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Bender et al.

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[45] **May 22, 1973**

[54] POWERED SURGICAL CUTTER

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Related U.S. Application Data

[63] Continuation of Ser. No. 841,741, July 15, 1969, abandoned.

[52] **U.S. Cl.** **128/305**

[51] **Int. Cl.** **A61b 17/32**

[58] **Field of Search** 128/305, 310, 318

[56] **References Cited**

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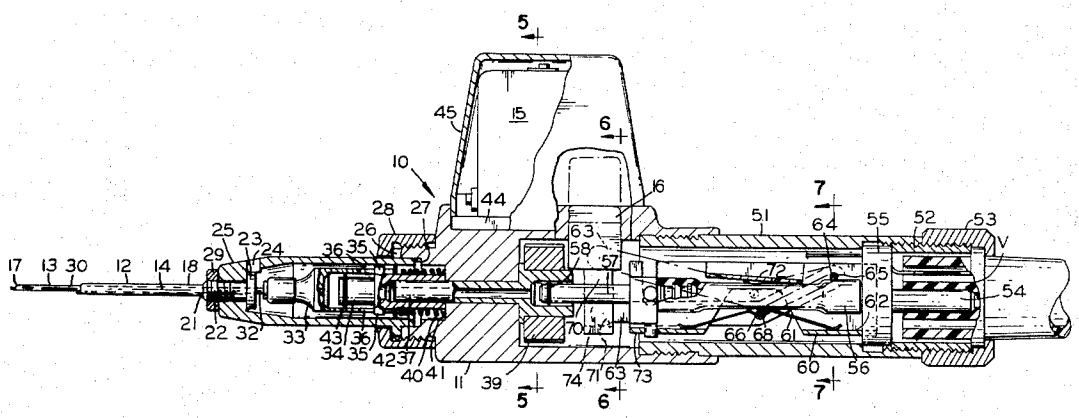
[57] **ABSTRACT**

A powered surgical cutter with its own controlled vacuum system designed to clip tissue and remove each piece as it is clipped through a vacuum line. The apparatus has an elongated external fixed tubular cutter interiorly of which a similar cutter rotates. The inner cutter is driven by a motor by means of a hollow drive shaft, the interior of which shaft is in communication with the interior of the inner cutter. Vacuum is supplied through the interior of the drive shaft to the interior of the cutter. Control means are provided whereby tissue drawn into an opening in the tubular cutter by the vacuum is sheared off by the rotation of the inner cutter inside and against the bore of the external cutter.

7 Claims, 9 Drawing Figures



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SHEET 1 OF 2

FIG. 1

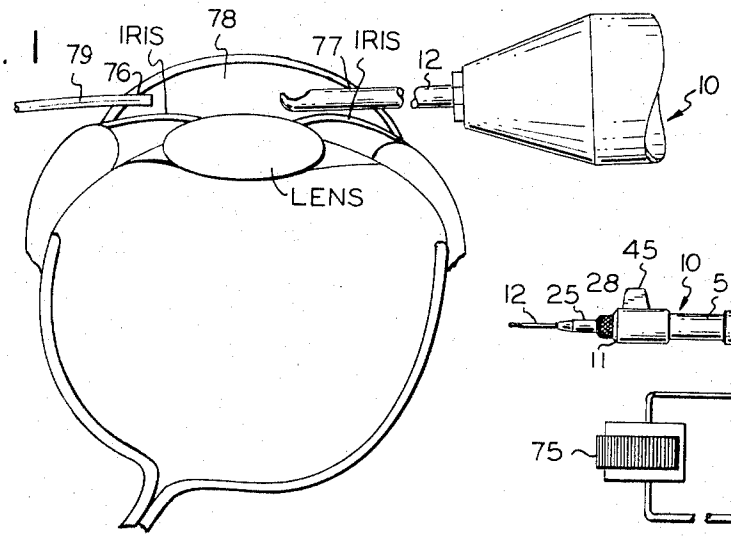


FIG. 9

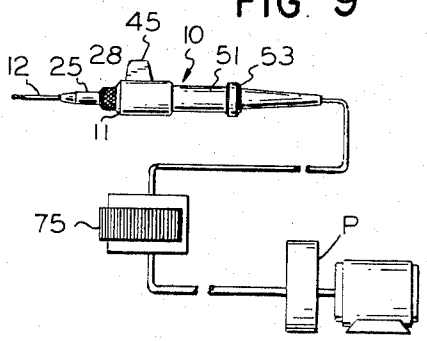


FIG. 2

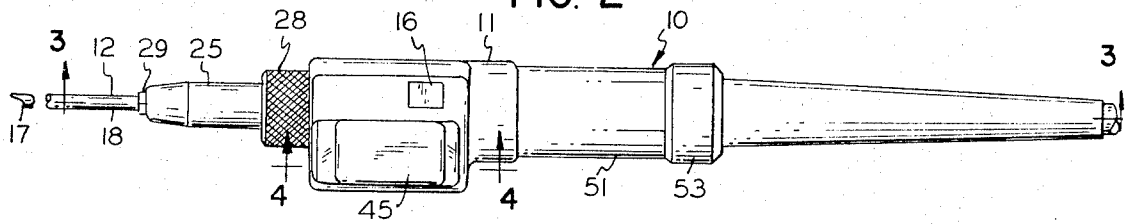


FIG. 5

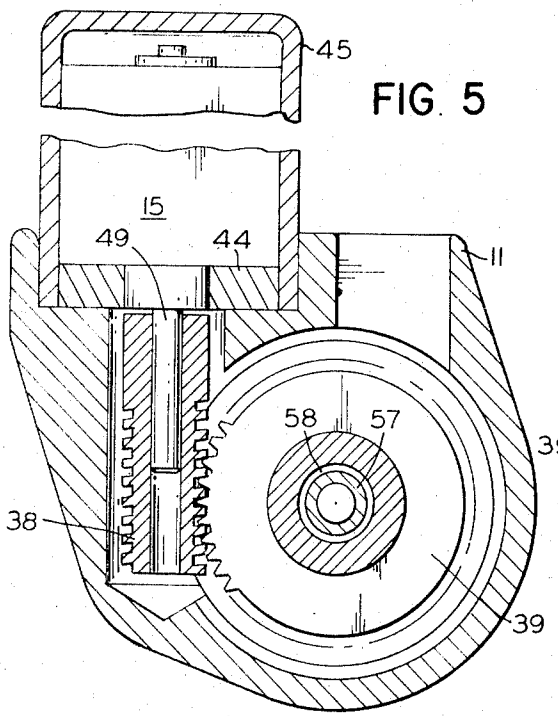
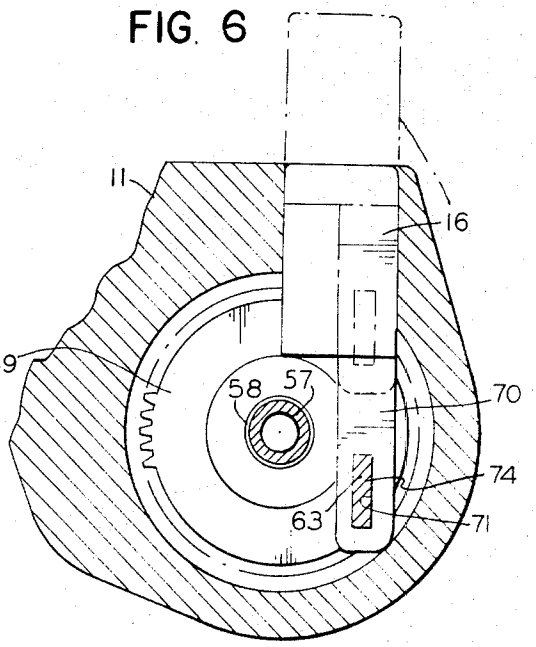


FIG. 6



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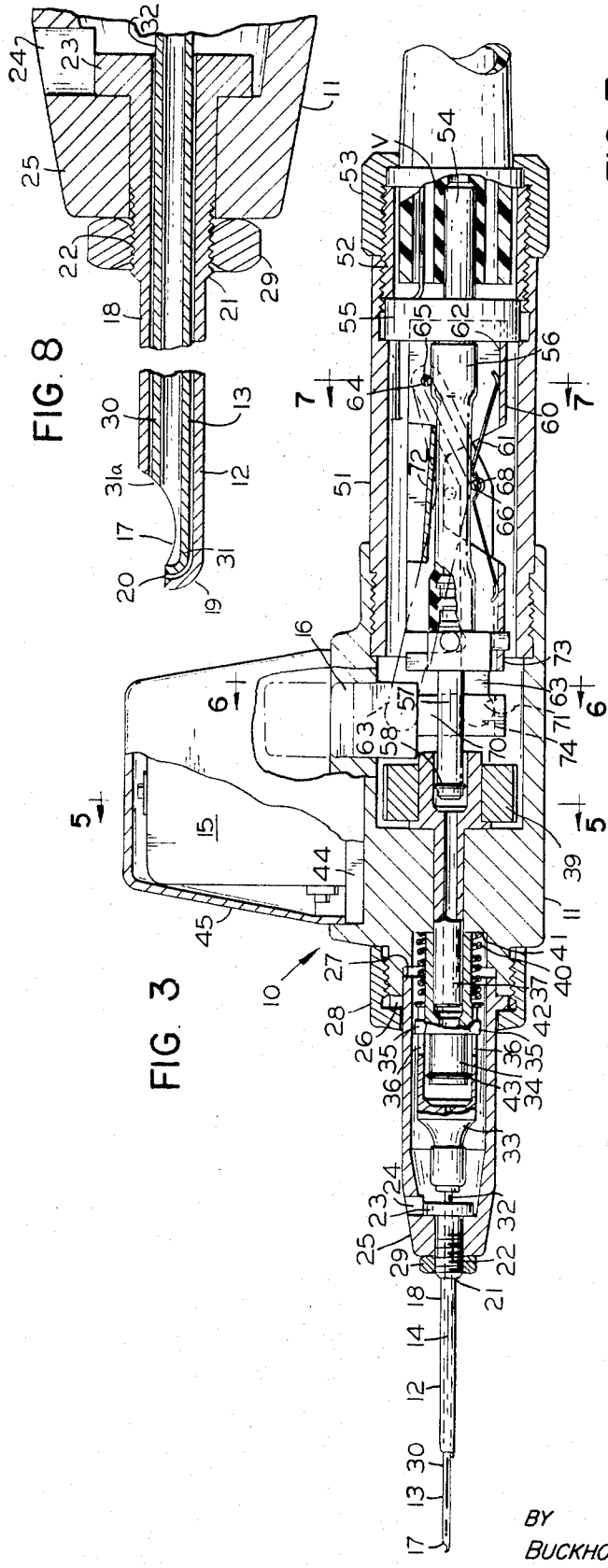

FIG. 3

FIG. 8

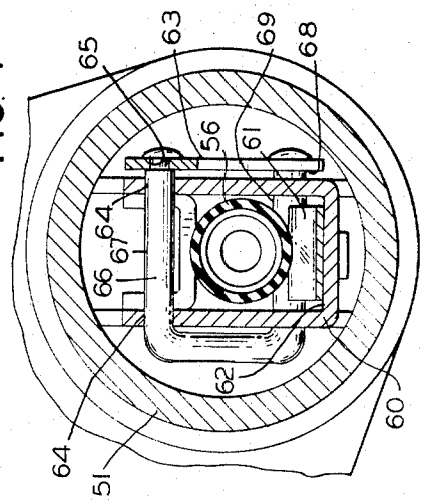

FIG. 7

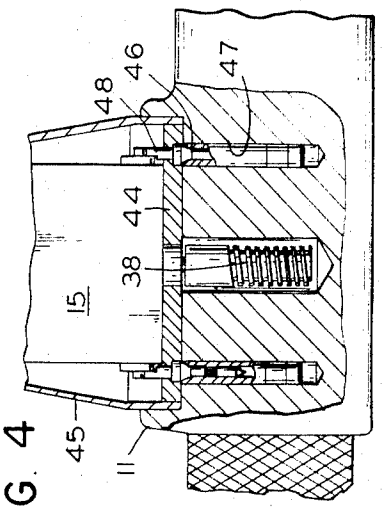

FIG. 4

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POWERED SURGICAL CUTTER

This application is a continuation of Ser. No. 841,741, filed July 15, 1969, and now abandoned.

BACKGROUND OF THE INVENTION

This invention relates to powered surgical cutters and more particularly, to a powered surgical cutter particularly adapted to perform eye surgery by cutting and removing tissue from inside the anterior aqueous chamber of the eye.

Eye surgery in the anterior aqueous chamber is presently performed by making two opposite incisions on the edge of the chamber and inserting a syringe containing fluid in one opening and a knife in the other opening, and cutting the tissue into small pieces. The knife is then removed and a second syringe is placed in the opening. The second syringe draws off the pieces of tissue while the liquid in the first syringe displaces that which is removed by the second syringe. The process is repeated several times. Due to the tough nature of the tissue itself and the fact that the tissue is suspended in a liquid in the anterior aqueous chamber, this is a very difficult operation to perform.

It is thus the object of the present invention to provide a powered surgical cutter for the above described operation. It is a further object of the present invention to provide a surgical cutter that can be inserted into the anterior aqueous chamber of the eye through a precut opening, the cutter being able to remain in place until the surgery is completed. It is a further object of the present invention to provide such a powered surgical cutter with its own controlled vacuum system, the cutter being designed to clip tissue and remove each piece as it is clipped through the vacuum line.

SUMMARY OF THE INVENTION

The surgical cutter of the present invention comprises a housing and motor means mounted in the housing. An elongated external fixed tubular cutter is attached at one end of the housing, the external cutter having an axial bore therethrough. The distal end of the external cutter is closed off and less than half of the diameter of the cutter is removed at the distal end to form a sharp edged opening through which tissue can be drawn.

An elongated inner tubular cutter is mounted in the bore of the external cutter for at least partial rotation about the axis thereof. The distal end of the inner cutter is similarly closed off, less than half the diameter of the inner cutter also being removed at the distal end to form an opening therein. The openings in both the inner and external cutters are in register so that rotation of the inner cutter will shear off tissue drawn into the opening.

Drive means are connected to the motor means for rotating the inner cutter. Such drive means comprise a hollow drive shaft, the interior of the drive shaft being in communication with the interior of the inner cutter. A source of vacuum is provided. Means are also provided to supply the vacuum from the source to the interior of the drive shaft and thence to the interior of the inner cutter. Finally, means are provided to control the supply of vacuum to the cutter.

In using the powered surgical cutter of the present invention to perform eye surgery in the anterior aqueous chamber of the eye, two openings are made in the chamber. A liquid-filled syringe is placed in one opening as previously described. The powered surgical cutter of the present invention is then inserted in the other opening while the vacuum and cutter are turned off. Once inside the anterior aqueous chamber, the cutter is turned on. The rotating inner cutter clips off pieces of tissue and draws each piece into the interior thereof and thence out the vacuum line. The vacuum is controlled by a control knob to stop the flow when desired. When the cutter is running, the tissue and liquid removed are replaced with liquid from the syringe to keep the anterior aqueous chamber properly inflated. The powered surgical cutter of the present invention, however, is not removed until the operation is complete.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a view showing the powered surgical cutter of the present invention performing an operation in the anterior aqueous chamber of the eye.

FIG. 2 is a top plan view of the powered surgical cutter of the present invention.

FIG. 3 is a longitudinal cross-sectional view taken on line 3—3 of FIG. 2.

FIG. 4 is a sectional view taken on line 4—4 of FIG. 2.

FIG. 5 is a sectional view taken on line 5—5 of FIG. 3.

FIG. 6 is a sectional view taken on line 6—6 of FIG. 3.

FIG. 7 is a sectional view taken on line 7—7 of FIG. 3.

FIG. 8 is a view to an enlarged scale and with parts broken away of the external and inner tubular cutters.

FIG. 9 is a view of the cutter showing the electrical control and vacuum pump connection.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Referring now to the drawings and in particular to FIGS. 2–8, the surgical cutter **10** of the present invention has a plastic body **11** of generally cylindrical form designed to be conveniently held in the surgeon's hand. An outer or external fixed tubular cutter **12** is attached to one end of the body **11** and an inner tubular rotatable cutter **13** is mounted within the cutter **12** for rotation about the axis **14** thereof. The inner cutter **13** is driven by a motor **15.** A vacuum is drawn on the interior of the inner cutter **13,** the vacuum being controlled by a knob **16** in a manner to be hereinafter described. Tissue drawn into an opening **17** at the end of the two cutters **12** and **13** is sheared off by the rotation of the inner cutter **13.** The tissue is drawn through the center of the inner cutter **13** by the vacuum and thence into the body **11.**

The external fixed cutter **12** comprises a thin-walled stainless steel tube **18,** the distal end **19** of which is formed into a hemisphere, closing it off. A little less than half of the diameter of the tube **18** is ground away as at **20** to form the end **19** into a sharp-edged cutter. The proximal end **21** of the tube **18** is enlarged in diameter and threaded as at **22,** terminating in a slotted disk **23** which is retained by a key **24** interiorly of an aluminum holder **25.** A flange **26** adjacent the proximal end **27** of the holder **25** is retained against the front of the body **11** by a knurled aluminum nut **28.** The disk **23** is maintained snugly against the distal end of the holder

25 and in engagement with the key 24 by the pressure exerted by a nut 29.

The inner rotatable cutter 13 is made the same way as the external cutter 12, but is smaller in diameter so as to just fit inside the external cutter 12 and still be free to rotate. The inner cutter 13 likewise comprises a thin walled tube 30, the distal end 31 of which is also closed off and formed into a hemisphere and ground away (as at 31*a*) so that a little less than half the diameter is removed. When the two cutters 12 and 13 are in place and lined up, the openings therein are in register so that the cutters appear to have been ground together. When the inner cutter 13 rotates inside the external cutter 12, the opening 17 gradually closes, thereby to clip off a piece of tissue drawn into the opening 17 by the action of the vacuum. The fact that the two cutters 12 and 13 are ground less than half their diameters allows the inner cutter 13 to be contained within the external cutter 12 at all positions of the inner cutter 13.

The proximal end 32 of the tube 30 is received in an enlarged hollow generally cylindrical portion 33 which is positioned within the holder 25. A hollow plastic drive coupling 34, keyed as at 35, is engaged in slots 36 in the portion 33 of the cutter 13. A hollow steel drive shaft 37 received in the coupling 34 rotates the same and thus rotates the cutter 13 within the cutter 12. The shaft 37 is driven by the motor 15 through a plastic worm 38 and gear 39. (See FIG. 5.) A helical compression spring 40 encircling the coupling 34 and being retained against an inner surface 41 in the body 11 exerts pressure against the portion 33 of the cutter 13 through a thrust washer 42. The spring 40 forces the inner cutter 13 against the distal end 19 of the external cutter 12, thereby to guarantee a good fit between the two cutting edges. A flange 43 on the drive coupling 34 maintains an airtight seal between the coupling 34 and the portion 33 of the inner cutter 13.

The motor 15 is of the plug-in type and is mounted on a high temperature plastic base 44 laterally offset within the body 11 and enclosed within a removable brass housing 45. Power to the motor 15 is furnished by electrical leads which enter the cutter 10 from the rear and contact plugs 46 received in sockets 47 received within the body 11, the motor 15 making contact with terminals 48 on the plugs 46 as shown in FIG. 4. The driving shaft 49 of the motor 15 furnishes power to the worm 38 which turns the gear 39 which in turn rotates the hollow drive shaft 37 which it encircles. (See FIG. 5.)

A cylindrical aluminum extension 51 is threadedly engaged with the rear of the body 11. An aluminum sleeve 52 is threadedly engaged with the rear of the extension 51 and a cable nut 53 received on the rear of the sleeve 52 effects the vacuum and electrical connections to the cutter 10. (See FIG. 9.)

A vacuum line V (see FIG. 3) is attached to a brass fitting 54 supported by a brass plate 55 within the extension 51. The inner end of the fitting 54 is received within a length of flexible hose 56 which is attached at its forward end to a plastic support fitting 57, which in turn makes an airtight connection by means of a flange 58 with the rear end of the hollow drive shaft 37. The latter being received within the coupling 34 extends the vacuum connection to the cylindrical portion 33 of the cutter 13 as previously mentioned.

The vacuum connection to the cutter 13 is normally closed. The vacuum supply is controlled by pressure applied to the knob 16. A valve frame 60 preferably made of brass is mounted within the extension 51 and is provided with two generally parallel surfaces 62 and 72. The frame 60 is positioned so that the hose 56 passes longitudinally through the frame and between the surfaces 62 and 72, the frame being supported at its rear in cooperating recesses cut in the plate 55, and at its front on a surface 73 of the body 11. The forward hose support fitting 57 is supported by the frame 60 as shown.

A valve spring 61 preferably made of copper-beryllium and shown in its normal position by the dashed lines in FIG. 3 rests against the surface 62 of the frame 60. A U-shaped steel contact pin 66 is supported by one leg 67 in apertures 64 in the frame 60. (See FIG. 7.) A steel valve arm 63 is pivotally supported as at 65 at the end of leg 67 of the pin 66, the other leg 69 of the pin 66 being received in an aperture 68 in arm 63. The lower surface of the leg 69 of the pin 66 rests on the spring 61 and the upper surface of the leg 69 is adapted to contact the vacuum hose 56.

The knob 16 has a depending portion 70 extending into the body 11 which is slotted as at 71 to receive the forward end 74 of the arm 63. (See FIG. 6.) When the knob 16 is in its normal or upper position, the pressure of the spring 61 rotates the pin 66 in the apertures 64 to force the leg 69 up against the hose 56, pinching it against the surface 72 on the frame 60 and closing off vacuum to the inner cutter 13. When the knob 16 is pressed downwardly and inwardly of the apparatus, the arm 63 is forced downwardly and away from the surface 72, thus to rotate the pin 66 by exerting pressure against the spring 61 through the leg 69, and permit the hose 56 to carry vacuum to the cutter 13.

The cutter of the present invention, although specifically designed for eye surgery, could also be used to remove any other body tissue in the same manner. Similarly, although an electric motor has been shown as the source of power for the inner cutter, an air or vacuum motor could be used or the motor could be designed to impart partial rotation to produce an oscillating motion of the inner cutter instead of continuous rotation.

In operation, the powered surgical cutter of the present invention functions as follows. Two openings 76 and 77 are made in the anterior aqueous chamber 78, as shown in FIG. 1. A liquid-filled syringe 79 is inserted in one opening and the cutter 10 is inserted in the other. After the cutter is inserted into the anterior aqueous chamber and before the cutter is turned on, the knob 16 is depressed to permit the vacuum to reach the interior of the inner cutter 13 from the source P. Power to the motor 15 is controlled by the foot treadle 75. (See FIG. 9.) As the inner cutter 13 turns, the edge 31*a* begins to close the opening 17. The vacuum draws tissue into the opening, and as the inner cutter 13 continues to turn, the opening 17 gets smaller until the outer edge of the inner cutter 13 shears against the inner edge of the external cutter 12. A piece of tissue is thus clipped off and is drawn through the center of the inner cutter 13 and into the body 11. The inner cutter 13 continues to rotate until it is again in its original position as shown in FIG. 8. The instrument is then ready to draw in another piece of tissue and repeat the operation.

In the foregoing description, the invention has been described with reference to a certain particular preferred embodiment, although it is to be understood that the specific details shown are merely illustrative and that the invention may be carried out in other ways without departing from the true spirit and scope of the following appended claims.

We claim:

1. A surgical cutter comprising:
a housing;
motor means mounted in said housing;
an elongated external fixed tubular cutter attached at one end to said housing, said external cutter having an axial bore therethrough, the other end of said external cutter being closed off, less than half the diameter of said external cutter being removed at said other end to form a sharp-edged opening in said cutter through which tissue can be drawn;
an elongated inner tubular cutter mounted in said bore for at least partial rotation about the axis thereof, and having an end adjacent said other end of said outer cutter, said end of said inner cutter being closed off, a portion of the diameter of said inner cutter being removed at said end of said inner cutter to form an opening therein, said opening in said inner cutter being in register with said opening in said external cutter;
drive means connected to said motor means for said rotation of said inner cutter, said drive means comprising a hollow drive shaft, the interior of said drive shaft being in communication with the interior of said inner cutter;
a source of vacuum;
means to supply vacuum from said source to said interior of said drive shaft and thence to said interior of said inner cutter; and
means to control the supply of vacuum to said interior of said drive shaft for drawing tissue into said opening in said inner cutter,
said tissue being sheared off by said rotation of said inner cutter inside and against said bore of said external cutter.

2. A cutter as in claim 1 in which said supply means comprise a flexible hose and means to attach said flexible hose to said hollow drive shaft.

3. A cutter as in claim 2 in which said control means comprise:
a frame mounted within said housing, said frame being provided with two generally parallel longitudinally-extending surfaces, said flexible hose passing longitudinally through said frame and between said surfaces;
spring means disposed against one of said surfaces of said frame and adapted normally to contact said flexible hose and pinch the same against the other of said surfaces; and means selectively to urge said spring means away from said other of said surfaces to permit a vacuum to be drawn through said hose to said interior of said drive shaft.

4. A cutter as in claim 3 in which said selective means comprise:
a knob, said knob having a depending portion extending into said housing, said depending portion having a slot therethrough; and
an arm pivotally supported at one end on said frame, the other end of said arm being received in said slot, said arm being adapted to contact said spring means and press the same away from said other of said surfaces.

5. The cutter of claim 1 further comprising a hollow coupling disposed between said drive shaft and said inner cutter, said coupling being attachable to said inner cutter, said drive shaft being received within said coupling to rotate the same and thereby to rotate said inner cutter.

6. The cutter of claim 5 further comprising a helical spring encircling said coupling, one end of said spring being retained against said housing, the other end of said spring contacting the proximal end of said inner cutter to urge the same against said other end of said external cutter.

7. The cutter of claim 5 further comprising a flange on said coupling to maintain an airtight seal between said coupling and said inner cutter.

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