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MOTOR DRIVEN SURGICAL KNIFE

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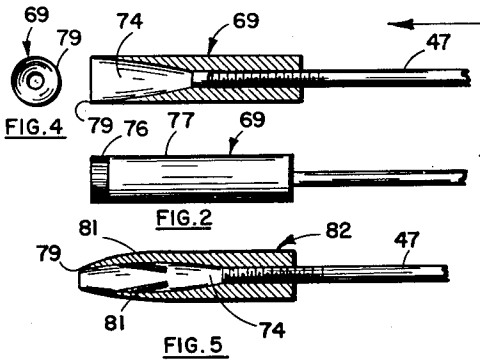


FIG. 4

FIG. 2

FIG. 5

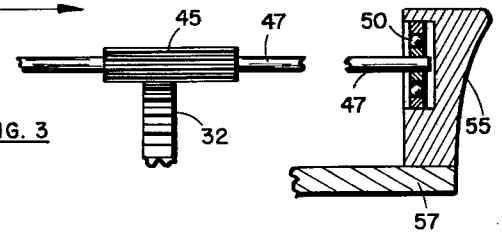


FIG. 3

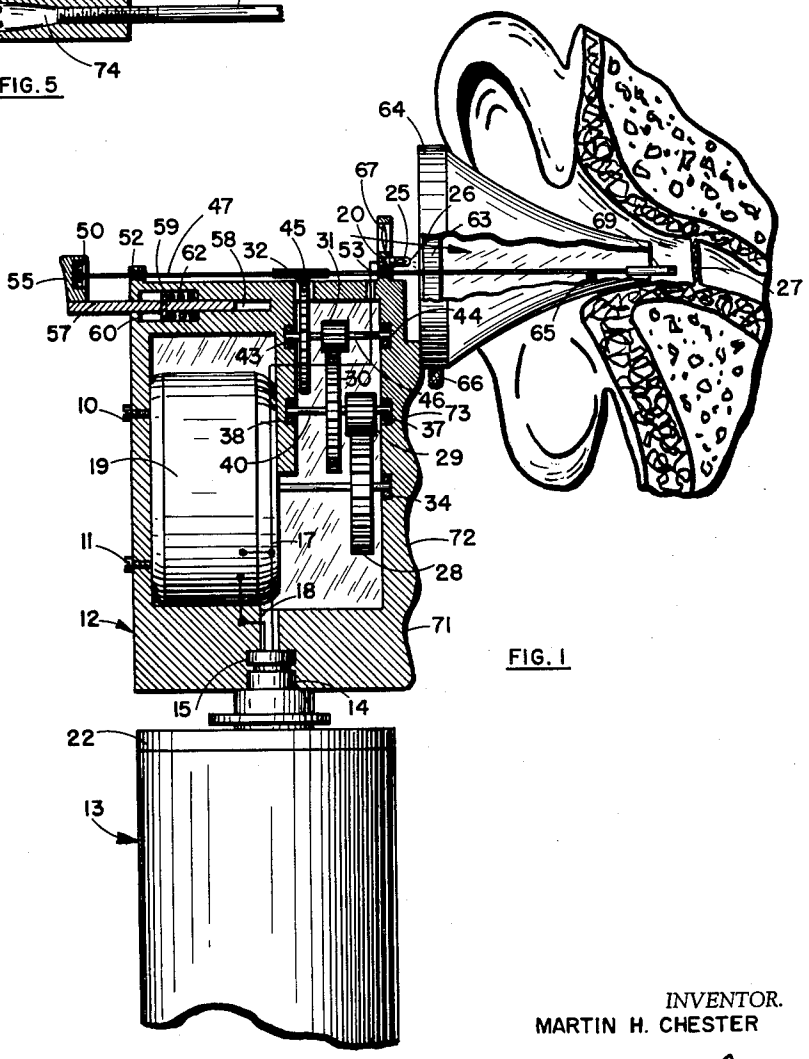


FIG. 1

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MOTOR DRIVEN SURGICAL KNIFE

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This invention relates to a motor driven surgical knife for performing such operations as a myringotomy and more particularly to a motor driven, circularly edged cutting instrument suitable for making a clean incision with a minimum of pain to the patient.

A myringotomy which is an operation well-known in the surgical art involves the making of an incision in the posterior inferior quadrant of the typmanic membrane. This is generally accomplished with a sharp pointed knife. A myringotomy combined with the use of chemotherapeutic agents is now the accepted and correct treatment of acute purulent otitis media which is a common ear disease. The operation satisfies a cardinal surgical principle for treatment of pus under pressure. It gives the patient considerable symptomatic relief and insures against the complications of acute otitis media. These complications which may result include mastoiditis and chronic otitis media with the formation of adhesions in the middle ear and subsequent progressive deafness. When antibiotics and chemotherapy were first used in the treatment of acute purulent otitis media they were so effective that it was thought that the myringotomy knife would be replaced by medical therapy. In recent years, however, with the emergence of antibiotic reistant bacteria, the necessity for the myringotomy is again being stressed by specialists in the field of otolaryngology.

While a myringotomy is frequently indicated, it is still a painful and hazardous operation requiring a considerable degree of skill when performed with the conventional myringotomy knife. Very often, a general anesthetic must be administered. An inexperienced surgeon using the conventional method will often make the mistake of scratching the posterior meatal wall close to the tympanic membrane or will merely make a superficial incision in the tympanic membrane which does not divide it and consequently is inadequate for proper paracentesis of the middle ear. In addition, the hazard of dislocating or engaging the stapes and tearing it from the foramen ovale is always a danger to be reckoned with when using the conventional myringotomy knife.

The device of this invention eliminates or minimizes most of the above enumerated drawbacks of the conventional myringotomy knife, and provides a simple, easily operated instrument which can be made to work on battery power furnished from a standard otoscope handle. The device of the invention comprises a cutting member having a circular cutitng edge which is rotatably driven about its axis at high speed. The device is designed so that the cutting member can readily be inserted into the ear and operated under the direct vision of the operating surgeon. Such operation is facilitated by an appropriately illuminated optical system mounted on the main frame of the device which focusses light on the area in which the incision is to be made and enables the surgeon to readily view the operation area. With the device of this invention, the surgeon can readily produce a perfect circular window in the tympanic membrane. Due to the high speed of rotation of the cutting member, little pressure is required to make an incision and there is a minimum of pain to the patient. Consequently, in most instances, the surgeon should be able to perform the operation without the use of general anesthestia, thereby reducing the hazards of the surgery. The circular window, which generally would be made in the posterior inferior quadrant and in an area which is not undergoing pressure necrosis, will effectively drain exudate from the middle ear. Since the incision can be performed under direct vision, there should be little danger of injuring the ear ossicles or oval window.

It is therefore an object of this invention to provide an improved surgical instrument for making incisions.

It is a further object of this invention to facilitate the performance of myringotomy operations.

It is another object of this invention to facilitate the making of surgical incisions in areas which are difficult of access.

It is a still further object of this invention to lessen the pain involved to the patient in performing a myringotomy or similar operation.

It is still another object of this invention to minimize the hazards involved in the performance of an operation such as a myringotomy.

It is a further object of this invention to lessen the amount of surgical skill needed to successfully perform a myringotomy.

It is another object of this invention to provide a surgical instrument for performing a myringotomy which is readily adaptable for use with a standard otoscope handle.

It is a still further object of this invention to facilitate the securing of biopsy tissue from inaccessible areas such as the middle ear.

Other objects of this invention will become apparent from the following description taken in connection with the accompanying drawings in which:

FIG. 1 is an elevation view of a preferred embodiment of the device of the invention;

FIG. 2 is an enlarged elevation view of a cutting member which may be use din the device of the invention;

FIG. 3 is an enlarged elevation view with a cutaway section of a cutting member and its associated drive shaft;

FIG. 4 is an enlarged end view of the cutting member of FIG. 2, and

FIG. 5 is an enlarged elevation view with a cutaway section of a cutting member especially adapted for taking biopsy specimens.

Referring to FIG. 1, an elevation view of a preferred embodiment of the device of the invention is illustrated. The main frame **12** of the device is mounted on a support **13**. Support **13** may be a standard otoscope handle having a mounting flange **14** which mates with a receptacle **15** in the base of the main frame **12**. The support and main frame may as in such a case be detachable from each other. If an otoscope handle is utilized for the support **13**, power for motor **19** and lamp **20** may be provided by a dry cell (not shown) mounted in the handle. The power which may be fed through insulated power pins and receptacles (not shown) in flange **14** and mating receptacle **15** may be connected from receptacle **15** to the lamp and motor by means of lead **17** which is attached to one input terminal on both the motor **19** and the lamp **20** and lead **18** which is connected to the main frame, the other terminals of the motor and the lamp being grounded to this same frame. The magnitude of the power may be controlled by an appropriate rheostat control **22** which is provided in most otoscope handles.

Power may be furnished for the motor and the lamp by any suitable means available. If so desired, provision may be made to utilize the regular A.-C. power mains, but in such a case, the wiring should be modified so that both leads **17** and **18** go respectively to each of the input terminals on the motor and the lamp and terminal **18** should not be connected to the main frame. The motor and lamp should, of course, be chosen or adapted so that they will operate satisfactorily with the power source to be used. Lamp **20** is mounted in a suitable receptacle

25 having a lens 26 which will suitably focus the light from lamp 20 in the vicinity of the operation area which as illustrated in FIG. 1 might be at eardrum 27.

Motor 19 may be one having a relatively low torque output which will rotate at from medium to high speeds. The motor may be fixedly mounted on main frame 12 by means of mounting screws 10 and 11. Motor 19 drives the gear train comprising gears 28, 29, 30, 31 and 32. Gear 28 is fixedly attached to the drive shaft of motor 19. This motor drive shaft is rotatably mounted in low friction ball bearing 34, the shaft being fixedly attached to the inner race of the ball bearing, the outer race of the bearing being fixedly attached to main frame 12. Gear 28 engages and drives gear 29 which is fixedly attached to shaft 40. Shaft 40 is rotatably mounted in low friction ball bearings 37 and 38, the shaft being fixedly attached to the inner races of these bearings, the outer races of the bearings being fixedly attached to main frame 12. Drive shaft 40 is fixedly attached to gears 29 and 30 and gear 30 is consequently driven at the same speed of rotation as gear 29. Gear 30 engages and drives gear 31 which is fixedly attached to shaft 46. Shaft 46 is rotatably mounted on low friction ball bearings 43 and 44, the shaft being attached to the inner races of these bearings, the outer races of the bearings being attached to main frame 12. Shaft 46 is fixedly attached to gear 31 and the output gear 32, the latter being driven in accordance with the rotation of gear 31. Gear 32 engages and drives gear 45 which is fixedly attached to output drive shaft 47. The gear train shown is only one of many that may be used. If a motor having a high rotational speed is used the gear train may even be eliminated. It is desirable that the rotation of the output drive shaft be in the neighborhood of 6000–10,000 r.p.m. and the gear train should be selected to achieve this desired end result with the particular motor utilized. With a higher speed motor, less rotational step-up is required in the gear train and vice-versa. There should be a minimum of friction and wobble in the gear train drive system to assure efficient operation of the device and a minimum amount of vibration in the output shaft. An appropriate hydraulic or pneumatic drive may be substituted for the motor and gear train by suitably adapting the output drive shaft to operate with such motive means.

Output drive shaft 47 may be rotatably mounted in ball bearing 50 and low friction nylon bearings 52, 53 and 65. The shaft may be fixedly attached to the inner race of ball bearing 50, the outer race of the bearing being fixedly mounted on actuator 55. Bearings 52 and 53 may be suitably fixedly mounted on main frame 12 while bearing 65 is mounted on the inner wall of speculum 64. Bearing 65 may be semi-circular in shape forming a cradle for the drive shaft and only encompassing its lower positioned half. Actuator 55 is fixedly attached to plunger rod 57 which is slidably mounted in recess 58 in main frame 12. The plunger rod 57 is normally held in an extended position with plunger rod stop 59 held against surface 60 by the constraining action of spring 62. Shaft 47 is fixedly attached to the inner race of ball bearing 50 so that it is free to rotate and to move slidably in bearings 52 and 53 with slidable motion of actuator 55 and its plunger rod 57.

Speculum 64 may be of the conventional type normally used in otoscopes and should be removably attached to the main frame by any suitable means such as a screw 66 having a knurled head to facilitate attachment and detachment and a circular mounting ring 63 which is fixedly attached to the main frame. Mounting ring 63 should be adapted so that the speculum will slide snugly over it and hold in place on the main frame with screw 66 providing additional holding action. The speculum should be readily removable to allow for the selection of an appropriate size of such instrument for each operation and to facilitate replacement of cutting member 69. A suitable lens 67 which will provide an enlarged image of eardrum 27 for the operating surgeon may be fixedly mounted on main frame 12 in a location suitable for such observation. Finger grips 71, 72 and 73 may be provided in main frame 12 to facilitate handling of the instrument.

Referring now to FIGS. 2, 3 and 4 which are enlarged views of the cutting member and its associated drive shaft, gear 45 is fixedly attached to drive shaft 47 by suitable means such as, for example, by swaging. As indicated in the cutaway section of FIG. 3, drive shaft 47 has a male threaded portion on one end which mates with a female threaded portion on cutting member 69. This facilitates detachment of the cutting member from the drive shaft for cleaning, sterilization or replacement, and enables the utilization of cutting members of various diameters for operating on various size ear drums or on other parts of the anatomy. As indicated in FIGS. 3 and 4, cutting member 69 has a circular cutting edge 79. Such a circular cutting edge permits complete detachment of the incised tissue thereby providing a clean incision which will not close up before there has been adequate drainage of the infected area. The incised tissue will tend to fall inside the hollow portion 74 of cutting member 69 and can be readily removed therefrom.

Referring particularly to FIG. 2 which is an elevation view of the cutting member, the cutting member 69 has a tip portion 76 which is readily visibly distinguishable from the remaining portion 77. Tip 76 may be made distinguishable from remaining portion 77 by providing color contrast, reflectivity contrast, or by any other means which will enable the operating surgeon to readily observe when tip 76 has penetrated into the tissue being operated on up to the dividing line between it and portion 77. Portion 76 may be, for example, approximately 3 mm. wide or any other suitable width that utilization requirements may dictate. The use of such a contrasting tip portion while not essential to the operation of the device of the invention, provides a safety feature by enabling the surgeon to easily gage the depth of the incision made and thereby avoid too deep a penetration which might unnecessarily injure tissue in the operation area.

Referring to FIG. 5, a cutting member 82 especially suited for obtaining biopsy specimens from a tumor site is illustrated. This cutting member is similar to that illustrated in FIG. 3 except that the diameter of the cutting edge 79 is made smaller than a good part of the hollow portion 74 and two flaps 81 attached to the inner wall of the hollow portion of the cutting member are added. These flaps should be of a resilient material such as spring steel and should be thin enough so that they can be readily held against the inner wall of the cutting member. The flaps 81 are shown in FIG. 5 in the position they normally would be in with the cutting member at rest. When the cutting member is rotated at high speed, the flaps, by the centrifugal force generated, are forced flat against the inner wall of the hollow portion of the cutting member. The incised tissue is therefore free to enter the hollow portion. When the incision has been made and rotation of the cutting member stopped, the flaps will tend to return to their normal resting position and will act as a fork-like stop to keep the incised tissue trapped in the hollow portion of the cutting member so that it can be withdrawn and used as a biopsy specimen.

While the device of the invention has been described in relation to its utilization in the performance of a myringotomy operation, it can be utilized for operations of other types on different parts of the anatomy with equal success. It can be most useful where the necessary operation must be performed in an area which is difficult of access. It is also well suited for obtaining biopsy specimens especially from portions of the anatomy which are difficult of access. The device of the invention is especially suited for making a clean, small incision

with a minimum of pain and with little hazard of injury to the patient when operated by a surgeon of limited experience.

While the invention has been described and illustrated in detail, it is to be clearly understood that this is not intended by way of limitation, the spirit and scope of the invention being limited only by the terms of the following appended claims.

I claim:

1. A surgical instrument for making an incision comprising a cutting member, a drive shaft, said cutting member being attached to said drive shaft, a main frame, said drive shaft being rotatably and slidably mounted on the top portion of said main frame, a drive gear fixedly attached to said drive shaft, gear means rotatably mounted on said main frame, said main frame having an aperture in the top portion thereof, said gear means extending through said aperture, motor means fixedly mounted on said main frame for rotatably driving said gear means, said drive gear slidably engaging said gear means for rotation therewith, an actuator adapted for thumb actuation, said drive shaft being rotatably attached to said actuator, a plunger rod fixedly attached to said actuator, said main frame having a recess formed in the top portion thereof, said plunger rod being slidably mounted within said recess, a speculum mounted on said main frame, said speculum surrounding a portion of said drive shaft, and spring means for constraining a portion of said plunger rod against a surface of said main frame to hold said cutting member within said speculum, said cutting member extending out from said speculum with actuation of said actuator.

2. The device as recited in claim 1 and additionally comprising an optical lens fixedly mounted on said main frame, said lens being positioned to provide an enlarged image of objects in the vicinity of the cutting edge of said cutting member.

3. The device as recited in claim 1 and additionally comprising an otoscope handle, said main frame being removably attached to said handle, and means enclosed within said handle for providing power for said motor means.

4. The device as recited in claim 2 and additionally comprising means mounted on said main frame for illuminating the area in the vicinity of said cutting member.

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