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(54) **LIQUID EJECTING APPARATUS FOR MEDICAL TREATMENT**

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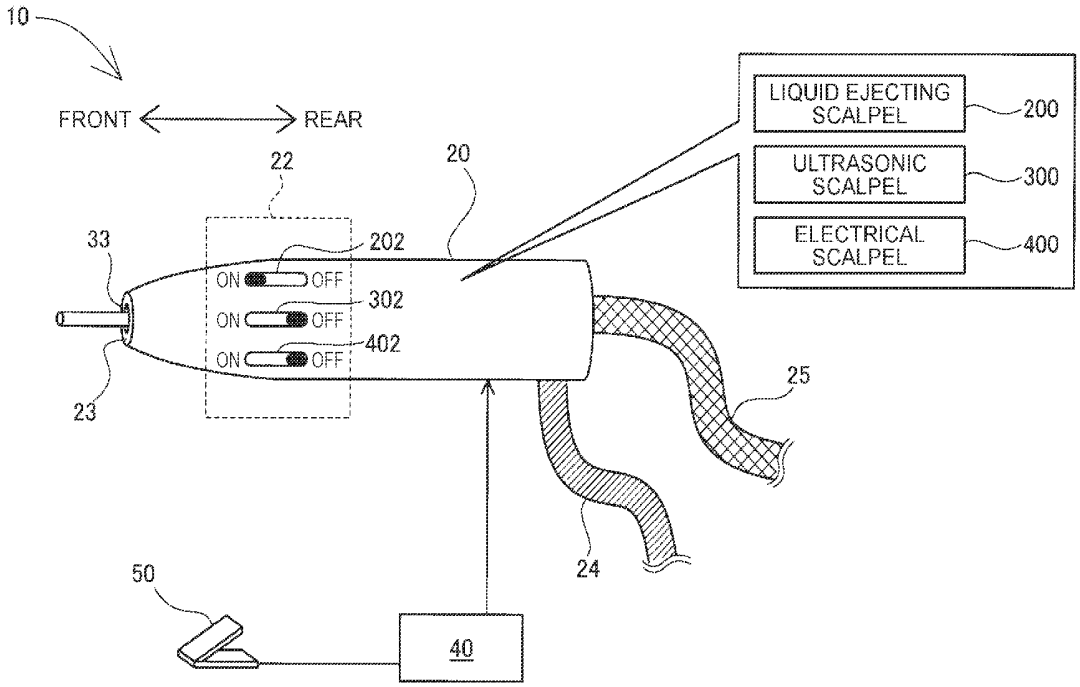
(57) **ABSTRACT**

A liquid ejecting apparatus for medical treatment includes a liquid ejecting scalpel that ejects a liquid, an ultrasonic scalpel that generates an ultrasonic wave, an inner body that accommodates the liquid ejecting scalpel and the ultrasonic scalpel and includes a first opening portion allowing a distal end portion of the liquid ejecting scalpel or a distal end portion of the ultrasonic scalpel to protrude therethrough, an outer body that accommodates the inner body and includes a second opening portion at a position corresponding to the first opening portion, a suctioning path that is made by an aperture formed between the inner body and the outer body, and a manipulation section that is arranged in the outer body and selectively causes the distal end portion of the liquid ejecting scalpel or the distal end portion of the ultrasonic scalpel to protrude through the first opening portion.



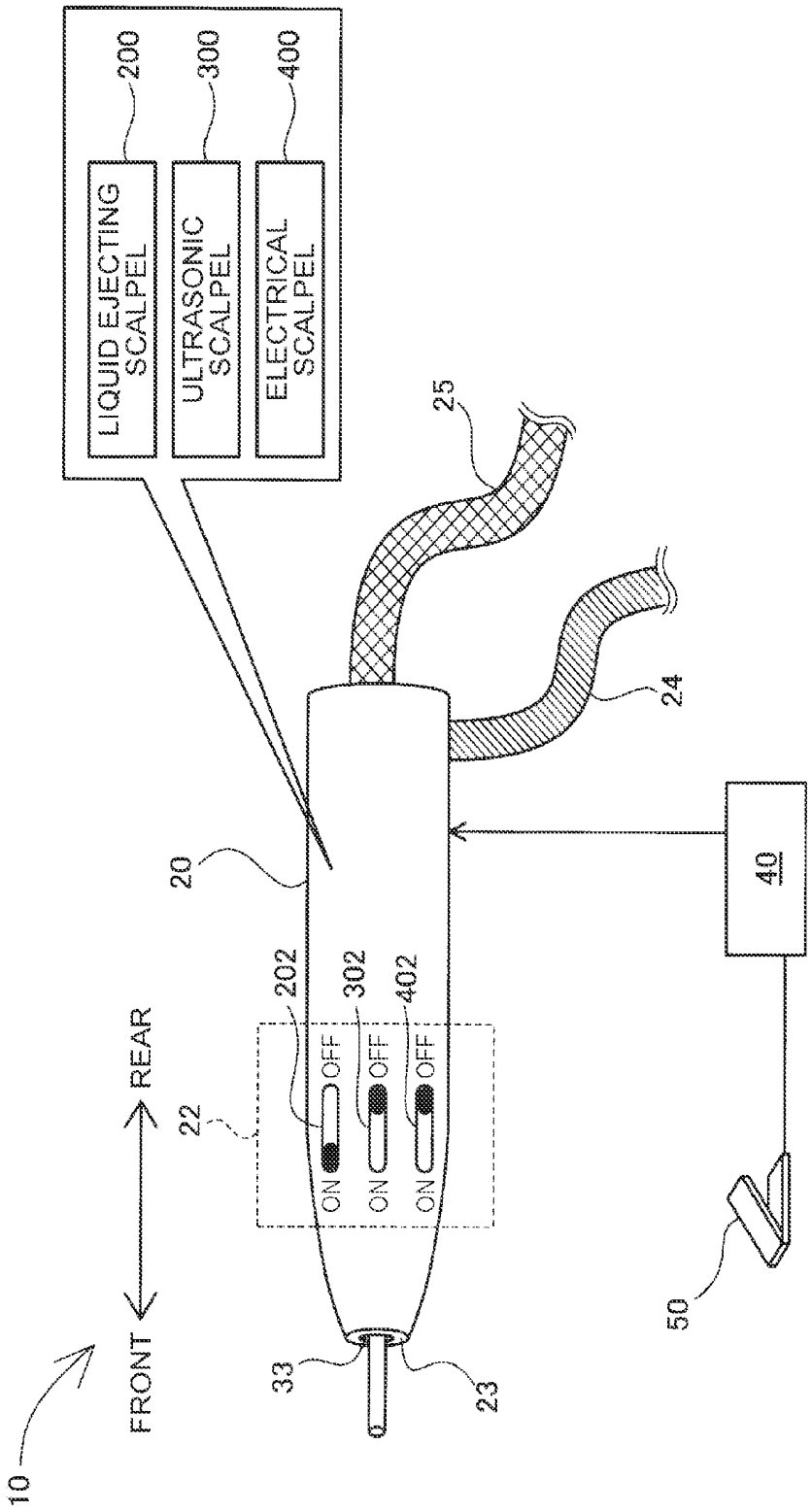

LIQUID EJECTING SCALPEL
ULTRASONIC SCALPEL
ELECTRICAL SCALPEL
200
300
400
25
24
20
40
202
302
402
OFF
ON
22
REAR
FRONT
10
33
23
50

FIG. 1

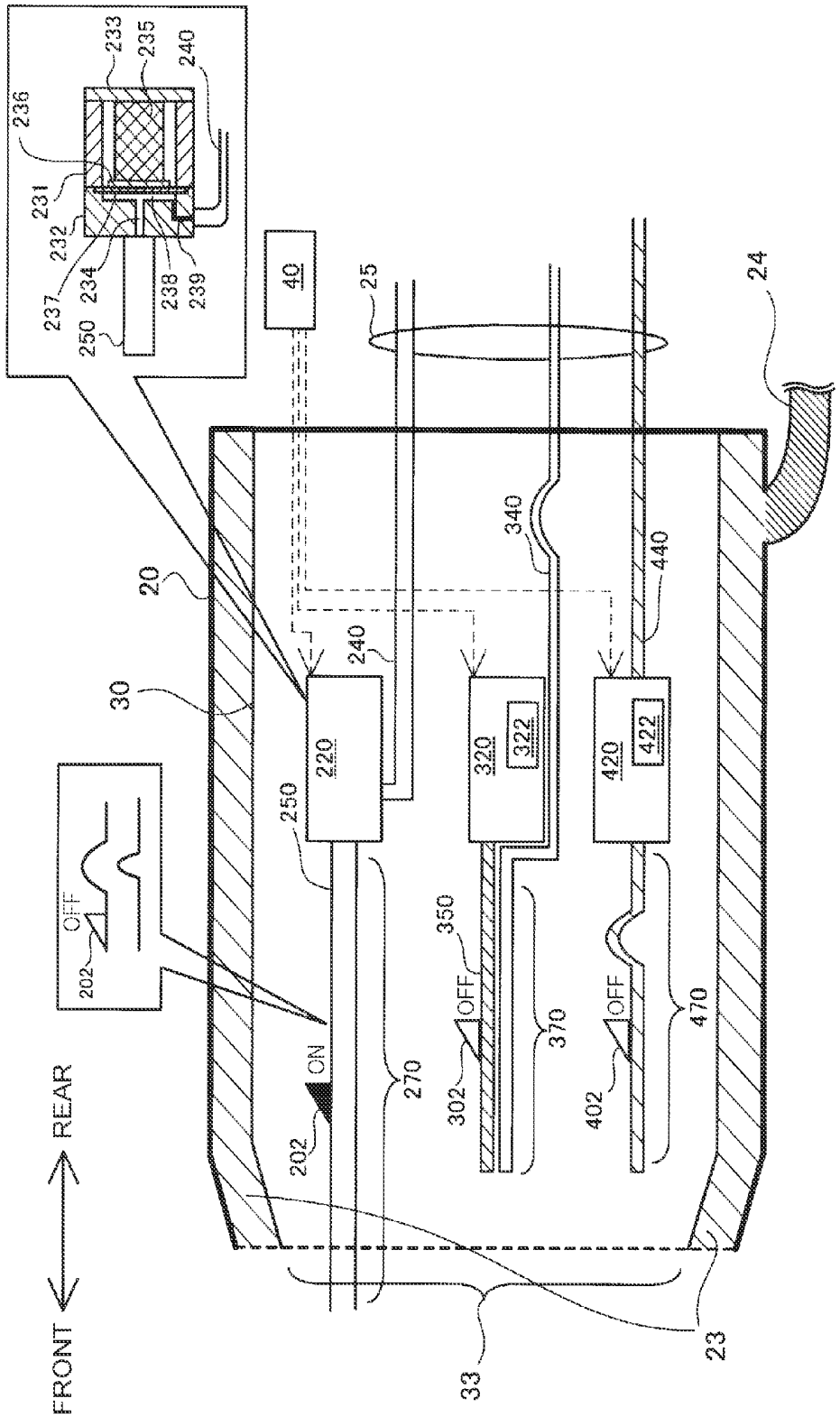

233
235
240
236
231
232
237
234
238
239
250
40
25
24
20
30
340
440
240
220
320
322
420
422
250
350
OFF
202
OFF
OFF
370
470
ON
270
302
402
202
FRONT
REAR
33
23

FIG. 2

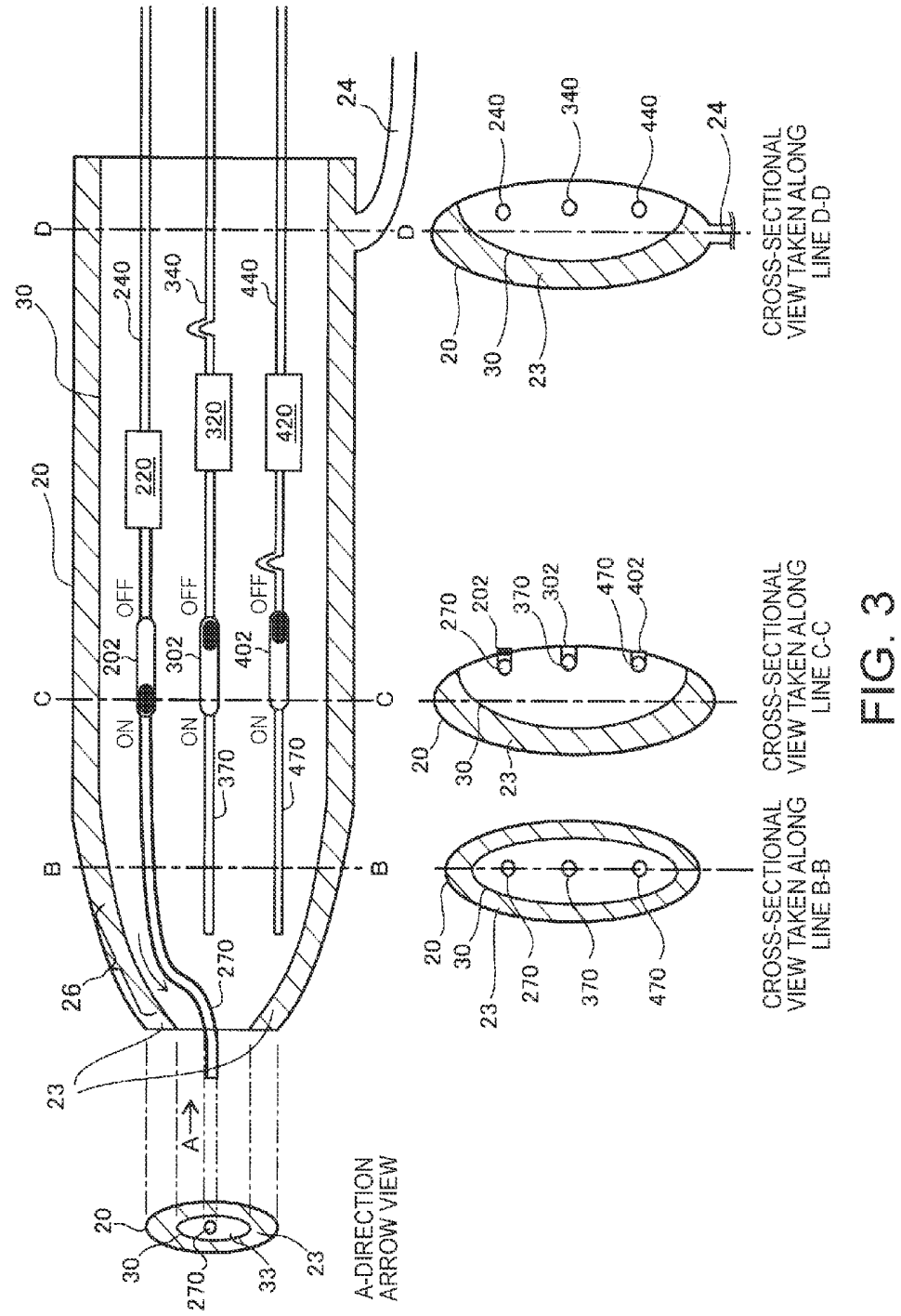

A-DIRECTION ARROW VIEW
CROSS-SECTIONAL VIEW TAKEN ALONG LINE B-B
CROSS-SECTIONAL VIEW TAKEN ALONG LINE C-C
CROSS-SECTIONAL VIEW TAKEN ALONG LINE D-D
220
320
420
OFF
ON
202
302
402
240
340
440
270
370
470
20
23
24
26
30
33
A
B
C
D

FIG. 3

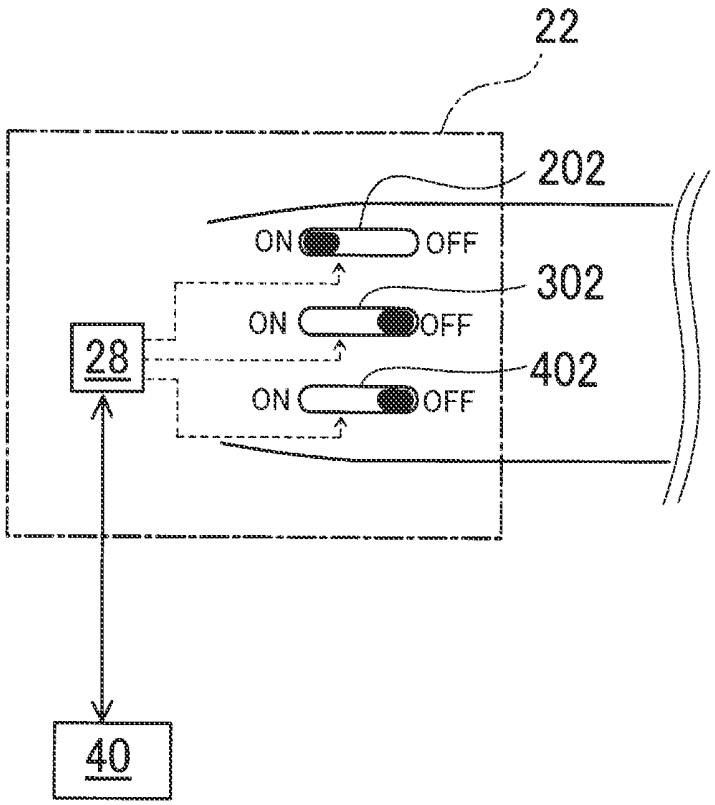


FIG. 4

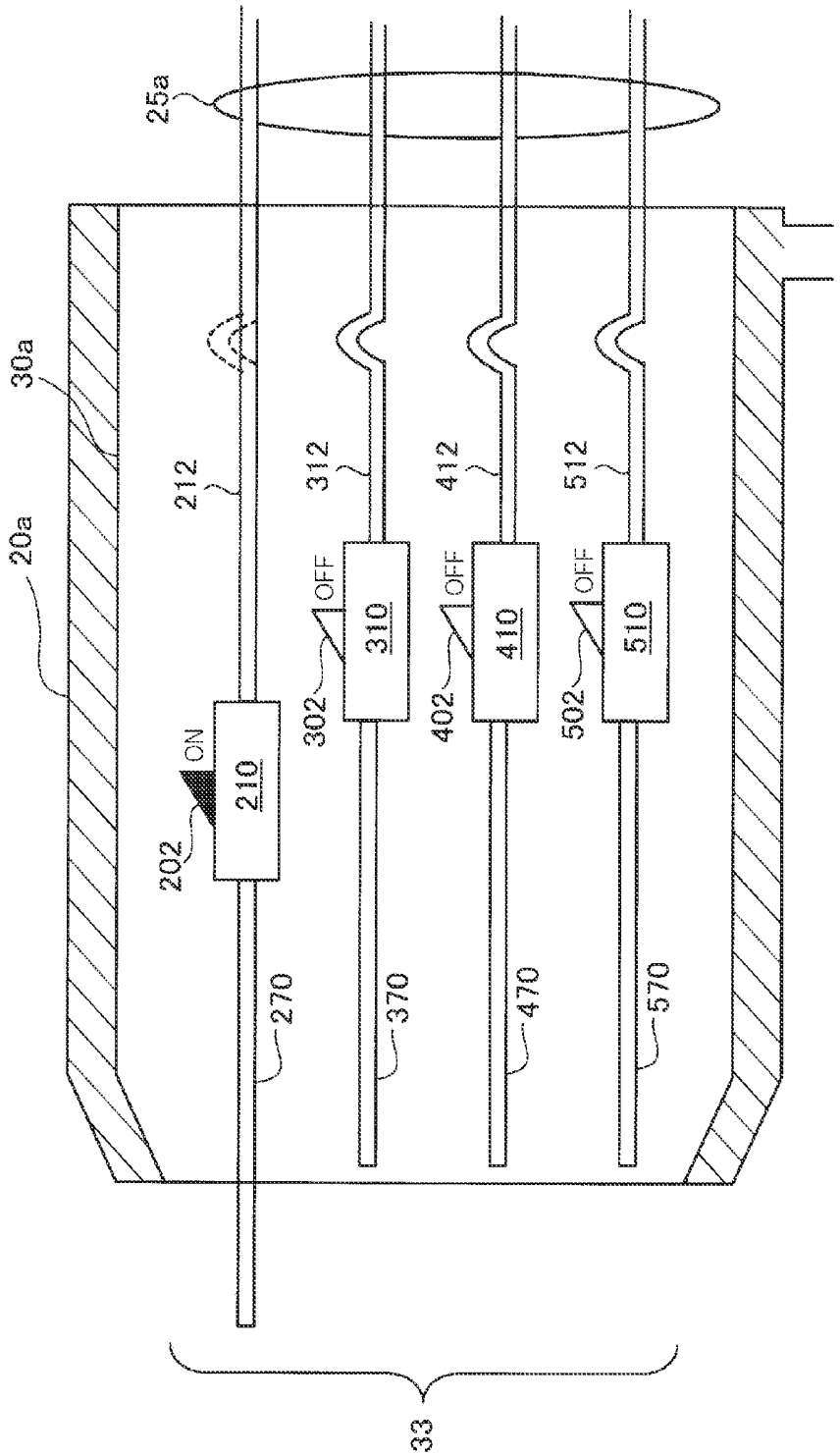

25a
30a
20a
212
312
412
512
ON
OFF
OFF
OFF
210
310
410
510
202
302
402
502
270
370
470
570
33

FIG. 5

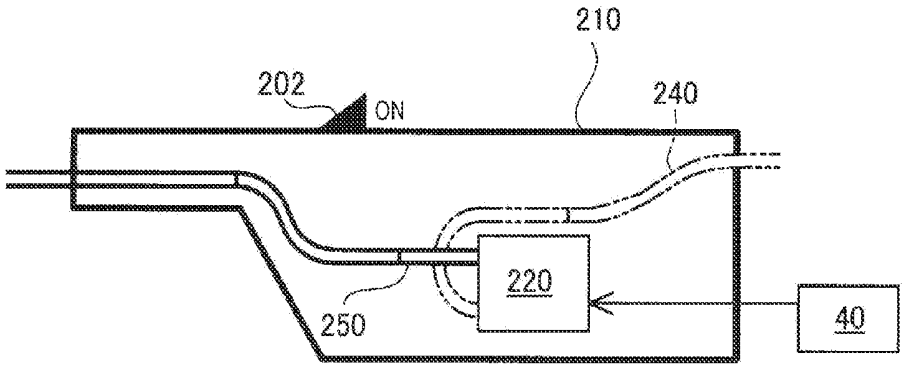


FIG. 6

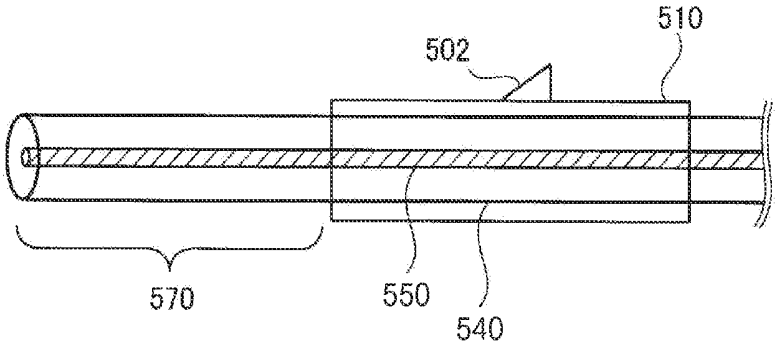


FIG. 7

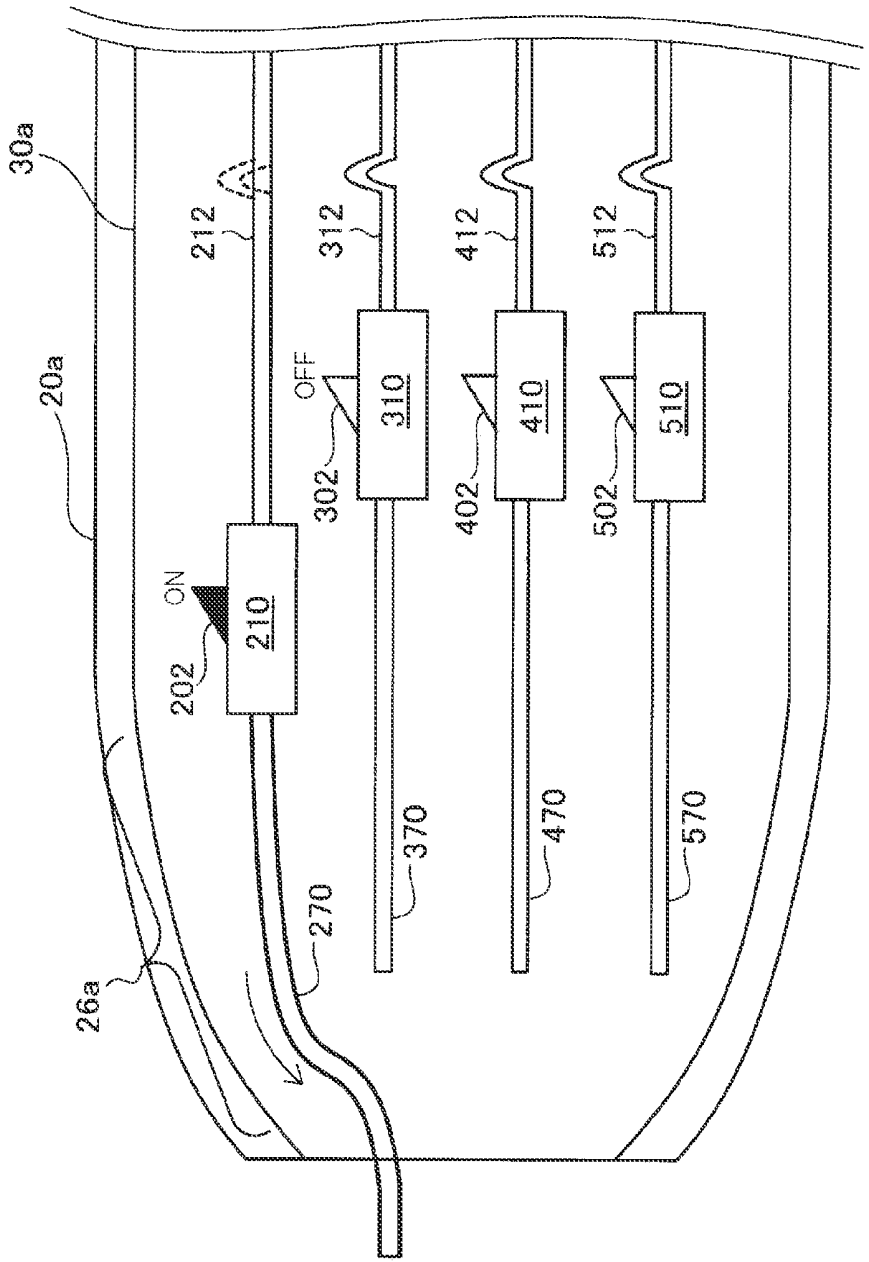

30a
20a
26a
212
312
412
512
ON
OFF
202
302
402
502
210
310
410
510
270
370
470
570

FIG. 8

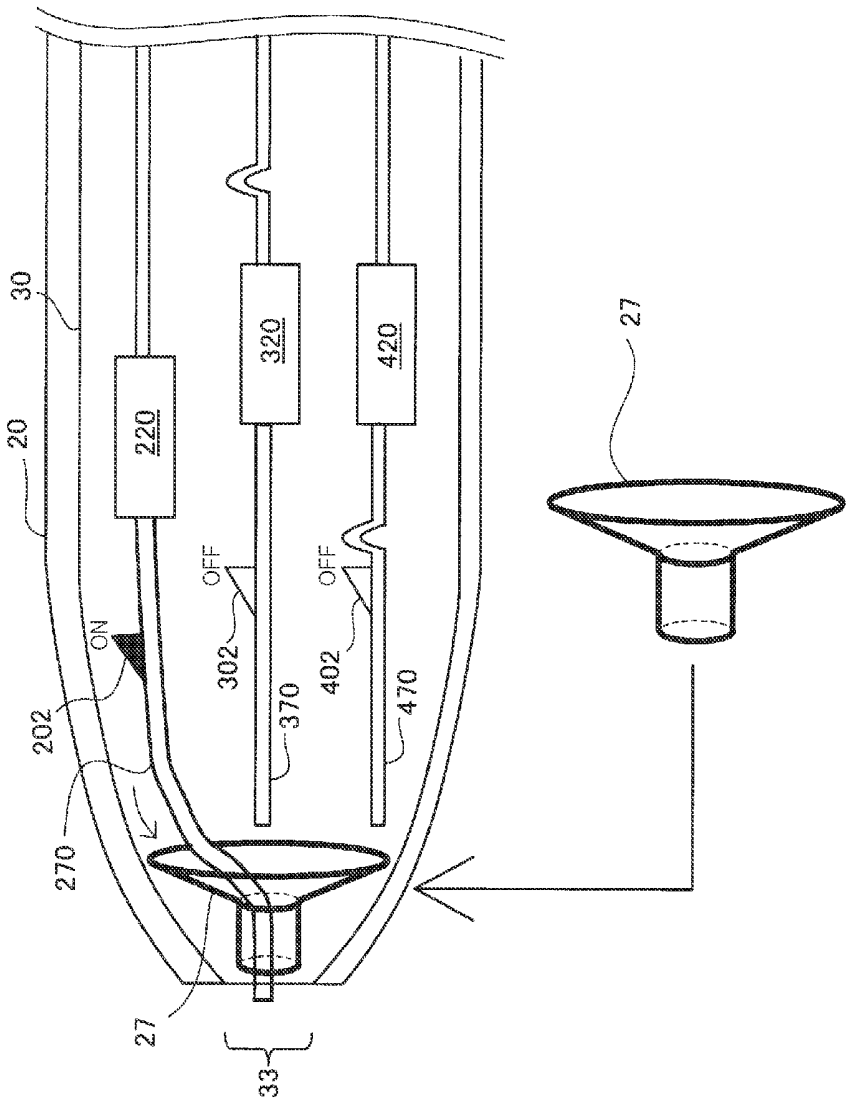


FIG. 9

LIQUID EJECTING APPARATUS FOR MEDICAL TREATMENT

[0001] This patent application claims the benefit of Japanese Patent Application No. 2013-194758, filed on Sep. 20, 2013. The content of the aforementioned application is hereby incorporated by reference in its entirety.

BACKGROUND

[0002] 1. Technical Field

[0003] The present invention relates to a technology of a liquid ejecting apparatus for medical treatment.

[0004] 2. Related Art

[0005] As surgical instruments which are used to carry out incision, excision, and the like of a biological tissue, there are known a liquid ejecting-type liquid ejecting scalpel, an electrical scalpel, an ultrasonic scalpel, and a laser scalpel (for example, JP-A-5-92009 described below).

[0006] Incidentally, medical doctors use appropriately different surgical instruments in order to carry out incision, excision, and hemostasis of a biological tissue among those surgical instruments, and thus, there has been a disadvantage that the operation has to be interrupted to switch the surgical instrument.

[0007] For example, in a case of a neurosurgical procedure, a medical doctor performs a surgical operation by using the surgical instruments while magnifying a lesion site by a microscope and the like. In the related art, medical doctors have to refocus their attention on the distal end of the surgical instrument every time they switch the surgical instrument, and thus, there has been a disadvantage that the repeated switching leads to poor concentration and physical exhaustion.

[0008] In a case of endoscopic/laparoscopic surgery, in order to replace the surgical instrument to be used, a medical doctor needs to draw the endoscope/laparoscope out of the body of a patient and to switch the distal end of the surgical instrument outside the body of the patient, thereby reinserting the endoscope/laparoscope into the patient. A series of the operations causes a disadvantage of deterioration in efficiency of the surgical operation.

[0009] For example, when employing a structure in which multiple types of scalpels are integrated, there is a disadvantage that the structure increases in size.

SUMMARY

[0010] An advantage of some aspects of the invention is to solve at least a part of the problems described above, and the invention can be implemented as the following forms.

[0011] (1) An aspect of the invention provides a liquid ejecting apparatus for medical treatment. The liquid ejecting apparatus for medical treatment includes a liquid ejecting scalpel that ejects a liquid, an ultrasonic scalpel that generates an ultrasonic wave, an inner body that accommodates the liquid ejecting scalpel and the ultrasonic scalpel and includes a first opening portion allowing a distal end portion of the liquid ejecting scalpel or a distal end portion of the ultrasonic scalpel to protrude therethrough, an outer body that accommodates the inner body and includes a second opening portion at a position corresponding to the first opening portion, a suctioning path that is made by an aperture formed between the inner body and the outer body, and a manipulation section that is arranged in the outer body and selectively causes the distal end portion of the liquid ejecting scalpel or the distal end portion of the ultrasonic scalpel to protrude through the first opening portion.

[0012] In the liquid ejecting apparatus for medical treatment of this aspect, the aperture between the outer body and the inner body has the suctioning path. The suctioning path can be commonly used with respect to different types of the scalpels. Therefore, compared to a case of having individual suctioning paths with respect to different types of the scalpels, the structure can be miniaturized.

[0013] (2) The liquid ejecting apparatus for medical treatment of the aspect described above may be configured such that the liquid ejecting apparatus for medical treatment further includes a controller that controls the liquid ejecting scalpel and the ultrasonic scalpel, and a switch that is connected to the controller and instructs a beginning of use or a cessation of use for each of the scalpels, and the controller switches functions of the switch to be associated with each scalpel based on a manipulation of the manipulation section.

[0014] With the liquid ejecting apparatus for medical treatment of this aspect, a user can instruct the beginning of use or the cessation of use for each of the scalpels by the same switch before and after the switching of the scalpel to be used.

[0015] (3) The liquid ejecting apparatus for medical treatment of the aspect described above may be configured such that the manipulation section includes a slider to which the scalpels are individually connected.

[0016] With the liquid ejecting apparatus for medical treatment of this configuration, the distal end portion of the liquid ejecting scalpel or the distal end portion of the ultrasonic scalpel can be selectively protruded through the first opening portion by the slider. A user can switch the scalpel to be used through a simple manipulation.

[0017] (4) Another aspect of the invention provides a liquid ejecting apparatus for medical treatment. The liquid ejecting apparatus for medical treatment includes a liquid ejecting scalpel that ejects a liquid, an electrical scalpel that generates a high frequency current, an inner body that accommodates the liquid ejecting scalpel and the electrical scalpel and includes a first opening portion allowing a distal end portion of the liquid ejecting scalpel or a distal end portion of the electrical scalpel to protrude therethrough, an outer body that accommodates the inner body, include a second opening portion at a position corresponding to the first opening portion, and forms a suctioning path made by an aperture formed between the inner body and the outer body, and a manipulation section that is arranged in the outer body and selectively causes the distal end portion of the liquid ejecting scalpel and the distal end portion of the electrical scalpel to protrude through the first opening portion.

[0018] In the liquid ejecting apparatus for medical treatment of this aspect, the suctioning path is included in the aperture between the outer body and the inner body. Therefore, the suctioning path can be used as a common suctioning path with respect to the different types of the scalpels. Accordingly, compared to the case of having individual suctioning paths with respect to the different types of the scalpels, the structure can be miniaturized.

[0019] (5) The liquid ejecting apparatus for medical treatment of the aspect described above may be configured such that the liquid ejecting apparatus for medical treatment further includes a controller that is connected to each of the liquid ejecting scalpel and the electrical scalpel and controls the liquid ejecting scalpel and the electrical scalpel, and a

switch that is electrically connected to the controller and instructs a beginning of use or a cessation of use for each of the scalpels, and the controller controls switching of functions of the switch to be associated with each scalpel based on a manipulation of the manipulation section.

[0020] With the liquid ejecting apparatus for medical treatment of this aspect, a user can instruct the beginning of use or the cessation of use for each of the scalpels by the same switch before and after the switching of the scalpel to be used.

[0021] (6) The liquid ejecting apparatus for medical treatment of the aspect described above may be configured such that the manipulation section includes the sliders to which each of the scalpels is individually connected.

[0022] With the liquid ejecting apparatus for medical treatment of this aspect, the distal end portion of the liquid ejecting scalpel or the distal end portion of the electrical scalpel can be selectively protruded through the first opening portion by the slider. A user can switch the scalpel to be used through a simple manipulation.

[0023] Not all of the multiple configuration elements included in each aspect of the invention described above are essential. In order to partially or entirely solve the above-described disadvantages, or in order to partially or entirely achieve the effects disclosed in this specification, it is possible to appropriately carry out a change, an elimination, replacement for another new configuration element, and a partial elimination of limited contents regarding a portion of the configuration elements among the plurality of configuration elements. In order to partially or entirely solve the above-described disadvantages, or in order to partially or entirely achieve the effects disclosed in this specification, it is possible to combine a portion or the entirety of the above-described technical features included in an aspect of the invention with a portion or the entirety of the above-described technical features included in another aspect of the invention so as to establish an individual aspect of the invention.

[0024] For example, an aspect of the invention can be implemented as an apparatus including one or more elements among the six elements such as the liquid ejecting scalpel, the ultrasonic scalpel, the inner body, the outer body, the suctioning path, and the manipulation section. In other words, the apparatus may have the liquid ejecting scalpel or need not have the same. The apparatus may have the ultrasonic scalpel or need not have the same. The apparatus may have the inner body or need not have the same. The apparatus may have the outer body or need not have the same. The apparatus may have the suctioning path or need not have the same. The apparatus may have the manipulation section or need not have the same.

[0025] The liquid ejecting scalpel may be configured to be as a liquid ejecting scalpel that ejects a liquid. The ultrasonic scalpel may be configured to be as an ultrasonic scalpel that generates an ultrasonic wave. The inner body may be configured to be as an inner body that accommodates the liquid ejecting scalpel and the ultrasonic scalpel and includes a first opening portion allowing the distal end portion of the liquid ejecting scalpel or the distal end portion of the ultrasonic scalpel to protrude therethrough. The outer body may be configured to be as an outer body that accommodates the inner body and includes the second opening portion at a position corresponding to the first opening portion. The suctioning path may be configured to be as a suctioning path that is made by an aperture formed between the inner body and the outer body. The manipulation section may be configured as a manipulation section that is arranged in the outer body and selectively causes the distal end portion of the liquid ejecting scalpel or the distal end portion of the ultrasonic scalpel to protrude through the first opening portion.

[0026] Such an apparatus can be implemented as a liquid ejecting apparatus for medical treatment as well as it can be used as another apparatus other than the liquid ejecting apparatus for medical treatment. According to the aspects described above, it is possible to solve at least one of various problems such as miniaturization of the apparatus, reduction in cost, saving of resources, facilitation in manufacturing, and enhancement of usability. A portion or the entirety of the above-described technical features according to each aspect of the liquid ejecting apparatus can be applied to the apparatus.

[0027] The invention can be implemented in various forms other than the instruments. For example, it is possible to be implemented in forms of a scalpel for medical treatment, a scalpel switching apparatus for medical treatment, a scalpel switching method for medical treatment, a liquid ejecting method, and a medical instrument.

BRIEF DESCRIPTION OF THE DRAWINGS

[0028] The invention will be described with reference to the accompanying drawings, wherein like numbers reference like elements.

[0029] FIG. **1** is a diagram illustrating a configuration of a scalpel apparatus for medical treatment.

[0030] FIG. **2** is a schematic view schematically illustrating a structure of a handpiece.

[0031] FIG. **3** is a schematic view illustrating a structure of an inner case.

[0032] FIG. **4** is a diagram illustrating a relationship between a manipulation section and a controller.

[0033] FIG. **5** is a diagram illustrating another handpiece.

[0034] FIG. **6** is a schematic view schematically illustrating a configuration of a functional portion accommodation case.

[0035] FIG. **7** is a schematic view schematically illustrating a configuration of another functional portion accommodation case.

[0036] FIG. **8** is a schematic view illustrating a state where a probe moves.

[0037] FIG. **9** is a diagram illustrating a guide member.

DESCRIPTION OF EXEMPLARY EMBODIMENTS

A. First Embodiment

A1. Scalpel Apparatus for Medical Treatment

[0038] FIG. **1** is a diagram illustrating a configuration of a scalpel apparatus **10** for medical treatment as a first embodiment of the invention. The scalpel apparatus **10** for medical treatment is a medical instrument including multiple types of scalpels for medical treatment.

[0039] The scalpel apparatus **10** for medical treatment includes a handpiece **20** and a controller **40**. The handpiece **20** accommodates a liquid ejecting scalpel **200**, an ultrasonic scalpel **300**, and an electrical scalpel **400** inside thereof.

[0040] The liquid ejecting scalpel **200** is a surgical instrument which ejects a liquid to perform incision or excision of a lesion site by a stream flow. The ultrasonic scalpel **300** is a surgical instrument which vibrates a vibrator using an ultrasonic frequency and emulsifies or destroys a biological tissue

by the vibration to perform incision or excision of a lesion site. The electrical scalpel **400** is a surgical instrument which performs incision or coagulation (hemostasis) of a lesion site by a thermic effect of a high frequency current.

[0041] The handpiece **20** includes a manipulation section **22**. The manipulation section **22** includes sliders **202**, **302**, and **402**. A user of the scalpel apparatus **10** for medical treatment selects one slider among the three sliders included in the manipulation section **22** and operates the same so that a scalpel to be used can be selected from the three scalpels accommodated in the handpiece **20**. The slider **202** is a slider to select the liquid ejecting scalpel **200**. The slider **302** is a slider to select the ultrasonic scalpel **300**. The slider **402** is a slider to select the electrical scalpel **400**. When using each of the scalpels, the user causes the slider corresponding to the scalpel to be used to be turned ON. While one slider is turned ON, the remaining sliders are turned OFF.

[0042] When a user selects and operates the slider, a distal end portion of the scalpel corresponding to the selected slider protrudes through an opening portion **33** formed in the handpiece **20**. The user performs incision, excision, hemostasis, and the like of a lesion site by bringing the distal end portion of the scalpel protruding through the opening portion **33** to be in contact or causing the distal end portion thereof to approach the lesion site.

[0043] A suctioning path **23** is formed outside the opening portion **33**. Inclusions such as excisions, blood, and a waste liquid which lie in the surrounding of the opening portion **33** are subjected to suctioning through the suctioning path **23**. The suctioning path **23** will be described later in detail.

[0044] A cable-shaped member group **25** extends from the rear end of the handpiece **20**. The cable-shaped member group **25** is a bundle of pipes and electrical wires necessary to operate the three scalpels.

[0045] The controller **40** is connected to the liquid ejecting scalpel **200**, the ultrasonic scalpel **300**, and the electrical scalpel **400**. The controller **40** controls the operations of the three scalpels. A foot switch **50** is connected to the controller **40**. When a user turns ON/OFF the foot switch **50**, the scalpel selected by the user through the manipulation section **22** is driven.

[0046] FIG. **2** is a schematic view schematically illustrating a structure of the handpiece **20**. The handpiece **20** accommodates an inner case **30** therein. The liquid ejecting scalpel **200**, the ultrasonic scalpel **300**, and the electrical scalpel **400** are accommodated in the inner case **30**.

[0047] The liquid ejecting scalpel **200** includes an actuator **220**, a liquid supply channel **240**, and a liquid ejection channel **250**. The liquid supply channel **240** is a flow channel to supply a liquid pumped from a pump (not illustrated) which is prepared outside the handpiece **20**, to the actuator **220**. The liquid supply channel **240** is composed of a member having flexibility. In the embodiment, the liquid supply channel **240** is formed with a PEEK member. The liquid supply channel **240** may be formed with various flexible members such as polyvinyl chloride, silicon, and thermoplastic elastomers. As the liquid to be supplied to the actuator **220**, it is possible to employ various liquids such as sterile water for medical use or pure water.

[0048] The actuator **220** applies a pulsation to a liquid which is supplied from the liquid supply channel **240**. The liquid applied with a pulsating flow is supplied to the liquid ejection channel **250**, thereby being ejected from a distal end of the liquid ejection channel **250** as a pulsatile liquid. The pulsatile liquid denotes a liquid in a state where a flow rate or a flow velocity is accompanied by fluctuation. As a form of ejecting a liquid in a pulsatile manner, intermittent ejection in which liquid is ejected while repeating the ejection and a pause is included. However, it is acceptable as long as the flow rate or the flow velocity of a liquid fluctuates, and thus, it does not necessarily have to be the intermittent ejection.

[0049] As illustrated in the drawing, the actuator **220** includes a first case **231**, a second case **232**, a third case **233**, a piezoelectric element **235**, a reinforcement plate **236**, and a diaphragm **237**. The first case **231** is a tubular member. An end of the first case **231** is connected to the second case **232**. Another end of the first case **231** is sealed by the third case **233**. The piezoelectric element **235** is arranged in a space formed inside the first case **231**.

[0050] The piezoelectric element **235** is a laminated piezoelectric element. One end of the piezoelectric element **235** is fixed to the diaphragm **237** via the reinforcement plate **236**. Another end of the piezoelectric element **235** is fixed to the third case **233**. The diaphragm **237** is formed with a thin metal film and a peripheral edge thereof is fixed to the first case **231**. An accommodation chamber **238** is formed between the diaphragm **237** and the second case **232**. The volume of the accommodation chamber **238** changes in response to driving of the piezoelectric element **235**.

[0051] A first flow channel **239** which allows a liquid to flow into the accommodation chamber **238** is formed in the second case **232**. The first flow channel **239** is connected to the liquid supply channel **240**. A second flow channel **234** which allows a liquid accommodated in the accommodation chamber **238** to flow out is formed in the second case **232**. The second flow channel **234** is connected to the liquid ejection channel **250**.

[0052] A drive signal at a predetermined frequency is applied from the controller **40** to the piezoelectric element **235**. The piezoelectric element **235** vibrates at a predetermined frequency upon reception of the drive signal from the controller **40**. When the piezoelectric element **235** vibrates, the volume of the accommodation chamber **238** changes via the diaphragm **237**, and then, the liquid accommodated in the accommodation chamber **238** is pressurized. A pulsation is applied to the liquid which is compressed or decompressed at a predetermined frequency. The liquid passes through the second flow channel **234** and the liquid ejection channel **250** and is ejected to the outside as the pulsatile liquid. The actuator **220** has such a configuration.

[0053] The slider **202** is connected to the liquid ejection channel **250**. When the slider **202** is slid to be turned ON, the liquid ejection channel **250** moves in a sliding direction. Then, the distal end portion of the liquid ejection channel **250** protrudes through the opening portion **33** formed in the distal end portion of the inner case **30**. The actuator **220** is fixed to the inner case **30**. Accordingly, even though the slider **202** moves, the actuator **220** does not move. The liquid ejection channel **250** is also referred to as a probe **270** for convenience of description.

[0054] The probe **270** has a sufficient length to be movable by the sliding of the slider **202**. When the slider **202** is turned OFF, the probe **270** is accommodated in the inner case **30** in a flexed state. The liquid ejection channel **250** is composed of a member having flexibility. In the embodiment, the liquid ejection channel **250** is formed with a PEEK member. The liquid ejection channel **250** may be formed with various flexible members such as polyvinyl chloride, silicon, and ther-

moplastic elastomers. The liquid ejection channel **250** may be configured of a member having elasticity. The liquid ejecting scalpel **200** has such a configuration.

[0055] The ultrasonic scalpel **300** includes an actuator **320**, an ultrasonic wave transmission body **330**, a liquid supply channel **340**, and a liquid ejection channel **350**. A configuration including the ultrasonic wave transmission body **330** and the liquid ejection channel **350** at a distal end from the actuator **320** is also referred to as a probe **370**.

[0056] The actuator **320** includes a vibrator **322** that generates an ultrasonic wave. The vibrator **322** is connected to the controller **40**. A drive signal having a predetermined voltage is applied to the vibrator **322** from the controller **40**. The vibrator **322** generates a vibrating ultrasonic wave upon reception of the drive signal. The ultrasonic wave generated by the vibrator **322** transmits the ultrasonic wave transmission body **330**, and destroys or emulsifies a biological tissue existing at a distal end of the ultrasonic wave transmission body **330**.

[0057] The liquid supply channel **340** is a flow channel to supply a liquid pumped from the pump which is prepared outside the handpiece **20**, to the distal end of the probe **270**. The liquid supplied from the liquid supply channel **340** transmits an ultrasonic wave which is transmitted to the ultrasonic wave transmission body **330**, to a lesion site. The liquid supplied from the liquid supply channel **340** performs washing of the lesion site. As the liquid, it is possible to employ various liquids such as sterile water for medical use or pure water. In the embodiment, the liquid supply channel **240** is formed with the PEEK member. The liquid supply channel **240** may be formed with various resins such as polyvinyl chloride, silicon, and thermoplastic elastomers.

[0058] In the embodiment, the probe **370** may have a configuration in which the ultrasonic wave transmission body **330** and the liquid ejection channel **350** come into contact with each other outside to be arranged in parallel. The slider **302** is connected to the probe **370**. When the slider **302** is slid to be turned ON, the probe **370** and the actuator **320** move in the sliding direction. Then, a distal end portion of the probe **370** protrudes through the opening portion **33**.

[0059] The liquid supply channel **340** has a sufficient length to be movable by the sliding of the slider **302** at the rear from the actuator **320**. The liquid supply channel **340** is composed of a member having flexibility. In the embodiment, the liquid supply channel **340** is formed with a PEEK member. The liquid supply channel **340** may be formed with various flexible members such as polyvinyl chloride, silicon, and thermoplastic elastomers. The liquid supply channel **340** may be configured of a member having elasticity. When the slider **302** is turned OFF, the liquid supply channel **340** is accommodated in the inner case **30** in a flexed state at the rear of the actuator **320**. The ultrasonic scalpel **300** has such a configuration.

[0060] The electrical scalpel **400** includes an actuator **420**, an electrical cable **440**, and a high frequency treatment electrode **450**. The high frequency treatment electrode **450** is also referred to as a probe **470**, for convenience of the description.

[0061] The electrical cable **440** is a cable that supplies electrical power to the actuator **420**. The electrical cable **440** is connected to a high frequency current generator (not illustrated) outside the handpiece **20**. The actuator **420** supplies a high frequency current which is supplied from the electrical cable **440**, to the high frequency treatment electrode **450**.

[0062] The high frequency current supplied to the high frequency treatment electrode **450** flows to a lesion site. In this case, Joule heat is generated due to a load or contact resistance resulting in coagulation of protein in the lesion site, thereby making hemostasis and the like possible.

[0063] The actuator **420** includes a switching element which performs turning ON/OFF of a high frequency current to the high frequency treatment electrode **450** upon reception of the control signal from the controller **40**. The actuator **420** further performs various types of controlling necessary to operate the electrical scalpel **400**. The switching element may be included in the high frequency current generator. The high frequency generator may be accommodated in the actuator **420**.

[0064] The slider **402** is connected to the high frequency treatment electrode **450**. When the slider **402** is slid to be turned ON, the high frequency treatment electrode **450** moves in the sliding direction. Then, a distal end of the high frequency treatment electrode **450** protrudes through the opening portion **33**. The actuator **420** is fixed to the inner case **30**. Accordingly, even though the slider **402** moves, the actuator **420** does not move.

[0065] The high frequency treatment electrode **450** is covered by an insulating resin excluding the distal end portion. The high frequency treatment electrode **450** configuring the probe **470**, and the insulating resin have flexibility. The probe **470** has a sufficient length to be movable by the sliding of the slider **402**. When the slider **402** is turned OFF, the probe **470** is accommodated in the inner case **30** in a flexed state. The electrical scalpel **400** has such a configuration.

[0066] The suctioning path **23** is formed between the handpiece **20** and the inner case **30**. The suctioning path **23** is connected to a suctioning pump (not illustrated) outside the handpiece **20**. Inclusions such as excisions excised by each of the scalpels, and a waste liquid which lie in the surrounding of the distal end portion of the handpiece **20** are subjected to suctioning through the suctioning path **23**. The suctioning path **23** is connected to a suctioning tube **24** at the rear end portion of the handpiece **20**. The suctioning tube **24** is connected to the suctioning pump (not illustrated) outside the handpiece **20**. A sucked substance sucked through the suctioning path **23** is sucked by the suctioning pump via the suctioning tube **24**, thereby being discharged outside.

[0067] FIG. **3** is a schematic view illustrating a structure of the inner case **30**. As seen in the A-direction arrow view and the cross-sectional view taken along line B-B in FIG. **3**, in the vicinity of the distal end of the handpiece **20**, the suctioning path **23** is formed throughout the entire periphery of the inner case **30** on the outside. As seen in the cross-sectional view taken along line C-C, a portion of an inner wall of the handpiece **20** and a portion of an outer wall of the inner case **30** are in contact with each other. The sliders **202**, **302**, and **402** are formed on the surface in which the handpiece **20** and the inner case **30** are in contact with each other. As seen in the cross-sectional view taken along line D-D, a portion of the inner wall of the handpiece **20** and a portion of the outer wall of the inner case **30** are in contact with each other at the rear end of the handpiece **20**.

[0068] A state in which the probe moves will be described with reference to FIG. **3**. The distal end portion of the inner case **30** is formed to have a curved shape. The curved portion of the inner case **30** is also referred to as a guide portion **26**. When the slider of each scalpel is moved forward, the guide portion **26** guides the distal end portion of the probe of each

scalpel to the opening portion **33**. The probe of each scalpel moves along the guide portion **26**, and every probe protrudes from the approximately same position of the opening portion **33**. Since the guide portion **26** is formed to have a smoothly curved shape, there is a little friction resistance between the probe and the guide portion **26** when the probe moves along the guide portion **26**, thereby allowing the probe to smoothly move.

[0069] FIG. **4** is a diagram illustrating a relationship between the manipulation section **22** and the control portion **40**. As illustrated in the drawing, the manipulation section **22** includes a sensor **28** that detects an ON/OFF state of each slider. The sensor **28** transmits a signal indicating the ON/OFF state of each slider to the controller **40**. The controller **40** receives a signal from the sensor **28**. The controller **40** controls a foot switch **50** to function as a switch to start/pause the operation of the scalpel of which the slider is turned ON, based on the ON/OFF state of each slider. A user performs the manipulation to start/pause the operation of the scalpel by using the foot switch **50** while any scalpel is used. The manipulation section **22** includes a locking function to respectively regulate only one slider among a plurality thereof to be in the ON state. The locking function allows a user to selectively use only one scalpel among the respective scalpels.

[0070] As described above, the liquid ejecting scalpel **200**, the ultrasonic scalpel **300**, and the electrical scalpel **400** are accommodated in the handpiece **20** (inner case **30**). The handpiece **20** also includes the manipulation section **22**. Therefore, the scalpel apparatus **10** for medical treatment allows a user to switch and use the each of the scalpels. Accordingly, the visual point of the user can be suppressed from moving when switching the scalpel to be used.

[0071] The liquid ejecting scalpel **200** is suitable for excising or incising a site having relatively little fibers or a site in which a minimized invasive operation is a major concern (for example, brain). The liquid ejecting scalpel **200** allows fine blood vessels or nerves to be soundly retained. The ultrasonic scalpel **300** is highly capable of destroying and emulsifying a biological tissue, thereby being suitable for excising or incising a site having relatively many fibers. The electrical scalpel is effective when performing hemostasis. Therefore, the scalpel apparatus **10** for medical treatment allows a user to use suitable scalpels, in accordance with the type of treatment.

[0072] The suctioning path **23** is formed in the aperture between the handpiece **20** and the inner case **30**. The suctioning path **23** can be used as a common suctioning path with respect to the different types of the scalpels. Accordingly, compared to the case of having individual suctioning paths with respect to the different types of the scalpels, it is possible to attain miniaturization in size, reduction in weight, simplification of the structure for the handpiece **20**. The suctioning path **23** is formed throughout the entire periphery of the opening portion **33** at the distal end of the handpiece **20**. Accordingly, compared to the configuration in which the suctioning paths are individually provided, it is possible to widen the range in which inclusions in the surrounding of the opening portion **33** can be sucked.

[0073] Since the inner case **30** includes the guide portion **26**, when each of the sliders is slid, the distal end of the probe of each scalpel protrudes from the approximately same position of the opening portion **33**. Accordingly, the visual point of the user can be suppressed to be minimized from moving when switching the scalpel to be used. Therefore, poor concentration and physical exhaustion of a user during the surgical operation can be suppressed.

[0074] The controller **40** controls the foot switch **50** to function as a switch to start/pause the operation of the scalpel of which the slider is turned ON, in accordance with the ON/OFF state of each slider. Accordingly, a user can manipulate the beginning of use or the cessation of use for each of the scalpels by using the same foot switch before and after the switching of the scalpel to be used.

[0075] The slider **202** included in the liquid ejecting scalpel **200** is connected to the probe **270**. When the slider **202** is slid, only the probe **270** moves, and the actuator **220** maintains a state of being fixed to the inner case **30**. Accordingly, when manipulating the slider, a user can slide the slider **202** by a relatively small force. Since the actuator **220** is fixed to the inner case **30**, when the slider **202** slides, movements of a centroid of the inner case **30** itself can be suppressed.

B. Second Embodiment

[0076] A second embodiment of the invention will be described. FIG. **5** is a diagram illustrating a handpiece **20***a* in the second embodiment. The difference between the second embodiment and the first embodiment is that a laser scalpel **500** is accommodated in an inner case **30***a*, and the scalpels are respectively accommodated in cases inside the inner case **30***a*. The laser scalpel **500** is a medical scalpel performing incision and excision of a biological tissue by using heat energy of a laser beam. As illustrated in the drawing, the liquid ejecting scalpel **200**, the ultrasonic scalpel **300**, the electrical scalpel **400**, and the laser scalpel **500** are accommodated in the inner case **30***a*.

[0077] The liquid ejecting scalpel **200** includes a functional portion accommodation case **210**. The probe **270** is stretched from the front of the functional portion accommodation case **210**. A cable-shaped member group **212** is stretched from the rear of the functional portion accommodation case **210**. The cable-shaped member group **212** includes the liquid supply channel **240** and a control wire through which a drive signal to drive the piezoelectric element **235** is transmitted (refer to FIG. **2**). The slider **202** is connected to the functional portion accommodation case **210**.

[0078] The ultrasonic scalpel **300** includes a functional portion accommodation case **310**. The probe **370** is stretched from the front of the functional portion accommodation case **310**. A cable-shaped member group **312** is stretched from the rear of the functional portion accommodation case **310**. The cable-shaped member group **312** includes the liquid supply channel **340** (refer to FIG. **2**). The slider **302** is connected to the functional portion accommodation case **310**.

[0079] The electrical scalpel **400** includes a functional portion accommodation case **410**. The probe **470** is stretched from the front of the functional portion accommodation case **410**. A cable-shaped member group **412** is stretched from the rear of the functional portion accommodation case **410**. The cable-shaped member group **412** includes the electrical cable **440** (refer to FIG. **2**). The slider **402** is connected to the functional portion accommodation case **410**.

[0080] The laser scalpel **500** includes a functional portion accommodation case **510**. A probe **570** is stretched from the front of the functional portion accommodation case **510**. A cable-shaped member group **512** is stretched from the rear of the functional portion accommodation case **510**. The cable-shaped member group **512** includes an optical fiber to trans-

mit laser light. A slider **502** is connected to the functional portion accommodation case **510**.

[0081] In the embodiment, when each of the sliders is slid, each of the probes and the functional portion accommodation cases moves. When the slider of each scalpel is turned OFF, the cable-shaped member groups **212**, **312**, **412**, and **512** are accommodated in the inner case **30***a* at the rear of each functional portion accommodation case in a flexed state. When the slider of each scalpel is turned ON, each of the flexed cable-shaped member groups is in an extended state. Similar to the first embodiment, when the slider of each scalpel is turned ON, each probe is guided to the opening portion **33** by a guide portion **26***a* included in the inner case **30***a*, thereby protruding through the opening portion **33**.

[0082] The cable-shaped member group of each of the scalpels may include another pipe and wire in accordance with the function included in each of the scalpels, in addition to the configuration described above. The cable-shaped member group **212**, the cable-shaped member group **312**, the cable-shaped member group **412**, and the cable-shaped member group **512** configure a cable-shaped member group **25***a* as a bundle. The cable-shaped member group **25***a* is stretched from the rear of the handpiece **20***a*.

[0083] FIG. **6** is a schematic view schematically illustrating a configuration of the functional portion accommodation case **210**. The actuator **220**, the liquid supply channel **240**, and the liquid ejection channel **250** are accommodated in the functional portion accommodation case **210**. In the embodiment, the liquid supply channel **240** is connected to the front surface of the actuator **220**. Regarding the function of each configuration, the description has been given in the first embodiment, thereby omitting the description.

[0084] The description for the functional portion accommodation case **310** with reference to the drawing will be omitted. The actuator **320** (FIG. **2**) is accommodated in the functional portion accommodation case **310**.

[0085] The description for the functional portion accommodation case **410** with reference to the drawing will be omitted. The actuator **420** (FIG. **2**) is accommodated in the functional portion accommodation case **410**.

[0086] FIG. **7** is a diagram schematically illustrating a configuration of the functional portion accommodation case **510**. In the functional portion accommodation case **510**, an optical fiber **550** through which a laser beam passes through, and a liquid supply channel **540** to which a liquid is supplied communicate with each another. The liquid supply channel **540** is inserted into the optical fiber **550**.

[0087] FIG. **8** is a schematic view illustrating another state where the probe moves. The inner case **30***a* includes the curved-shaped guide portion **26***a*. In the embodiment, when each of the sliders is slid, each of the functional portion accommodation cases of the scalpels moves. The guide portion **26***a* respectively guides the distal end portions of the probes of the scalpels to the opening portion **33** when the sliders of each of the scalpels are moved forward. The probes of the scalpels respectively move along the guide portion **26**, and every probe protrudes from the approximately same position of the opening portion **33**.

[0088] As illustrated above, each of the scalpels in the embodiment is individually accommodated in the cases inside the inner case **30***a*. Each of the sliders is connected to each of the cases. When each of the slider is slid, each of the cases and the probes moves. Accordingly, when each of the slider is OFF, the cable-shaped member group of each of the scalpels is accommodated in the inner case **30***a* in a flexed state. Accordingly, when each of the slider is turned OFF, it is possible to avoid the probe portion to be accommodated in a flexed state. Therefore, the distal end portion of the handpiece **20***a* (inner case **30***a*) can be thinned. Since each of the scalpels is individually accommodated in the functional portion accommodation case inside the inner case **30***a*, it is possible to improve the durability thereof.

C. Modification Example

[0089] The invention is not limited to the embodiments described above and can be embodied in various aspects without departing from the scope of the invention. For example, following modifications can also be made.

C1. Modification Example 1

[0090] In the scalpel apparatus **10** for medical treatment, the guide portion **26** is the curved portion formed in the inner case **30**. However, a guide member **27** may be separately included therein. FIG. **9** is a diagram illustrating the guide member **27**. As illustrated in the drawing, the guide member **27** has a structure in which a cylindrical member **27***b* is connected to the center of a conical-shaped member **27***a*. The guide member **27** is fixed to the distal end inside the inner case **30**. When the slider of each of the scalpels is slid to be in the ON state, the probe is guided from the conical-shaped member **27***a* to the cylindrical member **27***b*, thereafter, the probe is guided to the opening portion **33**. The inner case **30** in a Modification Example 1 separately includes the guide member **27**, and thus, there is no need to form the guide portion **26** at the distal end portion of the inner case **30**. Therefore, the shapes for the distal end portion of the handpiece **20** and the distal end portion of the inner case **30** are not limited. For example, a user can form the distal ends of the handpiece **20** and the inner case **30** to have a shape so as to be easily grasped.

C2. Modification Example 2

[0091] The ultrasonic scalpel **300** may be configured not to have the liquid ejecting channel **350**. It is possible to attain the miniaturization of the handpiece **20** (inner case **30**).

C3. Modification Example 3

[0092] In the scalpel for medical treatment as a liquid ejecting apparatus for medical treatment of the embodiments, a user can switch and use each of the scalpels by the manipulation section as described above. In other words, the scalpel apparatus **10** for medical treatment can be used by the following usage method.

[0093] There is provided a method of using a liquid ejecting apparatus for medical treatment including a liquid ejecting scalpel that includes a liquid ejecting portion ejecting a liquid and a pulsating flow applier applying a pulsating flow to the liquid, an ultrasonic scalpel that has an ultrasonic wave generation portion generating a ultrasonic wave, an electrical scalpel provided with a high frequency treatment electrode, an inner body that accommodates the liquid ejecting scalpel, the ultrasonic scalpel, and the electrical scalpel and includes a first opening portion through which a distal end portion of the liquid ejecting scalpel, a distal end portion of the ultrasonic scalpel, or a distal end portion of the electrical scalpel can protrude, an outer body that accommodates the inner body, includes a second opening portion at a position corre-

sponding to the first opening portion, and forms a suctioning path made by an aperture formed between the inner body and the outer body, and a manipulation section that is arranged in the outer body and selectively causes the distal end portion of the liquid ejecting scalpel and the distal end portion of the ultrasonic scalpel to protrude through the first opening portion.

[0094] The method of using a liquid ejecting apparatus for medical treatment includes at least using one scalpel, switching from one scalpel to another scalpel by manipulating the manipulation section, and using another scalpel.

[0095] According to the method of using a liquid ejecting apparatus for medical treatment, a user using the liquid ejecting apparatus for medical treatment can be suppressed in the visual point oriented to the distal end of the scalpel from being moving when switching the scalpel to be used.

C4. Modification Example 4

[0096] In addition to Modification Example 3, the liquid ejecting apparatus for medical treatment can be used as follows.

[0097] There is provided the method of using a liquid ejecting apparatus for medical treatment disclosed in Modification Example 3. The liquid ejecting apparatus for medical treatment further includes a controller that controls each of the scalpels, and a switch that instructs a beginning of use and a cessation of use for each of the scalpels. The liquid ejecting apparatus for medical treatment includes selecting one scalpel by manipulating the manipulation section, beginning use of one scalpel by manipulating the switch, ceasing use of one scalpel by manipulating the switch, selecting another scalpel by manipulating the manipulation section, beginning use of another scalpel by manipulating the switch, ceasing use of another scalpel by manipulating the switch.

[0098] According to the method of using the liquid ejecting apparatus for medical treatment, a user can instruct the beginning of use or the cessation of use for each of the scalpels by using the same switch before and after the switching of the scalpel to be used.

What is claimed is:

1. A liquid ejecting apparatus for medical treatment comprising:
- a liquid ejecting scalpel that ejects a liquid;
- an ultrasonic scalpel that generates an ultrasonic wave;
- an inner body that accommodates the liquid ejecting scalpel and the ultrasonic scalpel and includes a first opening portion allowing a distal end portion of the liquid ejecting scalpel or a distal end portion of the ultrasonic scalpel to protrude therethrough;
- an outer body that accommodates the inner body and includes a second opening portion at a position corresponding to the first opening;
- a suctioning path that is made by an aperture formed between the inner body and the outer body; and
- a manipulation section that is arranged in the outer body and selectively causes the distal end portion of the liquid ejecting scalpel or the distal end portion of the ultrasonic scalpel to protrude through the first opening portion.

2. The liquid ejecting apparatus for medical treatment according to claim **1**, further comprising:
- a controller that controls the liquid ejecting scalpel and the ultrasonic scalpel; and
- a switch that is connected to the controller and instructs a beginning of use or a cessation of use for each of the scalpels,
- wherein the controller switches functions of the switch to be associated with each scalpel based on a manipulation of the manipulation section.

3. The liquid ejecting apparatus for medical treatment according to claim **1**,
- wherein the manipulation section includes a slider to which the scalpels are individually connected.

4. A liquid ejecting apparatus for medical treatment comprising:
- a liquid ejecting scalpel that ejects a liquid;
- an electrical scalpel that generates a high frequency current;
- an inner body that accommodates the liquid ejecting scalpel and the electrical scalpel and includes a first opening portion allowing a distal end portion of the liquid ejecting scalpel or a distal end portion of the electrical scalpel to protrude therethrough;
- an outer body that accommodates the inner body, includes a second opening portion at a position corresponding to the first opening portion, and forms a suctioning path made by an aperture formed between the inner body and the outer body; and
- a manipulation section that is arranged in the outer body and selectively causes the distal end portion of the liquid ejecting scalpel and the distal end portion of the electrical scalpel to protrude through the first opening portion.

5. The liquid ejecting apparatus for medical treatment according to claim **4**, further comprising:
- a controller that controls the liquid ejecting scalpel and the electrical scalpel; and
- a switch that is connected to the controller and instructs a beginning of use or a cessation of use for each of the scalpels,
- wherein the controller switches functions of the switch to be associated with each scalpel based on a manipulation of the manipulation section.

6. The liquid ejecting apparatus for medical treatment according to claim **4**,
- wherein the manipulation section includes the sliders to which the scalpels are respectively connected one on one.

* * * * *

专利名称(译)	用于医疗的液体喷射装置		
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[标]申请(专利权)人(译)	精工爱普生株式会社		
申请(专利权)人(译)	SEIKO EPSON CORPORATION		
当前申请(专利权)人(译)	SEIKO EPSON CORPORATION		
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摘要(译)

一种用于医疗的液体喷射装置，包括喷射液体的液体喷射手术刀，产生超声波的超声波手术刀，容纳液体喷射手术刀和超声波手术刀的内部主体，并包括允许远端部分的第一开口部分。液体喷射手术刀或超声手术刀的远端部分从中伸出的外部主体，容纳内部主体并包括在与第一开口部分对应的位置处的第二开口部分，由第一开口部分制成的抽吸路径在内体和外体之间形成的孔，以及设置在外体中并且选择性地使液体喷射手术刀的远端部分或超声手术刀的远端部分突出穿过第一开口部分的操作部分。