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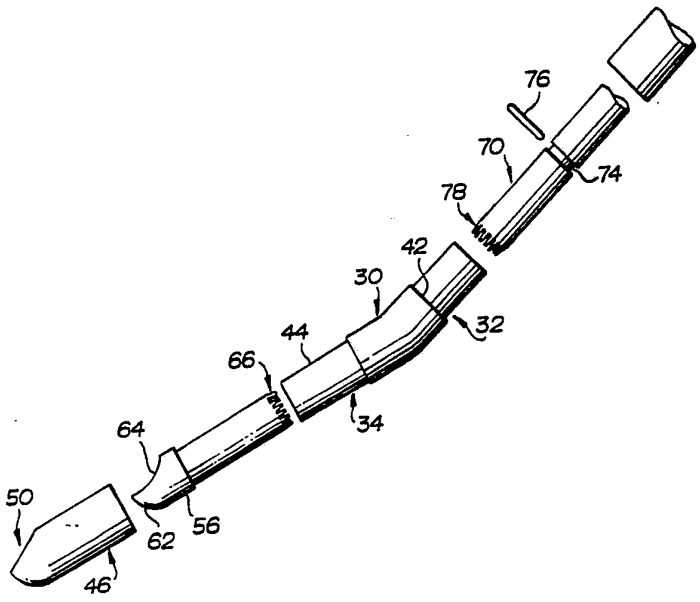

(57) Abstract

A surgical instrument with an elongate drive shaft (70) rotatably received through and in direct bearing engagement with the smooth bore of an outer tube (22). A rigid connector elbow (30) with the legs (32, 34) at a predetermined angle provides for an angular orientation of a cutter shaft (52) relative to the drive shaft with the shafts in driving engagement through meshing gear teeth (68, 80) provided on the adjacent ends of the shafts and within the peripheral confines of the shafts. The forward end of the cutter shaft has a laterally directed opening (64) formed therein provided with cutter edges which cooperate with a cutter window (50) defined laterally within the outer cutter sheath.

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Title: SURGICAL INSTRUMENT FOR MATERIAL REMOVAL

BACKGROUND OF THE INVENTION

The invention relates to surgical instruments of the type which have heretofore found principal use in endoscopic, and especially arthroscopic, surgical procedures. Such instruments, and specifically meniscus cutters utilized in shoulder, knee and other surgical procedures, have been considered less than completely acceptable in large part because of technical problems associated with the positioning of the meniscal tissue within the mouth or window of the cutter. This problem results principally from the space limitations encountered in endoscopic-type surgical procedures and the difficulty in angling and maneuvering the instrument to the meniscal material to be removed. As such, it is not unusual incident to the use of conventional (straight) surgical instruments to require multiple skin incisions and the use of a secondary instrument, such as a knife blade, in conjunction with the meniscus cutter to develop edges that can be brought in by suction to a position where they can be cut or otherwise removed from the body of a patient.

U.S. Patent No. 4,646,738 is illustrative of the prior art and the limitations of conventional arthroscopic instruments and surgical procedures that are commonly practiced. This referenced patent discloses a specific surgical instrument which is stated to overcome the inadequacies of the prior art devices at that time, principally by providing an instrument in which the cutting element is positioned at an angle relative the body of the instrument. The instrument includes a continuous outer tubular member which extends the length of the instrument and is bent during

manufacture to achieve a predetermined angle. An elaborate flexible transmission system which extends through the outer tube comprises a composite, spirally-wound tube consisting of an inner spiral, a middle spiral and an outer spiral. The arrangement of multiple spiral tubes, which are spot-welded, are each alternately spiraled relative to adjacent spirals to enable rotation of the transmission tube in opposite directions. It can be appreciated that the mechanical complexity of this device renders it unduly expensive to manufacture and therefore procure, and subjects the instrument to an increased likelihood of failure.

SUMMARY OF THE INVENTION

It is an object of the invention to provide a surgical instrument adapted for both arthroscopic and more general (open) surgical procedures in which the operating end portion or cutter head of the instrument is disposed at an angle with respect to the shaft of the instrument that is predetermined in accord with the procedure involved and the specific location of the operating site to allow access thereto with minimal trauma to the surgical site. Such an instrument, to be practical, should be structurally stable, incorporate a positive drive for both clockwise and counterclockwise rotational movement of a cutter device, include minimal suction channel disruption, be easily sterilizable, and inexpensive in both material cost and assembly procedures to thereby enable its use as an economically feasible disposable item.

In the surgical instrument of the present invention, the angular orientation of the cutter head is achieved by the provision of a hollow connector elbow between a linear outer tube and a linear cutter head sheath that are respectively mounted to the angularly oriented legs of the elbow. Instruments of different

angles are easily manufactured by the use of appropriately angled and rigid preformed elbows, with the remainder of the components being standardized, that are of the same or substantially similar construction regardless of the angle of the elbow.

The cutter includes a hollow cutter shaft with a generally laterally directed mouth at the distal end thereof having blade edges which, upon rotation of the cutter shaft, cooperate with blade edges in a window laterally defined through the cutter sheath to provide a compound cutting action that is applicable for use in removing tissue or other material from the body of a patient. As used herein, the terms "cutter" and "cutting" and respective derivatives thereof encompass various apparatus and processes for effecting as slicing, shaving and abrading by which body material is to be separated from a material source upon progressive advancement of the cutter device of the subject application thereagainst. The proximal end of the cutter shaft is provided with a plurality of equally spaced, rearwardly directed gear teeth that are positioned peripherally about and within the end portion of the shaft as a continuation of the inner and outer peripheries of the shaft to define a driven gear. The driven gear is located at the angle of the elbow and is in meshed driving engagement with a similarly formed gear on the distal end of an elongate hollow drive shaft. It is preferred that the angle defined by the connector elbow be between about 180 degrees (wherein the legs are in linear alignment) and approximately 90 degrees (where the legs are generally at right angles to each other). The depth and shape of the drive and driven gear teeth are such as to ensure a positive driving mesh at any of the desired angles within the aforementioned range. The preferred angle, that is the

angle considered to be most practical for standard arthroscopic surgery, is approximately 165 degrees.

The outer tube and elbow preferably present a smooth, continuous inner bearing surface that cooperate with smooth exterior bearing surfaces defined by the exterior surfaces of the drive shaft and cutter shaft along the lengths thereof for rotational support of the drive shaft and cutter shaft within the outer tube and cutter sheath without separate bearing means. The gear-joined drive shaft and cutter shaft define a smooth continuous interior material-withdrawing passage interrupted only at the meshing gears and adapted, through the meshing gears, for positive rotation in both clockwise and counterclockwise directions.

The outer tube and cutter sheath respectively telescopically engage the two legs of the connector elbow and are permanently fixed thereto, preferably by welding. However, other suitable securing means can be provided. When assembled, both the drive shaft and the cutter shaft, while freely rotatable, can be supported along substantially the full lengths thereof or by one or more bearing sections and are precluded from longitudinal shifting within the outer tube and cutter sheath.

Other features and advantages of the invention will be appreciated from the details of construction and manner of use of the instrument as more fully hereinafter presented.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a schematic illustration of a prior art instrument illustrating the difficulty in accessing posterior meniscus material with a straight shaft;

Figure 2 is a schematic illustration similar to Figure 1 illustrating the angled instrument of the present invention;

Figure 3 is an enlarged side elevational view of the forward angled portion of the instrument;

Figure 4 is a longitudinal cross-sectional view through the structure of Figure 3;

Figure 5 is a view of the cutter end of Figure 4 with the cutter shaft rotated 90 degrees and presented partially in elevation;

Figure 6 is an enlarged sectional detail illustrating the positioning means for the drive shaft;

Figure 7 is a cross-sectional view similar to Figure 4 with a connector elbow of a lesser angle;

Figure 8 is an exploded perspective view of the components of the instrument; and

Figures 9-12 are perspective views of various alternative cutter head arrangements.

DESCRIPTION OF PREFERRED EMBODIMENTS

Referring now more specifically to the drawings, wherein like reference characters represent corresponding components throughout the various views, and with particular reference to Figure 1, there is illustrated a conventional arthroscopic instrument 10 with the operating end portion thereof linearly aligned with the straight shaft. The problem of accessing angularly offset areas is apparent from the schematic cross section through the knee construction, as the instrument 10 is unable to negotiate the curvalinear channel 11a between bone elements 11b and 11c.

Figure 2, in the same or substantially similar surgical environment as shown in Figure 1, illustrates the surgical instrument 12 of the present invention in which provision is made for accessing angularly offset areas such as the channel 11a in a manner not possible with the conventional straight instrument 10 of Figure 1.

The instrument 12 comprises an elongate linear or straight shank 14 with an angularly-directed cutter head or operating end portion 16 at the distal end thereof. The proximal end of the shank 14 is associated, in a conventional manner, with a vacuum or suction source as schematically shown at 18, and a drive motor 20. As an alternative to the use of a drive motor, means can be provided for a manual driving of the cutter head 16.

The shank 14 comprises a hollow cylindrical outer tube 22 having a smooth surfaced bore 24 therethrough which, along substantially the full length thereof, defines a continuous bearing surface. The distal or forward end portion of the outer tube 22 is counterbored to define an annular recess 26 terminating in an annular, radially inwardly extending and forwardly directed shoulder 28, as shown in Figure 6.

The angle of the instrument, or more particularly the cutter head 16 with respect to the tube 22, is defined by a connector elbow 30, as shown more clearly in Figure 3. The elbow 30 is of rigid hollow tubular construction and, in accord with the specific area to be accessed by the instrument, can be configured so as to provide any of a range of angles "a" that are between approximately 90 degrees and approximately 180 degrees. As a practical matter, and as indicated in Figures 4 and 7, most surgical sites to which the subject invention is concerned can be accessed by cutter heads oriented at anywhere from a range of about 105 degrees (Fig. 7) to about 165 degrees (Fig. 4).

Referring now to Figure 4, the connector elbow 30, with its angularly related elongate proximal and distal legs 32 and 34 thereof and the angle juncture therebetween, is provided with smooth inner and outer surfaces defining, when assembled to the outer tube 22, smooth continuations of the inner and outer surfaces of the tube 22. The proximal leg 32 is exteriorly recessed

about the proximal end thereof to define an elongated exterior recess 36 which complements the counterbore 26 of the outer tube 22 for telescopic reception and nesting therein. As noted in the detail of Figure 6, the proximal edge 38 of the proximal elbow leg 32 terminates slightly forward of the shoulder 28 of the counterbore 26, defining therewith an annular recess or groove 40. The forward edge of the outer tube 22, as shown in Figures 4 and 7, abutts against the exterior annular shoulder 42 defined about the proximal leg 32 by the recess 36. The engagement of the recessed proximal end portion of the elbow leg 32 within the counterbored distal end portion of the outer tube 22 is rigidified, preferably by welding, and is such as to provide for substantially continuous outer and inner surfaces, with the exception of the annular recess 40, as described above.

The distal end portion of the distal leg 34 of the connector elbow is similarly externally recessed to define an elongated annular recess 44. An elongate cutter sheath 46, of a thickness corresponding to the depth of the recess 44, has the proximal end thereof received within the recess 44 along the length of the recess to define a smooth exterior surface continuation of the distal leg 34. The sheath 46 projects beyond the distal end of the distal elbow leg 34 and terminates in a retaining end 48 laterally directed at least partially across the forward or distal end of the cutter sheath 46. The cutter sheath includes at, or immediately adjacent the distal end thereof, a cutter window 50 with blade edges. The window 50 opens either completely or partially laterally along at least a portion of the linear extent of the cutter sheath 46.

Mounted within the cutter sheath 464 (Figure 4) is an elongate hollow cutter shaft 52 with a proximal portion coextensive with the distal leg 34 and having a

smooth exterior surface 54 in bearing engagement with the inner surface of leg 34 along the length thereof. The distal end portion 56 of the cutter shaft 52 is configured so as to be radially thicker than the proximal portion thereof and defines an exterior, rearwardly-directed annular shoulder 58 which bears against the leading edge of the distal leg 34 of the elbow 30. The exterior of the distal end portion 56 of the cutter shaft 52 is, for the linear extent of the sheath 46 forward of the leg 34 and to the retaining end 48, in bearing engagement with the inner surface of the sheath 46. The bore 60 which extends substantially axially through the cutter shaft 52 is of a smooth surface and exhibits a constant diameter that terminates in an end wall 62 having an exterior surface bearing against the retaining end 48 of the sheath 46.

With particular reference to Figures 4 and 5, there is depicted a cutter, comprising a mouth 64 with peripheral cutting edges, that is formed through the cutter shaft 52 immediately rearward of the distal end 62 thereof and generally laterally directed to cooperate with the sheath window 50, and more particularly the cutting edges 65 defined thereabout. At least one, and preferably both, of the cutter mouth and sheath window edges is formed from suitably sharpened, and optionally hardened surgical grade stainless steel. The cooperation provides for a shearing action as the cutter shaft 52 is rotated, either clockwise or counterclockwise, within the operating end portion 16 of the instrument. The preferred rotational rate of operation is from about 100 rpm to about 7,000 rpm, in accordance with such factors as surgeon preference, cutter head configuration, the type of drive motor 20 used with the instrument 12, and the type of surgery and location of the surgical site. Preferably, the instrument 12 is used with a drive motor 20 that is

controllable to provide a range of cutter blade rotational rates that can be controlled by the user.

The cutter sheath 46 is preferably rigidly joined at the telescopic overlap with the recessed distal end portion of the elbow leg 34 by conventional securing means such as welding. The cutter shaft 52, while freely rotatable within the cutter sheath 46 and elbow leg 34 and in stable bearing engagement along at least substantially the full length thereof, is retained against longitudinal movement or shifting by and between the retaining end 48 of the sheath 46 and the shoulder 58 on the cutter shaft 52 which engages the leading or distal end of the elbow leg 34.

The cutter shaft 52 is preferably configured so as to be gear driven with a driven gear 66 integrally defined at the proximal end of the shaft 52, located at the angle of the elbow connector 30, by a plurality of gear teeth 68 cut or otherwise formed directly in the proximal end portion of the cutter shaft 52, whereby the formed teeth 68 are provided with inner and outer surfaces which define smooth continuations of the respective inner and outer surfaces of the cutter shaft 52.

Rotatable driving of the cutter shaft 52 is effected by an elongate hollow drive shaft 70 that is longitudinally received within, and coextensive with, the outer tube 22 and the linearly-aligned proximal leg 32 of the connector 30. The outer surface 72 of the drive shaft 70 defines a smooth bearing surface in engagement with the inner surface 24 of the outer tube 22 and the inner surface of the proximal elbow leg 32 along the full length thereof. This outer surface 72 includes an annular groove 74 that is radially aligned with the groove 40 and forms therewith a closed channel which encircles the drive shaft 70. This closed channel receives a steel wire retainer ring 76 which extends

into both grooves 40 and 74, substantially completely filling the annular channel defined thereby. The retainer ring 76 retains the drive shaft 70 against longitudinal movement relative to the outer tube 22, while allowing for rotation of the drive shaft 72 within the outer tube with the shaft supported and stabilized during rotation by the substantially full length engaged bearing surfaces 24 and 72.

The distal end portion of the drive shaft 70 has a drive gear 78 formed thereat which complements the driven gear 68 formed on the proximal end of the cutter shaft 52 and similarly includes a series of equally spaced peripheral gear teeth 80, the opposed surfaces of which form smooth continuations of the inner surface or bore of the drive shaft 70 and the outer bearing surface 72 thereof.

The gear teeth 68 and 80 mesh at the angle joinder of the legs of the elbow 30 and are configured to provide for a positive driving mesh regardless of the angle of the elbow within the contemplated range of the invention. The adaptability of the meshing of the gear teeth will be appreciated from a comparison of the structures depicted Figures 4 and 7.

While not specifically detailed, it will be appreciated that the proximal end of the drive shaft 70 and the proximal end of the outer tube 22 are joined, in the manner of a conventional surgical cutting instrument, with both motor means 20 for effecting a driving of the drive shaft 70 and appropriate suction generating apparatus 18 for obtaining vacuum positioning of material to be cut by the surgical instrument 12 and removal of cut material through the aligned bores in the drive shaft and cutter shaft.

Constructed in the above manner, it will be appreciated that a full range of angular instruments can be manufactured wherein the components, other than for

the elbows, are standardized, thus facilitating assembly and through the use of preformed elbows assuring a consistent uniformity.

As described, the individual components are rigid elements which, with regard to the outer components including the outer tube 22, elbow 30 and cutter sheath 46, are rigidly fixed, as by welding, to rotatably receive the drive components therein and therethrough. The inner and outer components themselves provide for full length engaged bearing surfaces without additional bearing means, and can be configured from a wide range of surgical grade materials such as stainless steel, plastics, or a combination of stainless steel and plastic. Alternatively, one or more bearing sections can be provided along the respective inner and outer components. Similarly, and again without additional means such as separate gears or the like, the drive shaft and cutter shaft are in direct driving engagement through integral gear teeth formed at the adjacent ends thereof. The engaged gear teeth are operable through a range of fixed angular orientations and are equally effective for both clockwise and counterclockwise driving engagement.

With respect to Figures 9 through 12, it is contemplated that the instrument of the invention can utilize a variety of cutter heads in accord with the particular cutting or material accommodating situation. For example, rather than the flat ended mouth and window arrangement suggested in Figure 5, both the sheath window and cutter shaft mouth can be provided with a generally oval configuration with continuously curving surfaces as shown in Figure 9. Alternatively, the sheath window, as shown in Figure 10, can be configured with a multitude of apertures 90 of reduced dimension that are oval or circular in configuration and which cooperate with an underlying cutter shaft opening which,

upon rotation of the cutter shaft, sweeps by each of the individual windows to achieve a shaving effect as opposed to a broader cutting effect achieved by the cutter head of Figures 5 and 9. With respect to the cutter head arrangement depicted in Figure 11, the edge surface 65 of the sheath window 50 is provided with a serrated surface along its opposed edges that are aligned with the longitudinal axis of the cutter head so as to provide a plurality of opposed teeth 92 which, together with the rotary action of the cutter element, facilitate a broader cutting effect that is generally comparable, or even greater, than that provided by the arrangement depicted in Figure 9. As shown in Figure 12, the cutter head can be in the form of an abrader 64' rotatably received within the cutter window 50. In the depicted arrangement, the distal end 96 of the abrader 64' extends beyond the open, distal end 98 of the cutter window 50 to permit for the abrading of body material such as bone or cartilage upon axial or laterial extension, or any combination thereof, of the abrader 64' against the material to be removed. It is to be appreciated, however, that a variety of different configurations for abraders and cutter windows, including closed window configurations, can be provided in accordance with the teachings of the subject application. In each instance, the angle of the cutter head is determined by the fixed angle elbow with the material to be acted on drawn into the cutter head as a part of the cutting procedure, and upon being severed, effectively evacuated through the smooth bores of the aligned cutter and drive shafts.

While the surgical instrument of the invention has, in Figure 2, been illustrated as used in the performance of an arthroscopic procedure on a knee, the instrument has substantially broader applications. For example, the angled instrument of the subject invention is

particularly applicable for use in shoulder surgery for, among other of a wide variety of surgical applications, abrading the scapula neck inferior. Similarly, it is contemplated that the instrument will have practical applications in a wide range of surgical procedures other than arthroscopic procedures, such as conventional (open) surgery as well as microsurgical procedures upon appropriate scaling of the respective components of the surgical instrument.

From the foregoing, it will be appreciated that the described instrument is unique in its solution of the vexing problem of obtaining access to areas normally difficult to reach with conventional, i.e., straight, instruments and doing so in a manner which minimizes trauma to the surgical site as compared to that experienced in conventional procedures requiring multiple instruments or instruments of complex construction. As will be recognized, the principals of the invention, and in particular the rigid connector elbow and full length rigid shafts with direct bearing surfaces, can be utilized in conjunction with a variety of different forms of cutters, drive means and suction apparatus, all of which are to be regarded as falling within the scope of the invention as set forth in the foregoing detailed description and accompanying patent claims.

WE CLAIM:

1. An instrument for use in surgical procedures, said instrument comprising an elongate outer tube including a proximal end and a distal end, a rigid, hollow connector with proximal and distal legs, said proximal leg of said connector being joined to the distal end of said tube and forming a coaxial linear extension of said tube, said tube and said proximal leg defining a continuous bore with a smooth inner bearing surface, a hollow tubular cutter sheath joined to and defining a coaxial linear extension of said distal leg of said connector with said bore extending therethrough, an elongate rigid drive shaft rotatably received within said bore along said tube and proximal leg of said connector, said drive shaft having a smooth exterior surface defining a bearing surface in rotatable engagement with the smooth inner bearing surface of said bore, an elongate rigid cutter shaft rotatably received within said bore along said cutter sheath and said distal leg, said cutter shaft and said cutter sheath having generally coextensive distal end portions with cutting means thereat cooperating to sever body material in response to rotation of said cutter shaft within said cutter sheath, said drive shaft having a distal drive end within said proximal leg, said cutter shaft having a proximal driven end within said distal leg, said drive end being in driving engagement with said driven end for rotational driving of said cutter shaft in response to rotation of said drive shaft.

2. The surgical instrument of claim 1, wherein said drive end and said driven end are defined by a drive gear and a driven gear respectively on said drive end of said drive shaft and said driven end of said cutter shaft.

3. The surgical instrument of claim 2, wherein said drive gear and said driven gear each comprises gear teeth integrally formed on the respective drive end of said drive shaft and driven end of said cutter shaft.

4. The surgical instrument according to claim 19, wherein each of said connector legs is provided with an outer free end having an external peripheral recess about each leg extending inwardly from the free end thereof, said outer tube along a portion of the bore inward from the distal end thereof being peripherally recessed to define an internal recess having a length approximately equal to that of said external recess of said connector proximal leg and nesting therewith.

5. The surgical instrument according to claim 4, wherein a cutter sheath is provided which surrounds and is received in the recess of said connector distal leg and extends forwardly thereof, said outer tube and said sheath being rigidly joined to said connector legs.

6. The surgical instrument according to claim 5, wherein said driven member peripherally engages said sheath forward of said distal leg, said driven member including a peripheral rearwardly directed shoulder thereon engaged with said free end of said distal leg whereby rearward movement of said driven member relative to said connector is restricted, said cutter sheath including a forward retaining end engaging said driven member and precluding forward movement of said driven member relative to said connector.

7. The surgical instrument according to claim 6, wherein said drive member includes an annular exterior groove formed thereabout and radially aligned with a

corresponding groove defined at the inner end of the recess at the distal end of said tubular member, and a retaining ring received within said aligned grooves and precluding longitudinal movement of said drive member relative to said tubular member.

8. The surgical instrument of claim 7, wherein said drive shaft and said cutter shaft are hollow and define a continuous suction bore therethrough of substantially constant cross sectional area.

9. The surgical instrument of claim 8, wherein the legs of said connector are oriented at an angle of at least approximately 90 degrees relative to each other.

10. A surgical instrument for accessing areas angularly remote from an entry site, said instrument comprising an elongate outer tube including a proximal end and a distal end, a separate rigid, hollow connector elbow with proximal and distal legs angularly oriented at an angle of at least approximately 90 degrees relative to each other and defining a juncture therebetween, said proximal leg of said elbow joining to and forming a coaxial linear extension of said tube, said tube and said proximal leg defining a continuous bore with a smooth inner bearing surface, a hollow tubular cutter sheath joined to and defining a coaxial linear extension of said distal leg of said elbow with a bore extension extending therethrough at an angle to said bore, an elongate rigid drive shaft rotatably received within said bore along said tube and proximal leg of said elbow, said drive shaft having a smooth exterior surface defining a bearing surface in rotatable engagement with the smooth inner bearing surface in rotatable engagement with the smooth inner bearing

surface of said bore, an elongate rigid cutter shaft rotatably received within said bore extension along said cutter sheath and said distal leg, said cutter shaft and said cutter sheath having generally coextensive distal end portions with cutting means thereat cooperating to sever body material in response to rotation of said cutter shaft within said cutter sheath, said drive shaft having a distal drive end within said proximal leg, said cutter shaft having a proximal driven end within said distal leg, said drive end being in driving engagement with said driven end within the juncture between said legs for rotational driving of said cutter shaft in response to rotation of said drive shaft.

11. The surgical instrument of claim 10, wherein said drive end and said driven end are defined by a drive gear and a driven gear respectively on said drive end of said drive shaft and said driven end of said cutter shaft, said drive gear and said driven gear each comprising geared teeth integrally formed on the respective drive end of said drive shaft and driven end of said cutter shaft.

12. The surgical instrument of claim 11, wherein said elbow legs are oriented at an angle relative to each other of between approximately 105 degrees and 165 degrees.

13. A method of treating an internal body site having an obstruction to direct access thereto, including the steps of defining an obstruction avoiding angular path to said body site from an external incision, providing a surgical instrument with a leading operating end portion at an angle determined by the angular path, making an incision in the body in accord with the defined path, introducing the leading end

portion of the instrument through said incision and along said path, manipulating said instrument to guide said leading end portion past said obstruction and to said site, and operating said instrument to effect treatment at said body site.

14. A surgical cutting instrument, comprising:

an elongated cylindrical tubular member having a proximal segment and a distal segment defining a cutter window means, the tubular member segments defining a bore therein having a generally uniform bearing surface;

an elongated drive member receivable within the bore formed in the tubular member proximal segment, the drive member having a first end and a second end, said first end being engageable with drive member drive means, the drive member having a generally uniform bearing surface in rotatable engagement with the bearing surface of the tubular member; and

an elongated driven member receivable within the bore formed in the tubular member distal segment and having a first end and a second end defining a cutter member, said driven member having a generally uniform bearing surface in rotatable engagement with the bearing surface of the tubular member, the first end of the driven member being rotatably coupled to the second end of the drive member for effecting rotational displacement of the cutter member.

15. The surgical instrument according to claim 14, further comprising a tubular connector elbow interposed between the tubular member proximal and distal segments.

16. The surgical instrument according to claim 15, wherein the connector elbow positions the tubular member

proximal and distal segments at an angle of from about 90° to about 180°.

17. The surgical instrument according to claim 15, wherein the connector elbow defines a generally uniform bearing surface coextensive with the bearing surfaces of the tubular member proximal and distal segments.

18. The surgical instrument according to claim 15, wherein the drive member and the driven member are rotatably coupled to one another within the tubular connector elbow.

19. The surgical instrument according to claim 15, wherein the connector elbow comprises a proximal leg and a distal leg, each of which legs is receivable within a correspondingly-dimensioned recess defined respectively by the distal end of the tube member proximal segment and the proximal end of the tube member distal segment.

20. The surgical instrument according to claim 15, wherein the connector elbow is interchangeably mountable to the respective tubular member proximal and distal segments to vary the angular relationship between the tubular member proximal and distal segments.

21. The surgical instrument according to claim 14, wherein the drive member second end and the driven member first end are configured as mutually engageable gears to effect rotatable coupling of the respective drive and driven members.

22. The surgical instrument according to claim 21, wherein at least one of said gears comprises a plurality of gear teeth aligned substantially parallel with the

longitudinal axis of the respective member along which the gear is positioned.

23. The surgical instrument according to claim 14, wherein each of said drive and driven members defines a tubular lumen, said tubular lumens being in fluid communication with one another so as to define a passageway through which material received within said cutter member can be advanced.

24. The surgical instrument according to claim 23, wherein said tubular member proximal segment comprises means for coupling with material removal means operable to remove material received within said tubular lumens.

25. The surgical instrument according to claim 14, wherein at least one of the cutter window means and cutter member is defined by a body material cutting surface.

26. The surgical instrument according to claim 25, wherein said cutter window means is defined by a body material cutting surface having a generally smooth, sharp edge.

27. The surgical instrument according to claim 25, wherein said cutter window means is defined by a body material cutting surface having a generally jagged, sharp edge.

28. The surgical instrument according to claim 25, wherein said cutter window means comprises at least one generally annular aperture.

29. The surgical instrument according to claim 14, wherein said cutter member comprises an abrader.

30. The surgical instrument according to claim 29, wherein said cutter window means comprises a window having a distal open end, said abrader extending beyond said open window distal end.

31. A surgical cutting instrument, comprising:

an elongated cylindrical tubular member having a proximal segment and a distal segment defining a cutter window means, each of the tubular member segments defining a bore therein and having a bearing surface;

an elongated drive member receivable within the bore formed in the tubular member proximal segment and defining a tubular lumen, the drive member having a first end and a second end, said first end including means for engaging drive member drive means;

a tubular connector elbow defining a bore therein coextensively mountable with the bore formed in the tubular member proximal and distal segments, the second end of said drive member being receivable within said connector elbow bore; and

an elongated driven member having a first end and a second end defining a cutter member, said ends respectively being receivable within the bore found in the connector elbow and tubular member distal segment, said driven member defining a tubular lumen, the first end of the driven member being rotatably coupled to the second end of the drive member for positioning the respective lumens in fluid communication with one another and for effecting rotational displacement of the cutter mouth.

32. The surgical instrument according to claim 31, wherein the connector elbow positions the tubular member proximal and distal segments at an angle of from about 90° to about 180°.

33. The surgical instrument according to claim 31, wherein the connector elbow bore defines a bearing surface for receiving the rotatably coupled ends of the drive and driven members.

34. The surgical instrument according to claim 33, wherein the bearing surfaces of the tubular member segments and connector elbow are configured as generally uniform smooth surfaces that are coextensive with one another.

35. The surgical instrument according to claim 31, wherein the connector elbow is interchangeably mountable to the respective tubular member segments to vary the angular relationship between the tubular member proximal and distal ends.

36. The surgical instrument according to claim 31, wherein the drive member second end and the driven member first end are configured as mutually engageable gears for effecting rotatable coupling of the respective drive and driven members.

37. The surgical instrument according to claim 36, wherein at least one of said gears comprises a plurality of gear teeth aligned substantially parallel with the longitudinal axis of the respective member along which the gear is positioned.

38. The surgical instrument according to claim 31, wherein the tubular member proximal segment comprises means for coupling with material removal means operable to remove material received within said tubular lumens.

39. The surgical instrument according to claim 31, wherein said bearing surface is comprised of at least one discrete bearing member mounted along at least one of said bores of said tubular member segments.

40. The surgical instrument according to claim 31, wherein said bearing surface is configured as a generally uniform, smooth surface formed along substantially the entire length of the bore of at least one of said tubular member segments.

41. The surgical instrument according to claim 31, wherein said cutter member comprises an abrader.

42. The surgical instrument according to claim 41, wherein said cutter window means comprises a window having a distal, open end, said abrader extending beyond said open window distal end.

43. The surgical instrument according to claim 31, wherein the connector elbow comprises a proximal leg and a distal leg, each of which legs is receivable within a correspondingly-dimensioned recess defined respectively by the distal end of the tube member proximal segment and the proximal end of the tube member distal segment.

44. The surgical instrument according to claim 31, wherein the connector elbow is interchangeably mountable to the respective tubular member proximal and distal segments to vary the angular relationship between the tubular member proximal and distal segments.

45. The surgical instrument according to claim 44, wherein each of said connector legs is provided with an outer free end having an external peripheral recess about each leg extending inwardly from the free end

thereof, said outer tube along a portion of the bore inward from the distal end thereof being peripherally recessed to define an internal recess having a length approximately equal to that of said external recess of said connector proximal leg and nesting therewith.

46. The surgical instrument according to claim 45, wherein a cutter sheath is provided which surrounds and is received in the recess of said connector distal leg and extends forwardly thereof, said outer tube and said sheath being rigidly joined to said connector legs.

47. The surgical instrument according to claim 46, wherein said driven member peripherally engages said sheath forward of said distal leg, said driven member including a peripheral rearwardly directed shoulder thereon engaged with said free end of said distal leg whereby rearward movement of said driven member relative to said connector is restricted, said cutter sheath including a forward retaining end engaging said driven member and precluding forward movement of said driven member relative to said connector.

48. The surgical instrument according to claim 47, wherein said drive member includes an annular exterior groove formed thereabout and radially aligned with a corresponding groove defined at the inner end of the recess at the distal end of said tubular member, and a retaining ring received within said aligned grooves and precluding longitudinal movement of said drive member relative to said tubular member.

49. A method for removing with a surgical instrument having a rotatably drivable cutting surface material from an internal site located within the body of a patient, the method comprising the following steps:

defining a surgical path from the surface of the patient's body to the internal site that at least partially follows an angled internal passage extending between adjacent parts of the patient's body;

providing a surgical instrument having a rotatably drivable cutting surface that is angled with respect to a proximal end of the instrument at an angle substantially similar to the angled surgical path to be followed, the cutting surface being formed along a cylindrical tubular driven member that is rotatably drivable by a cylindrical drive member rotatably coupled thereto;

advancing the surgical instrument along the surgical path to the internal surgical site; and

rotatably driving the cylindrical drive member and driven cutting surface rotatably coupled thereto and advancing the cutting surface against material to be removed from the internal site.

50. The method according to claim 49, further comprising the step of removing material cut by the cutting surface.

51. The method according to claim 50, wherein the material to be removed is received within and advanced proximally along a passageway formed in the rotatably driven member.

52. The method according to claim 49, wherein the cutting surface is recessably mounted within a cutter window, the window being operable to receive the material to be cut prior to cutting by the rotatable cutting surface.

53. The method according to claim 52, wherein the cutting surface comprises an abrader that extends outwardly from said cutter window.

54. The method according to claim 52, wherein the material to be removed is cut by a sharp edge formed along the cutter window and the rotatably-driven cutting surface.

55. The method according to claim 49, wherein the drive and driven members are rotatably coupled by intermeshing gear surfaces positioned along adjacent surfaces of the respective members.

56. The method according to claim 49, wherein the angle formed in the angled surgical instrument is provided at a connector elbow which receives the rotatable coupling of the drive and driven members, further comprising the step of providing the surgical instrument with a connector elbow having an angle of from about 90° to about 180°.

57. The method according to claim 49, further comprising the step of rotating at least one of the drive and driven members along a bearing surface formed along the interior of a surrounding sleeve.

58. The method according to claim 57, wherein the bearing surface is formed along substantially the entirety of the interior of the surrounding sleeve.

59. The method according to claim 49, wherein the surgical instrument is inserted along a generally non-linear path.

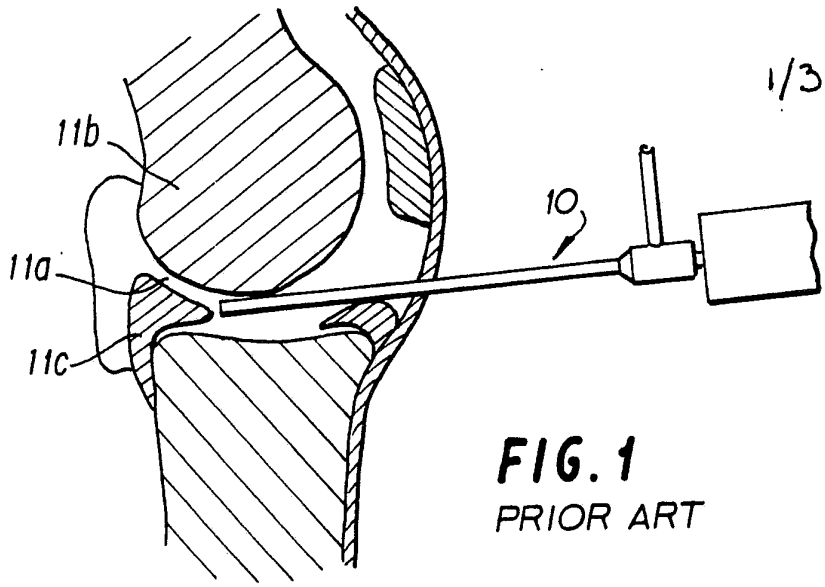

FIG. 1
PRIOR ART

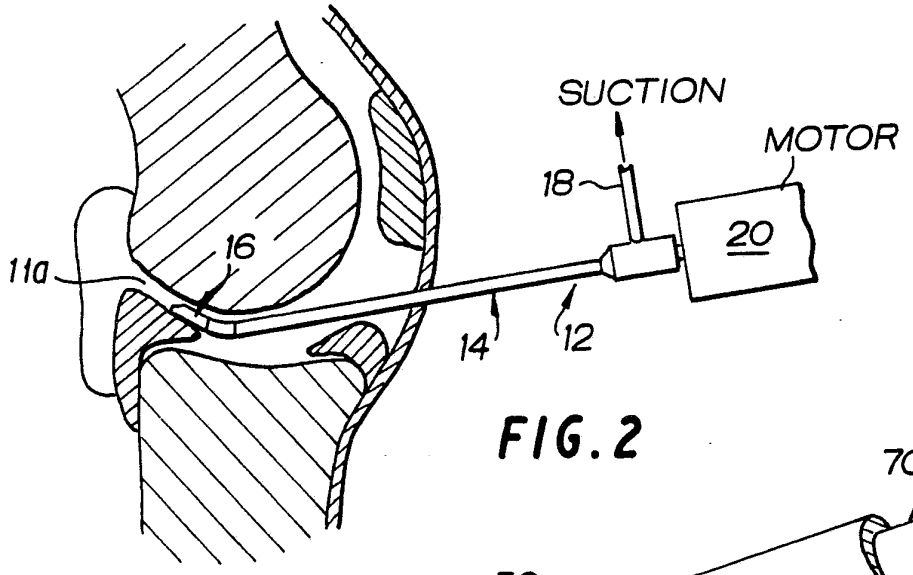

FIG. 2

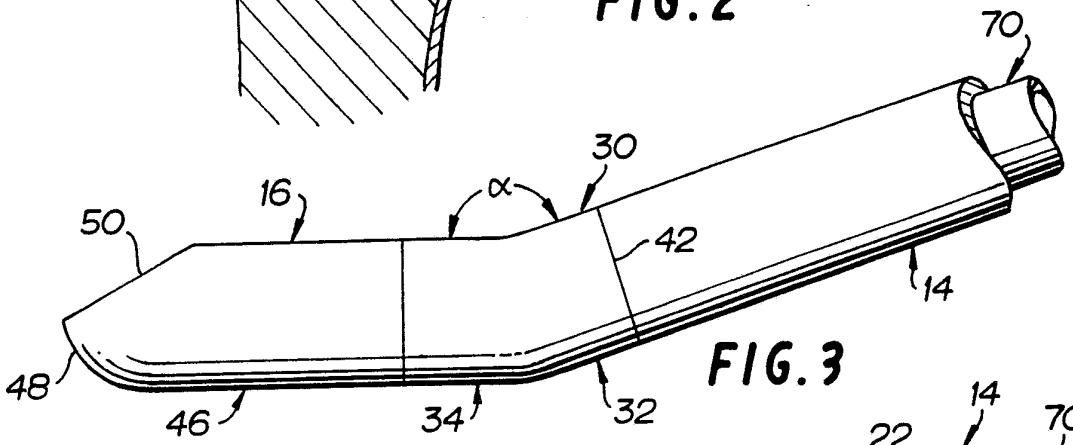

FIG. 3

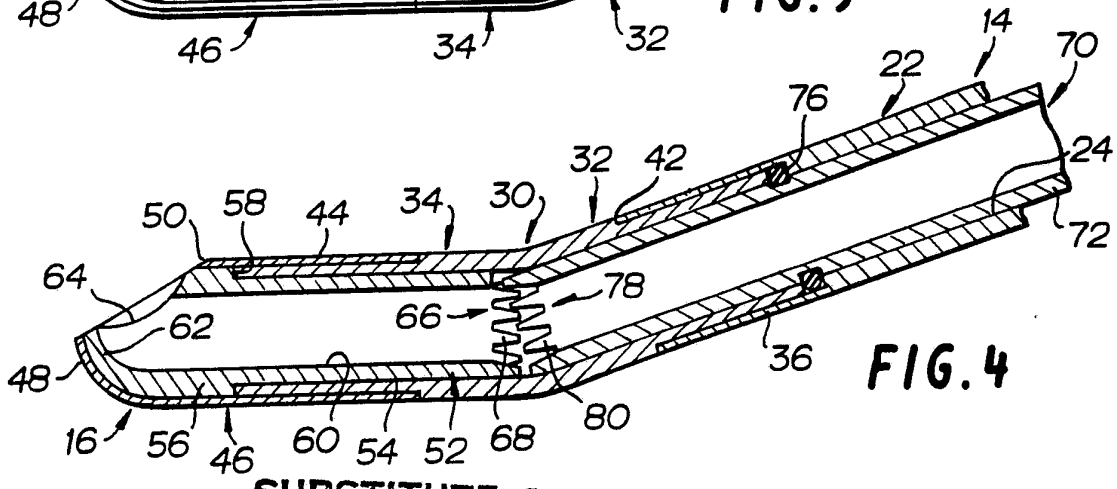

FIG. 4

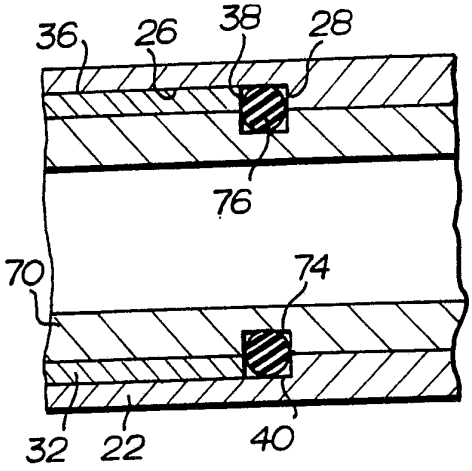

FIG. 6

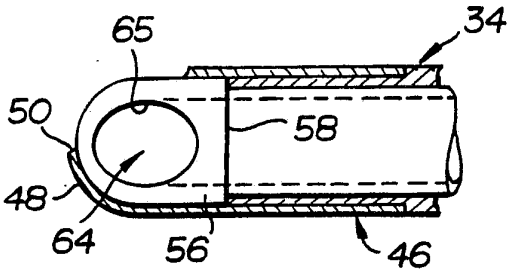

FIG. 5

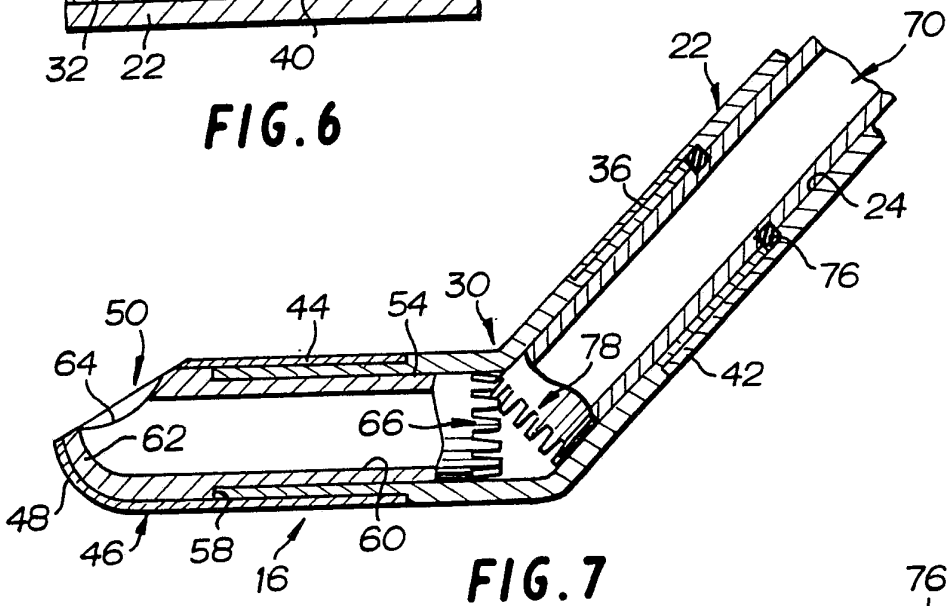

FIG. 7

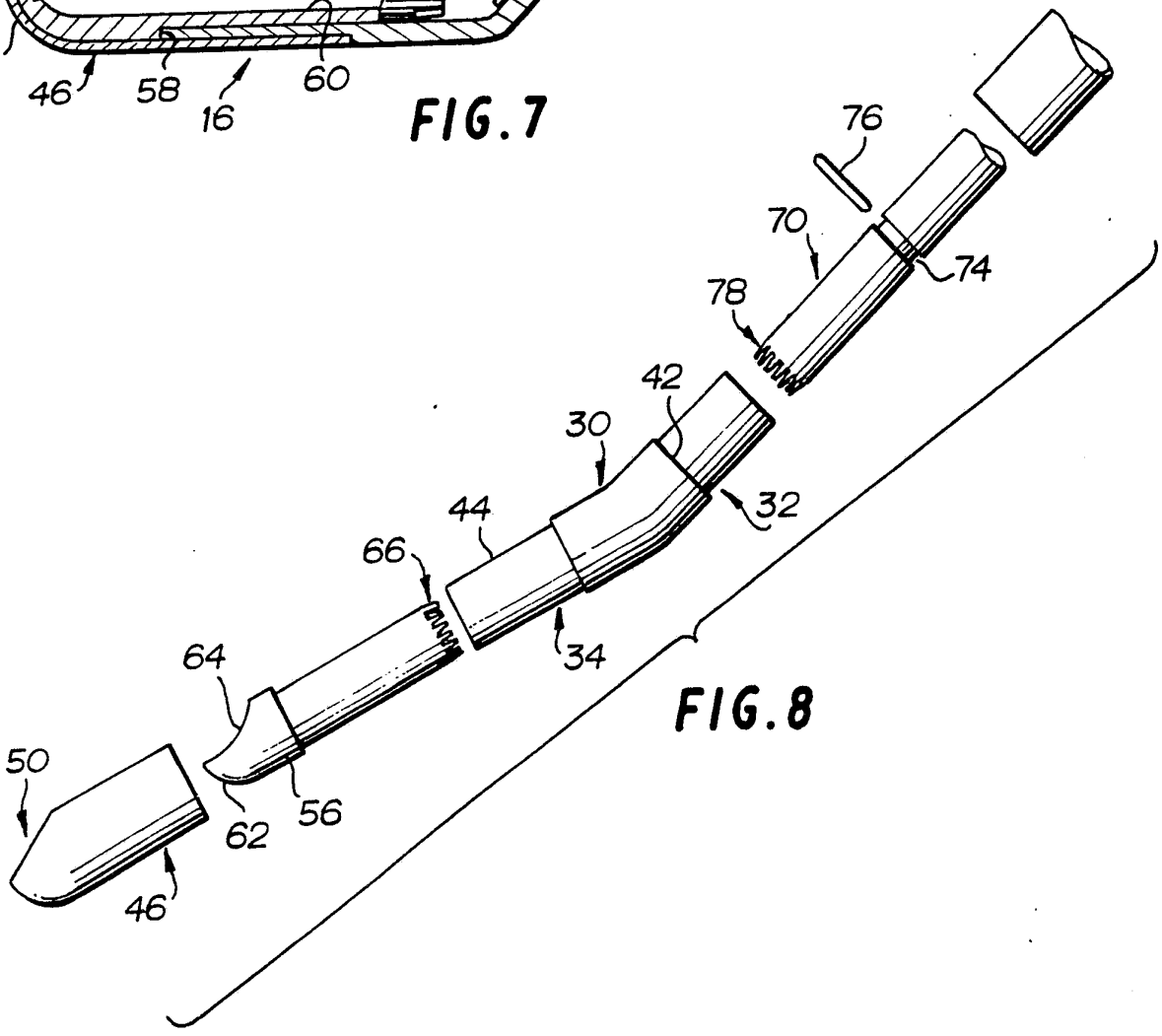

FIG. 8

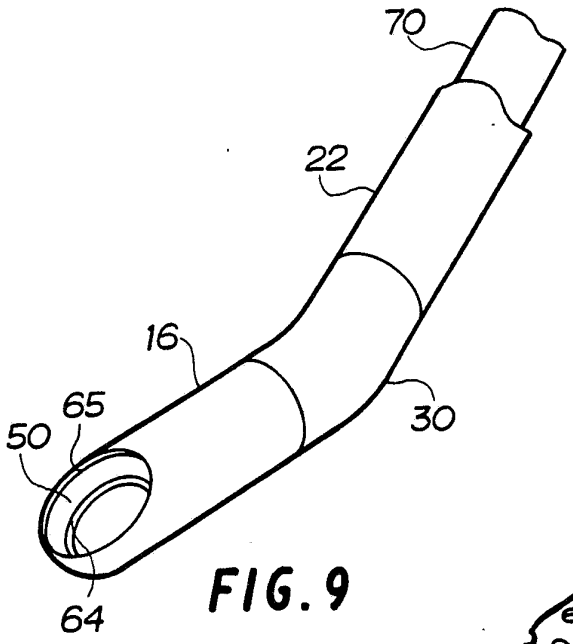

FIG. 9

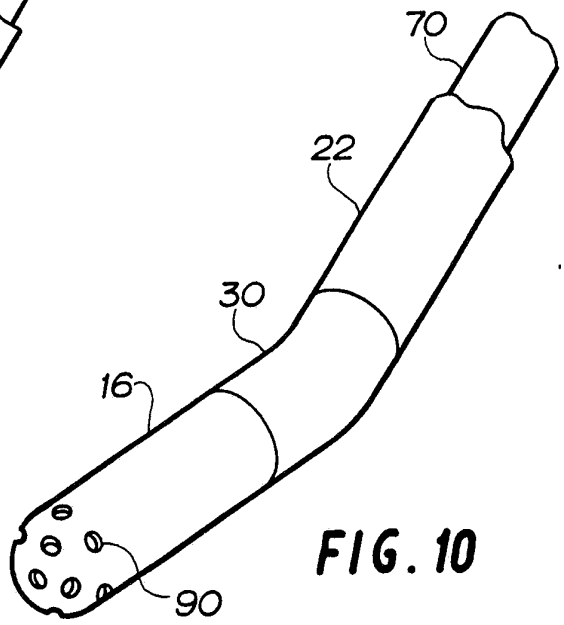

FIG. 10

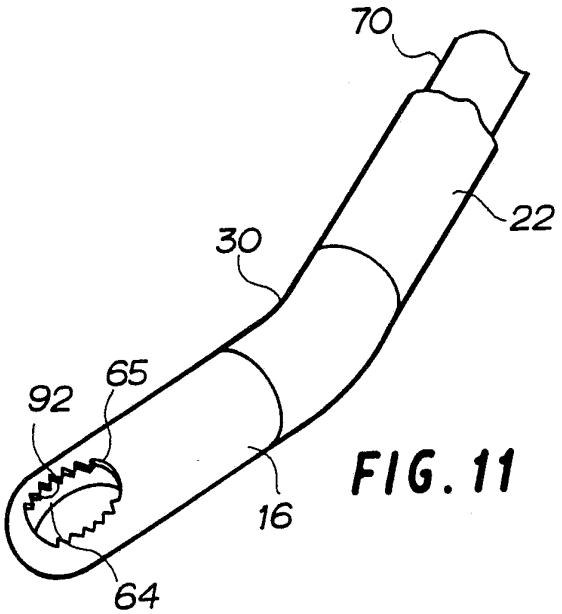

FIG. 11

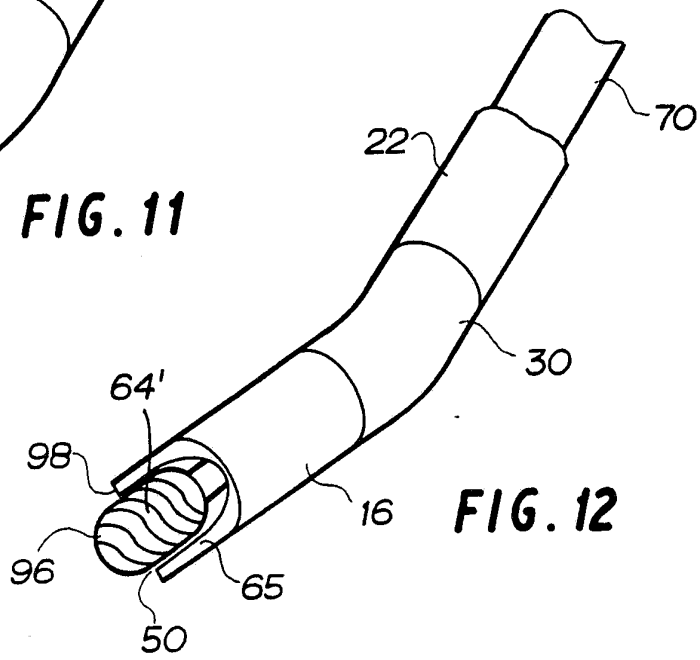

FIG. 12

INTERNATIONAL SEARCH REPORT

International Application No. PCT/US91/08348

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC(5): A61B 17/32

U.S. CL.: 606/80,170

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
U.S.	606/80,170,180; 604/22

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category *	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
X	US, A, 1,677,337 (GROVE) 17 July 1928, SEe entire document.	1-3,10-28,21, 22,25,28-30, 49,55-59
Y		4-9,19,20,23, 24,26,27,31-48, 52-54
X	US, A, 4,646,738 (TROTT) 03 March 1987, See entire document.	49-51,56-59
Y		4-9,19,20,23, 24,26,27,31-48, 52-54

* Special categories of cited documents: [10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search

14 JANUARY 1992

Date of Mailing of this International Search Report

19 FEB 1992

International Searching Authority

ISA/US

Signature of Authorized Officer

MICHAEL THALER