June 8, 1948. F. J. WALLACE 2,442,966

ELECTROSURGICAL RESECTING INSTRUMENT

Filed Sept. 7, 1946 3 Sheets-Sheet 1

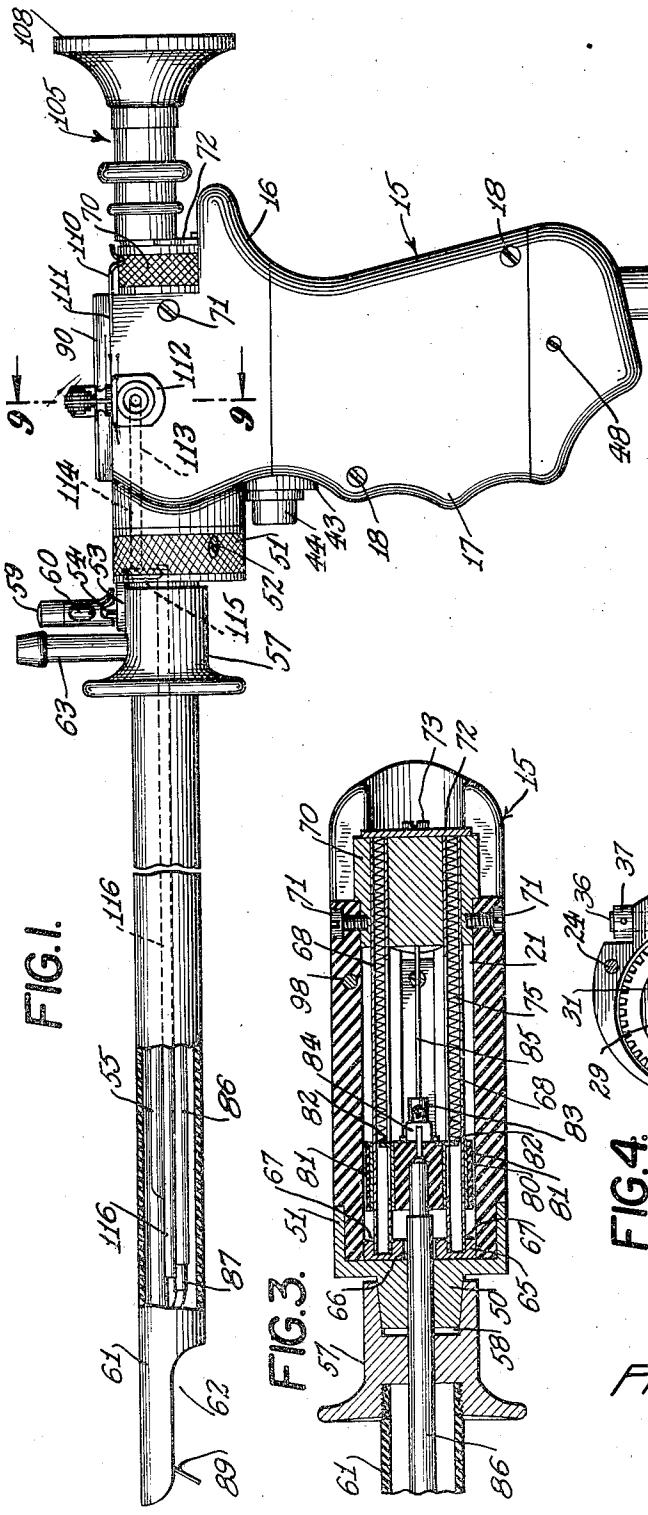

FIG. 1.

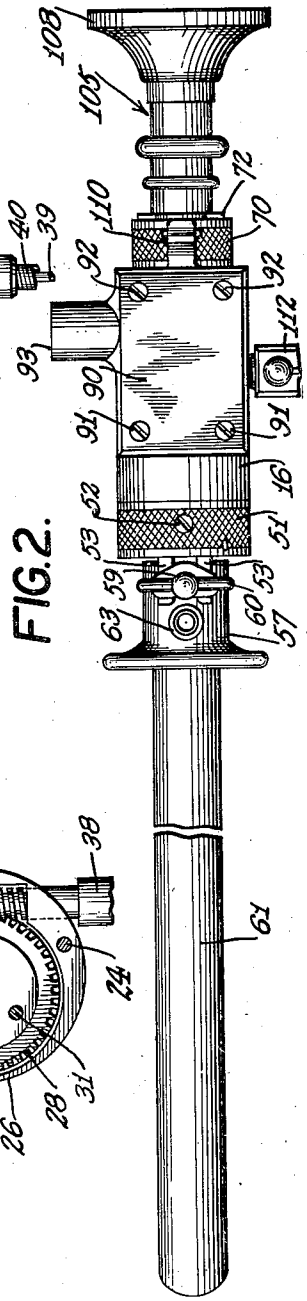

FIG. 2.

FIG. 3.

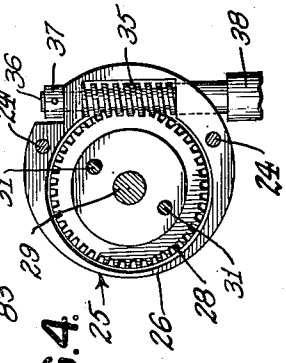

FIG. 4.

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ELECTROSURGICAL RESECTING INSTRUMENT

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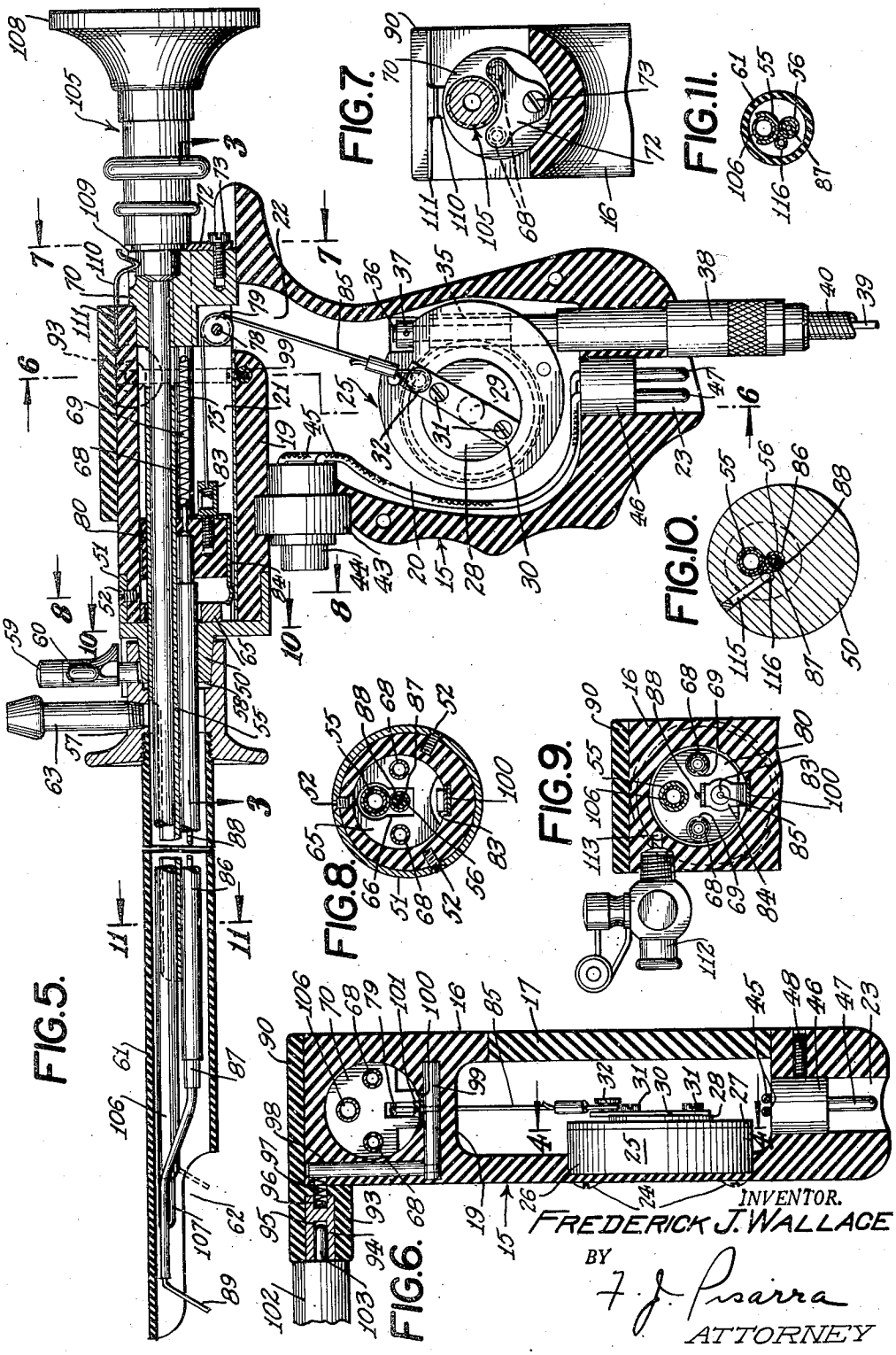

FIG.5.

FIG.6.

FIG.7.

FIG.8.

FIG.9.

FIG.10.

FIG.11.

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ELECTROSURGICAL RESECTING INSTRUMENT

Filed Sept. 7, 1946 3 Sheets-Sheet 3

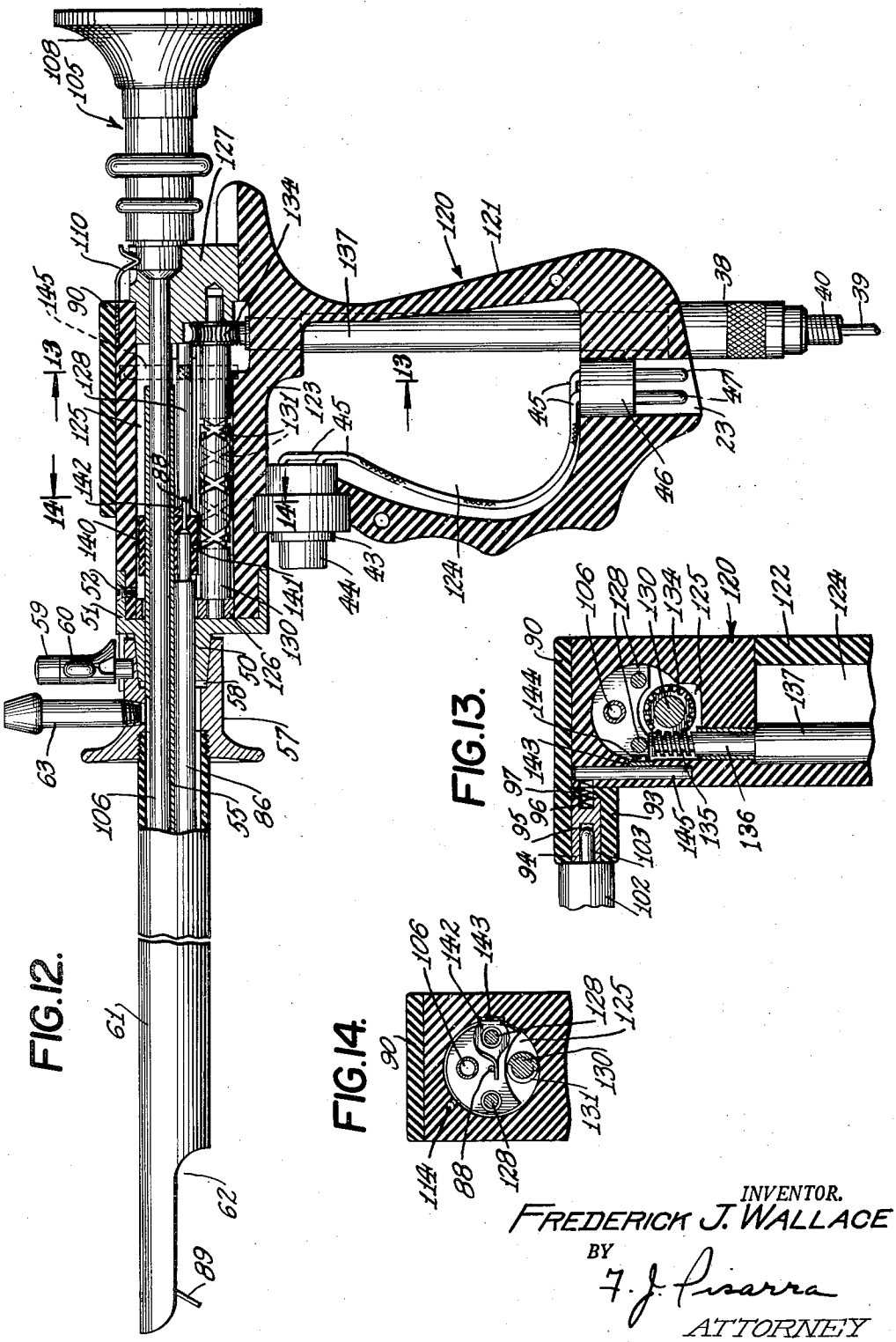

FIG. 12.

FIG. 13.

FIG. 14.

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UNITED STATES PATENT OFFICE

2,442,966

ELECTROSURGICAL RESECTING INSTRUMENT

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Application September 7, 1946, Serial No. 695,513

14 Claims. (Cl. 128—303.15)

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This invention relates generally to electrosurgery and has particular reference to an electrosurgical resecting instrument adapted to be advantageously employed for the removal of protrusions, tissue growths and the like with the aid of a high frequency electric current.

The invention pertains, in one of its more specific aspects, to an electrosurgical resecting instrument having a cutting electrode disposed in the region of a lateral fenestra in the sheath of an endoscopic tube and arranged to be reciprocated with respect to the sheath.

The instrument of this invention has wide application in the field of electrosurgery and is capable of readily removing protrusions, tumorous growths or other masses of body tissue that may be on the exterior of a body or within body passages or cavities. In this connection, the present invention is well suited for the speedy resection of protrusions in the urethra and bladder neck and for the excision of undesirable growths on the prostate gland and other internal organs.

An instrument constructed in accordance with this invention may be inserted in a body passage or cavity to the region of a protrusion or the like which is to be removed, whereupon the protrusion may be resected by a high frequency reciprocatory cutting electrode under conditions of illuminated vision. One of the features of the invention resides in the provision of a cutting electrode adapted to be reciprocated continuously and automatically to the end that the protrusion or tissue growth may be quickly and readily resected with a minimum of effort and strain on the part of the operating surgeon and with corresponding reduction in discomfort and nervous effect on the patient.

In present-day high frequency electrosurgical instruments employing a reciprocable cutting electrode, the cutting electrode is manually operated by the surgeon to thereby cut away a piece of a protrusion on each movement of the electrode. This procedure is objectionable for a number of reasons. For one thing, the resection or excision of a large mass of tissue by making small individual cuts is both tedious and time-consuming. Also, the operating surgeon is under a considerable physical strain and nervous tension, as he is obliged to manually actuate the electrode for each individual cut in pruning away a mass of tissue growth. Additionally, the patient is generally under considerable strain during an operation of this character and is often subjected to great pain and discomfort due to the presence of

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the instrument in his body and as a consequence of the operation of the instrument.

Several worthwhile developments have been made in comparatively recent years in connection with instruments of this general character. For example, F. C. Wappler Patents 2,038,393, granted April 21, 1936, and 2,090,923, granted August 24, 1937, both disclose endoscopic instruments that are provided with reciprocable cutting electrodes. In accordance with the teachings of these patents, it has been the general practice heretofore to manually actuate the cutting electrode by imparting movement thereto through the medium of a rack and pinion device. Instruments of this type require that the operating surgeon employ one hand to hold and control the instrument as a unit and his other hand for the actuation of the cutting electrode. Both of the operating surgeon's hands are thus occupied with the handling of the instrument, and the surgeon is thereby unable to conveniently use his hands for other purposes, such as for the palpation of the prostate gland, as may be necessary in many instances.

My present invention obviates the difficulties experienced heretofore, as will be apparent from the detailed description further along herein.

One of the outstanding features of this invention resides in the provision of an instrument of the character indicated having the parts so constructed and arranged that the operating surgeon can handle the instrument and control movement of the cutting electrode by using only one hand, the surgeon's other hand being free for manual palpation or for other purposes, as required. To this end the instrument includes a rotary driving unit and suitable means for translating rotation of the driving unit into reciprocation of the cutting electrode, all arranged within the instrument grip or handle and under the control of the operating surgeon at all times, and therefore capable of being readily placed into and out of service at will.

It is an important object of this invention to provide an improved electrosurgical resecting instrument of the type having a reciprocable cutting electrode.

Another object of the invention is to provide an instrument of the character indicated wherein a reciprocatory cutting electrode is actuated by a driving unit carried by the instrument and adapted to be placed into and out of active service at the will of the operating surgeon.

Another object of the invention is to provide a high frequency electrosurgical instrument having parts constructed and arranged so that the op-

erating surgeon can readily perform a complete resection with the instrument held in one hand, while his other hand is free for palpation of the prostate gland, or for other purposes, as may be required.

Another object of the invention is to provide an electrosurgical resecting instrument having a reciprocatory cutting electrode, capable of speedily removing a tissue growth within a body passage or cavity.

The invention has for a further object the provision of an instrument of the character indicated, including a reciprocatory cutting electrode that is adapted to be actuated through the medium of a rotary driving means.

A still further object of the invention is to provide an electrosurgical instrument of the type indicated that is simple and attractive in design; staunch in construction and dependable in operation.

With the above and other objects in view, the invention comprises the devices, combinations and arrangements of parts set forth in the following detailed description and illustrated in the annexed drawings of preferred embodiments of the invention, from which the several features of the invention, together with the advantages attainable thereby, will be readily understood by persons skilled in the art.

In the drawings, wherein like reference numerals denote corresponding parts throughout the several views:

Figure 1 is a side elevation view of one embodiment of an instrument constructed in accordance with this invention, with parts broken away for better illustration;

Figure 2 is a top plan view of the instrument illustrated in Figure 1;

Figure 3 is an enlarged cross-sectional view taken along line 3—3 of Figure 5;

Figure 4 is a cross-sectional view taken along line 4—4 of Figure 6;

Figure 5 is an enlarged longitudinal cross-sectional view of the instrument shown in Figure 1;

Figures 6, 7 and 8 are cross-sectional views taken along lines 6—6, 7—7 and 8—8, respectively, of Figure 5;

Figure 9 is an enlarged fragmentary cross-sectional view taken along line 9—9 of Figure 1;

Figures 10 and 11 are cross-sectional views taken along lines 10—10 and 11—11, respectively, of Figure 5;

Figure 12 is illustrative of a second embodiment of an instrument constructed in accordance with this invention and corresponds generally to Figure 5; and

Figures 13 and 14 are fragmentary cross-sectional views taken along lines 13—13 and 14—14, respectively, of Figure 12.

Referring now to the drawings and more particularly to Figures 1, 3, 5 and 6 thereof, a hollow instrument handle or support of the pistol grip type is generally indicated by numeral 15 and is preferably made of a suitable electrically insulating plastic material. Handle 15 consists of a molded body 16, having a removable side cover plate 17 that is maintained in position by screws 18, and a horizontal partition 19, integral with and extending part way across body 16. As is best shown in Figure 5, partition 19 divides the interior of handle 15 into a drive compartment 20, an instrument compartment 21, and a passage 22 establishing communication between compartments 20 and 21. The lower end of body 16 is hollowed out to form a plug receiving compartment 23 that merges with drive compartment 20.

Positioned within handle 15 and secured to the side wall thereof by screws 24 (Figure 6) is a rotary driving means 25 that will now be described. Driving means 25 includes a casing 26 and a cover plate 27. A worm gear 28, rotatably mounted on a stationary shaft 29, carried by casing 26, is disposed within the casing and projects through and beyond cover 27. A crank arm 30 is attached to the outer end of worm gear 28 by a pair of screws 31 and is provided with a peripherally grooved crank pin 32 proximate one end. Also within casing 26 and meshing with worm gear 28 is a worm 35 having an integral rotary shaft 36 that projects beyond casing 26 and that is restrained against downward axial movement by a collar 37. Shaft 36 extends downwardly and into a hollow connector sleeve assembly 38, wherein it is coupled to the upper end of a flexible shaft 39 that is rotatable in a flexible conduit 40.

Rotation is imparted to flexible shaft 39, shaft 36, worm 35, worm gear 28, crank arm 30 and crank pin 32, in the order named, through the medium of a suitable electric motor (not shown). Such a motor is usually located remotely from the instrument handle and is placed into and out of active service by an electric circuit, partially shown in Figure 5 and including a switch 43 carried by handle 15 and conveniently arranged to permit a spring pressed push button 44, for actuating the switch, to be readily depressed and released by the index finger of the hand used by the operating surgeon in gripping the instrument handle. A pair of electric leads 45, wholly within compartment 20, connects switch 43 with an electric plug 46 that is provided with a pair of electrical terminal posts 47. As is illustrated in Figure 5, plug 46 and terminal posts 47 are contained in plug compartment 23 of the handle and are maintained therein by a set screw 48 (Figures 1 and 6).

A forwardly tapered frustro-conical collar 50 has an integral ring flange 51 that accommodates the upper forward end of handle 15 and that is affixed to the handle by a series of screws 52 (Figures 1 and 8). Projecting forwardly of flange 51 is a pair of spaced parallel fingers 53 (Figure 2), either or both of which carries an upstanding locking pin 54 (Figure 1). A telescope guide tube 55 extends through and is attached to collar 50 in the usual manner.

A second collar 57 is flared at its forward end and is bored centrally at its rear end to obtain a forwardly and inwardly tapered recess 58 that is adapted to receive the forward end of collar 50 and form a snug, fluid-tight connection therewith. An upright post 59 is mounted on collar 57 and carries a locking attachment 60. When the parts are in the relative position shown in Figures 1 and 2, post 59 is located between fingers 53 and locking attachment 60 engages lock pin 54 so as to lock collars 50 and 57 together. The flared end of collar 57 is internally threaded to engage with corresponding external threads formed at the rear portion of an endoscopic tube or sheath 61 that is made of a suitable insulating material and that is provided with the usual fenestra 62. An irrigating liquid discharge conduit 63 is connected to collar 57 and communicates with the interior of endoscopic tube 61.

A plate 65 is disposed within instrument compartment 21 and abuts the rear end of collar 50. Plate 65 is provided with a through keyhole aperture 66 (Figure 8), for the free passage of tele-

scope guide tube 55 and an electrode rod shaft to be described, and with a pair of spaced blind bores 67 (Figure 3), for the reception and retention of the forward end of each of a pair of parallel guide tubes 68. As is depicted in Figures 5 and 9, each guide tube 68 has a longitudinal slot 69 and is insertable through a corresponding passage in a stationary block 70 that is attached to handle 15 by screws 71. A plate 72, fastened to block 70 by screws 73, serves as a closure for the rear end of both guide tubes 68 and also as an abutment for helical compression springs 75 that are housed within these tubes. A pin 78 mounted in block 70 freely supports a rotary pulley 79.

A slide block 80 of an electrical insulating material is disposed in instrument compartment 21 intermediate plate 65 and stationary block 70. Block 80 carries a pair of bearing sleeves 81 that are concentric with and permit reciprocation of this block with respect to and along guide tubes 68. Each sleeve 81 has a lateral extension 82 that projects into a corresponding slot 69 of guide tubes 68 (Figure 3) and that bears against the forward end portion of a corresponding compression spring 75. By virtue of the construction just described, slide block 80 is normally and yieldingly urged in a forward direction along guide tubes 68 due to the action of compression springs 75. Depending from and attached to block 80 by a threaded coupling member 83 is a spring contact element 84, having good electrical conductive properties (Figures 5 and 9). A flexible connector means 85, such as a relatively thin stranded cable, a strip of catgut or the like, is secured at one end to coupling member 83, passes over pulley 79, and is provided with a loop at its other end for engagement with crank 32 (Figure 5).

Reference is next had to Figures 5 and 11 for details of construction of a high frequency electrode forming part of this invention and including a tubular shaft 86 that is axially reciprocable through collar 50 and keyhole aperture 66 in plate 65. Imbedded in a sheath of fine insulating material 87 and concentric and reciprocable with tubular shaft 86 is an electrically conductive rod 88 which merges at its forward end with a cutting loop electrode 89 that is free of insulating material and that may be the same as or similar to the loop electrode disclosed in aforementioned Wappler Patent 2,038,393. The rear portion of tubular shaft 86 is anchored in slide block 80 while the exposed rearward extremity of conductive rod 88 projects through and beyond the rear end of block 80 and contacts the top portion of spring element 84.

A plate of insulating material 90 is affixed to the top of handle 15 by screws 91 and 92 (Figure 2) and carries an integral lateral socket body 93. Imbedded in socket body 93 is an electrically conductive element 94, which is best shown in Figure 6 and which has an outer blind bore 95 and an inner blind bore 96. A compression spring 97 establishes electrical contact between element 94 and a vertical conductive rod 98 in handle body 16. A horizontal conductive rod 99 also in body 16 is in intimate electrical contact with rod 98 and is maintained in electrical engagement with a conductive bar 100 by a screw 101. Bar 100 is disposed in a groove formed in the upper surface of partition 19 and is connected thereto by screws 101. Also bar 100 is parallel to the path of travel of slide block 80 and is at all times in contact with spring element 84. An electric

plug 102 includes a terminal 103 that is adapted to be snugly received in blind bore 95 and thus make suitable electrical contact with element 94. Plug 102 is adapted to be connected to an appropriate source of high frequency electric current (not shown) so as to electrically energize cutting loop electrode 89, through the medium of element 94, compression spring 97, vertical rod 98, horizontal rod 99, bar 100, spring contact element 84, and electrode rod 88, in the order set forth.

A telescope, generally denoted by numeral 105, includes a tubular body 106 of relatively small diameter adapted to be inserted successively through stationary block 70 and guide tube 55 so that a miniature electric lamp 107, carried at its forward end and energized in the usual manner, may be positioned directly opposite fenestra 62 for providing illumination therethrough. At the rear end of the telescope is a conventional eyepiece 108. The telescope forms a fluid-tight seal with stationary block 70 and is provided with a recessed aligning element 109 that is adapted to be engaged by a spring extension 110 integral with a plate 111 that is clamped between body 16 and plate 90 and retained in position by screws 92. The telescope lens system (not shown) may be of any suitable type, such as, for example, the lens system for commanding an obliquely forward field of vision disclosed in R. H. Wappler Patent 1,680,490, granted August 14, 1928.

Irrigating liquid may be transmitted into a body cavity by the instrument of this invention by a system of interconnecting devices and passages that will now be described, having particular reference to Figures 1, 9, 10 and 11. The irrigating liquid obtained from a convenient source of supply, not shown, is introduced into the instrument by way of a petcock 112 that is mounted on the side of and is in communication with a passage 113 in body 16. Passage 113 is in alignment with a longitudinal passage 114 in collar 50, the latter passage intersecting with a generally radially bored passage 115 which in turn connects with a tube 116 that is parallel and connected to tube 55 and terminates slightly rearwardly of fenestra 62 when the instrument is assembled.

For the purpose of briefly outlining the mode of operation of the above described instrument, let us first assume that the instrument is fully assembled; that endoscopic tube 61 has been inserted in a body passage so that fenestra 62 is in the region of the tissue growth to be resected; and that telescope lamp 107 is connected to a suitable source of electric current, plug 102 is connected to an appropriate source of high frequency current, and plug 46 and flexible shaft 39 are connected electrically and mechanically, respectively, to an electric motor. A quantity of an irrigating liquid may be transmitted into the body cavity by way of petcock 112, the passages communicating therewith, and endoscopic tube 61, and subsequently withdrawn through the endoscopic tube and conduit 63.

The operating surgeon is now ready to remove the tissue growth. He grips handle 15 with one hand, placing the forefinger of that hand lightly against switch button 44; and, sighting through eyepiece 108, he manipulates the instrument until the tissue growth is accommodated in fenestra 62. His other hand is free for manual palpation of the prostate gland, or for other purposes, as may be required. The surgeon then presses switch button 44 inwardly with his forefinger and thus completes the electric circuit to

the electric motor, to thereby impart rotation to flexible shaft 39 and worm 35. The high frequency electric circuit is completed simultaneously. Since worm 35 meshes with worm gear 28, the latter, as well as crank 32, is correspondingly rotated about the axis of shaft 29.

Assuming that crank 32 is rotating in a clockwise direction, as viewed in Figure 5, it will impart a downward pull on connector means 85 in turning approximately 180 degrees from the position shown, to thereby move slide block 80, electrode rod 88, and cutting electrode 89 toward the right against the action of compression springs 75. During the succeeding 180 degrees of rotation of crank 32, slide block 80, electrode rod 88, and cutting electrode 89 are moved toward the left due to the action of compression springs 75, as will be evident from an inspection of Figure 5. It will thus be noted that for each complete revolution of crank 32, a complete cycle of reciprocation is imparted to cutting electrode 89, during which a portion of the tissue growth is pruned away. The rate of reciprocation of the cutting electrode depends upon the speed of rotation of flexible shaft 39 and the ratio of worm 35 to worm gear 28; and should be such as to permit of as rapid resection of the tissue growth as is consistent with the skill of the operating surgeon and safety to the patient.

Reference is next had to Figures 12, 13 and 14 for an understanding of the construction of the embodiment of the invention illustrated therein. This embodiment is in many respects the same as the first described embodiment. In the second embodiment, an instrument support or handle 120 also includes a body 121 having a removable cover 122. A partition 123 divides the interior of the handle into a lower compartment 124 and an upper or instrument compartment 125. Positioned within and arranged at opposite ends of compartment 125 are a plate 126 and a stationary block 127, corresponding generally to elements 65 and 70, respectively, of the first embodiment of the invention, and supporting a pair of parallel guide rods 128. A shaft 130 having a continuous peripheral helical groove 131 is rotatably supported at its opposite ends in plate 126 and block 127. Rotatable with shaft 130 is a worm gear 134 that meshes with a worm 135 which is integral with a vertical shaft 136 rotatable in a vertical bearing sleeve 137.

A slide block 140, made of a suitable insulating material and slidable along guide rods 128, is secured to electrode rod 88 and is provided with a depending pin 141 that registers with groove 131. A contactor 142, embracing but not engaging one of the guide rods 128, is secured to slide block 140 and is in intimate contact with the exposed rearward end portion of electrode rod 88. Contactor 142 is also in intimate contact with an electrically conductive bar 143 in compartment 125 (Figures 13 and 14), the latter being in electrical communication with high frequency current plug 102 by means of a screw 144, a vertical conductive rod 145, spring 97 and element 94.

In operation, rotation of flexible shaft 39, vertical shaft 136, and worm 135 imparts corresponding rotation to worm gear 134 and horizontal shaft 130. Rotation of shaft 130 is translated into reciprocation of slide block 140, electrode rod 88 and cutting electrode 89 through the medium of pin 141 that registers and rides in continuous groove 131 in shaft 130.

From the foregoing, it is thought that the objects, construction, operation, and many advantages of the herein described invention will be apparent to those skilled in the art, without further description; and, it will be understood that various changes in the size, shape, proportion and minor details of construction may be resorted to without departing from the spirit, or sacrificing any of the advantages of the invention.

I claim:

1. In a surgical instrument of the character described, a support, an endoscopic tube carried by said support, an electrode rod movable longitudinally in said tube, a cutting electrode at the forward end portion of said rod and movable therewith, a block secured to the rearward end portion of said rod and reciprocably mounted to said support, rotary driving means carried by said support, means for imparting continuous rotation to said driving means, and means associated with said driving means and said block for translating rotational movement of said driving means into reciprocatory movement of said block and said rod.

2. In a surgical instrument of the character described, a support, an endoscopic tube carried by said support, an electrode rod movable longitudinally in said tube, a cutting electrode at the forward end portion of said rod and movable therewith, a block secured to the rearward end portion of said rod and reciprocably mounted to said support, rotary driving means carried by said support including a worm gear, means for imparting continuous rotation to said driving means including a rotary shaft and a worm meshing with said worm gear and rotatable with said shaft, and means associated with said driving means and said block for translating rotational movement of said driving means into reciprocatory movement of said block and said rod.

3. In a surgical instrument of the character described, a hollow handle, an endoscopic tube carried by said handle, an electrode rod movable longitudinally in said tube, a cutting electrode at the forward end portion of said rod and movable therewith, a block reciprocably arranged wholly within said handle and connected to the rearward end portion of said rod, rotary driving means wholly within said handle, means at least partially within said handle for imparting continuous rotation to said driving means, and means within said handle and associated with said driving means and said block for translating rotational movement of said driving means into reciprocatory movement of said block and said rod.

4. In a surgical instrument of the character described, a hollow handle, an endoscopic tube carried by said handle, an electrode rod movable longitudinally in said tube, a cutting electrode at the forward end portion of said rod and movable therewith, a block reciprocably arranged wholly within said handle and connected to the rearward end portion of said rod, rotary driving means wholly within said handle, including a worm gear, means for imparting continuous rotation to said driving means including a rotary shaft and a worm meshing with said worm gear and rotatable with said shaft, and means within said handle and associated with said driving means and said block for translating rotational movement of said driving means into reciprocatory movement of said block and said rod.

5. In a surgical instrument of the character described a, support, an endoscopic tube carried by said support, an electrode rod movable longitudinally in said tube, a cutting electrode at the forward end portion of said rod and movable there-

with, a block secured to the rearward end portion of said rod and reciprocably mounted to said support, rotary driving means carried by said support, means for imparting continuous rotation to said driving means, and means associated with said driving means and said block for translating rotational movement of said driving means into reciprocatory movement of said block and said rod, said last mentioned means comprising spring means for moving said block in one direction with respect to said support and means connected to said block and said driving means for moving said block in the opposite direction against the action of said spring means during a predetermined portion of each cycle of rotation of said driving means.

6. In a surgical instrument of the character described, a support, an endoscopic tube carried by said support, an electrode rod movable longitudinally in said tube, a cutting electrode at the forward end portion of said rod and movable therewith, a block secured to the rearward end portion of said rod and reciprocably mounted to said support, rotary driving means carried by said support, means for imparting continuous rotation to said driving means, and means associated with said driving means and said block for translating rotational movement of said driving means into reciprocatory movement of said block and said rod, said last mentioned means comprising spring means for moving said block in one direction with respect to said support and flexible connector means secured to said block and said driving means for moving said block in the opposite direction against the action of said spring means during a predetermined portion of each cycle of rotation of said driving means.

7. In a surgical instrument of the character described, a support, an endoscopic tube carried by said support, an electrode rod movable longitudinally in said tube, a cutting electrode at the forward end portion of said rod and movable therewith, a block secured to the rearward end portion of said rod and reciprocably mounted to said support, rotary driving means carried by said support including a worm gear, means for imparting continuous rotation to said driving means including a rotary shaft and a worm meshing with said worm gear and rotatable with said shaft, spring means for moving said block in one direction with respect to said support, and flexible connector means secured to said block and said worm gear for moving said block in the opposite direction against the action of said spring means during a predetermined portion of each cycle of rotation of said worm gear.

8. In a surgical instrument of the character described, a hollow handle, an endoscopic tube carried by said handle, an electrode rod movable longitudinally in said tube, a cutting electrode at the forward end portion of said rod and movable therewith, a block reciprocably arranged wholly within said handle and connected to the rearward end portion of said rod, rotary driving means wholly within said handle, means at least partially within said handle for imparting continuous rotation to said driving means, and spring means within said handle for moving said block in one direction with respect to said handle, and flexible connector means within said handle and secured to said block and said rotary driving means for moving said block in the opposite direction against the action of said spring means during a predetermined portion of each cycle of rotation of said driving means.

9. In a surgical instrument of the character described, a hollow handle, an endoscopic tube carried by said handle, an electrode rod movable longitudinally in said tube, a cutting electrode at the forward end portion of said rod and movable therewith, a block reciprocably arranged wholly within said handle and connected to the rearward end portion of said rod, rotary driving means wholly within said handle including a worm gear, means for imparting continuous rotation to said driving means including a rotary shaft and a worm meshing with said worm gear and rotatable with said shaft, and spring means within said handle for moving said block in one direction with respect to said handle, and flexible connector means within said handle and secured to said block and said rotary driving means for moving said block in the opposite direction against the action of said spring means during a predetermined portion of each cycle of rotation of said driving means.

10. In a surgical instrument of the character described, a hollow handle, an endoscopic tube carried by said handle, an electrode rod movable longitudinally in said tube, a cutting electrode at the forward end portion of said rod and movable therewith, at least one guide tube within said handle, a block within said handle and reciprocable along said guide tube, said block being rigidly attached to the rearward end portion of said rod, rotary driving means wholly within said handle including a worm gear and a crank rotatable in response to rotation of said worm gear, means for imparting continuous rotation to said driving means including a rotary shaft and a worm within said handle and meshing with said worm gear, and a compression spring concentric with said guide tube for moving said block in one direction along said guide tube, and flexible connector means within said handle and secured to said block and said crank for moving said block in the opposite direction along said guide tube against the action of said spring during a predetermined portion of each cycle of rotation of said crank.

11. In a surgical instrument of the character described, a support, an endoscopic tube carried by said support, an electrode rod movable longitudinally in said tube, a cutting electrode at the forward end portion of said rod and movable therewith, a block secured to the rearward end portion of said rod and reciprocably mounted to said support, rotary driving means carried by said support, means for imparting continuous rotation to said driving means, and means associated with said driving means and said block for translating rotational movement of said driving means into reciprocatory movement of said block and said rod, said last mentioned means comprising a member rotatable in response to rotation of said driving means and having a continuous peripheral groove formed therein and an element affixed to said block and registering with said groove.

12. In a surgical instrument of the character described, a support, an endoscopic tube carried by said support, an electrode rod movable longitudinally in said tube, a cutting electrode at the forward end portion of said rod and movable therewith, a block secured to the rearward end portion of said rod and reciprocably mounted to said support, rotary driving means carried by said support including a worm gear, means for imparting continuous rotation to said driving means including a rotary shaft and a worm meshing with said worm gear and rotatable with said

shaft, and means associated with said driving means and said block for translating rotational movement of said driving means into reciprocatory movement of said block and said rod, said last mentioned means comprising a member rotatable in response to rotation of said driving means and having a continuous peripheral groove formed therein and an element affixed to said block and registering with said groove.

13. In a surgical instrument of the character described, a hollow handle, an endoscopic tube carried by said handle, an electrode rod movable longitudinally in said tube, a cutting electrode at the forward end portion of said rod and movable therewith, a block reciprocably arranged wholly within said handle and connected to the rearward end portion of said rod, rotary driving means wholly within said handle including a worm gear, means for imparting continuous rotation to said driving means including a rotary shaft and a worm meshing with said worm gear and rotatable with said shaft, and means within said handle and associated with said driving means and said block for translating rotational movement of said driving means into reciprocatory movement of said block and said rod, said last mentioned means comprising a member rotatable in response to rotation of said driving means and having a continuous peripheral groove formed therein and an element affixed to said block and registering with said groove.

14. In a surgical instrument of the character described, a hollow handle, an endoscopic tube carried by said handle, an electrode rod movable longtiudinally in said tube, a cutting electrode at

the forward end portion of said rod and movable therewith, at least one guide rod within said handle, a block within said handle and reciprocable along said guide rod, said block being rigidly attached to the rearward end portion of said electrode rod, rotary driving means wholly within said handle including a worm gear, means for imparting continuous rotation to said driving means including a rotary shaft and a worm wholly within said handle and meshing with said worm gear, and means wholly within said handle and connected to said driving means and said block for translating rotational movement of said driving means into reciprocatory movement of said block and said rod, said last mentioned means including a shaft rotatable with said worm gear and having a continuous peripheral groove of generally helical configuration formed therein and a member projecting from said block and registering with said groove.

FREDERICK J. WALLACE.

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