** to **16** in the accompanying drawings. In the meantime, in the detailed description and the accompanying drawings, illustration and explanation on the construction and operation which a person skilled in the art can easily understand from a general surgical instrument, a general surgical instrument, endoscope, a robotic surgery, an endoscopic surgical instrument, a robotic surgical instrument, a nerve probe, an electric wire, a nerve monitoring system, a torsion spring, an energy device for surgical operations, an ultrasonic scalpel, a bipolar vessel sealing system, a thunderbeat, and the like will be briefly made or will be omitted to avoid redundancy. In particular, in the detailed description and the accompanying drawings, illustration and explanation on the detailed technical construction and operation of elements, which have no direct connection with the technical features of the present invention, will be omitted, and only the technical constructions directly related with the present invention will be briefly illustrated and explained.

[0038] The nerve probe **100** attachable and detachable to and from a surgical instrument according to an embodiment of the present invention includes a connection cable **120** and a main body block **110**. As shown in FIG. **1**, the electric current is applied to body tissue with which the surgical instrument **1** comes into close contact during surgery through the connection cable **120** connected to a control panel **210** to which a power supply **300** is connected so as to be supplied with electric power, the main body block **110**, and the surgical instrument **1**, and an electric signal generated from a muscle movement by the applied electric current is detected through a signal-detecting electrode **230** attached to a preset point of a body region and then is inputted to a nerve monitoring system **200** to allow a nerve to be identified by electromyogram analysis.

[0039] The connection cable **120** is connected to the power supply **300** and transmits an electric current applied thereto from the power supply **300** to the main body block **110**.

[0040] The main body block **110** is formed as a block body of a predetermined size at a distal end of the connection cable **120** so as to be detachably attached to the surgical instrument **1** made of an electrically conductive material. The main body block **110** is made of an electrically conductive material so as to receive the electric current from the connection cable **120** for application to the surgical instru-

ment **1**. Herein, the main body block **110** can include a magnet body **13** so as to be detachably attached to the surgical instrument **1** as shown in FIGS. **2**(*a*) and **3**. To this end, the main body block **110** has an electric conductivity similar to that of an electric wire and can be formed as a cylindrical body made of an iron material that is easily attracted to a magnet

[0041] The magnet body **130** can be disposed within the main body block **110**. In particular, the main body block **110** according to an embodiment of the present invention includes a plurality of magnets arranged therein so as to be connected in series to each other to increase the magnitude of a magnetic force and allow a magnetic force of more than a certain magnitude to be uniformly exerted in multiple directions. By virtue of this, an attachment force of the main body block **110** to the surgical instrument **1** can be enhanced.

[0042] Alternatively, the main body block **110** may include a claw-shaped hook **111** so as to be detachably attached to the surgical instrument **1** as shown in FIG. **2**(*b*), and may include a forceps **112** consisting of a pair of clampers **1121***a* and **1121***b* so as to be detachably attached to the surgical instrument **1** as shown in FIG. **2**(*c*).

[0043] In the meantime, the connection cable **120** according to an embodiment of the present invention includes a conducting wire **121** and a cladding **122** as shown in FIG. **3**.

[0044] The conducting wire **121** allows an electric current to flow therealong, and the cladding **122** encircle the conducting wire **121** to insulate the conducting wire **121** from the outside. Herein, the cladding **122** is arranged in expanded tubular form at a distal end thereof so that the main body block **110** can be inserted into the expanded distal end of the cladding **122**.

[0045] The main body block **110** according to an embodiment of the present invention includes a main body **110***a* that is opened at a rear end thereof so that the opened rear end of the main body **110***a* constituting the main body block **110** can be inserted into the expanded distal end of the cladding **122** constituting the connection cable **120** to allow the conducting wire **121** and the main body **110***a* to be electrically connected to each other.

[0046] The nerve probe **100** attachable and detachable to and from a surgical instrument according to an embodiment of the present invention is used to be detachably attached to various kinds and sizes of surgical instrument **1**.

[0047] In the meantime, the nerve probe **100** attachable and detachable to and from a surgical instrument according to an embodiment of the present invention may include a main body block **110** of a structure in which the detachable fixation of the nerve probe **100** to the surgical instrument **1** is performed in a stable and smooth manner as show in FIGS. **4** to **8**.

[0048] In other words, the main body block **110** includes a surgical instrument fitting groove **113** recessedly formed at a front end thereof to allow the surgical instrument **1** to be securely fitted into the surgical instrument fitting groove **113** of the main body block **110** as shown in FIG. **4** so that the engagement between the surgical instrument **1** and the nerve probe **100** can be held firmly and stably. As shown in FIG. **4**, the main body block **110** includes a magnet body **130** disposed therein.

[0049] In addition, the main body block **110** includes a main body (**110***a*) 와 auxiliary cap **110***b*, which are made of an electrically conductive material as shown in FIGS. **5** to **8**.

[0050] The main body **110***a* is formed in a cylindrical shape, and has a male thread machined face **114** formed on an outer circumferential surface thereof, and is connected to the connection cable **120**.

[0051] The auxiliary cap **110***b* has a female thread machined face **115** formed on an inner circumferential surface of a rear end thereof so as to be coupled with the main body **110***a* and retainingly secured to the surgical instrument **1**. In order for the auxiliary cap **110***b* to be retainingly secured to the surgical instrument **1**, the auxiliary cap **110***b* can include a surgical instrument fitting groove **113** formed at a front end thereof as shown in FIG. **5**, a claw-shaped hook **111** formed at the front end thereof to have a surgical instrument fitting groove **116** formed therein as shown in FIG. **5**, a pair of hook-shaped protrusions **111'** formed at the front end thereof to have a surgical instrument fitting groove **116** defined therebetween as shown in FIG. **7**, and a forceps **112** consisting of a pair of clampers **1121***a* and **1121***b* formed at the front end thereof to have a surgical instrument fitting groove **116** defined therebetween as shown in FIG. **8**. The auxiliary caps **110***b* show in FIGS. **5** to **8** may constitute a single set. As such, among various kinds of auxiliary caps **110***b* constituting the single set, an optimal auxiliary cap **110***b* conforming to the kind and size of the surgical instrument **1** can be selected and used. The main body **110***a* and the auxiliary cap **110***b* of the main body block **110** are configured so as to be detachably coupled to each other by means of a bolt-nut coupling structure, and thus various kinds of auxiliary caps **110***b* can be selectively mounted to the main body **110***a*.

[0052] Herein, the forceps **112** that can be formed at the auxiliary cap **110***b* consists of a pair of hooked clampers **1121***a* and **1121***b* which are pin-engaged with each other as shown in FIG. **8**, and elasticity can be imparted in a direction in which the clampers **1121***a* and **1121***b* are engaged with each other by means of a torsion spring (not shown) arranged at a pin-engagement portion of the forceps. By virtue of this configuration, the nerve probe **100** of the present invention can be firmly secured to the surgical instrument **1**.

[0053] The nerve probe **100** attachable and detachable to and from a surgical instrument according to an embodiment of the present invention as constructed above includes the main body block **110** and the connection cable **120**.

[0054] By virtue of a structure in which the main body block **110** includes the magnet body **130**, the forceps **112** or the hook **111** so as to be detachably mounted to the surgical instrument **1**, an electric current is applied to body tissue by the surgical instrument made of an electrically conductive material so that nerve identification can be performed in real-time at body tissue coming into close contact with the surgical instrument only by use of the surgical instrument even without suffering from inconvenience of having to frequently replace a separate nerve probe and the surgical instrument. The use of nerve probe **100** attachable and detachable to and from a surgical instrument according to an embodiment of the present invention enables real-time nerve identification and surgery to be performed simultaneously, leading to promotion of rapid surgery and improvement of convenience of medical staffs.

[0055] In addition, in the nerve probe **100** attachable and detachable to and from a surgical instrument according to an embodiment of the present invention, the main body block **110** including the magnet body **130**, the forceps **112**, or the

hook **111** is attached to the rear end of the surgical instrument **1**, and thus the nerve probe **100** can be used by being detachably attached to various forms of the surgical instruments **1** in a simple and easy manner, leading to promotion of acquisition of universality and enhancement of utility, and the nerve probe can be used easily without twisting of the wire irrespective of the kind and position of and any changes in posture of the surgical instrument, thus leading to optimization of an environment of surgery that is performed simultaneously with nerve identification.

[0056] In the meantime, the nerve probe **100** attachable and detachable to and from a surgical instrument according to another embodiment of the present invention as shown in FIGS. **9** to **11** can be applied to a endoscopic surgical instrument **1'** and a robotic surgical instrument **1"**.

[0057] The endoscopic surgical instrument **1'** or the robotic surgical instrument **1"** allows a surgery to be performed through a small body cavity, and is made of a non-electrically conductive material. For this reason, it is impossible that the nerve probe **100** attachable and detachable to and from a surgical instrument according to an embodiment of the present invention including the magnet body or the hook/forceps is attached to the surface of the endoscopic surgical instrument **1'** or the robotic surgical instrument **1"** to cause electricity to flow therethrough. In the meantime, the endoscopic surgical instrument **1'** or the robotic surgical instrument **1"** is a device that allows a surgery to be performed through a small body cavity, and thus when hemorrhage occurs during surgery, a surgeon's hands do not reach a relevant surgical site. Thus, the protruding pin **2** for electrocautery is formed at the rear end of the endoscopic surgical instrument **1'** or the robotic surgical instrument **1"** so as to perform hemostasis. Other portions of the endoscopic surgical instrument **1'** or the robotic surgical instrument **1"** does not permit the flow of electricity, but the distal end portion of the endoscopic surgical instrument **1'** or the robotic surgical instrument **1"** and the protruding pin **2** attached with the electrocautery unit permit the flow of electricity. Therefore, the main body block **110** of the nerve probe **100** attachable and detachable to and from a surgical instrument according to another embodiment of the present invention includes a surgical instrument-connecting terminal **116** formed at the front end thereof and having a fitting groove **1161** formed therein as shown in FIG. **9** so that the nerve probe **100** can be detachably attached to the protruding pin **2** formed at a preset point of the rear end of the endoscopic surgical instrument **1'** or the robotic surgical instrument **1"** as shown in FIGS. **10** and **11**.

[0058] Herein, the surgical instrument-connecting terminal **116** is made of an electrically conductive material and the outer surface of the main body block **110** can be coated with a non-electrically conductive material.

[0059] By virtue of this configuration, the presence and absence of a nerve can be identified by electromyogram through nerve stimulation according to the application of the current even during the use of the endoscopic surgical instrument **1'** or the robotic surgical instrument **1"**.

[0060] In the nerve probe **100** attachable and detachable to and from a surgical instrument according to another embodiment of the present invention as constructed above, by virtue of a structure in which the main body block **110** includes the fitting groove **1161** formed therein so as to be detachably mounted to the endoscopic surgical instrument **1'** or the robotic surgical instrument **1"**, an electric current is applied to body tissue by the endoscopic surgical instrument **1'** or the robotic surgical instrument **1"** so that nerve identification can be performed in real-time at body tissue coming into close contact with the endoscopic surgical instrument **1'** or the robotic surgical instrument **1"** only by use of the endoscopic surgical instrument **1'** or the robotic surgical instrument **1"** even without suffering from inconvenience of having to frequently replace a separate nerve probe and the surgical instrument. The use of nerve probe **100** attachable and detachable to and from a surgical instrument according to another embodiment of the present invention enables real-time nerve identification and surgery to be performed simultaneously, leading to promotion of rapid surgery and improvement of convenience of medical staffs.

[0061] Further, In the nerve probe **100** attachable and detachable to and from a surgical instrument according to another embodiment of the present invention as constructed above, the main body block **110** including the fitting groove **116** is attached to the protruding pin **2** formed the rear end of the endoscopic surgical instrument **1'** or the robotic surgical instrument **1"** so that the nerve probe **100** can be used by being detachably attached to the endoscopic surgical instrument **1'** or the robotic surgical instrument **1"** in a simple and easy manner, leading to promotion of acquisition of universality and enhancement of utility, and the nerve probe can be used easily without twisting of the wire irrespective of the kind and position of and any changes in posture of the endoscopic surgical instrument **1'** or the robotic surgical instrument **1"**, thus leading to optimization of an environment of surgery that is performed simultaneously with nerve identification.

[0062] In the meantime, the surgical energy device **100** attached with a nerve probe according to an embodiment of the present invention includes a surgical instrument **1**, a nerve probe **100**, electric wire **140** for probe as shown in FIG. **6**. The electric current transmitted from the power supply **300** through the connection cable **120** is applied to body tissue with which the surgical instrument **1** comes into close contact during surgery through the connection cable **120** of the nerve probe **100** and the electric wire **140** for probe of the surgical instrument **1**, and an electric signal generated from a muscle movement by the electric current applied to the body tissue is detected through a signal-detecting electrode **230** attached to a preset point of a body region and then is inputted to a nerve monitoring system **200** to allow a nerve to be identified by electromyogram analysis. Herein, the electric signal refers to an electric signal transmitted from body tissue which comes into close contact with the surgical instrument **1** and the electric wire **140** for probe.

[0063] The surgical instrument **1** is an medical instrument used by medical staffs during surgical operations. The electric wire **140** for probe is attached integrally to the surgical instrument **1** and the nerve probe **100** is detachably mounted to the surgical instrument **1**. In particular, an energy device for surgical operations, which generates heat to perform hemostasis, is used as the surgical instrument **1** according to an embodiment of the present invention. Of course, the surgical instrument **1** is not limited thereto.

[0064] As the energy device for surgical operations for implementing the surgical instrument **1**, an ultrasonic scalpel using ultrasonic energy, a bipolar vessel sealing system using bipolar high frequency energy, and a thunderbeat that is a dual energy device using both ultrasonic energy and

bipolar high frequency energy can be used. In addition, the energy device for surgical operations for implementing the surgical instrument **1** may be either an endoscopic surgical instrument or a robotic surgical instrument.

[0065] Herein, the surgical instrument **1** according to an embodiment of the present invention includes a protruding pin **2** formed protrudingly at a preset point of a rear end thereof. In the case where the surgical instrument **1** is an endoscopic surgical instrument or a robotic surgical instrument, the protruding pin **2** is attached with an electrocautery unit. In the surgical instrument **1** according to an embodiment of the present invention, the nerve probe **100** is mounted to the protruding pin **2**.

[0066] The nerve probe **100** is detachably mounted to a preset portion of the surgical instrument **1**. The nerve probe **100** according to an embodiment of the present invention includes a surgical instrument-connecting terminal **116** formed at a front end thereof, the surgical instrument-connecting terminal **116** having a fitting groove **1161** formed therein so that the nerve probe **100** is detachably mounted to the surgical instrument **1**. In addition, the nerve probe **100** according to an embodiment of the present invention includes a connection cable **120** and a main body block **110**.

[0067] The connection cable **120** transmits an electric current applied thereto from the power supply **300**.

[0068] The main body block **110** is formed as a block body of a predetermined size at a distal end of the connection cable **120** so as to be detachably attached to the surgical instrument **1**. The surgical instrument-connecting terminal **116** having a fitting groove **1161** formed therein is formed at a front end of the main body block **110**.

[0069] The electric wire **140** for probe is attached integrally to the surgical instrument **1** and is electrically connected to the nerve probe **100**. Herein, the electric wire **140** for probe may be formed exposedly on an outer surface of the surgical instrument **1**, and may be arranged insertedly within the surgical instrument **1**. The exposed formation or the inserted arrangement of the electric wire **40** is determined depending on the shape and structure of the surgical instrument **1**.

[0070] The electric wire **140** for probe is disposed at a distal end of the surgical instrument **1**, which comes into close contact with body tissue, to allow the electric current to be applied to body tissue. The electric wire **140** for probe preferably is attached to a blade formed at a front end of the surgical instrument **1** so as to surround left and right lateral sides and a front side of the blade. Alternatively, the electric wire **140** for probe may be attached to at least one of a top side and a bottom side of the blade formed at the front end of the surgical instrument **1**.

[0071] Herein, the ultrasonic scalpel for implementing the surgical instrument **1** includes an upper blade acting as an "active blade" that is vibrated by an ultrasonic wave of frequency 55,000 Hz to generate heat, and a lower blade acting as an "inactive blade" that is inactivated to function to protect body tissue. As shown in FIG. **14**, the electric wire **140** for probe of the surgical instrument **1** implemented as the ultrasonic scalpel is attached to the lower blade so as to surround left and right lateral sides and a front side of the lower blade as the "inactive blade". Specifically, the electric wire **140** for probe is preferably attached to the lower blade so as to be positioned at an adjacent position within a spaced height ranging from 0.1 to 10 mm from a contact face where the upper and lower blades are in close contact with each other. Of course, the attachment position of the electric wire **140** for probe is not limited thereto.

[0072] Moreover, the bipolar vessel sealing system for implementing the surgical instrument **1** is a medical instrument that cuts out a blood vessel while performing hemostasis of the blood vessel by bipolar electrocautery. Thus, electricity flows through the upper and lower blades. As shown in FIG. **15**, the electric wire **140** for probe of the surgical instrument **1** implemented as the bipolar vessel sealing system is preferably attached to the lower blade so as to be positioned at an adjacent position within a spaced height ranging from 0.1 to 10 mm from a contact face where the upper and lower blades are in close contact with each other. Of course, the attachment position of the electric wire **140** for probe is not limited thereto.

[0073] As in the bipolar vessel sealing system, in the case where the electric wire **140** for probe is installed at the blade made of an electrically conductive material so as to be applied with the electric current, when the electric current is applied to the surgical instrument **1** in order for the surgical instrument **1** to perform its own intrinsic function, the current applied to the blade may reversely flow through the electric wire **140** for probe. In order to prevent this reverse flow of the current, a circuit breaker **150** can be installed at the surgical instrument **1** as shown in FIG. **16**. The circuit breaker **150** is fixedly mounted at a preset point of the surgical instrument **1** so as to be electrically connected to the nerve probe **100** and the electric wire **140** for probe, and interrupts the electrical connection between nerve probe **100** and the electric wire **140** for probe upon the application of the electric current to the blade to prevent reverse flow of the current.

[0074] In the surgical energy device attached with a nerve probe according to an embodiment of the present invention as constructed above, the nerve probe **100** is detachably mounted to a surgical instrument **1**, and an electric wire **140** for probe attached integrally to the surgical instrument **1** is formed extendedly at a distal end of the surgical instrument **1** so as to be electrically connected to the nerve probe **100** so that real-time nerve identification is performed by a nerve monitoring system **200** along with the application of the current to body tissue coming into close contact with the surgical instrument **1** by the electric wire for probe, and thus nerve identification and surgery can be performed simultaneously at body tissue coming into close contact with the surgical instrument only by use of the surgical instrument, leading to promotion of rapid surgery and improvement of convenience of medical staffs. In particular, the surgical energy device **1** attached with a nerve probe according to an embodiment of the present invention is applied to an ultrasonic scalpel, a bipolar vessel sealing system, or a thunderbeat that is an energy devices for surgical operations, which requires a special attention to be paid to nerve injury due to generation of heat so that nerve identification and early finding of nerve injury caused by heat can be performed in an accurate and smooth manner, leading to minimization of nerve injury during surgery by an energy device for surgical operations.

[0075] While the nerve probe attachable and detachable to and from a surgical instrument and the surgical energy device attached with a nerve probe according to the preferred embodiments of the present invention has been described and illustrated in connection with specific exemplary embodiments with reference to the accompanying

drawings, it will be readily appreciated by those skilled in the art that it is merely illustrative of the preferred embodiments of the present invention and various modifications and changes can be made thereto within the technical spirit and scope of the present invention.

INDUSTRIAL APPLICABILITY

[0076] The nerve probe attachable and detachable to and from a surgical instrument according to the present invention can be used by being detachably attached to various forms of the surgical instruments (a general surgical instrument, an endoscopic surgical instrument, and a robotic surgical instrument) in a simple and easy manner, leading to promotion of acquisition of universality and enhancement of utility. In addition, the surgical energy device attached with a nerve probe according to the present invention is effectively applied to the energy devices for surgical operations, which requires a special attention to be paid to nerve injury due to generation of heat so that nerve identification and early finding of nerve injury caused by heat can be performed in an accurate and smooth manner, leading to stability of the energy device for surgical operations and enhancement of utility.

1. A nerve probe attachable and detachable to and from a surgical instrument, comprising:

a connection cable **120** connected to a power supply **300** and configured to transmit an electric current applied thereto from the power supply **300**; and

a main body block **110** formed as a block body of a predetermined size at a distal end of the connection cable **120** so as to be detachably attached to a surgical instrument **1** made of an electrically conductive material, the main body block **110** being made of an electrically conductive material so as to receive the electric current from the connection cable **120** for application to the surgical instrument **1**,

whereby the electric current is applied to body tissue with which the surgical instrument **1** comes into close contact during surgery through the connection cable **120**, the main body block **110**, and the surgical instrument **1**, and an electric signal generated from a muscle movement by the applied electric current is detected through a signal-detecting electrode **230** attached to a preset point of a body region and then is inputted to a nerve monitoring system **200** to allow a nerve to be identified by electromyogram analysis.

2. The nerve probe according to claim **1**, wherein the main body block **110** comprises a magnet body **13** so as to be detachably attached to the surgical instrument **1**.

3. The nerve probe according to claim **2**, wherein the main body block **110** comprises any one of a forceps **112** consisting of a pair of clampers **1121***a* and **1121***b*, and a claw-shaped hook **111** so as to be detachably attached to the surgical instrument **1**.

4. The nerve probe according to claim **1**, wherein the main body block **110** comprises a surgical instrument-connecting terminal **116** formed at a front end thereof, and the surgical instrument-connecting terminal **116** has a fitting groove **1161** formed therein so that the surgical instrument-connecting terminal **116** is detachably attached to a protruding pin **2** formed at a preset point of a rear end of each of an endoscopic surgical instrument **1'** and a robotic surgical instrument **1"**.

5. The nerve probe according to claim **1**, wherein the main body block **110** comprises:

a cylindrical main body **110***a* made of an electrically conductive material, having a male thread machined face **114** formed on an outer circumferential surface thereof, and connected to the connection cable **120**; and

an auxiliary cap **110***b* made of an electrically conductive material, having a female thread machined face **115** formed on an inner circumferential surface of a rear end thereof so as to be coupled with the main body **110***a*, and including any one of a forceps **112** consisting of a pair of clampers **1121***a* and **1121***b* and a claw-shaped hook **111**, which is formed at a front end thereof, so as to be retainingly secured to the surgical instrument **1**.

6. A surgical energy device attached with a nerve probe, comprising:

a surgical instrument **1** used in a surgical operation;

a nerve probe **100** detachably mounted to a preset portion of the surgical instrument **1**; and

an electric wire **140** for probe attached to the surgical instrument **1** so as to be electrically connected to the nerve probe **100**, and disposed at a distal end of the surgical instrument **1**, which comes into close contact with body tissue, to allow an electric current to be applied to body tissue,

wherein the nerve probe **100** comprises:

a connection cable **120** configured to transmit the electric current applied thereto from the power supply **300**;

a main body block **110** formed as a block body of a predetermined size at a distal end of the connection cable **120** so as to be detachably attached to the surgical instrument **1**,

whereby the electric current transmitted from the power supply **300** through the connection cable **120** is applied to body tissue with which the surgical instrument **1** comes into close contact during surgery through the connection cable **120** of the nerve probe **100** and the electric wire **140** for probe of the surgical instrument **1**, and an electric signal generated from a muscle movement by the electric current applied to the body tissue is detected through a signal-detecting electrode **230** attached to a preset point of a body region and then is inputted to a nerve monitoring system **200** to allow a nerve to be identified by electromyogram analysis.

7. The surgical energy device according to claim **6**, wherein the surgical instrument **1** is implemented as an energy device for surgical operations, which generates heat to perform hemostasis, the surgical instrument **1** being any one selected from the group consisting of an ultrasonic scalpel using ultrasonic energy, a bipolar vessel sealing system using bipolar high frequency energy, and a thunderbeat that is a dual energy device using both ultrasonic energy and bipolar high frequency energy.

8. The surgical energy device according to claim **6**, wherein the surgical instrument **1** is any one of an endoscopic surgical instrument and a robotic surgical instrument.

9. The surgical energy device according to claim **6**, wherein the surgical instrument **1** comprises a protruding pin **2** formed protrudingly at a preset point of a rear end thereof, and the nerve probe **100** comprises a surgical instrument-connecting terminal **116** formed at a front end thereof, the surgical instrument-connecting terminal **116** having a fitting groove **1161** formed therein so that the nerve probe **100** is detachably mounted to the surgical instrument **1**.

10. The surgical energy device according to claim **6**, wherein the electric wire **140** for probe is attached to a blade formed at a front end of the surgical instrument **1** so as to surround left and right lateral sides and a front side of the blade.

11. The surgical energy device according to claim **6**, wherein the electric wire **140** for probe is installed at a blade made of an electrically conductive material and configured to be applied with the electric current, and

wherein the surgical energy device further comprises a circuit breaker **150** fixedly mounted at a preset point of the surgical instrument **1** so as to be electrically connected to the nerve probe **100** and the electric wire **140** for probe, the circuit breaker being configured to interrupt the electrical connection between nerve probe **100** and the electric wire **140** for probe upon the application of the electric current to the blade to prevent reverse flow of the current.

12. The nerve probe according to claim **1**, wherein the main body block **110** comprises any one of a forceps **112** consisting of a pair of clampers **1121***a* and **1121***b*, and a claw-shaped hook **111** so as to be detachably attached to the surgical instrument **1**.

* * * * *

专利名称(译)	可以与手术器械连接/分离的神经探针，以及附接有神经探针的能量设备手术器械		
公开(公告)号	US20190313971A1	公开(公告)日	2019-10-17
申请号	US16/319339	申请日	2016-08-31
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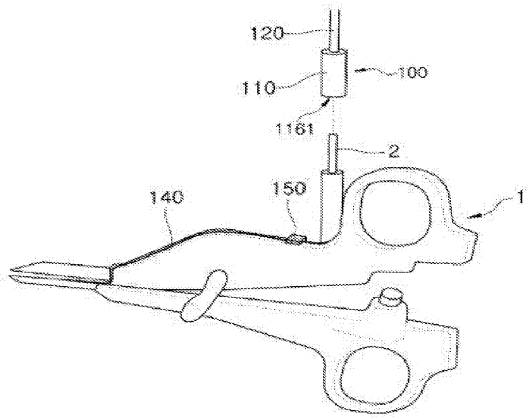
IPC分类号	A61B5/00 A61B5/0492 A61B18/12		
CPC分类号	A61B2018/0063 A61B2017/320082 A61B2018/126 A61B5/0492 A61B2018/1412 A61B2017/00876 A61B2018/00839 A61B2505/05 A61B2017/00477 A61B5/4893 A61B18/1233 A61B2018/00607 A61B5/04001 A61B5/6848 A61B17/320092 A61B18/1442 A61B2018/00178 A61B2018/1457 A61B2018/146 A61B2018/1462 A61B2562/225 A61B5/00 A61B5/04012 A61B17/320016 A61B18/04 A61B34/30 A61B2017/320093 A61B2018/00589 A61B2018/00595 A61B2034/302		
优先权	1020160111913 2016-08-31 KR 1020160111923 2016-08-31 KR		
外部链接	Espacenet USPTO		

摘要(译)

根据本发明的可与手术器械连接和拆卸的神经探针的技术特征在于，其可拆卸地安装至由手术器械制成的手术器械（普通手术器械，内窥镜手术器械或机器人手术器械）。一种导电材料，以允许通过手术器械将电流施加到身体组织，以便仅通过使用手术器械就可以在与手术器械紧密接触的身体组织上同时进行实时神经识别和手术即使不必经常更换单独的神经探头和手术器械也不会带来麻烦，也可以促进快速手术并提高医护人员的便利性。



(Bipolar vessel sealing system)