US 20170245881A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2017/0245881 A1**

KIM (43) **Pub. Date: Aug. 31, 2017**

(54) **AMPUTATOR USING ULTRASONIC WAVES FOR AMPUTATING AND ULTRASONIC SURGICAL APPARATUS PROVIDED WITH SAME**

(71) Applicant: **Ligasonix, Inc.**, New York, NY (US)

(72) Inventor: **Eung Kook KIM**, Seocho-gu (KR)

(21) Appl. No.: **15/122,399**

(22) PCT Filed: **Feb. 28, 2014**

(86) PCT No.: **PCT/KR2014/001709**

§ 371 (c)(1),
(2) Date: **Jan. 30, 2017**

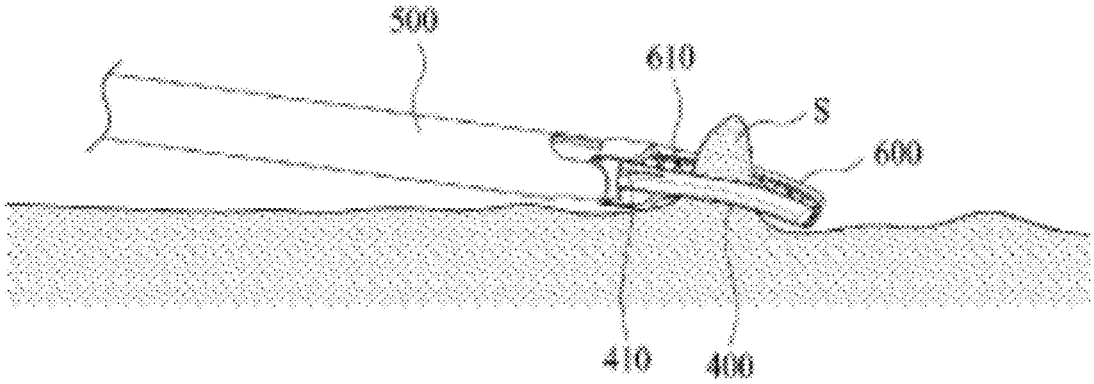
Publication Classification

(51) **Int. Cl.**
A61B 17/32 (2006.01)

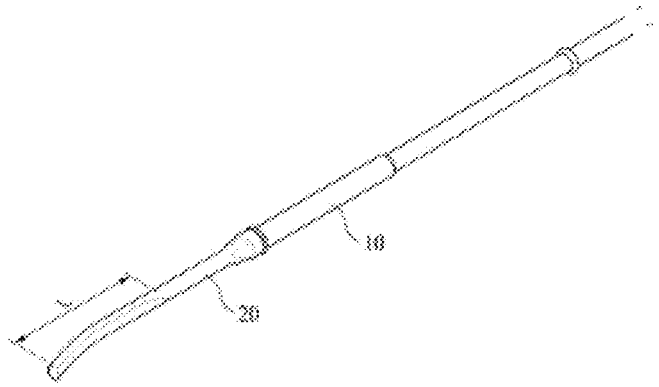
(52) **U.S. Cl.**
CPC ***A61B 17/320092*** (2013.01); *A61B 2017/320072* (2013.01)

(57) **ABSTRACT**

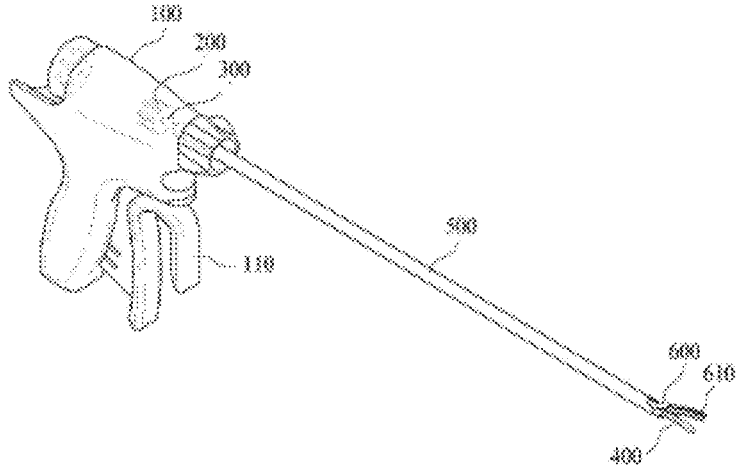
Disclosed is an amputator, which is provided at one end of a transmitting rod connected to a vibrator generating ultrasonic waves, for amputating a surgical site by means of ultrasonic waves transmitted from the transmitting rod, the amputator comprising: an amputating side which comes in contact with the surgical site; and a direction switching means, which has a depression in one part thereof from a point corresponding to a vibration node, for concentrating the ultrasonic waves on the amputating side, the ultrasonic waves being transmitted at an angle toward the amputating side along the lengthwise-direction.



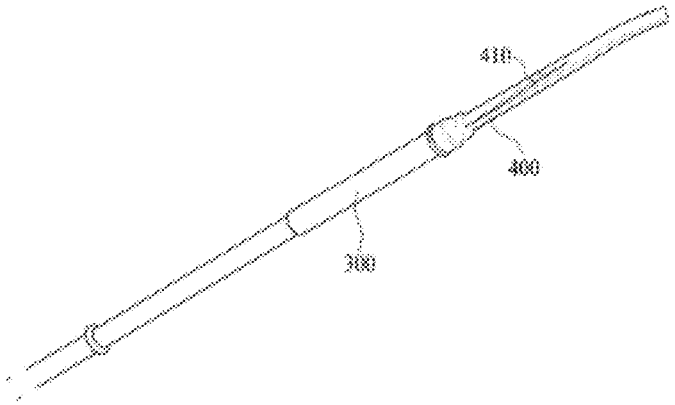
[Fig. 1]



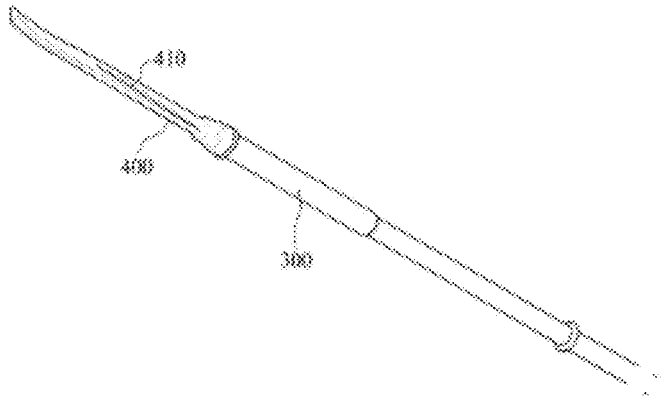
[Fig. 2]



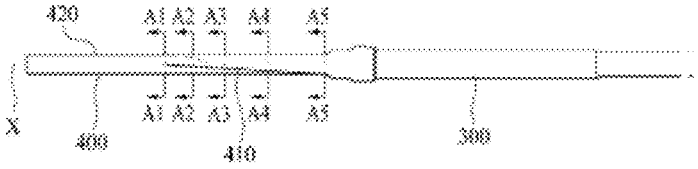
[Fig. 3]



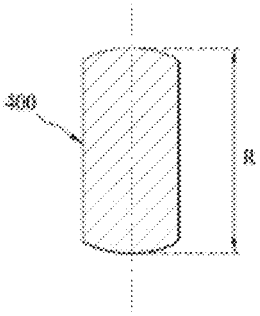
[Fig. 4]



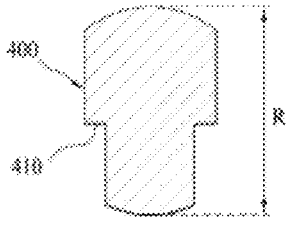
[Fig. 5]



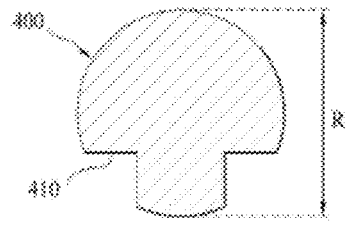
[Fig. 6]



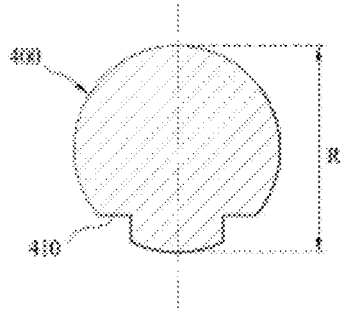
[Fig. 7]



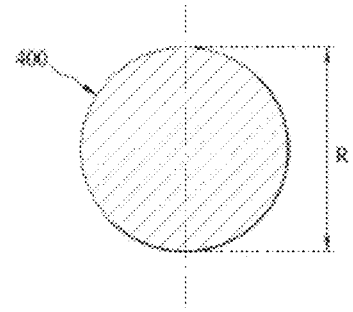
[Fig. 8]



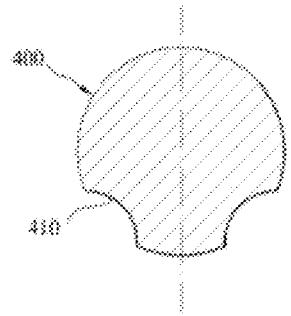
[Fig. 9]



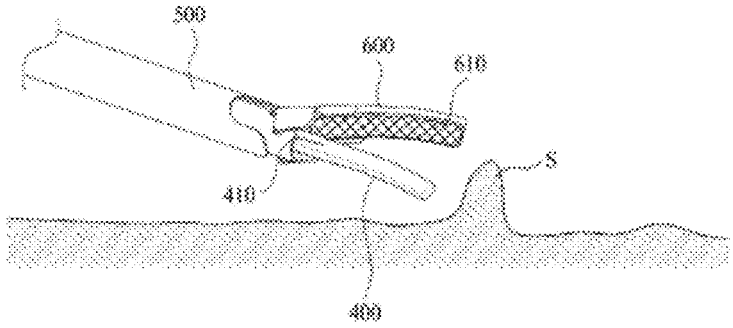
[Fig. 10]



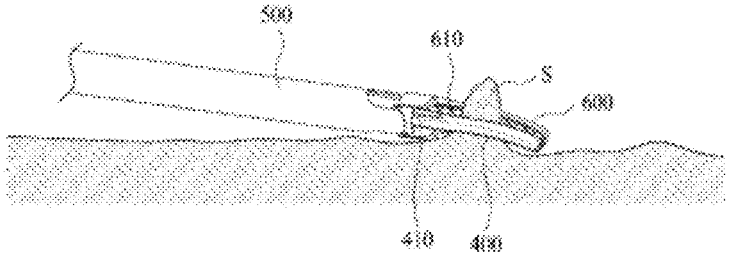
[Fig. 11]



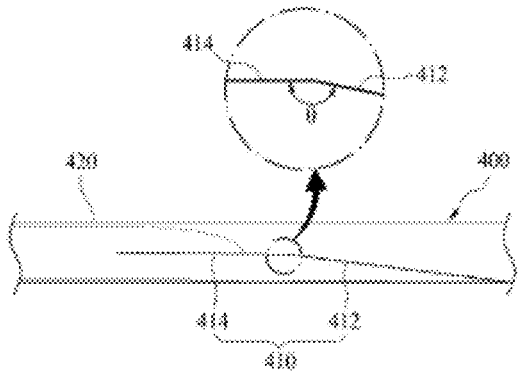
[Fig. 12]



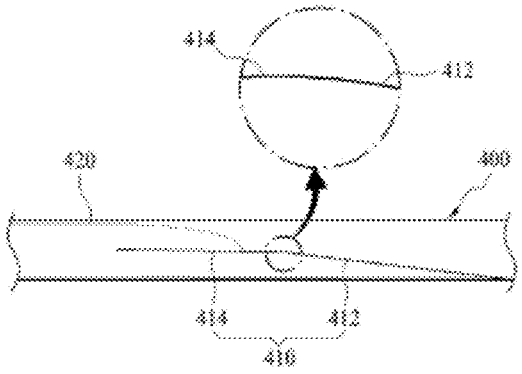
[Fig. 13]



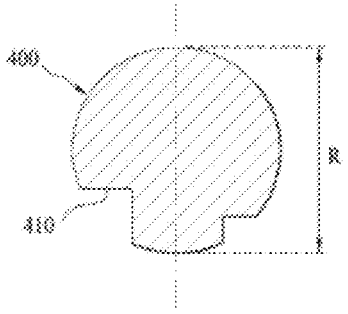
[Fig. 14]



[Fig. 15]



[Fig. 16]



AMPUTATOR USING ULTRASONIC WAVES FOR AMPUTATING AND ULTRASONIC SURGICAL APPARATUS PROVIDED WITH SAME

TECHNICAL FIELD

[0001] The present invention relates to an amputator using ultrasonic waves and an ultrasonic surgical apparatus provided with the same, and more particularly, an amputator using ultrasonic waves that can amputate faster and more effectively by regulating the intensity of the ultrasonic waves applied to the amputating side and an ultrasonic surgical apparatus using the same.

BACKGROUND ART

[0002] Recently, surgical apparatuses using ultrasonic waves are being developed. Among them, the surgical apparatuses similar with harmonic scalpel are the most representative.

[0003] The surgical apparatuses having such shape normally comprises: a gun-shaped handle unit gripped in the operators hand; an amputator provided in front of the handle unit for amputating a surgical site using ultrasonic waves transmitted from a vibrator provided in the handle unit; and a jaw provided at a position facing with the amputator for gripping a surgical site together with the amputator.

[0004] The amputator in accordance with the present invention is devised for amputating a surgical site using ultrasonic waves received from an ultrasonic wave generator. While the amputators can be configured in various ways, and FIG. **1** shows an ordinary, conventional amputator.

[0005] As shown in FIG. **1**, a typical amputator of conventional configuration has a minimized size (volume) in order to concentrate ultrasonic waves on the amputating side, however, reducing size (volume) only can result in uneven distribution of ultrasonic waves applied to an amputating side according to the point of the reduction of the size (volume).

DETAILED DESCRIPTION OF THE INVENTION

Technical Objects

[0006] An aspect of the present invention is to provide an amputator using ultrasonic waves provided with a direction conversion means that can concentrate ultrasonic waves on the amputating side by more even distribution to accomplish faster and more effective amputating and an ultrasonic surgical apparatus using the same.

[0007] The present invention is not restricted to the technical objective set forth above. The above and other aspects of the invention not described herein will become apparent to those skilled in the art to which the invention pertains by referencing the detailed description of the invention below.

Means for Achieving the Technical Object

[0008] To solve above described problem, the amputator using ultrasonic waves in accordance with an embodiment of the present invention is provided on one end of a transmission rod connected to a vibrator, and amputates a surgical site using the ultrasonic waves transmitted through the transmission rod. A portion of the amputating side contacting with a surgical site and from the point corresponding with a vibration node are concaved, forming a certain slope angle towards the amputating side along the lengthwise direction to concentrate ultrasonic waves on the amputating side, which constitutes a direction conversion means.

[0009] Here, the direction conversion means can be characterized by a concave whose depth increases according to the distance from the point of vibration node.

[0010] The direction conversion means is characterized by having a predetermined length and a first slope formed in the direction meeting with a virtual line extending in the lengthwise direction of the transmission rod and a second slope formed by being extended from one end in the lengthwise direction of the first slope and parallel with a virtual line extending the lengthwise direction of the transmission rod.

[0011] The first and the second slopes are formed in straight lines and connected at a predetermined angle.

[0012] In addition, the first slope can be characterized by the portion formed by the second slope being extended is formed in a curved line.

[0013] In addition, the direction conversion means can be characterized by having the concave in an angled shape.

[0014] In addition, the direction conversion means can be characterized by being provided in a pair, arranged left-right symmetrical pivoting up-down direction, when positioned with the amputating side above, and sloped in the same direction.

[0015] In addition, the maximum thickness in the vertical direction is not changed when positioned with the amputating side above.

[0016] The ultrasonic surgical apparatus devised to solve above described problems in accordance with another aspect of the present invention comprises: a vibration device for generating ultrasonic waves; a transmission rod formed in a cylindrical bar to transmit ultrasonic waves generated by a vibrator coupled to one end to an amputator formed by extending from an opposite end; An amputator provided on one end of a transmission rod connected to a vibrator, and amputates a surgical site using the ultrasonic waves transmitted through the transmission rod, and a portion of the amputating side contacting with a surgical site and from the point corresponding with a vibration node are concaved, forming a certain slope angle towards the amputating side along the lengthwise direction to concentrate ultrasonic waves on the amputating side, which constitutes a direction conversion means; A rod cover surrounding the transmission rod using a plurality of vibration nodes form in the process of transmitting ultrasonic waves through the transmission rod as the connecting points; and a jaw coupled with one end of the rod cover in a tiltable manner, at a position facing with the amputator to grip the surgical site by mating with the amputator.

Effect of the Invention

[0017] An aspect of the present invention is to provide an amputator using ultrasonic waves provided with a direction conversion means that can concentrate ultrasonic waves on the amputating side by more even distribution to accomplish faster and more effective amputating and an ultrasonic surgical apparatus using the same.

[0018] The effect of the present invention is not restricted to those set forth above. The above and other aspects of the invention will become apparent to those skilled in the art to which the invention pertains by the description of the claims.

BRIEF DESCRIPTION OF THE DRAWING

[0019] FIG. **1** is a schematic, perspective, view of a conventional amputator,

[0020] FIG. **2** is an exemplary ultrasonic surgical apparatus using an amputator using ultrasonic waves in accordance with an embodiment of the present invention,

[0021] FIG. **3** is a schematic perspective view of the configuration of the amputator and transmission rod of the surgical apparatus of FIG. **2**,

[0022] FIG. **4** is a perspective view of the amputator and transmission rod of the surgical apparatus of FIG. **2** in a different angle of view,

[0023] FIG. **5** is a side view of the amputator and transmission rod of the surgical apparatus of FIG. **2**,

[0024] FIG. **6** is a cross-sectional view taken from line A**1** of FIG. **5**,

[0025] FIG. **7** is a cross-sectional view taken from line A**2** of FIG. **5**,

[0026] FIG. **8** is a cross-sectional view taken from line A**3** of FIG. **5**,

[0027] FIG. **9** is a cross-sectional view taken from line A**4** of FIG. **5**,

[0028] FIG. **10** is a cross-sectional view taken from line A**5** of FIG. **5**,

[0029] FIG. **11** is a cross-sectional view of an amputator having a round-shape sunk,

[0030] FIG. **12** is a schematic diagram showing the surgical apparatus utilizing ultrasonic waves of FIG. **2** approaching a surgical site,

[0031] FIG. **13** is a schematic diagram showing the surgical apparatus utilizing ultrasonic waves of FIG. **11**, gripping and amputating a surgical site,

[0032] FIG. **14** is a view showing the deformed shape of the direction conversion means of the amputator of FIG. **2**,

[0033] FIG. **15** is a view showing another deformed shape of the direction conversion means of the amputator of FIG. **2**, and

[0034] FIG. **16** is a view showing the direction conversion means of the amputator of

[0035] FIG. **2**, having different left and right side slope angles.

NUMBERING SCHEME OF THE MAJOR PARTS OF THE DRAWINGS

[0036] **100**: handle unit
[0037] **200**: vibrator
[0038] **300**: transmission rod
[0039] **400**: amputator
[0040] **410**: direction conversion means
[0041] **412**: first slope portion
[0042] **414**: second slope portion
[0043] **420**: amputating side
[0044] **500**: rod cover
[0045] **600**: jaw

MODE FOR CARRYING OUT THE INVENTION

[0046] An embodiment of the present invention is described hereinbelow by referring to the accompanying drawings. In the description of the present invention, known functions and/or configuration can be omitted in order to clarify the spirit of the present invention.

[0047] In the description of the present invention, the terms referring to directions, i.e., up, down, or front, rear, are used solely to help those skilled in the art understand the present invention more clearly. As such, such directions are on a relative basis and shall not be interpreted to restrict the scope of the right of the present invention.

[0048] As shown in FIGS. **2** through **16**, the embodiment of an amputator **400** using ultrasonic waves and a surgical apparatus using the same comprises: a handle unit **100** gripped in a hand of an operator, a vibrator **200**, a transmission rod **300**, an amputator **400**, a rod cover **500** and a jaw **600**.

[0049] The handle unit **100** is provided in a gun-shape for being held in a hand of an operator, comprising: a vibrator **200** inside for generating vibration, a transmission rod **300** connected with the vibrator **200** and a rod cover **500** connected in forward direction. In addition, an additional operating means **110** is provided to control the wavelength, amplitude and frequency of the ultrasonic waves generated by the vibrator **200**.

[0050] The vibrator **200** generates ultrasonic waves by receiving electric signals from input terminals. (However, the electric circuit and wiring for transmitting the signals between the vibrator **200** and the input terminals are not indicated in the drawings.)

[0051] The frequency of the ultrasonic waves generated by the vibrator **200** varies by the conditions of the transmission rod **300** and amputator **400** which will be described later. That is, the ultrasonic waves generated by the vibrator **200** can be adjusted by the configuration and material of the transmission rod **300** and/or design of the gain steps and operating length of the amputator **400**.

[0052] In addition, the wavelength, amplitude and frequency of the ultrasonic waves generated by the vibrator **200** can be controlled with the operating means **110** taking the surgical site S to be amputated into consideration.

[0053] For example, if the surgical site S is a thick tissue or containing a blood vessel, the intensity of the ultrasonic waves should be adjusted to be higher, or the intensity can be controlled to be lower to avoid hindrance of the byproducts of amputation to the operation.

[0054] Meanwhile, the transmission rod **300** connects the vibrator **200** and amputator **400** to transmit the ultrasonic waves generated by the vibrator **200** to the amputator **400**.

[0055] The transmission rod **300** in accordance with an embodiment of the present invention is provided in a long, rod-shape whose one end and the opposite end are connected to the vibrator **200** described earlier and amputator **400** described later, respectively.

[0056] While not shown in the drawings, the transmission rod **300** can be configured in a long, thin, cylindrical bar so that the amputator **400** can be inserted in a hole formed on a trocar used in laparoscopy to reach a surgical site S easily.

[0057] In addition, the length of the transmission rod **300** can be provided sufficiently for laparoscopy, and to allow repetition of the vibration **200** nodes (the points where the intensity of ultrasonic wave is substantially zero) and vibration anti-node (a concept opposite to the vibration node, the points where the intensity of ultrasonic wave is the highest) by a plurality of numbers.

[0058] In addition, while the transmission rod **300** can be made with various materials, titanium material would be preferable for efficient transmission of the ultrasonic waves generated in the vibrator **200** as described earlier.

[0059] In the present embodiment, the transmission rod **300** is formed in a long cylindrical bar shape, a portion of

which is connected inside of the handle unit **100** and the opposite portion protrudes out forward.

[0060] The amputator **400** for cutting a surgical site S utilizing ultrasonic waves is provided on one end of the transmission rod **300** to receive the ultrasonic waves generated by the vibrator **200** to cut a surgical site S.

[0061] The amputator **400** in accordance with the present invention can be formed by being extended from one end of the transmission rod **300** described earlier, and can cut a surgical site S by pressing and gripping the surgical site S together with the jaw **600**, to be described later, provided on the opposite side.

[0062] Since the amputator **400** operates utilizing ultrasonic waves, it does not have a sharp edge, different from other ordinary cutting devices. That is, the amputator **400** is designed to cut a surgical site S using ultrasonic waves, thus, it is effective when amputating a surgical site S through which a blood vessel or vessels pass.

[0063] Since the amputator **400** should be able to amputate a surgical site S utilizing the ultrasonic waves transmitted through the transmission rod **300**, it should have a gain step (indicating that the actual ratio of amplification is 1 or higher).

[0064] For a means to provide the amputator **400** with a gain step, the shape and jaw **600** of the amputator **400** can be diversified, In accordance with an embodiment of the present invention, the lateral cross-sectional area of the amputator **400** is reduced to be smaller than that at the vibration node so that the energy of the ultrasonic waves can be amplified according to the ratio of the cross-sectional area. Accordingly, when the amputator **400** is formed by being extended from the transmission rod **300**, a portion of the round cross-sectional area is flattened to reduce the area and to form a gain step.

[0065] In the formation of the amputator **400**, one thing that is as important as the gain step is active length.

[0066] That is, even the amputator **400** amplifies the energy of ultrasonic waves with gain step, if the active length is too short, i.e., if the intensity is not sufficient for amputating a surgical site S, the apparatus would be useless for a user who desires to amputate a surgical site S.

[0067] To secure sufficient active length, the amputator **400** in accordance with an embodiment of the present invention is provided with an amputating side **420** contacting with a surgical site S, and direction conversion means **410**, a portion of which is concaved from the point of vibration node and sloped lengthwise in the direction of the amputating side **420** to concentrate transmitted ultrasonic waves to the amputating side **420**.

[0068] Here, the direction conversion means **410**, when positioned with the amputating side **420** above, is formed on the side in the lengthwise direction of the amputator **400** with the concave depth increasing gradually according to the distance from the point of vibration node.

[0069] As shown in FIG. **5**, the direction conversion means **410** is formed crossing a virtual extension line X in the lengthwise direction of the transmission rod **300**, sloped upward in the direction of the amputating side **420**.

[0070] As the direction conversion means **410** is formed with concave and sloped upward in the direction of the amputating side **420**, the ultrasonic waves transmitted through the transmission rod **300** is concentrated towards the amputating side **420** by the direction conversion means **410**.

[0071] In the present embodiment in accordance with the present invention, the direction conversion means **410** are provided in a pair arranged symmetrically left and right, centering a vertical axis, when the amputating side **420** is in the upper position, in order for effective transmission of the ultrasonic waves transmitted through the transmission rod **300** to the amputating side **420**. Different from the drawing, the amputator may be provided with a single direction conversion means **410**

[0072] The direction conversion means **410** in accordance with the present invention are sunk from the bottom of the point corresponding with a vibration node and sloped upwards up to the cross point with the extension line X, and are formed along a portion of the length of the amputator **400**.

[0073] Here, the angle between the extension line X and the direction conversion means **410** can be varied according to the intensity (frequency, amplitude) of the ultrasonic waves and the material of the amputator **400**. In the present embodiment in accordance with the present invention, the slope angle of the direction conversion means **410** can be in the range of between from about 2 to about 7 degrees.

[0074] The shape of the direction conversion means **410** in the present embodiment in accordance with the present invention is discussed in further details. As shown in FIGS. **6** through **10**, the direction conversion of the amputator **400** means **410** is concaved from the points corresponding with vibration nodes and the depth of the concave becomes deeper as the distance from the vibration node increases.

[0075] The purpose of this design is to generate gain steps by reducing the cross-sectional area of the amputator **400**.

[0076] Here, while the direction conversion means **410** is sloped upward from the vibration nodes along the lengthwise direction of the amputator **400**, however, the slope ends before arriving at the amputating side **420**.

[0077] In the present embodiment, one end of the direction conversion means **410** extends up to the center point with reference to the vertical length R of the amputator **400**. However, the actual configuration can be changed according to the intensity of the ultrasonic waves or the material of the amputator **400**.

[0078] As shown in the figures, the amputator **400** is formed with direction conversion means **410** in a concaved shape that reduces the cross-sectional area of the amputator **400** in the lengthwise direction, the maximum vertical thickness of the amputator **400** is not changed.

[0079] Accordingly, when the jaw **600** pushes towards the amputating side **420** as described later, the deflection of the amputator **400** can be minimized protecting the amputator **400** from being damaged.

[0080] Meanwhile, the direction conversion means **410** in accordance with the present invention is formed as a concave in an angled shape on the amputator **400**. As a result, the direction conversion means **410** can further concentrate the ultrasonic waves transmitted through the transmission rod **300**.

[0081] As shown in FIG. **11**, it the concaved point of the direction conversion means **410** is curved, the concentration effect of the ultrasonic waves transmitted to the amputator **400** resulting in reduced intensity of the ultrasonic waves concentrated on the amputating side **420**.

[0082] As described above, the amputator **400** in accordance with the present invention is concaved by a certain length in the lengthwise direction and provided the direction

conversion means **410** formed towards the amputating side **420** so that the ultrasonic waves can be transmitted to the amputating side **420** with an even intensity.

[0083] The rod cover **500** surrounds the transmission rod **300** to protect the ultrasonic waves transmitted through the transmission rod **300**. As such, the rod cover **500** in accordance with an embodiment of the present invention is a long, hollow rod, allowing the transmission rod **300** to penetrate through the hollow portion.

[0084] In addition, the opposite end is coupled and fixed with the handle unit **100** described earlier, and the amputator **400** penetrates and exposed outwards through the one end.

[0085] The rod cover **500** in accordance with an embodiment of the present invention has a length corresponding with the length of the transmission rod **300** described earlier, the opposite end is coupled with the handle unit **100** and the amputator **400** protrudes out from the hollow of the rod cover.

[0086] While the rod cover **500** is preferably not contacting with the transmission rod **300**, however, it may be necessary to be connected if the transmission rod **300** is long. Here, the connection point is preferably be made on a plurality of the vibration nodes on the transmission rod **300** formed by the ultrasonic waves.

[0087] This is because, since the intensity of the ultrasonic waves is not zero at any other points than the vibration nodes, if the transmission rod **300** and rod cover **500** are connected at any other points than the vibration nodes, the energy of the ultrasonic waves being transmitted through the transmission rod **300** is transmitted to the rod cover **500** and lost (wasted).

[0088] That is, though not shown, the rod cover **500** and transmission rod **300** in accordance with an embodiment of the present invention can be configured to contact with each other partially along on the lengthwise direction.

[0089] The jaw **600**, positioned facing with the amputator **400** to grip a surgical site S by adhering to the amputator **400**. In the present invention, the jaw is selectively tilted so that one side can contact with the amputator **400**.

[0090] If without the jaw **600**, it is difficult to amputate a surgical site S because the surgical site S is not backed up when pushed by the amputator **400** for amputating. That is, the jaw **600** assists **600** the amputator **400** for amputating a surgical site S.

[0091] The jaw **600** may be formed by being integrated with the transmission rod **300**, however, such configuration can hinder the transmission of ultrasonic waves to the amputator **400**. Therefore, it is preferably coupled with an end of the rod cover **500**.

[0092] In addition, it can be coupled with the rod cover **500** in a tiltable manner for easier gripping and releasing of a surgical site S.

[0093] In addition, the jaw **600** can be provided grooves **610** forms by predetermined intervals on the inner side facing one side of the amputator **400** in order to prevent the surgical site S from being released from between the amputator **400** and the jaw.

[0094] Here, the groove **610** can be tilted towards the lengthwise direction of the jaw **600**, with reference to the direction perpendicular with the lengthwise direction of the jaw **600**.

[0095] That is, if the lengthwise direction of the jaw **600** is defined by a direction parallel with the line connecting a vibration mode N**1** and an anti-vibration node A**1**, and let the slope of a line perpendicular with the lengthwise direction is zero (0), the grooves **610** can be sloped by a certain angle in the lengthwise direction of the jaw **600**

[0096] That is, if the certain angle is small, the grooves **610** are formed perpendicular to the lengthwise direction of the jaw **600**, and if the angle is large, the grooves **610** are formed in the lengthwise direction of the jaw **600**.

[0097] The surgical apparatus utilizing ultrasonic waves and the amputator **400** are described in detail hereinabove. The gripping of the surgical site S by the surgical apparatus utilizing ultrasonic waves in accordance with an embodiment of the present invention is described in detail below.

[0098] As shown in FIG. **12**, the amputator **400** in accordance with an embodiment of the present invention approaches close to a surgical site S without contacting with each other and with the jaw **600** being tilted. Here, a portion of the surgical apparatus utilizing ultrasonic waves has already been inserted in the body of an operatee, and the surgical site S refers to a portion of the body which is the target of the operation.

[0099] After inserted into the body of the operate, the amputator **400** and jaw **600** grip the surgical site S or part to be cut off, as shown in FIG. **13**. At this time, the operator tilts the jaw **600** by using the operating means **110**, so that the amputator **400** and one side of the jaw **600** contact with and grip the surgical site S.

[0100] Then, the operator starts the vibrator **200** to amputate the surgical site S.

[0101] With the above described method, the ultrasonic surgical apparatus in accordance with an embodiment of the present invention can perform amputating a surgical site S faster and more effectively.

[0102] Referring to FIGS. **14** and **15**, the variants of the amputator **400** in accordance with the present invention are described below.

[0103] A variant of the amputator **400** in accordance with the present invention is provided with the direction conversion means **410** which comprises a first slope portion **412** and a second slope portion **414**.

[0104] The first slope portion **412** is sloped in the direction to the crossing point with a virtual extension line X in the lengthwise direction of the transmission rod **300**. The second slope portion **414** is formed by extending from one end of the first slope portion **412** in the lengthwise direction in parallel with the extension line X.

[0105] That is, the first slope portion **412** and the second slope portion **414** are formed in long lines meeting with each other in the lengthwise direction, having different angles of slope.

[0106] Since the direction conversion means **410** comprise a first slope portion **412** and a second slope portion **414** having different slope angles, the ultrasonic waves transmitted to the amputator **400** can be effectively concentrated on the amputating side **420**.

[0107] As shown in FIG. **14**, the first slope portion **412** and a second slope portion **414** are formed in a straight line which can meet with each other at a predetermined angle. Here, the first slope portion **412** can be formed at the point formed by extension of the second slope portion **414** at a predetermined angle.

[0108] In addition, as shown in FIG. **15**, the first slope portion **412** can be formed at the point formed by extension of the second slope portion **414** in a curved line.

[0109] That is, while the first slope portion **412** and the second slope portion **414** are formed with different slope angle, the two can cross each other in straight or curved lines.

[0110] While the second slope portion **414** of the present embodiment is parallel with the extension line X, the relation between the two lines is not limited to parallelism but can form any angle. In addition, it is be obvious that the first slope portion **412** and the second slope portion **414** can be formed in curved lines, not the straight line described in the present embodiment.

[0111] The variants of the direction conversion means **410** formed on the amputator **400** are described by referring to FIG. **16** below.

[0112] FIG. **16** is a cross-sectional view of the direction conversion means **410** formed with different slope angles on the amputator **400** of FIG. **2**.

[0113] As shown in, the direction conversion means **410** can be formed on the amputator **400** with different angles on the left and right sides when placed under the amputating side **420**.

[0114] More particularly, referring to FIG. **16** showing the cross-sections along the lengthwise direction of the amputator **400**, the direction conversion means **410** can be formed on the amputator **400** with different angles on the left and right sides to transmit the ultrasonic waves transmitted from the transmission rod **300** to the amputating side **420**.

[0115] Here, since a pair of direction conversion means **410** are provided with different slope angles, the intensity of the ultrasonic waves transmitted to the amputating side **420** is changed.

[0116] More particularly, by providing the direction conversion means **410** with different slope angles, the intensity of the ultrasonic waves transmitted to the amputating side **420** can be adjusted by the materials of the amputator **400** and transmission rod **300** and the intensity of the ultrasonic waves generated in the vibrator **200**.

[0117] While an embodiment of the present invention is described by referring to a harmonic scalpel, it would be obvious that the present invention can be applied to other types of surgical instruments utilizing ultrasonic waves, and further, other medical systems such as computer-integrated robotic surgery systems.

[0118] From the foregoing it is believed that those skilled in the pertinent art will recognize the meritorious advancement of this invention and will readily understand that while the present invention has been described in association with a preferred embodiment thereof, and in the accompanying drawings, numerous changes and modifications may be made therein by those skilled in the art without departing from the spirit and scope of this invention. Therefore, the modifications and changes shall not be interpreted independently from the technical spirit and point of view, and the modified embodiments shall be interpreted to be within the scope of the present invention.

What is claimed is:

1. An amputator provided at one end of a transmission rod connected to a vibrator that generated ultrasonic waves for amputating a surgical site using the ultrasonic waves transmitted from the transmission rod, comprising:

an amputating side contacting with the surgical site; and direction conversion means formed as a depression from a point corresponding with a vibration node, having slope angles along the lengthwise direction towards the amputating side to concentrate the ultrasonic waves on the amputating side.

2. The amputator of claim **1**,

wherein the direction conversion means

are characterized by a depression whose depth increases according to the distance from the point of vibration node.

3. The amputator of claim **2**,

wherein the direction conversion means comprises:

a first slope formed in the direction meeting with a virtual line extending in the lengthwise direction of the transmission rod; and a second slope formed by being extended from one end in the lengthwise direction of the first slope and parallel with a virtual line extending the lengthwise direction of the transmission rod.

4. The amputator of claim **3**,

wherein the first and the second slopes are formed in straight lines and connected at a predetermined angle.

5. The amputator of claim **3**,

wherein the first slope is characterized by the portion formed by the second slope being extended is formed in a curved line.

6. The amputator of claim **1**,

wherein the direction conversion means is characterized by,

having an angle-shaped depression.

7. The amputator of claim **1**,

wherein the direction conversion means is characterized by;

being provided in a pair, arranged left-right symmetrical pivoting up-down direction, when positioned with the amputating side above, and sloped in the same direction.

8. The amputator of claim **1**,

wherein the maximum thickness in the vertical direction is not changed when positioned with the amputating side above.

9. A surgical apparatus comprising:

a vibrator for generating ultrasonic waves;

a transmission rod formed in a cylindrical bar to transmit ultrasonic waves generated by a vibrator coupled to one end to an amputator formed by extending from an opposite end;

an amputator provided on one end of a transmission rod connected to a vibrator, and amputates a surgical site using the ultrasonic waves transmitted through the transmission rod, and a portion of the amputating side contacting with a surgical site and from the point corresponding with vibration node are concaved, forming a certain slope angle towards the amputating side along the lengthwise direction to concentrate ultrasonic waves on the amputating side, which constitutes a direction conversion means;

A rod cover surrounding the transmission rod using a plurality of vibration nodes form in the process of transmitting ultrasonic waves through the transmission rod as the connecting points; and

a jaw coupled with one end of the rod cover in a tiltable manner, at a position facing with the amputator to grip the surgical site by mating with the amputator.

* * * * *