

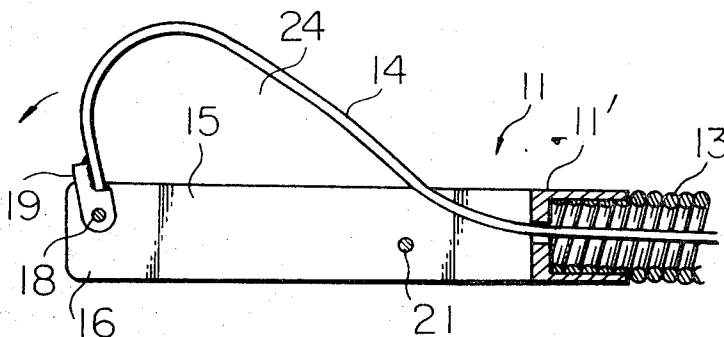


Fig. 1

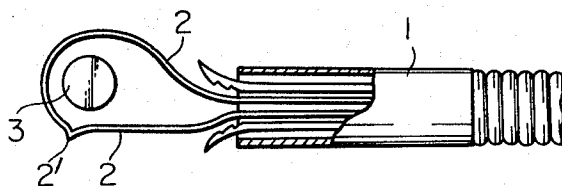


Fig. 2

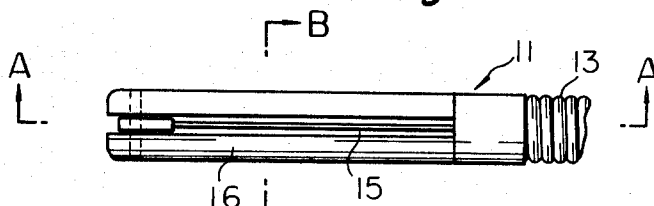


Fig. 3

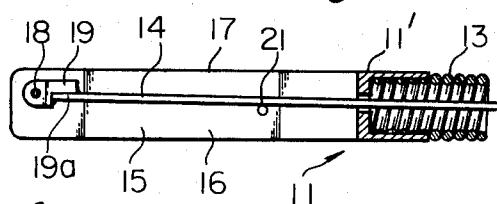


Fig. 4

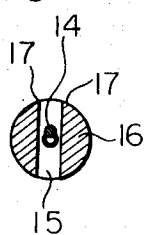
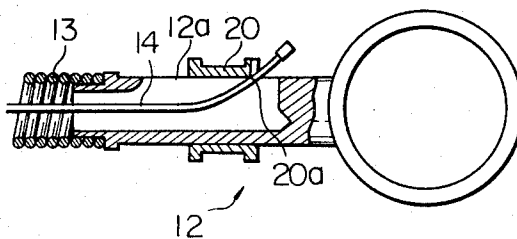


Fig. 5



INVENTOR
Mitsuto Itoh
BY
Kelman and Berman
AGENTS

Fig. 6

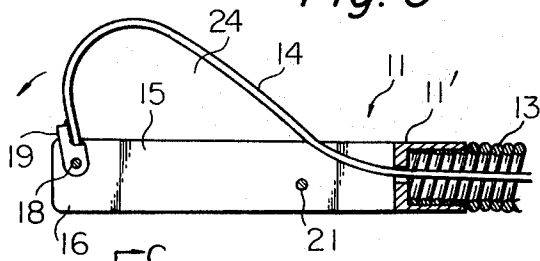


Fig. 7

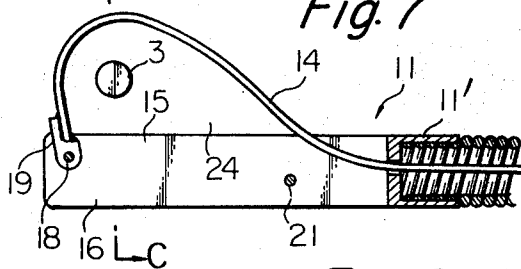


Fig. 8

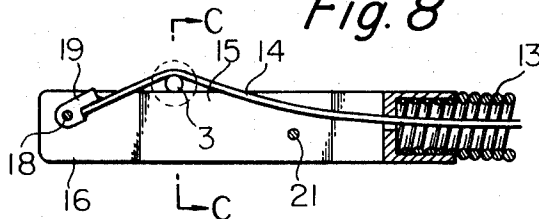


Fig. 9

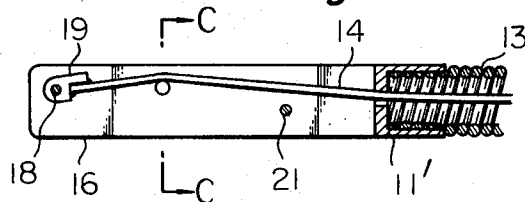


Fig. 10

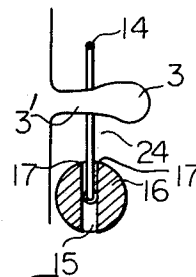


Fig. 11

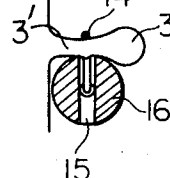
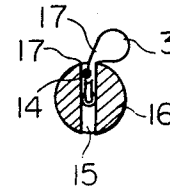


Fig. 12



INVENTOR
Mitsuto Itoh
BY *Kellogg and Berner*
AGENTS

Fig. 13

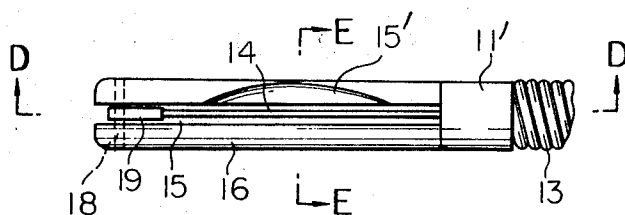


Fig. 14

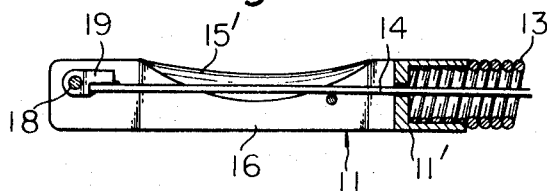


Fig. 16

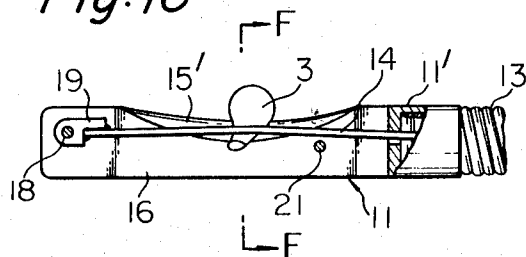


Fig. 15

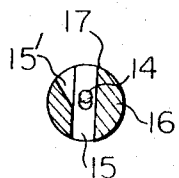
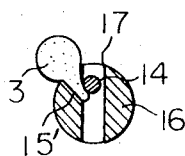


Fig. 17



INVENTOR
Mitsuto Itoh
BY Kelman and Berman
AGENTS

Fig. 18

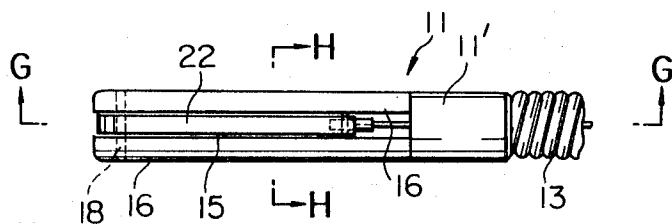


Fig. 19

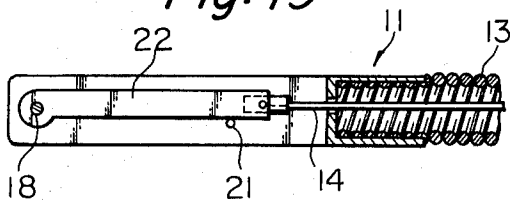


Fig. 20

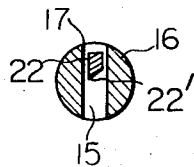
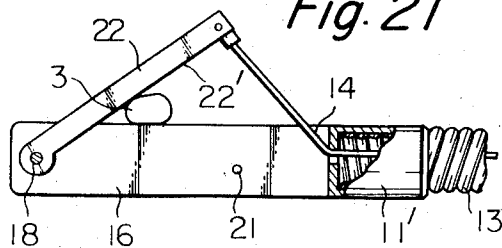


Fig. 21



INVENTOR
Mitsuto Itoh
BY Kelman and Berman
ATTORNEYS

Fig. 22

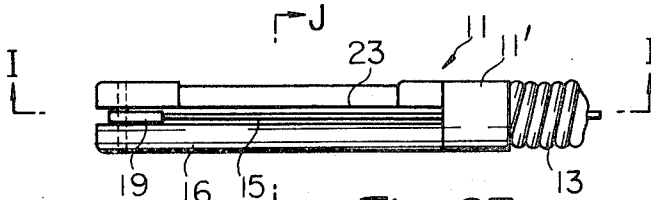


Fig. 23

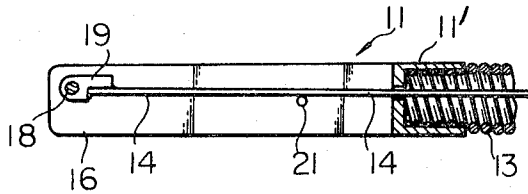


Fig. 24

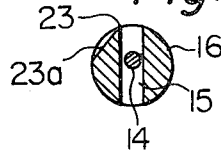


Fig. 25

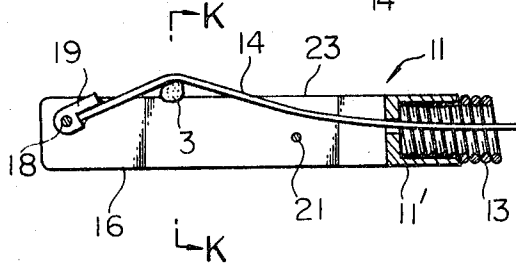
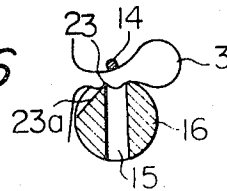


Fig. 26



INVENTOR
Mitsuo Itoh
BY Kelenan and Berman
AGENTS

Fig. 27

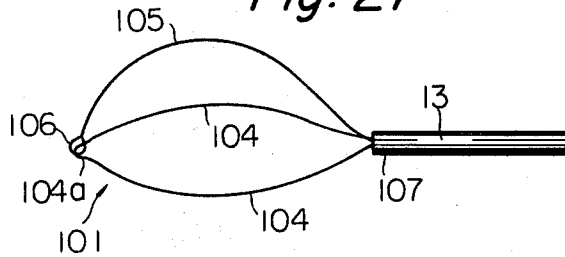


Fig. 28

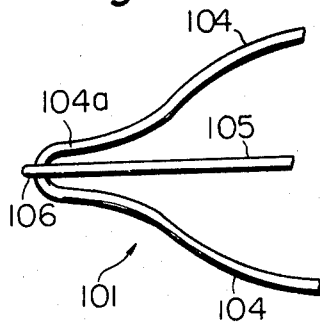


Fig. 29

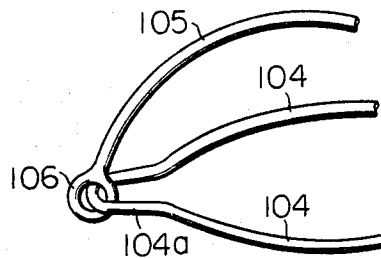


Fig. 30

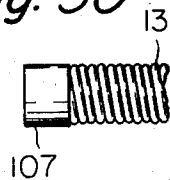


Fig. 31

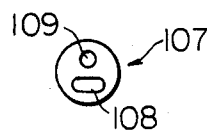
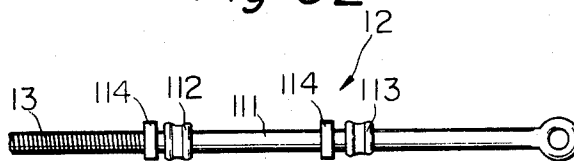


Fig. 32



INVENTOR
Mitsuto Itoh
BY Kellman and Berman
AGENTS

Fig. 33

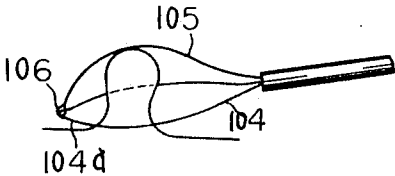


Fig. 34

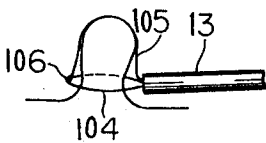


Fig. 35

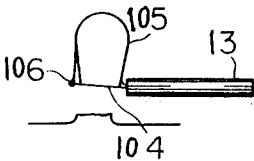


Fig. 36

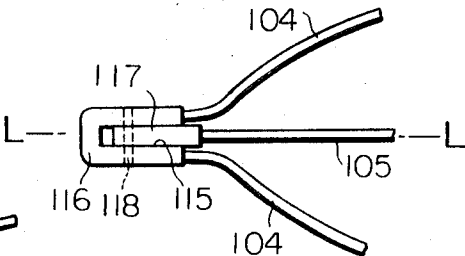


Fig. 38

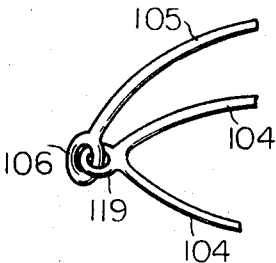
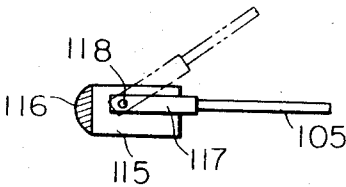


Fig. 37



INVENTOR
Mitsuto Itoh
BY Kelmman and Belman
AGENTS.

SURGICAL INSTRUMENT

BACKGROUND OF THE INVENTION

The present invention relates to a forceps for use with an endoscope and, more particularly, to forceps capable of positively capturing and severing a mass projecting into a body cavity such as a polyp without destroying the tissue surrounding the polyp and taking out the severed mass.

Heretofore, no effective forceps for use with an endoscope has been developed for severing and taking out a projecting mass such as a polyp growing in the stomach, gullet and the like of a living body.

A prior art forceps of the type described above uses a loop of a wire extending from the distal end portion of a forceps and the projecting mass captured by the loop of the wire is severed by pulling the branches of the wire extending from the loop and extending through the elongated tube of the forceps rearwardly by means of a control means in the proximal control portion of the forceps so as to contract the loop to sever the projecting mass.

In such a forceps, a wire having a relatively large diameter must be used for forming the loop in order to avoid the breakage of the wire during the repeated use of the forceps, thereby deteriorating the efficient severing performance of the wire. Further, there is a danger to destroy the tissue surrounding the projecting mass to be severed because of the deteriorated severing performance of the wire.

Further, it has been very difficult to positively take out the severed mass such as the polyp without fail because of the peristaltic movement of organ through which the severed mass must be taken out, thereby resulting in substantial inconvenience in the operation of the forceps.

SUMMARY OF THE INVENTION

The object of the present invention is to provide a novel and useful forceps for use with an endoscope capable of positively capturing, severing a projecting mass such as a polyp growing in a hollow portion of a living body and taking the severed mass out of the hollow portion without destroying the portions surrounding the projecting mass to be severed.

The above object is achieved in accordance with the present invention by the provision of a forceps having a proximal control portion, a distal end portion and an elongated flexible tube connecting the distal end portion to the proximal control portion, the forceps being characterized by the distal end portion having a pair of longitudinal parallel legs separated from each other by a longitudinal slot formed in the distal end portion, a wire shiftably extending through the flexible tube and the slot, a pin secured to the pair of legs adjacent to the forward ends thereof so as to extend in the slot laterally thereto, the forward end of the wire being swingably attached to the pin, and control means provided in the proximal control portion, the rearward end of the wire being connected to the control means so as to be actuated thereby, so that, when the wire is pushed forwardly, the forward portion thereof is bent to form a loop in the range of the legs thereby providing a space between the loop of the wire and the legs, while the wire is tensioned to move into the slot when the wire is pulled rearwardly at least one of the longitudinal

edges of the pair of legs forming a cutting edge while the width of the slot is slightly larger than the diameter of the wire, so that the cutting edge cooperates with the wire when the same is tensioned, thereby permitting a projecting mass such as a polyp captured in the space between the loop of the wire and the legs to be severed by the cutting edge cooperating with the wire thus tensioned.

An inclined capturing surface may be formed in the surface of one of the legs facing against the other of the legs for positively holding the severed projecting mass on the capturing surface by the wire tensioned by the control means so as to sever the projecting mass.

A sharp cutting edge may be formed in either or both of the legs by cutting aslant the outer surface thereof along the longitudinal edge of the leg forming the cutting edge so as to move effectively sever the projecting mass.

Alternatively, a cutting member may be provided having one end swingably fixed to the pin and having a length and a width less than those of the slot, respectively, so that the cutting member is swung into and out of the slot by the swinging movement of the cutting member, the cutting member being formed with a cutting edge while one of the legs is provided at its longitudinal edge with a longitudinal cutting edge cooperating with the cutting edge of the cutting member. The wire shiftably extending through the flexible tube is pivotally secured to the free end of the cutting member at its forward end, while the rearward end of the wire is connected to the control means so as to be actuated thereby, so that, when the wire is pushed forwardly, the cutting member is swung out of the slot to provide a space between the cutting member and the legs for capturing the projecting mass therein, while the cutting member is swung into the slot when the wire is tensioned, thereby permitting the projecting mass captured in the space to be severed by the cutting member cooperating with the cutting edge of the leg.

In accordance with another characteristic feature of the present invention, the forceps may be provided with a first wire forming a loop projecting from the distal end portion, the branches which extend from the loop shiftably extending through the flexible tube, a second wire shiftably extending through the flexible tube with its forward end swingably connected to the distal end of the loop of the first wire, a first control means provided in the proximal control portion, the rearward ends of the branches of the first wire being connected to the first control means so as to be actuated thereby, so that the loop is enlarged when the first wire is pushed forwardly so as to facilitate to capture a projecting mass therein while the loop is contracted to sever the projecting mass captured in the loop when the first wire is pulled rearwardly, and a second control means provided in the proximal control portion, the rearward end of the second wire being connected to the second control means so as to be actuated thereby, so that the thus severed projecting mass is positively captured by the second wire, when the same is pulled rearwardly.

In accordance with a further characteristic feature of the present invention, a high frequency electric source is provided and the forceps are electrically isolated from the endoscope through which the forceps extends, one terminal of the high frequency electric source being connected to the forceps while the other terminal

is adapted to contact with a body of which the hollow portion is to be operated by the forceps introduced therein together with the endoscope, thereby permitting the severing of the projecting mass projecting from the hollow portion to be carried out under the influence of a high frequency electric current so as to locally heat the portion to be severed.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an enlarged side view showing the distal end portion of a prior art forceps for use with an endoscope;

FIGS. 2 to 12 are fragmentary views showing the first embodiment of the forceps constructed in accordance with the present invention, FIG. 2 showing the distal end portion in enlarged plan view, FIG. 3 being a sectional view taken along line A—A in FIG. 2, FIG. 4 being a cross-section taken along line B—B in FIG. 2, FIG. 5 showing the proximal control portion of the forceps in elevational section, FIGS. 6 to 9 show various steps of operation of the forceps of FIG. 3, while FIGS. 10 to 12 show the devices of in FIGS. 7 to 9, respectively, in section on the line C—C;

FIGS. 13 to 17 are views showing a modification of the forceps shown in FIGS. 2 to 12, FIG. 13 being a plan view showing the distal end portion of the forceps as seen from the upper side thereof, FIG. 14 being a longitudinal sectional view taken along line D—D in FIG. 13, FIG. 15 being a cross-sectional view taken along line E—E in FIG. 13, FIG. 16 being the longitudinal sectional view similar to FIG. 14 but showing the severed projecting mass which is captured on the capturing surface by the wire while FIG. 17 is a cross-sectional view taken along line F—F in FIG. 16;

FIGS. 18 to 21 are views showing a further modification of the forceps shown in FIGS. 2 to 12 which is provided with a cutting member, FIG. 18 being a plan view showing the distal end portion of the forceps as seen from the upper side thereof, FIG. 19 being the longitudinal sectional view taken along line G—G in FIG. 18, FIG. 20 being a cross-sectional view taken along line H—H in FIG. 18, while FIG. 21 is a view similar to FIG. 19 but showing the cutting member swung out of the distal end portion to be ready for commencing the severing of the projecting mass;

FIGS. 22 to 26 are views showing a still further modification of the forceps shown in FIGS. 2 to 12, FIG. 22 being a plan view showing the distal end portion as seen from the upper side thereof, FIG. 23 being the longitudinal sectional view taken along line I—I in FIG. 22, FIG. 24 being a cross-sectional view taken along line J—J in FIG. 22, FIG. 25 being the sectional view similar to FIG. 23 but showing the projecting mass captured between the distal end portion and the wire, while FIG. 26 is a cross-sectional view taken along line K—K in FIG. 25 showing the manner how the projecting mass captured between the distal end portion and the wire is severed;

FIG. 27 is a schematic perspective view showing the essential part of the distal end portion of the second embodiment of the forceps of the present invention;

FIG. 28 is a plan view showing the connection of the wires used in the forceps of FIG. 27;

FIG. 29 is a perspective view of FIG. 28;

FIG. 30 is a fragmentary view in magnified scale showing the distal end portion of the forceps of FIG. 27;

FIG. 31 is a front view showing the configuration of the distal end portion of FIG. 30;

FIGS. 32 is a fragmentary side view showing the proximal control portion of the forceps of FIG. 27;

FIGS. 33 to 35 are views showing the steps how the projecting mass is captured and severed by the forceps of FIG. 27;

FIGS. 36 and 37 are fragmentary views showing a modification of connection of the first wire to the second wire; and

FIG. 38 is a fragmentary view similar to FIG. 36 but showing a further modification of connection of the first and second wires.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to FIG. 1 showing the prior art forceps, a wire 2 is shown to form a loop extending from the distal end portion 1 of the forceps which is connected to a proximal control portion (not shown) by an elongated flexible tube a portion of which is shown as connected to the distal end portion 1. The branches of the wire 2 extending from the loop extend through the distal end portion 1 and the elongated flexible tube and the rearward ends of the branches of the wire 2 are connected to a control means (not shown) provided in the proximal control portion so that the wire 2 is pushed forwardly and pulled backwardly by the operation of the control means. In operation, the wire 2 is first pushed forwardly after the distal end portion 1 is inserted into a hollow portion to be operated together with the endoscope with which the forceps is used so that the loop of the wire 2 is enlarged so as to capture a projecting mass 3 such as a polyp growing in the hollow portion as shown. Then the wire 2 is pulled rearwardly by the operation of the control means, thereby contacting the loop to sever the projecting mass 3. In such a forceps, since the distal end of the loop formed by the wire 2 is turned back upon itself during the operation of the forceps to form a node 2', the wire 2 tends to be easily broken at the node 2' as the operation of the forceps is repeated. Further it is difficult to capture the projecting mass by such a forceps thereby making the operation of the forceps troublesome and time consuming in addition to the danger which might occur when the wire 2 is broken.

FIGS. 2 to 12 show first embodiment of the forceps of the present invention. The forceps shown comprises a distal tubular end portion 11 and a proximal tubular control portion 12 connected to the distal end portion 11 by an elongated flexible tube 13 made of a closely wound helical coil.

The distal end 11 carries a pair of parallel legs 16 extending forwardly of the distal end portion 11 and separated from each other by a slot or elongated recess 15.

The end wall 11' of the distal end portion 11 is formed with a central hole through which a wire 14 shiftably extends into the bore of the tube 13. The forward end of the wire 14 is secured to a connecting piece 19 by means of solder 19a, the connecting piece 19 being in turn rotatably mounted on a pin 18 secured to the legs 16 and extending in the slot 15 laterally thereto. The longitudinal end portion of the wire 14 seen in FIG. 2 is thus limited in its longitudinal movement while being capable of pivotal movement about an axis transverse of the elongation of the slot 15.

The rearward end of the wire 14 extends outwardly of the cylindrical portion of the proximal control portion 12 through an elongated slot 12a formed in the cylindrical portion and secured by solder 20a to an operating or control ring 20, slidably mounted on the cylindrical portion so that the wire 14 is pushed forwardly or pulled rearwardly by the operation of the operating ring 20.

Thus, when the wire 14 is pushed forwardly, the forward portion of the flexible wire 14 between the connecting piece 19 and the end wall 11' is bent outward of the open side of the slot 15 to form a loop 24 between a wire 14 and the legs 16 in which the projecting mass 3 is easily captured. When the wire 14 is pulled rearwardly, the loop is contracted so that the wire 14 moves into the slot 15 in tensioned state.

At least one leg 16 has a sharp, longitudinal cutting edge 17, and the width of the slot 15 between the wall faces of the legs 16 is only slightly greater than the diameter of the wire 14 permitting the same to easily move into the slot 15 while close contact of the cutting edge 17 with the wire 14 is insured.

Thus, the projecting mass 3 captured in the loop 24 is easily and efficiently severed by the cutting edge 17 when the wire 14 is pulled rearwardly by the operating ring 20 without damage to tissue surrounding the projecting mass 3. The thus severed mass 3 is positively held in the slot 15 by means of the tensioned wire 14.

Pin 21 extending between the legs 16 in the slot 15 serves to prevent the wire 14 from buckling in the direction opposite to that shown in the figures so that the loop of the wire 14 is positively formed at the side where the cutting edge 17 is formed in the leg 16.

In the drawings, the slot 15 is shown as extending from one peripheral surface to the diametrically opposite peripheral surface, however, the slot 15 may be partly closed by a longitudinal bottom surface.

FIGS. 13 to 17 show a modification of the forceps shown in FIG. 2. The forceps of FIGS. 13 to 17 is substantially similar to that shown in FIG. 2 except that a shallow, concave receptacle 15' is formed in the face of one of the legs directed toward the slot 15 and the cutting edge 17 on the other leg 16. The bottom wall of the receptacle is obliquely inclined relative the slot 15.

The operation of the forceps of FIG. 13 is similar to that of FIG. 2, except that the severed projecting mass 3 is more safely held in the slot 15 by virtue of the provision of the receptacle 15' as shown in FIG. 17.

FIG. 18 to 21 show a further modification of the forceps of FIG. 2. In this embodiment, one end of an arm member 22 having a cutting edge 22' is swingably mounted on the pin 18 and the free end of the more rigid member 22 is pivotally connected to the forward end of the wire 14 so that the member 22 is swung out of the open side of the slot 15 when the wire 14 is pushed forwardly while the member 22 is moved into the slot 15 when the wire 14 is pulled rearwardly. The width of the member 22 is made slightly smaller than the width of the slot 15 for free swinging movement of the member 22 into and out of the slot 15 while the cutting edge 22' of the member 22 shearingly cooperates with the cutting edge 17 of the leg 16 when the member 22 is swung into the slot 15.

The operation of the embodiment of FIG. 18 is substantially similar to that of FIG. 2.

FIGS. 22 to 26 show a further modification of the forceps of FIG. 2.

This embodiment is substantially similar to that of FIG. 2 except that a surface 23a is formed in either one of the outer surfaces of the legs 16 merging with the longitudinal edge thereof so as to form a sharp cutting edge 23 as shown in FIG. 24. Thus, the projecting mass 3 captured between the wire 14 and the legs 16 can be most efficiently severed by the cutting edge 23 cooperating with the tensioned wire 14.

FIGS. 27 to 32 show the second embodiment of a forceps of the present invention which comprises a first wire 104 forming a loop extending from the distal end portion 107 with the branches or the portions of the wire 104 extending from the respective ends of the loop through the flexible tube 13 toward the proximal control portion 12. The ends of the branches of the wire 104 pass through an elongated slot (not shown) formed in a cylindrical guide tube 111 and are connected to a first operating or control ring 112 slidably guided on the cylindrical guide tube 111 so that the wire 104 is pushed forwardly to enlarge the loop or pulled rearwardly to contract the loop by the operation of the operating ring 112. The loop of the wire 104 serves to capture the projecting mass and sever the same when the loop is contracted.

A second wire 105 extends through the flexible tube 13, and an eye 106 provided at its distal end is pivotally connected to a bent back portion 104a formed at the distal end of the loop of the wire 104 while the rearward end of the wire 105 passes through the elongated slot in the cylindrical guide tube 111 and is connected to a second operating ring 113 slidably guided on the cylindrical guide tube 111 so that, when the operating ring 113 is actuated, the wire 105 is pushed forwardly to form a loop between the eye 106 and the distal end portion 107 or is pulled rearwardly to contract the loop. The second wire 105 serves to positively hold the severed projecting mass. Stationary stop rings 114 are secured to the cylindrical guide tube 111 of the proximal control portion 12 so that the stroke of each of the operating rings 112, 113 is appropriately limited. The stop rings 114 may be adjustable to suit the conditions under which the operation is to be carried out.

As is shown in FIG. 31, a hole 109 formed in the end wall of the distal end portion 107 is used to slidably pass therethrough the second wire 105 while the elongated hole 108 is used for slidably passing therethrough the branches of the wire 104 extending from the loop of the wire 104.

FIGS. 33 to 35 show the manner how a polyp projecting from an inner wall of a living body is captured and severed by the forceps of FIG. 27.

First, the first and second wires 104, 105 are pushed forwardly by the operation of the operating rings 112, 113 after the distal end portion 107 is inserted together with the endoscope into a body cavity so as to capture the projecting mass within the loop of the wire 104 and in the loop of the wire 105 as shown in FIG. 33 while the projecting mass is observed through the optical system of the endoscope, not shown. Then, the operating ring 112 is manually moved rearwardly to pull the wire 104 so as to contract the loop of the wire 104 thereby severing the projecting mass captured therein. At the same time or after the operation of the first operating ring 112, the second operating ring 113 is moved rearwardly to contract the loop of the wire 105 so that the

severed projecting mass is positively held by the wire 105 as shown in FIG. 35.

FIGS. 36 and 37 show a modification of the connection of the wire 104 with the wire 105. The leg end of a U-shaped connecting piece 116 having a slot 115 are 5 attached to respective, distal end portions of the wire 104. A pin 118 is secured to the piece 116 extending laterally of the slot 115 and a pivot piece 117 connected to the distal end of the wire 105 is pivotally 10 mounted on the pin 118 in the slot 115. The operation of the embodiment is similar to that shown in FIG. 28.

FIG. 38 shows a further modification of the connection between the wires 104 and 105. In this embodiment, an eye 119 is provided at the distal end of the loop formed by the wire 104 and the eye 119 is pivotally 15 engaged with the eye 106 of the wire 105.

In accordance with a further feature of the present invention, a high frequency electric operation may be carried out during the operation of the forceps.

In this case, the forceps is electrically isolated from 20 the endoscope through which the forceps is inserted for the operation thereof. One of the terminals of a high frequency electric source (not shown) is connected to the forceps while the other terminal of the electric source is contacted with the body of which the hollow 25 portion is to be operated by the forceps.

In operation, a high frequency electric current is supplied through the forceps to the portion of the body to which the operation of the forceps is applied by appropriately operating the switch of the electric source during 30 the operation of the forceps. Therefore, the portion severed by the forceps is locally heated to minimize the damage such as bleeding in the portion to which the operation is applied.

I claim:

1. A forceps for use with an endoscope comprising:
 - a. an elongated flexible tube having two longitudinally terminal portions and formed with a longitudinal bore therethrough;
 - b. wall means elongated in the direction of elongation 40 of said tube and longitudinally projecting from one of said terminal portions,
 1. said wall means defining a recess elongated in said direction and having a side open transversely of said direction,
 2. said wall means having an elongated cutting edge adjacent said recess,

3. said recess having one longitudinal part adjacent said one terminal portion and communicating with said bore and another longitudinal part spaced from said one part and remote from said one terminal portion;
- c. an elongated flexible member slidably guided in said bore and said recess;
- d. pivot means securing one longitudinal end portion of said flexible member to said wall means for pivotal movement about an axis transverse to said direction in said other part of said recess and for limiting movement of said one end portion in said direction; and
- e. control means on the other longitudinally terminal portion of said tube operatively connected to the other longitudinal end portion of said flexible member for moving said other end portion toward and away from said one terminal portion and for thereby moving said one end portion transversely of said direction outward of said recess through said open side until said one end portion and said wall means bound a loop, and for thereafter reducing the size of said loop and moving said one end portion into said recess.
2. A forceps as set forth in claim 1, wherein said wall means include two leg members elongated in said direction and laterally bounding said recess.
3. A forceps as set forth in claim 2, wherein said leg members have respective opposite faces in said recess, one of said faces terminating in said cutting edge, and the other face being formed with a receptacle.
4. A forceps as set forth in claim 1, wherein said pivot means include an elongated arm pivoted to said wall means for angular movement about said axis inward and outward of said open side and having a free end fastened to said one end portion of said flexible member, said arm being more rigid than said flexible member.
5. A forceps as set forth in claim 4, wherein said arm has a longitudinal cutting edge located for shearing cooperation with the cutting edge of said wall means during said angular movement.
6. A forceps as set forth in claim 1, further comprising means in said recess for limiting buckling of said one end portion of the flexible member away from said open side.

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