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Okada et al.

[11] **3,910,279**
[45] **Oct. 7, 1975**

[54] **ELECTROSURGICAL INSTRUMENT**

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[30] Foreign Application Priority Data
June 20, 1973 Japan ..... 48-72170[U]

[52] U.S. Cl. 128/303.15
[51] Int. Cl.² A61B 17/32
[58] Field of Search 128/303.15, 303.13, 303.14, 128/303.16, 303.17, 345

[56] References Cited
UNITED STATES PATENTS

359,506	3/1887	Goodwillie	128/303.14
1,967,015	7/1934	Wappler	128/303.15
2,047,535	7/1936	Wappler	128/303.17
2,447,169	8/1948	De Sousa	128/303.14
2,484,059	10/1949	Wallace	128/303.15
3,149,633	9/1964	Zingale	128/303.15
3,495,586	2/1970	Regenbogen	128/345
3,805,791	4/1974	Seuberth et al.	128/303.14

FOREIGN PATENTS OR APPLICATIONS

321,112	5/1902	France	128/303.14

Primary Examiner—Richard A. Gaudet
Assistant Examiner—Lee S. Cohen

[57] ABSTRACT

In the forward end portion of the flexible insulating tube of an electrosurgical instrument there is formed an opening or fenestra at the side surface thereof, and when an electrode wire is forced into the insulating tube, the working section thereof is outwardly looped through said opening, so that said looped working section is brought into contact with the tissue of the body cavity to resect the same. This instrument is introduced into a predetermined position of the body cavity using an endoscope while an operator is observing the endoscope.

6 Claims, 10 Drawing Figures

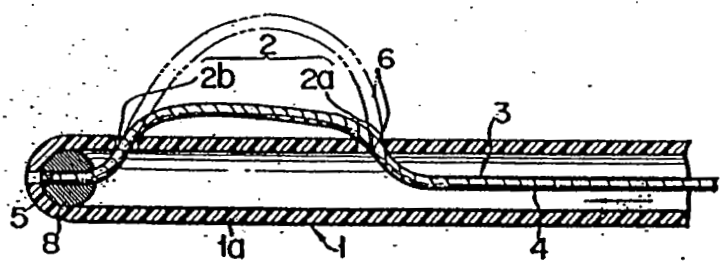

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FIG. 1

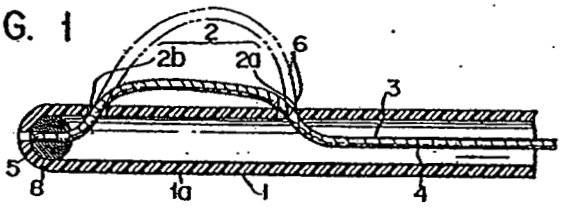


FIG. 2

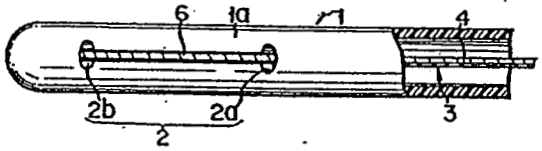


FIG. 3

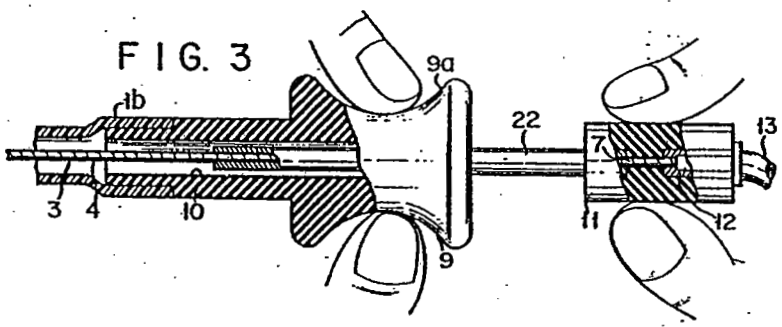


FIG. 5

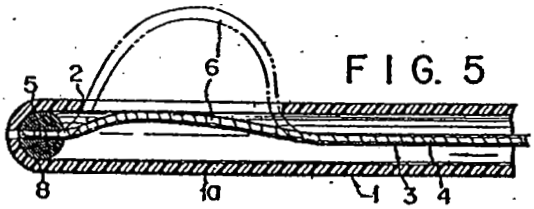


FIG. 6

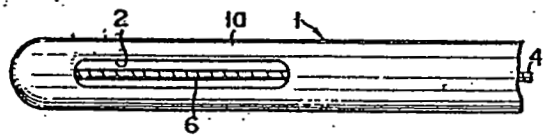


FIG. 7

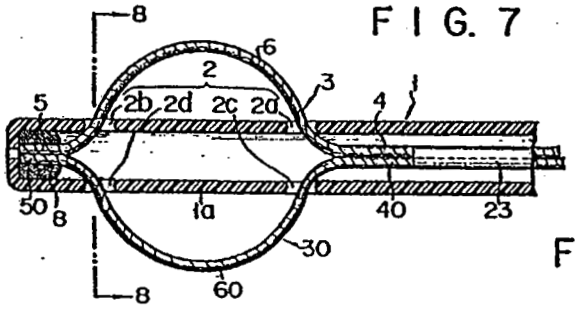


FIG. 4

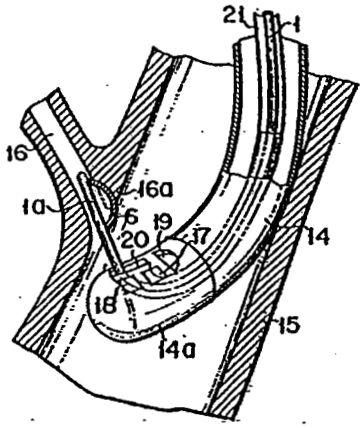


FIG. 8

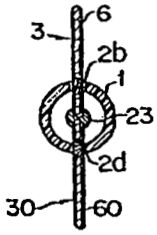


FIG. 9

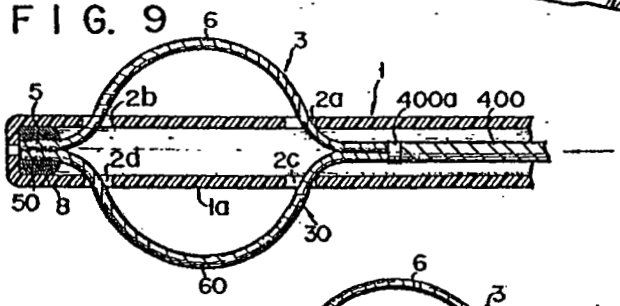
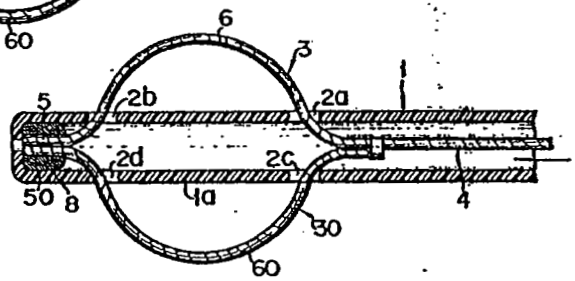


FIG. 10



ELECTROSURGICAL INSTRUMENT

BACKGROUND OF THE INVENTION

This invention relates to an electrosurgical instrument for resecting the tissue of body cavity of a human being.

An example of the prior art electrosurgical instrument of this type is disclosed in the respective specifications of, for example, U.S. Pat. Nos. 2,018,335 and 2,545,865. In the electrosurgical instrument shown in these U.S. patent specifications, an electrode shaped into a loop at its tip end portion is exteriorly extended from the fenestra formed in the distal end of the endoscopic tube. Said looped working section of the electrode is arranged in a substantially transverse direction to the axial line of the tube, and by causing said section to contact the tissue of the body cavity the electrosurgical resection operation of cutting or coagulating the body tissue is carried out. Said electrode is so constructed as to slide the looped working section longitudinally of the tube.

In the electrosurgical instrument having such a construction, however, the fenestra formed in the distal end of the tube should be large enough to enable the looped working section to slide therethrough. But where the fenestra is rendered large, the peripheral portion thereof and the structural portion within the tube unpreferably contact the inner wall of the body cavity during the resection operation to damage often the body tissue.

Further, where the fenestra is rendered large, a large amount of body liquid is entered into the tube from said fenestra during the resection operation to break the insulating condition. Therefore, measures for preventing the breakage of the insulating condition should previously be taken, which results in a complicated structure of the instrument.

Where it is desired to insert the tube particularly into a relatively fine or narrow body cavity and spread the inlet or outlet portion of the body cavity by operation of the instrument, the looped working section is made to abut against said inlet or outlet portion to be unpreferably bent or interrupted from sufficiently contacting the same because the looped working section is arranged transversely to the axial line of the tube.

Furthermore, since, in the instrument having the conventional construction, the endoscopic tube is formed of rigid material and therefore has no high flexibility, the places in the body organ or cavity where the resection operation can be performed are limited, failing to sufficiently carry out the required resection operation using this instrument.

SUMMARY OF THE INVENTION

This invention is characterized in that for the purpose of solving various problems arising from the electrosurgical instrument having the conventional construction the working section of the electrode wire having a body section disposed lengthwise within the insulating tube, said working section being designed to be directly contacted with the body tissue, is made to round out in the form of a loop with respect to the axial line of the tube on the same plane including said axial line via the opening formed at the side surface of the distal end or forward end of the tube; and that the insulating tube and electrode wire are respectively formed of material having high flexibility. The aforesaid characterizing construction of the invention enables the narrowing of the opening for allowing the working section of the insulating wire to be looped, so that entry of body liquid into the tube is prevented to a minimum extent and simultaneously there is no fear of damaging the inner wall of the body cavity during the resection operation. Further, since the working section is outwardly looped from the opening along the axial direction of the tube, it is effectively contacted with the inlet or outlet portion of the body cavity, thereby enabling a sufficient resection operation at said portion to be performed. Further, since the tube and wire have high flexibility, the tube can be brought to a given position within the body organ or cavity which is to be resected.

In the preferred embodiment of the invention, the insulating tube is inserted through the endoscope and inserted together with the endoscope into the body organ or cavity while said endoscope is being observed by a viewer or an operator. Accordingly, it is possible to quickly and exactly bring the instrument to a desired position to be subjected to the resection operation, so that the operation range has been extremely enlarged. Further, since the insulating tube is integrally formed of, for example, polytetrafluoroethylene resin known under the name of "Teflon," and the electrode wire is integrally formed of stainless steel, the instrument is made simple in construction and the instrument trouble has been reduced in number. Provided for the base portion of the insulating tube is a grip member for being manually operated by a viewer or an operator. Simultaneously mounted on the base section of the electrode wire is a knob member. For this reason, if the operator manually operates said grip member and knob member, the working section of the wire will be able to be outwardly looped with ease and the looping degrees will be able to be simultaneously adjusted.

The later described embodiments illustrate the manner in which the electrosurgical instrument according to the invention is introduced into the body organ or cavity using the endoscope, but it is also possible to introduce said instrument alone directly into the body organ or cavity. In the instrument having a construction permitting such direct introduction, means for observing the interior of the body organ or cavity, such as a fiber bundle-made image guide is provided in a manner extending from the forward end or distal end of the tube into the tube.

Accordingly, a first object of the invention is to provide an electrosurgical instrument capable of resecting the tissue of the inner wall of the body cavity with high efficiency.

A second object of the invention is to provide an electrosurgical instrument capable of performing the tissue resection in a given place within the body cavity where resection is needed.

A third object of the invention is to provide an electrosurgical instrument which can be made simple in construction and therefore manufactured at low cost and which has high securability with respect to the living body during the use.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a longitudinal sectional view of the forward end section of an electrosurgical instrument according to an embodiment of the invention;

FIG. 2 is a plan view, partly in section, of the forward end section of the instrument shown in FIG. 1;

FIG. 3 is a side view, partly broken, of the base section of the instrument shown in FIG. 1;

FIG. 4 illustrates the manner in which the instrument of FIG. 1 is introduced into the body cavity using the endoscope to permit the resection of the tissue of the body cavity;

FIG. 5 is a longitudinal sectional view of the forward end section of an electrosurgical instrument according to a second embodiment of the invention;

FIG. 6 is a plan view of the forward end section of the instrument shown in FIG. 5;

FIG. 7 is a longitudinal sectional view of the forward end section of an electrosurgical instrument according to a third embodiment of the invention;

FIG. 8 is a cross sectional view on line 8—8 of FIG. 7;

FIG. 9 is a longitudinal sectional view of the forward end section of an electrosurgical instrument according to a fourth embodiment of the invention; and

FIG. 10 is a longitudinal sectional view of the forward end section of an electrosurgical instrument according to a fifth embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In the forward end section of an electrosurgical instrument shown in FIGS. 1 and 2, an insulating tube 1 is formed of material having high flexibility such as a polytetra-fluoroethylene resin known under the name of "Teflon." The forward end portion 1*a* of the tube 1 is formed at its side surface with two through holes 2*a* and 2*b* spaced from each other at a prescribed interval along the axial line of the tube 1. Said both holes 2*a* and 2*b* constitute openings or fenestras 2 for permitting the passage of the working section of an electrode wire 3. Said electrode wire 3 is a single flexible wire prepared, for example, by twisting a large number of fine stainless stell elements together. Said wire 3 is divided into three sections, namely, a body section 4, end section 5 and working section 6 though they are not mutually discriminated in the illustrations by clear boundary lines. The body section 4 has a base end 7 as later described, and is disposed lengthwise of the tube 1 within the same. The end section 5 of the wire 3 is fixed within the tip end of the forward end portion 1*a* of the tube by fixing means, for example, the silver soldering. The working section 6 between said end section 5 and body section 4 is a section for performing the resection operation by direct contact with the tissue of the body cavity, and succeeds the body section 4 at one end via said through hole 2*a* and succeeds the end section 5 at the other end via said through hole 2*b*. The working section 6 is wholly exposed to the exterior of the tube 1. When, as later described, the wire 3 is pushed toward the forward end portion 1*a* along the axial line of the tube 1 as indicated by an arrow of FIG. 1, it is made to round out in the form of a large loop transversely to the axial line of the tube 1 as denoted by two dots-and-dash lines of FIG. 1. The rounding-out operation of the working section 6 is performed on the same plane including the axial line of the tube 1. In other words, upon pushing-into operation of the wire 3 the working section 6 is outwardly looped in a manner going away from the outer circumference of the tube 1 along the axial line thereof, and, upon drawing-out operation of the wire 3, conversely is shrunk in a manner approaching said outer circumference. The pushing-into or drawing-out operation by an operator of the wire 3 is carried out along the axial line of the tube 1. As seen from the conditions of the working sections 6 indicated by solid lines and two dots-and-dash lines, the length of the working section 6 of the wire 3 is made larger under the looped condition indicated by the two dots-and-dash lines, so that the length of the body section 4 is made smaller by that extent. It can be considered that the boundary line between the working section 6 and the body section 4 is varied in position with the pushing-into or drawing-out operation of the wire 3. Similarly, the boundary line between the working section 6 and the end section 5 will be somewhat varied in position, though extremely slightly.

In the base section of the electrosurgical instrument shown in FIG. 3, the base end portion 1*b* of the tube 1 is slightly enlarged in diameter, and a grip member 9 is fitted at one end into said enlarged base end portion 1b in alignment with the axial line of the tube 1. The grip member 9 has a wire insertion hole 10 in alignment with the axial line of the tube 1. The other end portion of the grip menber 9 is enlarged and has at its outer circumference a semicircle-shaped grip surface 9*a*, which is so formed that an operator can easily take hold of said grip surface 9*a* with his fingers as shown. The base section 4 of said electrode wire 3 is inserted into the wire insertion hole 10 of the grip member 9, and is extended from said other end portion of the grip member 9. Mounted onto the extended base end portion 7 of the wire is a knob member 11. The base end portion 7 of the wire 3 within the knob member 11 is electrically connected to an output code 13 by means of a connector 12. The output code 13 is connected to a proper current supply source not shown. A high frequency current is flowed in the base end 7 of the wire 3 via the output code 13 and the connector 12 from said source. Said high frequency current is supplied from the base end portion 7 to the looped working section 6 through the wire 3, and the looped working section 6 supplied with said current is brought into contact with the tissue of the body cavity, thereby to cut or coagulate the same.

As shown in FIG. 3, the operator can take hold of said knob member 11 with his fingers as in the case of the grip member 9.

It is to be noted that the knob member 11 and grip member 9 are both formed of a proper insulating material such as a synthetic resin.

Referring to FIG. 4, the endoscope 14 is in a state inserted into the duodenum 15 constituting the body organ of a human being. In said state, the distal end 14*a* of the endoscope 14 just reaches the vicinity of the pancreatic duct 16 opened to the duodenum. This endoscope 14 is of a general construction, and introduction of the endoscope 14 into the duodenum 15 is carried out while the operator or viewer is observing the interior of the body cavity via a proper observation means provided within the endoscope 14. For this reason, said introduction of the endoscope is smoothly performed, so that it is possible to quickly bring the distal end to a diseased part within the body cavity which is to be observed. Said observation means includes, for example, an eyepiece disposed within the proximal end portion of the endoscope 14 not shown, an image-guide consisting of a flexible fiber bundle disposed within the endoscope and lengthwise thereof, and an objective lens disposed within the distal end 14*a*. These constituent ele-

ments, however, are of a general construction, and the illustrations thereof are omitted.

Provided for the side surface of the distal end 14*a* are an image guide window 17, illumination light guide window 18 and fluid suction port 19, which however are also known.

Also provided for the side surface of the distal end 14a is a window opening 20 for allowing the electrosurgical instrument to be projected therethrough. This window opening 20 communicates with an instrument insertion channel 21 formed in a manner extending from the distal end 14*a* into the endoscope 14.

Into said insertion channel 21 is inserted the electrosurgical instrument according to the invention, the forward end portion 1*a* of which is projected into the body cavity through the window opening 20. At the projecting time, the working section 6 of the wire 3 is shrunk to a state contacting the outer circumference of the tube 1 of the instrument. When, thereafter, the operator or viewer has found, while observing the outlet portion 16*a* of the pancreatic duct 16 opened to the duodenum 15, that said outlet portion is extremely narrowed, and has to resect partially the tissue of the outlet portion 16*a* by means of the instrument for the purpose of enlarging said narrowed outlet portion 16*a*, the resection operation is carried out as follows. While the forward end portion 1*a* of the tube 1 of the instrument is being inserted into the outlet portion 16*a* of the pancreatic duct 16, the working section 6 is outwardly looped as shown in FIG. 4. While the outwardly looped working section 6 is pressing the tissue of the narrowed outlet portion 16*a* in a manner to enlarge the outlet portion 16*a*, the section 6 resects the pressed tissue by the high frequency current flowing through the section 6. Since the working section 6 performing the resection operation as such is in a state ourwardly looped in the same plane including the axial line of the tube 1 as previously described, the working section 6, even when the tube 1 is brought into contact with the body tissue while being inserted deeply into the pancreatic duct 16, maintains its sufficient rigidity without being bent by said body tissue. In this manner, the looped working section 6 cuts or coagulate for resection the tissue of the narrowed outlet portion 16*a* of the pancreatic duct 16, enabling the outlet portion to be enlarged to a sufficiently large size. As the result, communication of the pancreatic duct 16 with the duodenum is sufficiently attained, thus executing the desired medical treatment.

The operation for looping the working section 6 is carried out by manually operating the grip member 9 and the knob member 11 shown in FIG. 3. Namely, the operator moves the knob member 11 in a direction in which it approaches the grip member 9, with the grip member 9 held by the fingers of one hand and the knob member 11 held by the fingers of another. Then, the wire 3 is forced into the tube 1 to permit the working section 6 to be outwardly looped as indicated by two dots-and-dash lines of FIG. 1. On the other hand, if the operator moves the knob member 11 in a direction in which it goes away from the grip member 9, the wire 3 will be drawn out from the tube 1, so that the working section 6 is returned to the shrunk state indicated by solid lines from the looped state indicated by two dots-and-dash lines.

The wire 3 is covered with a rigid guide pipe 22 by the extent of a predetermined length extending from its base end 7. Said guide pipe 22 is inserted through the wire insertion hole 10 provided for the grip member 9, and so acts as to maintain the wire 3 straight in cooperation with said hole 10. The guide pipe 22 functions to prevent the wire 3 from buckling at the above-mentioned forcing-into or drawing-out operation time. For this reason, such operation can smoothly be performed with safety.

In FIGS. 5 and 6, the forward end section of an electro-surgical instrument according to a second embodiment of the invention is only illustrated. Since, however, the base end section has the same construction as that illustrated in FIG. 3, the illustration thereof is omitted. In the forward end section of the instrument shown here in FIGS. 5 and 6, the same parts end sections as those of FIGS. 1 and 2 are denoted by the same reference numerals. The difference between the construction shown in FIGS. 5 and 6 and that shown in FIGS. 1 and 2 resides in that the opening 2 in the latter construction is constituted by the two through holes 2*a* and 2*b* whereas the opening 2 in the former is constituted by an elongate slot having a prescribed length. This elongate slot 2 is formed lengthwise of the flexible insulating tube 1 in the side surface of the forward end portion 1*a* thereof. The working section 6 of the wire 3 within the tube 1 is outwardly projectively looped from the shrunk position indicated by solid lines of FIG. 5 to the position indicated by two dots-and-dash lines through the elongate slot 2. Said projectively looped working section 6 is made to contact the tissue of the body cavity for resecting the same. In FIG. 5, in the shrunk position, the working section 6 is in a state wholly hidden within the tube 1. Also in such shrunk position, however, the working section 6 may be exposed somewhat exteriorly of the tube 1 from the elongate slot 2.

It is to be noted that the body section 4 and end section 5 of the wire 3 have the same construction as those illustrated in FIGS. 1 and 2.

In FIGS. 7 and 8, the forward end section of an electrosurgical instrument according to a third embodiment of the invention is only illustrated. Since, however, the base end section thereof has the same construction as that illustrated in FIG. 3, the illustration thereof is omitted. The difference between the construction shown in FIGS. 7 and 8 and that shown in FIGS. 1 and 2 resides in that in the latter construction a single wire 3 and a pair of through holes 2*a* and 2*b* therefor are provided whereas in the former construction an additional wire 30 and an additional pair of through holes 2*c* and 2*d* for allowing said wire 30 to be passed therethrough are provided. That is to say, in the instrument shown in FIGS. 7 and 8, the additional wire 30 is a single electrode wire prepared by twisting a number of fine stainless steel elements together and has high flexibility, as in the case of the wire 3. The body section 40 of the wire 30 is disposed lengthwise of the tube 1 within the same in a state gathered together with the body section 4 of the wire 3. Said both body sections 4 and 40 are covered by a cover tube 23. The end section 50 of the wire 30 is fixed within the tube 1 by the fixing means 8, for example, by the silver soldering jointly with the end section 5 of the wire 3. The working section 60 between the end section 50 and the body section 40 is projectively looped outwardly of the tube 1 via the through holes 2*c* and 2*d* in a diametrical direction and yet in a direction opposite to that in which the working section 6 is looped. As clearly seen from FIG.

8, the looping plane of the working section 60 is flush with a flat plane including the axial line of the tube 1, and said flat plane is the same as the looping plane of the working section 6. Accordingly, said additional pair of through holes 2c and 2d are formed, along the axial line thereof at a prescribed interval in a state spaced from each other, in those portions of the tube 1 which diametrically oppose said pair of through holes 2a and 2b.

In FIG. 7, the condition in which the wires 3 and 30 are forced into the tube 1 to permit both working sections 6 and 60 to be largely looped exteriorly of the tube 1 is shown. Under this condition, a high frequency current is flowed in both looped working sections 6 and 60, which are brought into contact with the tissue of the body cavity, thereby performing the resection of said tissue.

If, as above described, two or more electrode wires are disposed within the tube 1, thereby to permit a plurality of working sections to be projectively looped from the outer circumference of the tube 1 in different directions, the operation for resecting the body tissue will more quickly be carried out. Furthermore, according to the invention, a plurality of wires are all gathered or collected into a single bundle within the body section, so that the operations by the operator are the same as in the case of a single wire.

In the case shown in FIGS. 7 and 8, the working section 60 of the wire 30 may not necessarily be so constructed as to diametrically oppose the working section 6 of the wire 3. Accordingly, the looping plane of the working section 60 may not be made flush with that of the working section 6. Accordingly, the pair of through holes 2c and 2d may not diametrically oppose the through holes 2a and 2b.

The through holes 2c and 2d constitute the opening 2 of the tube 1 together with the through holes 2a and 2b. As will be understood from the previously described embodiments, the opening 2 may be formed small because it has only to have a size permitting the passage of a fine electrode wire 3. Further, during the resection operation the working section is in a state passed through the opening 2, so that entry of body liquid into the tube 1 is extremely avoided.

An electrosurgical instrument according to a fourth embodiment shown in FIG. 9 has almost the same construction as that shown in FIG. 7. The difference therebetween only resides in that in the construction of FIG. 9 the body section 400 corresponding to those of the wires 3 and 30 of FIG. 7 is constituted by a single relatively thick conductive wire having a large thickness than that of the working section. The forward end of the body section 400 is rigidly connected at 400a to the rearward ends of the working sections 6 and 60, for example, by the welding process. When the body section 400 is pushed in an arrow-indicated direction by the manual operation of the operator, the both working sections 6 and 60 are projectively looped exteriorly of the tube 1. On the other hand, when the body section 400 is pulled in the opposite direction, the two looped working sections 6 and 60 are shrunk at the same time. If the body section 400 is constituted by a single relatively thick wire larger in thickness than that of the working section as in this embodiment, the fear will be more reduced that the body section is buckled when pushed into or drawn out from the tube 1. It is to be noted that the end sections 5 and 50 can also be constituted by a single wire. In other words, it is possible that the working section alone is constituted by a plurality of relatively thin electrode wires whereas the remaining sections by a single common wire.

An electrosurgical instrument according to a fifth embodiment shown in FIG. 10 has almost the same construction as that shown in FIG. 7. The difference therebetween only resides in that in the construction of FIG. 10 one electrode wire 30 has no body section and the body section 4 of the other electrode wire 3 is concurrently used for both wires 3 and 30. One end of the working section 60 of the wire 30 is secured to one end of the working section 6 of the wire 3, for example, by the welding process. Accordingly, when the body section 4 is pushed in an arrow-indicated direction, the both working sections 6 and 60 are respectively projectively looped exteriorly of the tube 1. On the other hand, when the body section 4 is pulled in the opposite direction, the both looped working sections are shrunk at the same time. It is to be noted that construction can be made such that the both ends of the working section 60 of the wire 30 are secured to the both ends of the working section 6 of the wire 3. If arrangement is made as such, the end section 50 of the wire 30 will not be required and the end section 5 will concurrently function as the section 50.

What we claim is:

1. An electrosurgical instrument for resecting the tissue of a body cavity comprising:

a flexible insulating tube including a forward end portion substantially straight along the axial line of the tube and having a fixed tip end and a pair of axially aligned holes formed in a side of the forward end portion of the tube;

a flexible electrode wire affixed to said tip end and capable of being manually forced into and withdrawn from the tube along its axis, said electrode wire including a body section having a base end disposed within said tube lengthwise thereof, an end section fixed within the tip end of the forward end portion of the tube and a working section outside of the tube having both of its ends respectively connected to the body section and the end section and projectively looped in an axial plane through said pair of holes and radially adjustable in response to the force exerted on said electrode wire; and

means for connecting said base end of the body section to a source of electric current including means to radially adjust the working section whereby said looped working section may be brought into contact with the tissue of the body cavity thereby to resect said tissue.

2. An electrosurgical instrument according to claim 1, wherein said flexible electrode wire is a single wire.

3. An electrosurgical instrument according to claim 1, which further comprises a second pair of axially aligned holes formed in a side of said forward end portion of the tube, a second flexible electrode wire capable of being manually forced into and withdrawn from the tube along its axis and having a second body section disposed within the tube lengthwise thereof and secured to the body section of the first aforesaid electrode wire, and a second end section fixed within the tip end of the forward end portion together with the end section of the first aforesaid electrode wire and a second working section outside of the tube disposed between said second body section and said second end

section and projectively looped in another axial plane through said second pair of holes and radially adjustable in response to the force exerted on both electrode wires, said second body section being connected to said connecting means.

4. An electrosurgical instrument according to claim 1, which further comprises a grip member secured to a base end of the insulating tube and having an insertion hole for allowing said electrode wire to be inserted therethrough in the axial direction of the tube, a grip surface at its outer circumference, and a rigid guide pipe covering the electrode wire at the base end of the body section and slidably extending through the insertion hole of the grip member, thereby to prevent the electrode wire from buckling during insertion and withdrawal of said wire, said connecting means including a manually operable knob member secured to said guide pipe.

5. An electrosurgical instrument according to claim 1, which further comprises a second electrode wire having a second working section outside of the tube and having one end thereof connected to the body section of said first aforesaid electrode wire and the other end fixed within the tip end of said forward end portion;

a second pair of axially aligned holes provided for different portions of the side of the forward end portion of the tube, said second working section being connected to the body section and tip end and being projectively looped in another plane in relation to the axial line of the tube through said second pair of holes transversely with respect to said axial line.

6. An electrosurgical instrument according to claim 5, wherein the body section of the electrode wire is constructed of a single wire larger in thickness than that of each respective working section.

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