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(54) **RF ELECTROSURGICALLY-ACTIVATED CUTTER**

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* cited by examiner

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(57) **ABSTRACT**

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(58) **Field of Classification Search** 606/49, 606/45, 166, 171, 32, 33, 37, 39, 42, 50, 606/170; 604/22; 600/10, 11, 564
See application file for complete search history.

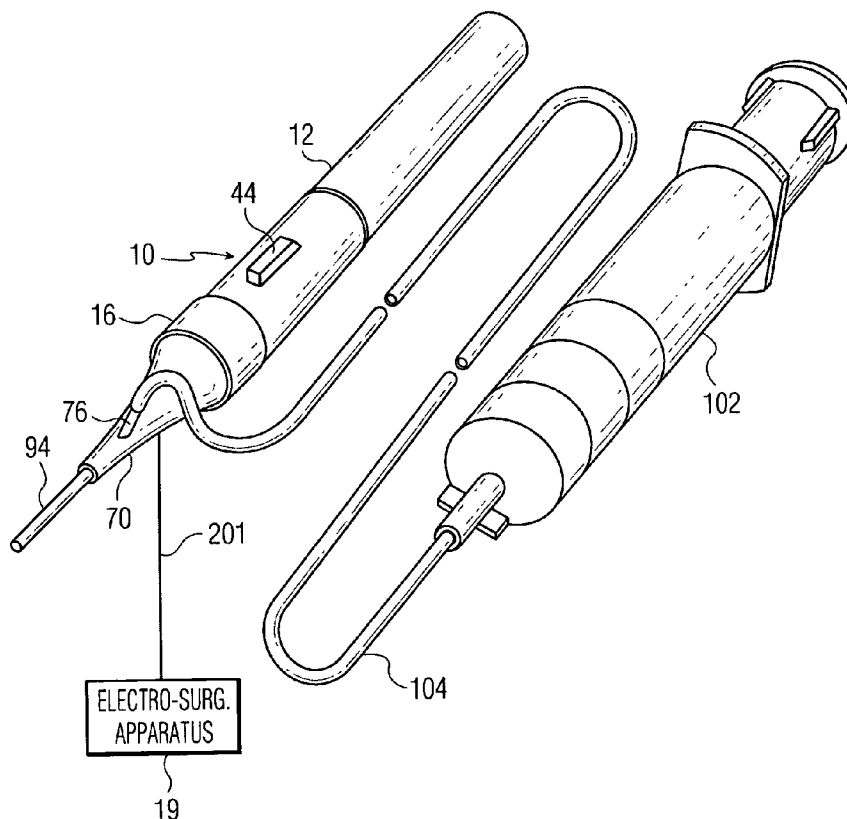
A novel cutter instrument uses radiofrequency (RF) electro-surgery and RF energy to achieve the desired cutting action with minimum of mechanical force, thereby reducing the risk of tissue damage due to excessive mechanical cutting action. Preferably, a cutter head of the instrument comprises an outer tube of electrically-insulating material with an aperture into which is telescoped an inner electrically-conductive tube. When the working or leading end of the latter is reciprocated across the aperture in the outer tube while RF electro-surgical currents are applied to the inner tube, the cutting action of tissue entering the aperture takes place primarily via the RF electro-surgical currents.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,108,182 A *	8/1978	Hartman et al.	606/171
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5 Claims, 2 Drawing Sheets



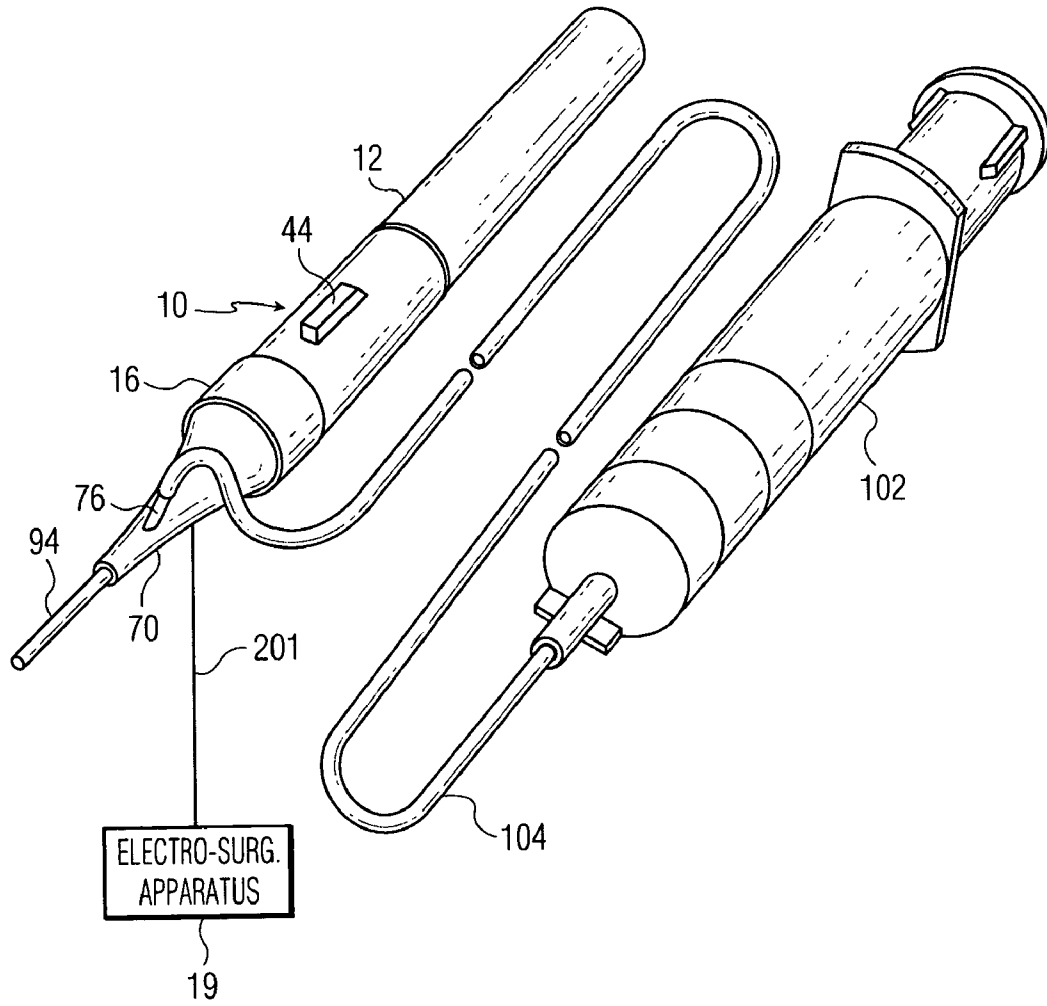


FIG. 1

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RF ELECTROSURGICALLY-ACTIVATED CUTTER

This invention relates to an electrosurgical cutter for carrying out various surgical procedures. In particular, it relates to an electrosurgical cutter instrument of the reciprocating type, and cutter heads for use with such electrosurgical cutters.

BACKGROUND OF THE INVENTION

U.S. Pat. No. 4,108,182, whose contents are hereby specifically incorporated by reference, describes a suction reciprocating cutter head especially useful for removing vitreous material under suction and for other surgical uses. The technique there described applies mechanical forces for shredding and cutting the vitreous into pieces while sucking the cut vitreous to disposal means. Another feature is the use of a protective sheath over the instrument part that provides the reciprocating action coupled with making the cutter head removable, with the result that the latter can be made disposable after use without the need to sterilize the protected instrument part that provides the reciprocating action.

A disadvantage of such an instrument is that, however small the applied mechanical force, there can always be a pulling or pressing force on the vitreous than can cause tearing damage on the vitreous.

SUMMARY OF THE INVENTION

An object of the invention is a cutting instrument that reduces the risk of tearing, spooling, or wind-up damage to the vitreous, as well as to other tissue in other surgical procedures.

Briefly stated, the novel cutter instrument in accordance with a feature of the invention uses radiofrequency (RF) electrosurgery and RF energy to achieve the desired cutting action with minimum mechanical force, thereby reducing the risk of tissue damage due to excessive mechanical cutting action.

In a preferred embodiment, the cutter head comprises an outer tube of electrically-insulating material with an aperture into which is telescoped an inner electrically-conductive tube. When the working or leading end of the latter is reciprocated across the aperture in the outer tube while RF electrosurgical currents are applied to the inner tube, the cutting action of tissue entering the aperture takes place primarily via the RF electrosurgical currents, and the inner tube functions mainly to uncover the aperture to allow tissue to enter and subsequently to cover the aperture to allow the suction to suction away the separated material. Thus, the leading edge of the inner tube, that in the prior art device must be sharpened to function properly, need not be given a particularly sharp edge in the instrument of the invention as it plays a much smaller role than in the prior art device. To provide RF electrosurgical currents at the inner electrically-conductive tube, an electrically-conductive connection is preferably made to a region of the inner tube remote from its leading edge or to an electrically-conductive part that is mechanically and electrically connected to the inner tube. The electrically-conductive connection is terminated by an external connector that can be connected to standard electrosurgical apparatus at a unipolar outlet.

Preferably, the electrosurgical cutter instrument of the invention works best with relatively high-frequency RF electrosurgical currents in excess of 1.5 MHz, preferably in the range of 1.5–4 MHz, as we believe that using electro-

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surgical currents in the MHz range causes relatively low tissue temperatures avoiding possible damage to adjacent tissue.

The various features of novelty which characterize the invention are pointed out with particularity in the claims annexed to and forming a part of this disclosure. For a better understanding of the invention, its operating advantages and specific objects attained by its use, reference should be had to the accompanying drawings and descriptive matter in which there are illustrated and described the preferred embodiments of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. 1 is a perspective view of one form of electrosurgical cutter instrument of the reciprocating type in accordance with the invention shown connected to suitable electrosurgical apparatus;

FIG. 2 is a cross-sectional view along the longitudinal axis of the removable cutter head of the embodiment of FIG. 1.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The reader is directed to the referenced prior patent which will assist in understanding the improvements offered by the present application. For the convenience of the reader, the same instrument assembly as described in the patent is used to illustrate the invention with the improvements of the present invention incorporated therein. The same reference numerals as used in the drawings of the references patent are also used for the convenience of the reader. The reader is directed to that patent for any further details of the overall assembly construction which are omitted here as unnecessary to a complete understanding of the present invention. More particularly, those skilled in the art will recognize that the invention is not limited to the specific construction of the reciprocating mechanism described in the patent, and other well-known reciprocating mechanisms in similar type instruments are deemed within the scope of the present invention. Moreover, the invention is not limited to cutter constructions in which the cutter head is removable and disposable.

Conventional electrosurgical apparatus can be used with instruments of the invention, but it is preferred to use low-power electrosurgical apparatus. Such apparatus is available from Ellman International of Hewlett, N.Y. as Model IEC50. The latter has the advantage that it generates RF electrosurgical currents in the MHz range, specifically, about 1.5–4 MHz, which we prefer for their less damaging effect on neighboring tissue.

In the preferred embodiment of a reciprocating cutter instrument according to the invention illustrated in FIG. 1, the instrument **10** comprises a drive housing **12** containing on its interior a power source and a conventional motor section. A switch **44** turns the motor on and off. The disposable, removable cutter head **16** when mounted engages a bayonet type connector to maintain the units assembled with the motor shaft engaging and rotating a cam **80** having a cam surface **82** in the cutter head **16**.

The RF cutting device **10** of the present invention contains all the parts such as battery, motor, switch, spring coil **86**, as described in the patent, but certain critical changes are necessary to implement the invention. These changes include the following.

The housing of the drive section **12**, which is generally cylindrical, is made of an electrically-insulating material, such as a suitable plastic. Also, the body **70** of the cutter head **16** also is made of an electrically-insulating material, such as a suitable plastic. In addition, the cam **80** is similarly made of an electrically-insulating material, such as a suitably hard plastic provided with a smooth inclined cam face **82** which contacts an electrically-conductive metal cam follower assembly **84** held against the cam face by an electrically-conductive coil spring **86**. Other changes are also necessary which will be explained below.

In this embodiment, the cam follower assembly **84** comprises a periphery which is hexagonal in shape slightly smaller than the hexagonal bore **73** of the body which permits axial movement of the cam follower assembly **84** but which prevents rotation. In this manner, well known in the art, rotary movement of the cam **80** is converted to reciprocating movement of the cam follower **84**. Bearing against the reverse side of follower **84** is the metal spring **86** which is seated against an electrically-conductive retaining ring **92**, for example, of metal, mounted in the bore **93** of the body **70**. The electrically-conductive retaining ring **92** has a wire **201** mechanically bound and soldered to the ring **92** on the side of the bore **93** and is thus electrically connected to the wire **201**. The wire **201**, which is insulated wire, extends through a tubular extension **202** to an external small electrical jack **203**, to which it may be connected by, for example, a quick banana connector (not shown) to the unipolar outlet of an electrosurgical generator **19** via the usual cable.

The generated RF energy from the electrosurgical generator **19** will go through the cable to the wire **201**, the conductive retaining ring **92**, the conductive coil spring **86**, and then the cam follower **84** which has a hollow cutting inner electrically-conductive tube blade **95**, for example, of metal, mounted in the bore **93** in the stem of the cam follower and reciprocates therewith. The inner electrically-conductive tube **95** is positioned within an outer stationary electrically-insulating, for example, of hard plastic, outer tube **94** fixed to the end of the nose body in a plastic cap member **97**. The inner metal cutting tube blade **95** and the outer plastic tube **94** may be of any configuration as long as they are matched for a close telescoping fit in the area where tissue cutting or separation takes place. As in the instrument described in the patent, a tubular extension **76** provides access to the inner bore **71**. The extension **76** in turn is coupled to a conduit **104** which terminates in a suction-generating device **102**. The inner tube **95** is also provided with an aperture **151** which provides access to the hollow inner tube interior. When suction is activated, the bore **71** is emptied as well as the hollow inner tube **95** when the tube is in its retracted position and the tube aperture **151** exposed. At the distal end of the structure, to the left in FIG. 2, the outer tube end is closed off **99** except for an aperture **98** which provides access for tissue into the distal end of the outer tube **94**. In the patent arrangement, when the inner tube **95** is reciprocated to its forward extended position, the open cutter end **101** of the inner tube **95** traverses the aperture **98** thereby slicing off or separating, and receiving in the hollow inner tube **95**, any tissue drawn by the suction through the aperture **98** into the interior of the hollow outer tube **94**. The suction then suctions away the tissue or any fluids present via the aperture **151** and the tubular extension **76** to the collecting means of the suction generator **102**.

In the inventive instrument, however, the tissue excision takes place mainly due to the RF energy supplied by the electrosurgical apparatus **19** which is present at the electri-

cally-conductive end **101** of the inner tube **95**, substantially free of the mechanical pressing force of the prior art device. The return path for the RF energy is the usual large indifferent plate placed in contact with the patient. The aperture **98** in the outer plastic tube **94** may be of any preferred shape or size in the side wall near the end of the outer plastic tube **94** to permit entry of the tissue, especially, vitreous material, when suction is applied.

The relative lengths of the inner **95** and outer **94** tubes are such that the open end **101** of the inner tube **95**, which may or may not be sharpened, passes across the aperture **98** with each down stroke of the cam **80**. Each upstroke of the cam **80** uncovers the aperture **98** to permit entry of fresh vitreous or other tissue material. The upstroke is accomplished by the action of the conductive coil spring **86** which is sealed on the retaining ring **92** pushing against the force of the cam follower **84** and driving it towards the cam face **82**. The down stroke action of the blade **95** with RF energy at its working end **101** disintegrates the vitreous material between the tube end **101** of the inner tube **95** and the edge of the aperture **98**. It is not necessary to have a sharp cutting surface for the aperture, since the cutting is mainly by the RF energy, and very little, if any, pressing force is required. The cam follower assembly is mounted in the retainer ring **92** which abuts a circular seal **100** to prevent entry of foreign material from cavity **71** into the bore **52** of the cutter head. The reciprocating cutter tube blade **95** is also provided with the aperture **151** which allows the cut vitreous or tissue or fluids to be drawn upward through the inside diameter of the inner cutting tube **95** and out through the opening **151** into the suction chamber **71** and then into the syringe **102**.

The external fixed thin wall tube **94** projects from the end of the body **70** with the distal end **99** being formed into a smoothly blended non-conductive enclosure to prevent any unintended scattering of RF energy.

The conductive retaining ring **92** and seal **100** are mounted around the cam follower **84** to keep fluids from entering into the cavity housing the coupling means, thus preventing any leakage of vitreous material, fluid, blood or other materials past the shaft. The seal also prevents air from being drawn into the syringe via motor shaft leakage. The cam follower shaft **105** and ring **92** and seal **100** effectively seal off bore **71** to form the fluid receiving chamber **71**. It is important to confine the RF energy in the controlled area adjacent the distal end **101** of the electrically-conductive inner tube **95**.

It will be appreciated that, in the preferred embodiment, the outer parts of the structure are electrically insulating to prevent accidental electrical shock to the surgeon or patient and prevent inadvertent tissue damage upon contact. The electrically-conductive parts which carry the RF electrosurgical currents are all buried within the structure. In order to transmit the RF energy from the wire **201** to the inner tube **95**, the wire is electrically connected to the conductive retaining ring **92** which in operation is axially fixed. The electrical path is from the retaining ring **92** to the electrically-conductive spring **86** to the electrically-conductive cam follower **84** and thereby to the electrically-conductive inner tube **95** which is mounted to the cam follower **84** via the shaft **105**. Of those parts, only the retaining ring **92** is immovable and thus the preferred wire connecting member. Extending the wire **201** to connect to the reciprocating cam follower shaft **105** or directly to the inner tube **95** is also possible, but has the possible disadvantages of constant flexing of the wire end that may reduce its lifetime and exposure of the wire end to the withdrawn body fluids. However, this is less of a problem with a disposable cutter

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head which undergoes only one use before being thrown out. By also making the cam 80 of electrically-insulating material prevents the RF energy from flowing back to the power source, which may include control circuitry, that may be damaged by the RF energy.

The structure 77 at the right end of FIG. 2 is for mounting of the cutter head 16 to the power assembly 12.

The surgical procedure is as follows. Only the steps relative to the invention are recited in broad terms. The cutter 10 is connected in the usual way to the electrosurgical apparatus 19. The surgeon inserts the working end 99 into the tissue to be excised and removed. The surgeon then activates the electrosurgical apparatus 19 choosing operating parameters such that relatively low power, low voltage settings of the apparatus are chosen. For the IEC50 instrument, which generates an output power of about 50 watts, a typical power setting of about 3–8 can be used. These values can be determined beforehand using test tissue, typically animal, and measuring the temperature due to resistive heating in the tissue surrounding the tip of the needle after a reasonable ON time of the instrument, say about 2–10 sec. The goal should be a low tissue temperature of about 50EC. The ON switch of the cutter is then depressed. The tissue inside the aperture 98 and subject to the RF energy from the reciprocating inner tube end 101 disintegrates and is suctioned out by the applied suction. The procedure is otherwise the same as that used with the electromechanical reciprocating cutter. No heating occurs around the electrically-insulating sections, because they are adequately electrically-insulated and no electrosurgical currents flow into the tissue from those sections.

The device described has particular utility for treating viscera disorders.

While the invention has been described in connection with preferred embodiments, it will be understood that modifications thereof within the principles outlined above will be evident to those skilled in the art and thus the invention is not limited to the preferred embodiments but is intended to encompass such modifications.

What is claimed is:

1. A cutter head for cutting patient tissue during reciprocation by electrosurgery, comprising:

- a) an outer housing of electrically-insulating material including an axially-projecting electrically-insulating outer tube having a distal end surface formed by a

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closed end, an aperture located in a side wall of the outer tube adjacent to the distal end of the outer tube for receiving tissue to be cut,

- b) an inner electrically-conductive tube telescoped within the outer tube and having at its distal end an open-ended working end of sufficient length such that when reciprocated between an extended and a retracted position the working end alternately covers and uncovers the outer tube aperture,
- c) means for providing an electrical connection capable of supplying RF electrosurgical currents to the inner tube,
- d) means for reciprocating the inner tube within the outer tube such that, when the inner tube's working end is reciprocated across the aperture in the outer tube while RF electrosurgical currents are applied to the inner tube via the electrical connection, any tissue entering the outer tube aperture is excised primarily via the RF electrosurgical currents.

2. A cutter head as claimed in claim 1, further comprising:

- e) means for providing suction to the interior of the inner tube to remove the excised tissue,
- f) the inner tube comprising a side aperture normally open to the suction means when the inner tube is in its retracted position but is closed to the suction means when the inner tube moves forward to its extended position.

3. A cutter head as claimed in claim 2, further comprising:

- g) a suction chamber surrounding a portion of the inner tube including the inner tube aperture,
- wherein the means for providing suction comprises means coupled to the suction chamber and accessible externally of the cutter head for connection to a suction source.

4. A cutter head as claimed in claim 1, wherein the means for reciprocating the inner tube comprises a spring-biased cam follower, and an electrically-conductive retaining ring fixed against axial movement and coupled to the spring, the electrical connection being made to the retaining ring.

5. A cutter head as claimed in claim 4, wherein the retaining ring, the spring, and the cam follower are constituted of electrically-conductive material, and the inner tube is mounted to the cam follower.

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