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

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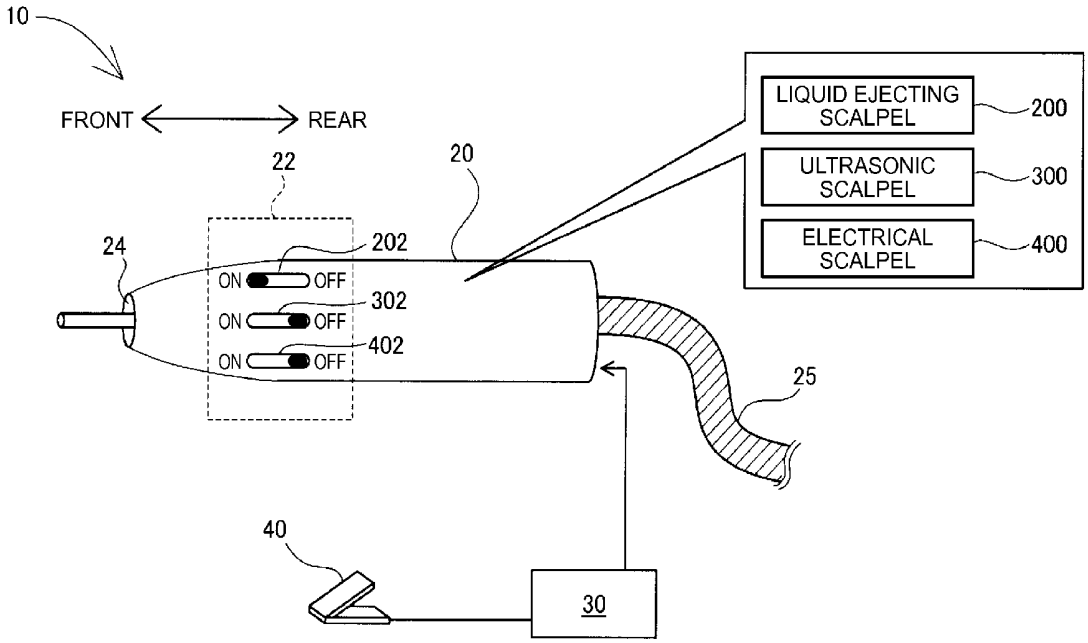
(57) **ABSTRACT**

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 outer case that accommodates the liquid ejecting scalpel and the ultrasonic scalpel and includes an opening portion allowing a distal end portion of the liquid ejecting scalpel or a distal end portion of the ultrasonic scalpel to protrude therethrough, a guide portion that is arranged in the outer case and guides the distal end portion of the liquid ejecting scalpel or the distal end portion of the ultrasonic scalpel to the opening portion, and a manipulation section that is arranged in the outer case 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 opening portion.



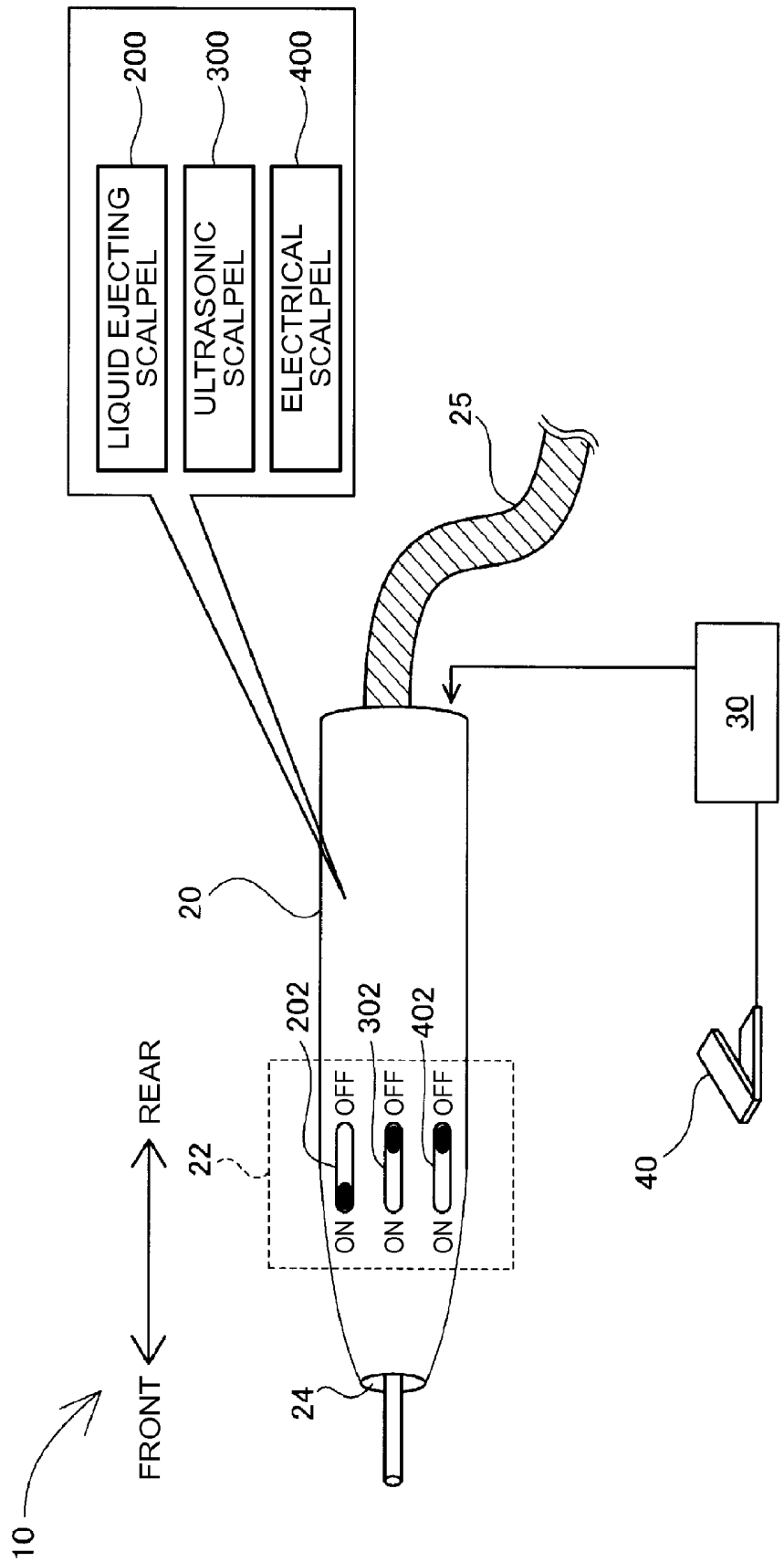

200
300
400
LIQUID EJECTING SCALPEL
ULTRASONIC SCALPEL
ELECTRICAL SCALPEL
25
30
20
202
302
402
OFF
OFF
OFF
ON
ON
ON
22
REAR
FRONT
24
40
10

FIG. 1

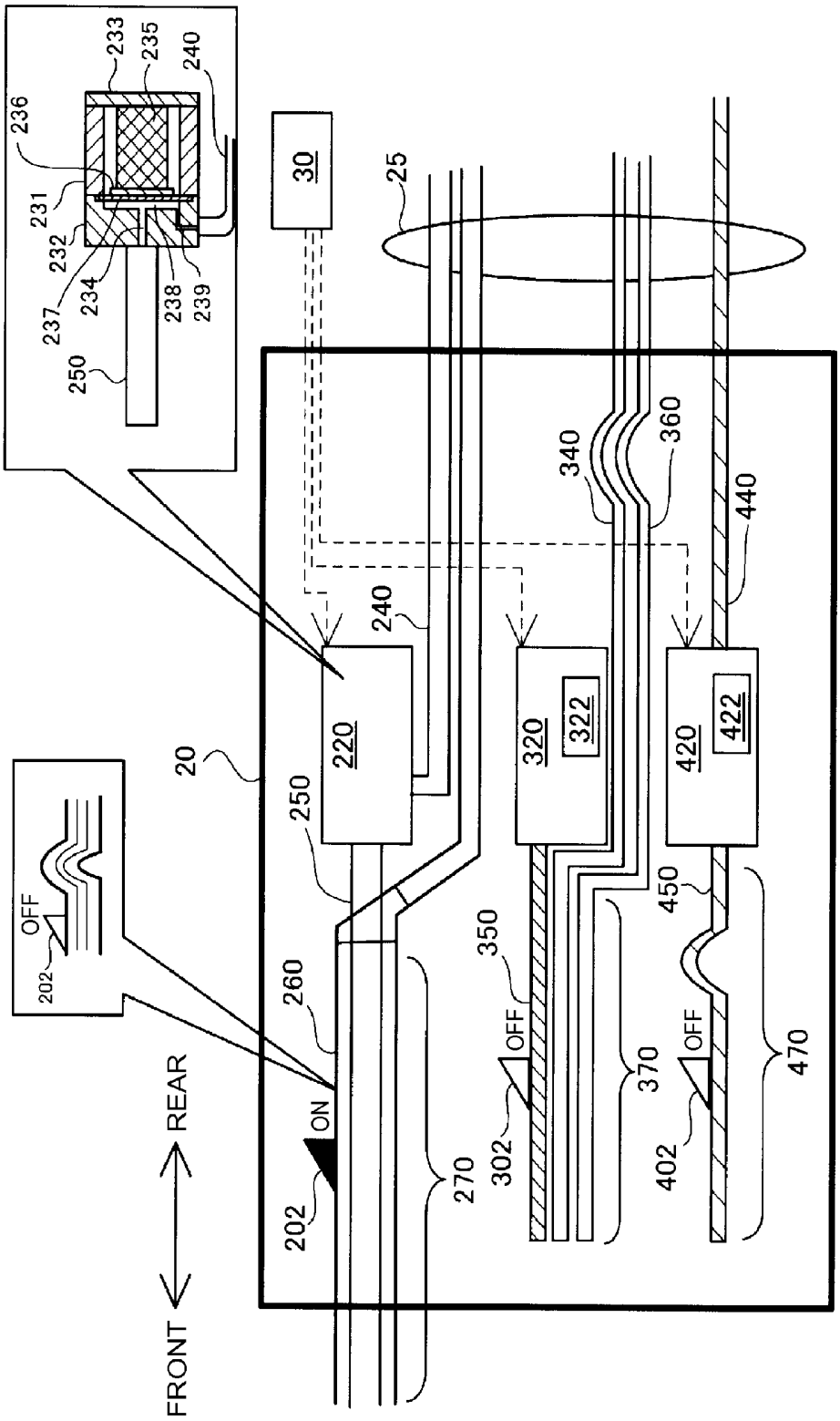

233
235
240
236
231
232
234
237
238
239
250
30
25
340
360
440
240
220
320
322
420
422
20
250
OFF
202
260
ON
202
350
OFF
302
450
OFF
402
370
270
470
FRONT
REAR

FIG. 2

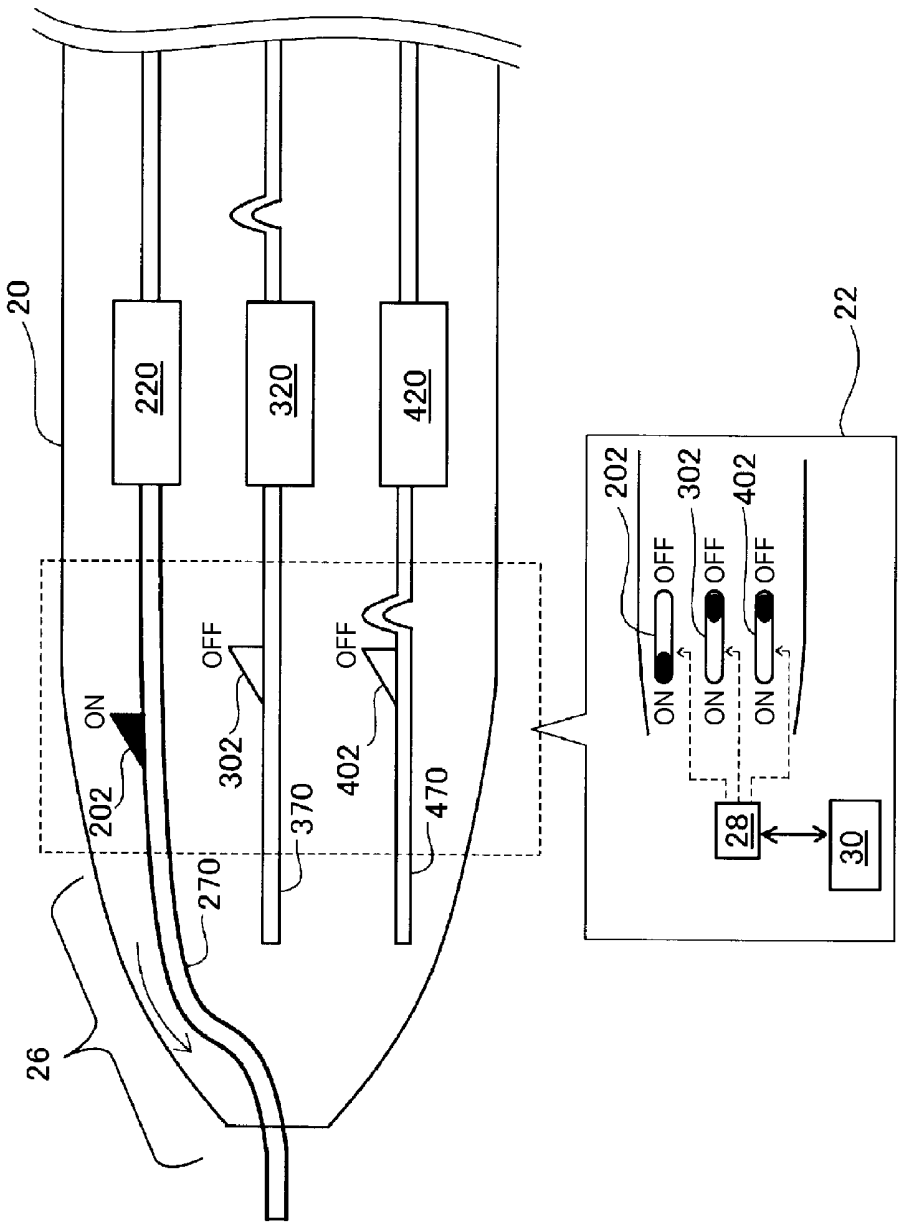


FIG. 3

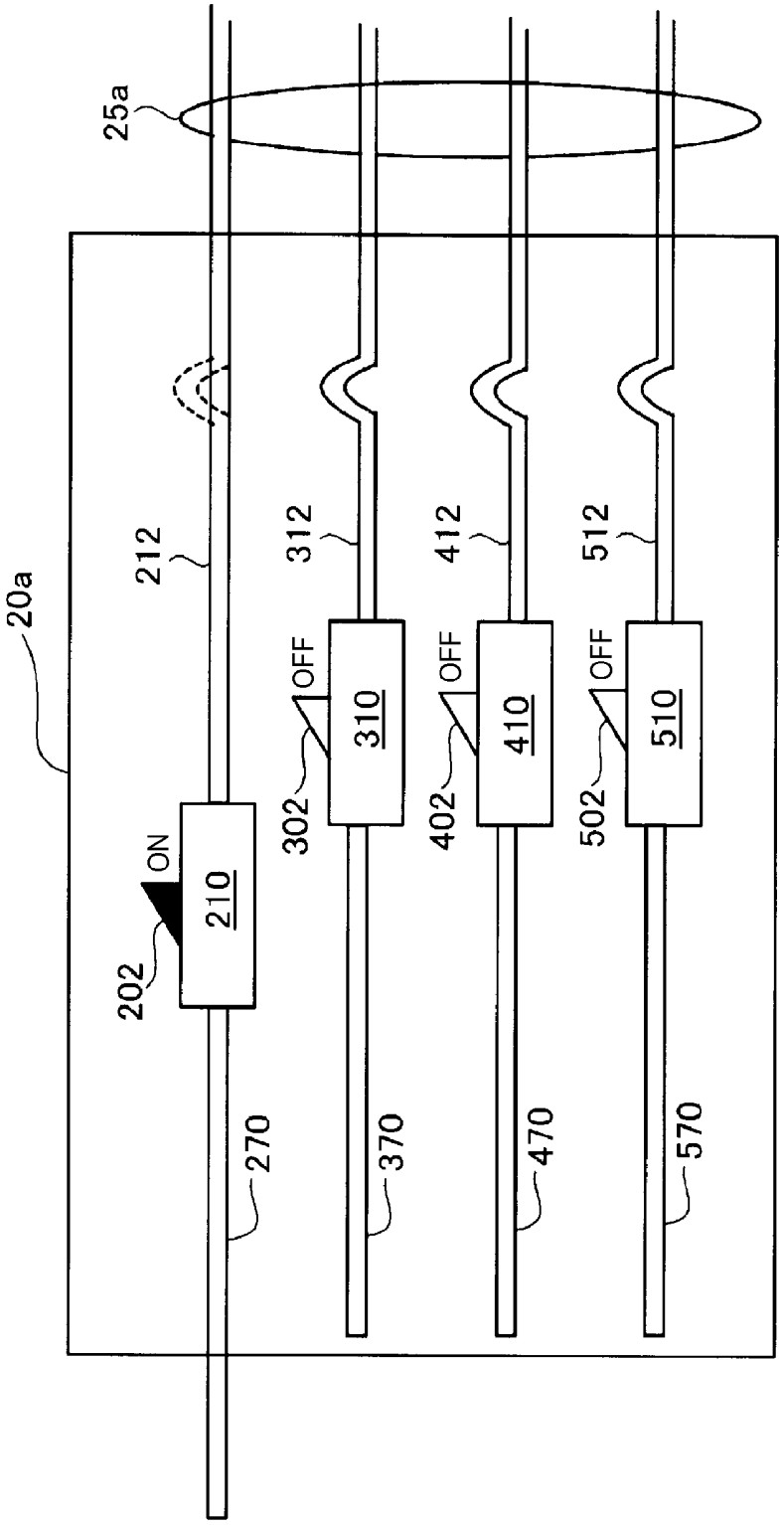

25a
20a
212
312
412
512
ON
OFF
OFF
OFF
210
310
410
510
202
302
402
502
270
370
470
570

FIG. 4

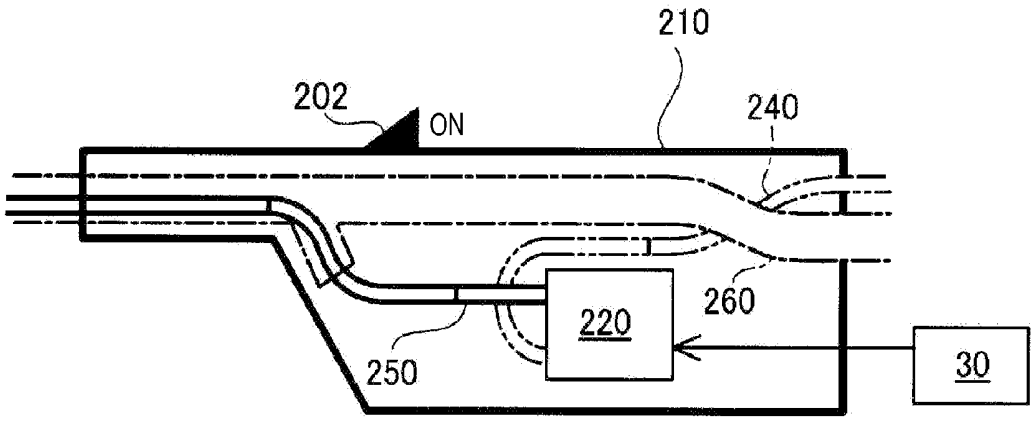


FIG. 5

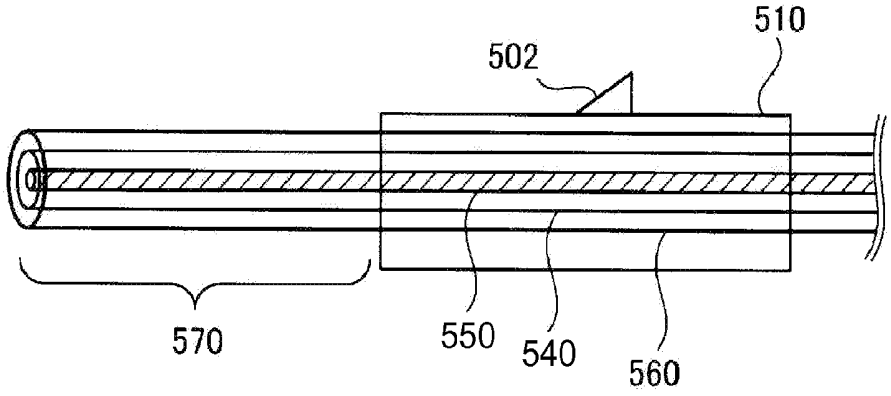


FIG. 6

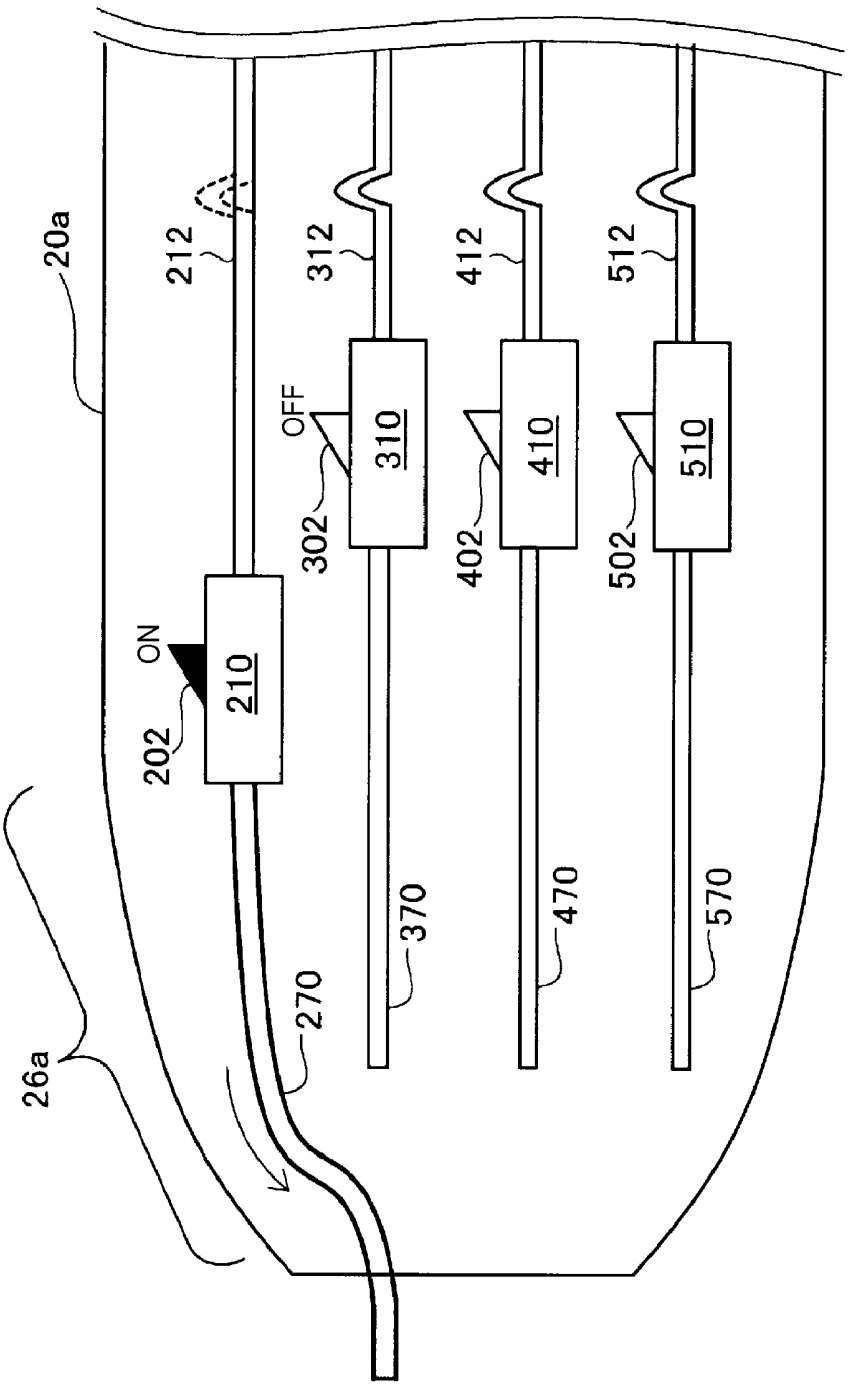

20a
212
312
412
512
OFF
310
410
510
302
402
502
ON
210
202
370
470
570
270
26a

FIG. 7

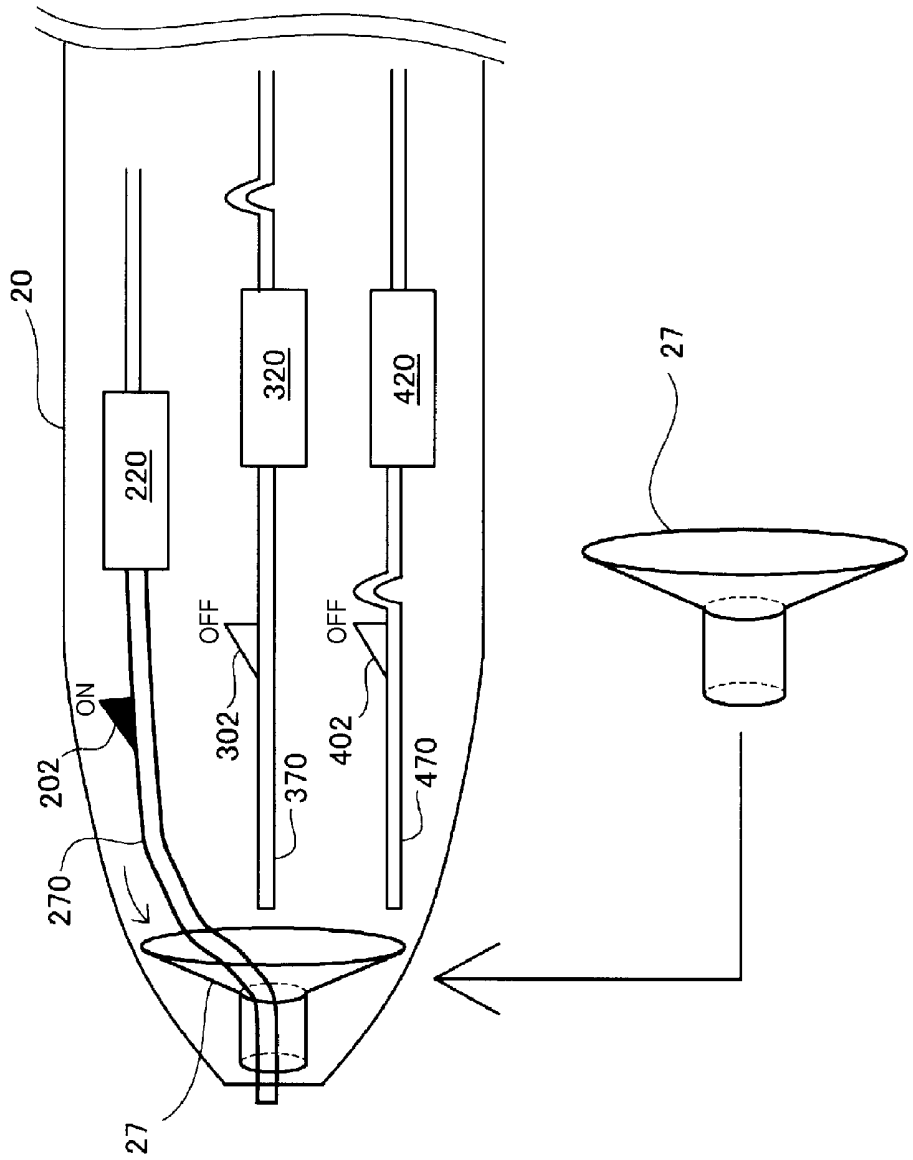


FIG. 8

LIQUID EJECTING APPARATUS FOR MEDICAL TREATMENT

[0001] This application claims the benefit of Japanese Patent Application No. 2013-194756, 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, hemostasis, 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. The medical doctor needs to perform the surgical operation while checking the surgical instrument and the lesion site through the microscope. 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.

SUMMARY

[0009] 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.

[0010] (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 outer case that accommodates the liquid ejecting scalpel and the ultrasonic scalpel and includes an opening portion allowing a distal end portion of the liquid ejecting scalpel or a distal end portion of the ultrasonic scalpel to protrude therethrough, a guide portion that is arranged in the outer case and guides the distal end portion of the liquid ejecting scalpel or the distal end portion of the ultrasonic scalpel to the opening portion, and a manipulation section that is arranged in the outer case 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 opening portion.

[0011] In the liquid ejecting apparatus for medical treatment of this aspect, since the guide portion is included, when a user manipulates the manipulation section, it is possible to cause the distal end portion of the liquid ejecting scalpel or the distal end portion of the ultrasonic scalpel to protrude from the approximately same position before and after the manipulation. Accordingly, it is possible to suppress the visual point of the user oriented to a distal end of the scalpel from moving before and after the switching of the scalpel.

[0012] (2) The liquid ejecting apparatus for medical treatment of the aspect described above maybe 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 electrically connected to the controller and designates 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 of the scalpels based on a manipulation of the manipulation section.

[0013] With the liquid ejecting apparatus for medical treatment of this aspect, a user can manipulate 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.

[0014] (3) The liquid ejecting apparatus for medical treatment of the aspect described above maybe configured such that the manipulation section includes a plurality of sliders to which the scalpels are connected respectively, the liquid ejecting scalpel includes a communication channel through which a pulsating flow applier applying a pulsation to a liquid and a liquid ejecting portion ejecting the liquid to which a pulsation is applied communicate with each other, the slider connected to the liquid ejecting scalpel is connected to the communication channel, and the communication channel is composed of a tubular-shaped member having flexibility.

[0015] In the liquid ejecting apparatus for medical treatment of this aspect, since the slider connected to the liquid ejecting scalpel is connected to the communication channel, when a user slides the slider, it is possible to cause the distal end portion of the liquid ejecting scalpel to protrude through the opening portion by sliding the communication channel.

[0016] (4) The liquid ejecting apparatus for medical treatment of the aspect described above maybe configured such that the manipulation section includes a plurality of sliders to which each of the scalpels is connected respectively, the liquid ejecting scalpel includes a pulsating flow applier which applies a pulsation to a liquid and a liquid ejecting portion which ejects the liquid to which a pulsation is applied, and the slider connected to the liquid ejecting scalpel is connected to a functional portion of the liquid ejecting scalpel including the liquid ejecting portion.

[0017] With the liquid ejecting apparatus for medical treatment of this aspect, since the slider connected to the liquid ejecting scalpel is connected to the functional portion of the liquid ejecting scalpel, when a user slides the slider, it is possible to cause the distal end portion of the liquid ejecting scalpel to protrude through the opening portion by sliding the functional portion.

[0018] (5) 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 outer case that accommodates the liquid ejecting scalpel and the electrical scalpel and includes an opening portion allowing a distal end portion of

the liquid ejecting scalpel or a distal end portion of the electrical scalpel to protrude therethrough, a guide portion that guides the distal end portion of the liquid ejecting scalpel or the distal end portion of the electrical scalpel to the opening portion, and a manipulation section that is arranged in the outer case and selectively causes the distal end portion of the liquid ejecting scalpel or the distal end portion of the electrical scalpel to protrude through the opening portion.

[0019] With the liquid ejecting apparatus for medical treatment of this aspect, since the guide portion is included, when a user manipulates the manipulation section, it is possible to cause the distal end portion of the liquid ejecting scalpel or the distal end portion of the electrical scalpel to protrude from the approximately same position before and after the manipulation. Accordingly, it is possible to suppress the visual point of the user oriented to a distal end of the scalpel from moving before and after the switching of the scalpel.

[0020] (6) The liquid ejecting apparatus for medical treatment of the aspect described above maybe configured such that the liquid ejecting apparatus for medical treatment further includes a controller that controls the liquid ejecting scalpel and the electrical scalpel, and a switch that is electrically connected to the controller and designates 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 of the scalpels based on a manipulation of the manipulation section.

[0021] With the liquid ejecting apparatus for medical treatment of this case, a user can manipulate 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.

[0022] (7) The liquid ejecting apparatus for medical treatment of the aspect described above maybe configured such that the manipulation section includes a plurality of sliders to which the scalpels are connected respectively, the liquid ejecting scalpel includes a communication channel through which a pulsating flow applier applying a pulsation to a liquid and a liquid ejecting portion ejecting the liquid to which a pulsation is applied communicate with each other, the slider connected to the liquid ejecting scalpel is connected to the communication channel, and the communication channel is composed of a tubular-shaped member having flexibility.

[0023] With the liquid ejecting apparatus for medical treatment of this case, since the slider of the liquid ejecting scalpel is connected to the communication channel, when a user slides the slider, it is possible to cause the distal end portion of the liquid ejecting scalpel to protrude through the opening portion by sliding the communication channel.

[0024] (8) The liquid ejecting apparatus for medical treatment of the aspect described above maybe configured such that the manipulation section includes a plurality of sliders to which each of the scalpels is connected respectively, the liquid ejecting scalpel includes a pulsating flow applier which applies a pulsation to a liquid and a liquid ejecting portion which ejects the liquid to which a pulsation is applied, and the slider connected to the liquid ejecting scalpel is connected to a functional portion of the liquid ejecting scalpel including the liquid ejecting portion.

[0025] With the liquid ejecting apparatus for medical treatment of this aspect, since the slider connected to the liquid ejecting scalpel is connected to the functional portion of the liquid ejecting scalpel, when a user slides the slider, it is possible to cause the distal end portion of the liquid ejecting scalpel to protrude through the opening portion by sliding the functional portion.

[0026] 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.

[0027] For example, an aspect of the invention can be implemented as an apparatus including one or more elements among the five elements such as the liquid ejecting scalpel, the ultrasonic scalpel, the outer case, the guide portion, 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 outer case or need not have the same. The apparatus may have the guide portion or need not have the same. The apparatus may have the manipulation section or need not have the same.

[0028] 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 outer case may be configured to be as an outer case that accommodates the liquid ejecting scalpel and the ultrasonic scalpel and includes an opening portion allowing a distal end portion of the liquid ejecting scalpel or a distal end portion of the ultrasonic scalpel to protrude therethrough. The guide portion may be configured to be as a guide portion that is arranged in the outer case and guides the distal end portion of the liquid ejecting scalpel or the distal end portion of the ultrasonic scalpel to the opening portion. The manipulation section may be configured to be as a manipulation section that is arranged in the outer case and selectively causes the distal end portion of the liquid ejecting apparatus or the distal end portion of the ultrasonic scalpel to protrude through the opening portion.

[0029] 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.

[0030] The invention can be implemented in various forms other than the apparatus described above. For example, it is possible to be implemented in forms of a scalpel for medical treatment, a scalpel switching apparatus for medical treat-

ment, a scalpel switching method for medical treatment, a liquid ejecting method, and a medical instrument.

BRIEF DESCRIPTION OF THE DRAWINGS

[0031] The invention will be described with reference to the accompanying drawings, wherein like numbers reference like elements.

[0032] FIG. **1** is a diagram illustrating a configuration of a scalpel apparatus for medical treatment.

[0033] FIG. **2** is a schematic view schematically illustrating a structure of a handpiece.

[0034] FIG. **3** is a schematic view illustrating a state where a probe moves.

[0035] FIG. **4** is a diagram illustrating the handpiece in a second embodiment.

[0036] FIG. **5** is a schematic view schematically illustrating a configuration of a functional portion accommodation case.

[0037] FIG. **6** is a diagram schematically illustrating a configuration of the functional portion accommodation case.

[0038] FIG. **7** is a schematic view illustrating another state where the probe moves.

[0039] FIG. **8** is a diagram illustrating a guide member.

DESCRIPTION OF EXEMPLARY EMBODIMENTS

A. First Embodiment

A1. Scalpel Apparatus for Medical Treatment

[0040] 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.

[0041] The scalpel apparatus **10** for medical treatment includes a handpiece **20** and a controller **30**. The handpiece **20** accommodates a liquid ejecting scalpel **200**, an ultrasonic scalpel **300**, and an electrical scalpel **400** inside thereof.

[0042] 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.

[0043] 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.

[0044] 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 **24** 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 **24** to be in contact or causing the distal end portion thereof to approach the lesion site.

[0045] 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.

[0046] The controller **30** is connected to the liquid ejecting scalpel **200**, the ultrasonic scalpel **300**, and the electrical scalpel **400**. The controller **30** controls the operations of the three scalpels. A foot switch **40** is connected to the controller **30**. When a user turns ON/OFF the foot switch **40**, the scalpel selected by the user through the manipulation section **22** is driven.

[0047] FIG. **2** is a schematic view schematically illustrating a structure of the handpiece **20**. As described above, the liquid ejecting scalpel **200**, the ultrasonic scalpel **300**, and the electrical scalpel **400** are accommodated in the handpiece **20**.

[0048] The liquid ejecting scalpel **200** includes an actuator **220**, a liquid supply channel **240**, a liquid ejection channel **250**, and a suctioning channel **260**. 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.

[0049] 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.

[0050] 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**.

[0051] 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**.

[0052] 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**.

[0053] A drive signal at a predetermined frequency is applied from the controller **30** to the piezoelectric element **235**. The piezoelectric element **235** vibrates at a predetermined frequency upon reception of the drive signal from the controller **30**. 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.

[0054] The suctioning channel **260** is connected to a suctioning pump (not illustrated) outside the handpiece **20**. Excision which is excised by a liquid ejected from the liquid ejection channel **250**, a waste liquid, or the like are subjected to suctioning through the suctioning channel **260**. In the embodiment, the liquid ejection channel **250** is inserted into the suctioning channel **260** at a distal end portion of the handpiece **20**. The suctioning channel **260** may be configured to be arranged so as to abut on the outside of the liquid ejection channel **250** in parallel thereto.

[0055] The slider **202** is connected to the suctioning channel **260**. When the slider **202** is slid to be turned ON, the liquid ejection channel **250** and the suctioning channel **260** move in a sliding direction. Then, distal end portions of the liquid ejection channel **250** and the suctioning channel **260** protrude through the opening portion **24**. The actuator **220** is fixed to the handpiece **20**. Accordingly, even though the slider **202** moves, the actuator **220** does not move. The state where the slider **202** and the liquid ejection channel **250** are connected to each other includes a case where the suctioning channel **260** moves by the movement of the slider **202** and the liquid ejection channel **250** moves in accordance with the movement of the suctioning channel **260**, as in the embodiment. A piping configuration configured to have the liquid ejection channel **250** and the suctioning channel **260** at a distal end from the actuator **220** is also referred to as a probe **270**.

[0056] 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 handpiece **20** in a flexed state. The liquid ejection channel **250** and the suctioning channel **260** are configured of members having flexibility. In the embodiment, the liquid ejection channel **250** and the suctioning channel **260** are formed with PEEK members . The liquid ejection channel **250** and the suctioning channel **260** may be formed with various flexible members such as polyvinyl chloride, silicon, and thermoplastic elastomers. The liquid ejection channel **250** and the suctioning channel **260** may be configured of members having elasticity. The liquid ejecting scalpel **200** has such a configuration.

[0057] The ultrasonic scalpel **300** includes an actuator **320**, an ultrasonic wave transmission body **330**, a liquid supply channel **340**, a liquid ejection channel **350**, and a suctioning channel **360**. A configuration including the ultrasonic wave transmission body **330**, the liquid ejection channel **350**, and the suctioning channel **260** at a distal end from the actuator **320** is also referred to as a probe **370**.

[0058] The actuator **320** includes a vibrator **322** that generates an ultrasonic wave. The vibrator **322** is connected to the controller **30**. A drive signal having a predetermined voltage is applied to the vibrator **322** from the controller **30**. 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**.

[0059] 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.

[0060] The suctioning channel **360** is connected to the suctioning pump (not illustrated) outside the handpiece **20**. Excision which is destroyed and emulsified by an ultrasonic wave, a waste liquid, or the like is subjected to suctioning through the suctioning channel **360**.

[0061] In the embodiment, the probe **370** may have a configuration in which the ultrasonic wave transmission body **330**, the liquid ejection channel **350**, and the suctioning channel **360** 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 **24**.

[0062] The liquid supply channel **340** and the suctioning channel **360** have a sufficient length to be movable by the sliding of the slider **302** at the rear from the actuator **320**. When the slider **302** is turned OFF, the liquid supply channel **340** and the suctioning channel **360** are accommodated in the handpiece **20** in a flexed state at the rear of the actuator **320**. The ultrasonic scalpel **300** has such a configuration.

[0063] 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.

[0064] 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**.

[0065] 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.

[0066] 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 **30**. 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**.

[0067] 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 **24**. The actuator **420** is fixed to the handpiece **20**. Accordingly, even though the slider **402** moves, the actuator **420** does not move.

[0068] 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 handpiece **20** in a flexed state. The electrical scalpel **400** has such a configuration.

[0069] FIG. **3** is a schematic view illustrating a state where the probe moves. The distal end portion of the handpiece **20** forms a curved shape. The curved portion of the handpiece **20** is also referred to as the guide portion **26**.

[0070] The guide portion **26** respectively guides the distal end portions of the probes of the scalpels to the opening portion **24** 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 **24**.

[0071] 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 **30**. The controller **30** receives a signal from the sensor **28**. The controller **30** controls the foot switch **40** 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 **40** while any scalpel is used.

[0072] 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.

[0073] As described above, the liquid ejecting scalpel **200**, the ultrasonic scalpel **300**, and the electrical scalpel **400** are accommodated in the handpiece **20**. 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. Accordingly, the scalpel apparatus **10** for medical treatment allows a user to switch and use each of the scalpels in accordance with the type of treatment.

[0074] A user can switch the scalpel to be used by the manipulation section **22**. Accordingly, the visual point of the user can be suppressed from moving when switching the scalpel to be used.

[0075] Since the handpiece **20** includes the guide portion **26**, when each of the sliders is slid, the distal end of the probe of each of the scalpels protrudes from the approximately same position of the opening portion **24**. Accordingly, the visual point of the user can 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.

[0076] The controller **30** controls the foot switch **40** 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 the same foot switch before and after the switching of the scalpel to be used.

[0077] 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 handpiece **20**. 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 handpiece **20**, when the slider **202** slides, movements of a centroid of the handpiece **20** itself can be suppressed.

B. Second Embodiment

[0078] A second embodiment of the invention will be described. FIG. **4** 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 the handpiece **20***a*, and the scalpels are respectively accommodated in cases inside the handpiece **20***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 handpiece **20***a*.

[0079] 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**, the suctioning channel **260**, 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**.

[0080] 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** and the suctioning channel **360** (refer to FIG. **2**). The slider **302** is connected to the functional portion accommodation case **310**.

[0081] 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**.

[0082] 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 transmit laser light. A slider **502** is connected to the functional portion accommodation case **510**.

[0083] In the embodiment, when each of the sliders is slid, each of the probes and the 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 handpiece **20***a* at the rear of each case in a flexed state. When the slider of each scalpel is turned ON, the 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 **24** by a guide portion **26***a* included in the handpiece **20***a*, thereby protruding through the opening portion **24**.

[0084] 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*.

[0085] FIG. **5** is a schematic view schematically illustrating a configuration of the functional portion accommodation case **210**. The actuator **220**, the liquid supply channel **240**, the liquid ejection channel **250**, and the suctioning channel **260** are accommodated in the functional portion accommodation case **210**. In the embodiment, the liquid supply channel **240** is connected to the entire surface of the actuator **220**. Regarding the function of each configuration, the description has been given in the first embodiment, thereby omitting the description.

[0086] 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**.

[0087] 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**.

[0088] FIG. **6** 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, a liquid supply channel **540** to which a liquid is supplied, and a suctioning channel **560** communicate with one another. The liquid supply channel **540** is inserted into the optical fiber **550**. The liquid supply channel **540** is inserted into the suctioning channel **560**.

[0089] FIG. **7** is a schematic view illustrating the state where the probe moves. The handpiece **20***a* includes the curved-shaped guide portion **26***a*. In the embodiment, when each of the sliders is slid, each of the 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 **24** 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 **24**.

[0090] As illustrated above, each of the scalpels in the embodiment is individually accommodated in the cases inside the handpiece **20***a*. Each of the sliders is connected to each of the cases. When each of the sliders 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 handpiece **20***a* in a flexed state. Accordingly, when each of the sliders 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* can be thinned. Since each of the scalpels is individually accommodated in the case inside the handpiece **20***a*, it is possible to improve the durability thereof.

C. Modification Example

[0091] 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

[0092] In the scalpel apparatus **10** for medical treatment, the guide portion **26** is the curved portion formed in the handpiece **20**. However, a guide member **27** may be separately included therein. FIG. **8** 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 handpiece **20**. 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 **24**. The handpiece **20** 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 handpiece **20**. Therefore, the shape of the distal end portion of the handpiece **20** is not limited. For example, a user can form the distal end of the handpiece **20** to have a shape so as to be easily grasped.

C2. Modification Example 2

[0093] In the embodiment, each of the scalpels includes the suctioning channel in accordance with necessity. However, the suctioning channel may be configured not to be included. In this manner, the structure of the inside of the handpiece **20** can be facilitated. Therefore, it is possible to miniaturize the handpiece **20**.

C3. Modification Example 3

[0094] The ultrasonic scalpel **300** may be configured not to include the liquid ejection channel **350**. Thus, it is possible to attain the miniaturization of the handpiece **20**.

C4. Modification Example 4

[0095] 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 manipu-

lation section as described above. In other words, the scalpel apparatus **10** for medical treatment can be used by the following usage method.

[0096] 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 outer case that accommodates the liquid ejecting scalpel, the ultrasonic scalpel, and the electrical scalpel and has an 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, a manipulation section that selectively causes the distal end portion of each scalpel to protrude through the opening portion, and a guide portion that guides the distal end portion of each scalpel to the opening portion.

[0097] 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. 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.

C5. Modification Example 5

[0098] In addition to Modification Example 4, the liquid ejecting apparatus for medical treatment can be used as follows.

[0099] There is provided the method of using a liquid ejecting apparatus for medical treatment disclosed in Modification Example 4. The liquid ejecting apparatus for medical treatment further includes a controller that is electrically connected to each of the liquid ejecting scalpel, the ultrasonic scalpel, and the electrical scalpel to perform controlling of each of the scalpels, and a switch that is electrically connected to the controller and designates 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.

[0100] According to the method of using the liquid ejecting apparatus for medical treatment, a user can designate 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 outer case that accommodates the liquid ejecting scalpel and the ultrasonic scalpel and includes an opening portion allowing a distal end portion of the liquid ejecting scalpel or a distal end portion of the ultrasonic scalpel to protrude therethrough;
- a guide portion that is arranged in the outer case and guides the distal end portion of the liquid ejecting scalpel or the distal end portion of the ultrasonic scalpel to the opening portion; and
- a manipulation section that is arranged in the outer case 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 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 designates a beginning of use or a cessation of use for each of the scalpels,
- wherein the controller controls switching of functions of the switch to be associated with each of the scalpels 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 plurality of sliders to which the scalpels are connected respectively,
- wherein the liquid ejecting scalpel includes a communication channel through which a pulsating flow applier applying a pulsation to a liquid and a liquid ejecting portion ejecting the liquid to which a pulsation is applied communicate with each other,
- wherein the slider connected to the liquid ejecting scalpel is connected to the communication channel, and
- wherein the communication channel is composed of a tubular-shaped member having flexibility.

4. The liquid ejecting apparatus for medical treatment according to claim **1**,
- wherein the manipulation section includes a plurality of sliders to which each of the scalpels is connected respectively,
- wherein the liquid ejecting scalpel includes a pulsating flow applier which applies a pulsation to a liquid and a liquid ejecting portion which ejects the liquid to which a pulsation is applied, and
- wherein the slider connected to the liquid ejecting scalpel is connected to a functional portion of the liquid ejecting scalpel including the liquid ejecting portion.

5. 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 outer case that accommodates the liquid ejecting scalpel and the electrical scalpel and includes an opening portion allowing a distal end portion of the liquid ejecting scalpel or a distal end portion of the electrical scalpel to protrude therethrough;
- a guide portion that guides the distal end portion of the liquid ejecting scalpel or the distal end portion of the electrical scalpel to the opening portion; and
- a manipulation section that is arranged in the outer case and selectively causes the distal end portion of the liquid ejecting scalpel or the distal end portion of the electrical scalpel to protrude through the opening portion.

6. The liquid ejecting apparatus for medical treatment according to claim **5**, further comprising:
- a controller that controls the liquid ejecting scalpel and the electrical scalpel; and

a switch that is connected to the controller and designates a beginning of use or a cessation of use for each of the scalpels,

wherein the controller controls switching of functions of the switch to be associated with each of the scalpels based on a manipulation of the manipulation section.

7. The liquid ejecting apparatus for medical treatment according to claim **5**,

wherein the manipulation section includes a plurality of sliders to which the scalpels are connected respectively,

wherein the liquid ejecting scalpel includes a communication channel through which a pulsating flow applier applying a pulsation to a liquid and a liquid ejecting portion ejecting the liquid to which a pulsation is applied communicate with each other,

wherein the slider connected to the liquid ejecting scalpel is connected to the communication channel, and

wherein the communication channel is composed of a tubular-shaped member having flexibility.

8. The liquid ejecting apparatus for medical treatment according to claim **5**,

wherein the manipulation section includes a plurality of sliders to which each of the scalpels is connected respectively,

wherein the liquid ejecting scalpel includes a pulsating flow applier which applies a pulsation to a liquid and a liquid ejecting portion which ejects the liquid to which a pulsation is applied, and

wherein the slider connected to the liquid ejecting scalpel is connected to a functional portion of the liquid ejecting scalpel including the liquid ejecting portion.

* * * * *

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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刀的外壳，并且包括允许远端部分的开口部分。液体喷射手术刀或超声手术刀的远端部分从中穿过，引导部分设置在外壳中并将液体喷射手术刀的远端部分或超声手术刀的远端部分引导到开口所述部分和操作部分布置在所述外壳中并且选择性地使所述液体喷射手术刀的远端部分或所述超声手术刀的远端部分通过所述开口部分突出。