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(54) Title: WAVEGUIDE HANDPIECE

(57) Abstract: A waveguide handpiece, a system utilizing a waveguide handpiece and methods utilizing the same. The waveguide handpiece has an at least partially hollow elongated tubular member capable of receiving a terminal fiber optic endoprobe such as a hollow waveguide. The waveguide handpiece is capable of use with an apparatus that propagates electromagnetic radiation from a radiation source. The entire waveguide handpiece is suitable for autoclaving, as well as other methods of sterilization, and reuse.



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WAVEGUIDE HANDPIECE

FIELD OF THE INVENTION

[0001] The present invention relates generally to electromagnetic radiation waveguides. More particularly, the present invention relates to a waveguide handpiece.

BACKGROUND OF THE INVENTION

[0002] Electromagnetic radiation has a number of industrial applications. Certain types of electromagnetic radiation are particularly effective at vaporization or ablation. For example, it is well recognized that infrared radiation, having wavelengths generally between 750 nm and 1 mm in length, have particular application in laser devices.

[0003] Electromagnetic radiation emitted from a radiation source, such as a laser, is often used in medical and industrial applications. The electromagnetic radiation can be delivered to an application site using a fiber optic delivery system. A typical fiber optic delivery system can include a laser source which generates electromagnetic radiation that travels through either an intermediary optical fiber to terminal optical fiber, or directly through an optical fiber, to an application site.

[0004] Often times, during procedures utilizing a fiber optic delivery system, debris will become disposed on the hand piece or the terminal optical fiber thereby necessitating sterilization. For example, a hand piece, or a terminal optical fiber

associated therewith, which comes in contact with biological material during a medical procedure will require sterilization or disposal in order to prevent the spread of infection.

[0005] Therefore a need exists for a hand piece that is easily sterilized for reuse.

SUMMARY OF THE INVENTION

[0006] In general, the invention is directed to an easily sterilized waveguide handpiece for use with an apparatus that propagates electromagnetic radiation from a radiation source. The entire waveguide handpiece is suitable for autoclaving, as well as other methods of sterilization, and reuse.

[0007] Accordingly, the invention is directed to a waveguide handpiece having an elongated tubular member. The elongated tubular member has a first end and a second end, an outer surface and an at least partially hollow interior. The at least partially interior is capable of receiving a hollow fiber optic member such as a terminal hollow waveguide. The waveguide handpiece is attachable to an electromagnetic radiation source.

[0008] A particular problem exists with regard to sterilization of hollow waveguide optical fiber; therefore, the present invention provides a remedy for this problem.

[0009] The at least partially hollow interior of the waveguide handpiece is capable of receiving a hollow fiber optic member such as a terminal hollow

waveguide. Typically, where a fiber optic system employs a terminal hollow waveguide fiber optic as a terminal fiber optic endoprobe, debris can accumulate both on and within the terminal hollow waveguide. To sterilize the terminal hollow waveguide, in addition to an autoclaving procedure, a separate vapor removing operation requiring potentially harmful gasses to remove vapors left behind from the autoclaving procedure is required.

[0010] Accordingly, when a terminal hollow waveguide (or other terminal fiber optic endoprobe) is used in accordance with the present waveguide handpiece, it can be removed and discarded as needed. The handpiece can then be sterilized, by autoclaving if so desired, and a replacement terminal hollow waveguide (or other terminal fiber optic endoprobe) can be inserted into the at least partially interior of the present waveguide handpiece.

[0011] In an alternate embodiment, a waveguide handpiece comprising an elongated tubular member is provided. The elongated tubular member has a first end, a second end and an at least partially hollow interior. A hollow fiber optic member is disposed within the partially hollow interior of the elongated tubular member. The hollow fiber optic member is capable of insertion into, or removal from, the at least partially hollow interior of the elongated tubular member

[0012] In accordance with yet another embodiment, a waveguide handpiece having an elongated tubular member is provided. The elongated tubular member has a first end and a second end, an outer surface and an at least partially hollow interior capable of receiving a hollow fiber optic member. A ferrule having a first ferrule end

and a second ferrule end is also provided. The ferrule is positioned within the at least partially hollow interior of the elongated tubular member. A hollow tip is coupled to the first end of the elongated tubular member. The hollow tip further comprises a collet and a connector. A nozzle having an aperture with a diameter sufficient to accommodate the hollow fiber optic member is also provided. The nozzle has a complementary connector capable of attachment to the hollow tip at the connector of the hollow tip.

[0013] In accordance with yet still another embodiment, a waveguide system is provided. The system has a waveguide handpiece having an elongated tubular member having a first end, a second end, an at least partially hollow interior. A hollow fiber optic member disposed within the at least partially hollow interior of the elongated tubular member. The hollow fiber optic member is capable of insertion into, or removal from, the at least partially hollow interior of the elongated tubular member. The system further includes an electromagnetic radiation energy source capable of being attached and detached to the first end of the elongated tubular member.

[0014] An alternative embodiment provides a method of transmitting electromagnetic radiation comprising: generating electromagnetic radiation; propagating the electromagnetic radiation through an intermediary source waveguide to a ferrule; and propagating the electromagnetic radiation through the ferrule to a hollow fiber optic member of a waveguide handpiece. The waveguide handpiece includes an elongated tubular member having a first end, a second end and an at least

partially hollow interior. The hollow fiber optic member is disposed within the at least partially hollow interior of the elongated tubular member and capable of insertion into, or removal from, the at least partially hollow interior of the elongated tubular member.

[0015] Another embodiment provides a method of cutting. The method includes the steps of: generating at least one infrared wave; propagating the at least one infrared wave through an intermediary source waveguide to a ferrule; propagating the at least one infrared wave through the ferrule to a hollow fiber optic member of a waveguide handpiece; and directing the infrared wave toward an object to be cut. The waveguide handpiece includes an elongated tubular member having a first end, a second end and an at least partially hollow interior. The hollow fiber optic member is disposed within the at least partially hollow interior of the elongated tubular member and capable of insertion into, or removal from, the at least partially hollow interior of the elongated tubular member.

[0016] In accordance with yet another embodiment, a method of cauterizing is provided. The method includes the steps of: generating at least one infrared wave; propagating the at least one infrared wave through an intermediary source waveguide to a ferrule; propagating the at least one infrared wave through the ferrule to a hollow fiber optic member of a waveguide handpiece; and directing the infrared wave toward an on an object to be cauterized. The waveguide handpiece includes an elongated tubular member having a first end, a second end and an at least partially hollow interior. The hollow fiber optic member is disposed within the at least partially

hollow interior of the elongated tubular member and capable of insertion into, or removal from, the at least partially hollow interior of the elongated tubular member.

[0017] In accordance with another embodiment, a hollow fiber optic member comprising a hollow waveguide member is provided. The hollow waveguide member has an outer diameter. A stainless steel sheath is disposed on at least a portion of the outer diameter of the hollow waveguide member. Additionally, a polytetrafluoroethylene (PTFE) sheath is disposed on at least a portion of the outer diameter of the hollow waveguide member.

[0018] In another embodiment, a hollow fiber optic is provided. The hollow fiber optic member comprises a hollow waveguide member having an outer diameter. On at least a portion of the outer diameter of the hollow waveguide member, a first sheath is disposed. Additionally, a second sheath is disposed on at least a portion of the outer diameter of the hollow waveguide member.

[0019] There has thus been outlined, rather broadly, certain embodiments of the invention in order that the detailed description thereof herein may be better understood, and in order that the present contribution to the art may be better appreciated. There are, of course, additional embodiments of the invention that will be described below and which will form the subject matter of the claims appended hereto.

[0020] In this respect, before explaining at least one embodiment of the invention in detail, it is to be understood that the invention is not limited in its application to the details of construction and to the arrangements of the components

set forth in the following description or illustrated in the drawings. The invention is capable of embodiments in addition to those described and of being practiced and carried out in various ways. Also, it is to be understood that the phraseology and terminology employed herein, as well as the abstract, are for the purpose of description and should not be regarded as limiting.

[0021] As such, those skilled in the art will appreciate that the conception upon which this disclosure is based may readily be utilized as a basis for the designing of other structures, methods and systems for carrying out the several purposes of the present invention. It is important, therefore, that the claims be regarded as including such equivalent constructions insofar as they do not depart from the spirit and scope of the present invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0022] The invention can be understood with reference to the following drawings. The components in the drawings are not necessarily to scale. Also, in the drawings, like reference numerals designate corresponding parts throughout the several views.

[0023] FIG. 1 is a planar view of the waveguide handpiece according to an embodiment of the present invention;

[0024] FIG. 2 is a planar view of the assembly of a waveguide handpiece according to an embodiment of the present invention;

[0025] FIG. 3 is a cross-sectional view of the assembled waveguide handpiece

of FIG. 2;

[0026] FIG. 4 is a planar view of a hollow fiber optic member capable of insertion into or removal from the waveguide handpiece of FIG. 1;

[0027] FIG. 5 is a view of a waveguide system.

[0028] FIG. 6 is a schematic representation of a method of transmitting electromagnetic radiation;

[0029] FIG. 7 is a schematic representation of a method of cutting;

[0030] FIG. 8 is a schematic representation of a method of cauterizing

DETAILED DESCRIPTION

[0031] The invention will now be described with reference to the drawing figures, in which like reference numerals refer to like parts throughout.

[0032] With reference to FIG. 1, shown is a waveguide handpiece 101 according to an embodiment of the present invention. The waveguide handpiece 101 has an elongated tubular member 103 having a first end 105 and a second end 107.

[0033] As shown, the waveguide handpiece 101 is capable of attachment to an electromagnetic radiation source at the first end 105 of the elongated tubular member 103.

[0034] Also illustrated, a hollow fiber optic member 109, capable of insertion into, or removal from the waveguide handpiece 101, is shown disposed within the waveguide handpiece 101.

[0035] The waveguide handpiece 101 is capable of being attached either

directly to a source capable of producing electromagnetic radiation, or to an intermediary source of electromagnetic radiation.

[0036] In one embodiment, the waveguide handpiece 101 is completely reusable. Because of its construction, it is possible to sterilize the waveguide handpiece and reuse it.

[0037] The source electromagnetic radiation could be any device capable of generating electromagnetic radiation including a laser. In one embodiment, the source of the electromagnetic radiation is CO₂ laser produces which a beam of infrared light with a principal wavelength of around 9 to 11 microns.

[0038] In alternative embodiments, any infrared wave, including mid-infrared waves, near infrared waves, and the like, can be utilized in conjunction with the present invention. Generally infrared waves are those with wavelengths in the range of from about 750 nm and 1 mm in length. Mid-infrared waves are those with wavelengths in the range of about 5 to 40 microns. Near infrared waves are those with wavelengths of about .7 to 5 microns.

[0039] In one embodiment, the intermediary source of electromagnetic radiation is a waveguide. The waveguide may be formed from hollow metal, a hollow silica-glass tube, a solid-core fiber, solid transparent glass, solid transparent plastic, or the like.

[0040] The hollow fiber optic member 109 is a terminal fiber optic endoprobe. The terminal fiber optic endoprobe, as depicted, is the final fiber optic in a system or apparatus utilizing a fiber optic to emit a beam or a wave of electromagnetic radiation.

More specifically, in the embodiment shown the hollow fiber optic member 109 is a glass waveguide.

[0041] In alternative embodiments, the hollow fiber optic member may be formed from hollow metal, a hollow silica-glass tube, a solid-core fiber, solid transparent glass, solid transparent plastic, and the like. The hollow fiber optic member 109 can be disposable.

[0042] The design of the waveguide handpiece 101 ensures that the hollow waveguide member 109 portion can be optically coupled to a source of electromagnetic radiation. Electromagnetic radiation, can be directed out of the tip of the hollow fiber optic member 109 in the waveguide handpiece 101, preserving beam integrity over several millimeters distance.

[0043] In alternate embodiments, any terminal fiber optic endoprobe may be used with the waveguide handpiece 101. Therefore, fiber optic endoprobes that are rigid, semi-rigid, and the like may be used with the waveguide handpiece 101.

[0044] In alternate embodiments, other terminal fiber optic endoprobe configurations are possible by utilizing a hollow core terminal fiber optic endoprobe that is rigid or semi flexible and reusable. By adding a diamond window to the distal tip of such a terminal fiber optic endoprobe, the probe can be inserted in a fluid filled surgical field. The diamond window can be brought in contact with tissue, which can then be ablated with a pulse of laser light energy. The diamond window is transparent to laser light of all wavelengths, which passes through it largely with no attenuation.

[0045] By using a diamond window fabricated into a plano-convex shape, the

laser light energy can be focused to a fine beam a fraction of a millimeter in diameter with a very close working distance. This type of probe would be useful for relieving fluid pressure in delicate physiologic structures like the ear drum or the eye.

[0046] In an alternative embodiment, another possible terminal fiber optic endoprobe configuration allows normally inaccessible tissue to be ablated. The distal tip of terminal fiber optic endoprobe is fitted with a diamond prism, configured so that laser light energy fires radially out the side of a catheter. This permits ablation of tissue along the walls of long tubular structures in the body such as arteries, veins, lungs (emphysema) and other fluid containing channels. When rotating the terminal fiber optic endoprobe, while the laser fires, circular sections can be ablated with a high degree of precision.

[0047] All of the terminal fiber optic endoprobe configurations described above are compatible with the reusable waveguide handpiece 101 as well as alternate embodiments of the waveguide handpiece. Therefore the waveguide handpiece 101 is suited to perform a variety of surgical procedures, including: topical procedures, surgical procedures, minimally invasive surgical procedures, invasive surgical procedures, and the like.

[0048] Referring next to FIG. 2, shown is a view of an assembly of a waveguide handpiece according to an embodiment of the present invention. In the shown embodiment, a ferrule 111 having a first ferrule end 113 and a second ferrule end 115 is capable of being positioned in an elongated tubular member 117.

[0049] In the embodiment shown, the elongated tubular member 117 has an

outer surface 119 having a grip portion 121 disposed thereon.

[0050] As shown, the grip portion 121 is formed on the outer surface 119 of the elongated tubular member 117 as a series of beveled edges. However, in other embodiments, the grip portion 121 can be any means capable of improving grip to the waveguide handpiece. The grip portion 121 may be formed, molded, machined or the like. In other embodiments, the grip portion 121 may be made out of a material different from that of the waveguide handpiece and fixed to the outer surface 119.

[0051] The elongated tubular member 117 has a first end 123 and a second end 125. As shown, a connector 127 is located at the first end 123 of the elongated tubular member 117. As shown, the connector 127 has an outer surface 129 with threading 131 disposed thereon.

[0052] While threading 131 is used in the embodiment shown, any means for coupling the elongated tubular member 117 to another object such as a screw fit, friction fit, and the like, can be used.

[0053] Also shown is a hollow tip 133 which is capable of attachment to the second end 125 of the elongated tubular member 117. The hollow tip 133 has a collet 135 and a connector 137.

[0054] In one embodiment, the hollow tip 133 is fixed to the second end 125 of the elongated tubular member with an epoxy such as EP42HT epoxy, class VI. In other embodiments the hollow tip 133 may be coupled to the second end by other epoxies, a screw fit, a friction fit, or the like.

[0055] Also shown is a nozzle 139 which is capable of attachment to the

hollow tip 133. The nozzle 139 has a complementary connector 141 that is attachable to the connector 137 of the hollow tip 133. Further, the nozzle 139 has an aperture 143 with a diameter sufficient to accommodate a hollow fiber optic member.

[0056] In one embodiment, the connector 137 of the hollow tip 133 has threading which is capable of receiving the complementary connector 141 of the nozzle 139. In other embodiments, alternative means for engaging the connector 137 to the complementary connector 141 other than threading may be used such as a screw fit, friction fit, and the like.

[0057] Turning to FIG. 3, shown is a crosssectional view of the assembled waveguide handpiece of FIG. 2. In the embodiment shown, the elongated tubular member 117 is completely hollow. In other embodiments, the elongated tubular can be partially hollow.

[0058] As shown, a ferrule 111 is positioned within the elongated tubular member 117 toward the first end 123. In the embodiment shown, the first end 123 of the elongated tubular member 117 has a first end opening 145. As shown, a void of area 147 exists between the first end opening 145 and the first ferrule end 113.

[0059] In the embodiment shown, the void of area 147 is provided such that the waveguide handpiece can be attached to an electromagnetic radiation source that has a protrusion. In one embodiment, the void area 147 is capable of receiving a ferrule from, for example, an FSMA connector.

[0060] As shown, the void of area 147 is .394 inches in length. However, in other embodiments, the void of area 147 can be any distance. In alternative

embodiments, there may be no void of area 147 whatsoever.

[0061] In the shown embodiment, the hollow tip 131 is coupled to the elongated tubular member 117 at the second end 125 of the elongated tubular member 117. The nozzle 139 is attached to the hollow tip 131.

[0062] Referring to FIG. 4, shown is a view of a hollow fiber optic member 149 capable of insertion into or removal from the waveguide handpiece of FIG. 1. As shown, the hollow fiber optic member 149 is a fiber optic endoprobe. More specifically, the hollow fiber optic member 149 is a glass waveguide 151 with a first end 153 and a second end 155. The glass waveguide 151 has a coating 157 which is peeled back at the first end 153.

[0063] In alternate embodiments, the hollow fiber optic member may be formed from hollow metal, a hollow silica-glass tube, a solid-core fiber, solid transparent glass, solid transparent plastic, and the like.

[0064] The hollow fiber optic member 149 has an outer surface 159. In the embodiment shown, a first sheath 161 is disposed directly on the outer surface 159 of the hollow fiber optic member 149. A second sheath 163 is also disposed on the outer surface 159 of the hollow fiber optic member 149. As shown the second sheath 163 overlaps the first sheath 161.

[0065] The coating 157 is a moisture buffer which will prevent breakage caused by atmospheric moisture penetrating the surface of the glass and causing microcracks to form. The coating 157 is peeled back prevent burning when the stray energy heats up the glass at the first end 153 of the hollow fiber optic member 149.

Any distance sufficient to achieve this will suffice. In one embodiment, a distance of 1.5mm is sufficient.

[0066] The first sheath 161 is provided to protect hollow fiber optic member from external pressure applied by a waveguide handpiece as well as to stabilize it within a waveguide handpiece. The first sheath 161 can be made from any material suitable for use with fiber optics such as metal, stainless steel, titanium, plastic extrusion tubing, braided metal tubing, corrugated or spiral wound metal flexible tubing, and the like.

[0067] As show, in one embodiment, the second sheath 163 is substantially disposed at the second end 155 of the hollow fiber optic member 149.

[0068] Also, according to an alternate embodiment, the second sheath 163 is flexible to allow for bending of the hollow fiber optic member 149. The second sheath 163 can be made from any material suitable for use with fiber optics such as polytetrafluoroethylene (PTFE), ethylene-propylene (FEP), perfluoroalkoxy polymer resin (PFA), polyethylene, plastics, and the like.

[0069] In one embodiment, flexibility of the hollow fiber optic member 149 aids in its use in certain medical procedures. The waveguide handpiece 101 of Fig.1 can be used with the hollow fiber optic member 149 of Fig. 4. For example, for use in medical procedures, the waveguide handpiece 101 and the hollow fiber optic member 149 can be used in conjunction with a number of medical scopes including, but not limited to: arthroscopes; bronchoscopes; colonoscope; colposcope; cystoscope; endoscope; laparoscope; laryngoscope; otoscope; proctoscope; sigmoidoscope; sinus

scope; and the like.

[0070] The hollow fiber optic member 149 can be customized to such that it has a diameter sufficient to fit into a waveguide handpiece. Also, the hollow fiber optic member 149 has a length that is generally in the range of about 2 inches to 3 meters. However the hollow fiber optic member 149 can be as short or as long as necessary.

[0071] In one embodiment, the hollow fiber optic member 149 has a diameter of 1.5mm. In an alternative embodiment, the hollow fiber optic member has a diameter of 2.5mm.

[0072] Certain medical and industrial scopes have specific curvature. Therefore, in an alternate embodiment, the hollow fiber optic member 149 can be curved.

[0073] As illustrated, the hollow fiber optic member 149 has a first sheath 161 as well as a second sheath 163. In an alternative embodiment, the hollow fiber optic member 149 may only have a first sheath 161.

[0074] Debris disposed on the hollow fiber optic member may reduce the effectiveness. Therefore, in one embodiment, the hollow fiber optic member 149 may be disposable.

[0075] In many of the procedures requiring a hollow fiber optic member 149, there is a need for it to be sterile. For example, for use in a medical procedure, a sterile hollow fiber optic member will help prevent the spread of infection. Therefore, in one embodiment, the hollow fiber optic member 149 may be sterile. The hollow

fiber optic member 149 may be provided in pre-sterilized in sterile packaging for immediate use such as a sterile blister pack and the like.

[0076] Turning finally to FIG. 5, shown is a waveguide system. As shown, the waveguide system 165 has a waveguide handpiece 167 having an elongated tubular member 169. The elongated tubular member 169 has a first end 171 a second end 173 and an at least partially hollow interior.

[0077] In the embodiment of the invention shown, the waveguide system 165, has a hollow fiber optic member 175 disposed within the at least partially hollow interior of the elongated tubular member 171. The hollow fiber optic member 175 is capable of insertion into, or removal from, the at least partially hollow interior of the elongated tubular member 171.

[0078] The waveguide system 165 has an electromagnetic radiation source. In the embodiment of the invention as shown, the electromagnetic radiation source includes an electromagnetic radiation generating device 177 having an output 179 and an intermediary source waveguide 181 having a first end 183 and a second end 185. The first end 183 of intermediary source waveguide 181 is coupled to the output 179 of the electromagnetic radiation generating device 177. The second end 183 of the intermediary waveguide source 181 is coupled to the waveguide handpiece 167 at the first end 171 of the elongated tubular member 169.

[0079] The electromagnetic radiation generating device 177 could be any device capable of generating electromagnetic radiation including a laser. In one embodiment the electromagnetic radiation generating device 177 is a CO₂ laser that

produces a beam of infrared light with a principal wavelength of around 9 to 11 microns.

[0080] In alternative embodiments, any infrared wave, including mid-infrared waves, near infrared waves, and the like, can be utilized in conjunction with the inventive subject matter disclosed herein. Generally infrared waves are those with wavelengths in the range of from about 750 nm and 1 mm in length. Mid-infrared waves are those with wavelengths in the range of about 5 to 40 microns. Near infrared waves are those with wavelengths of about .7 to 5 microns.

[0081] As shown, the waveguide system is fully assembled. However, the waveguide handpiece 167 is capable of attachment and detachment from the intermediary source waveguide 181. Further, the intermediary source waveguide 181 is capable of attachment and detachment from the electromagnetic radiation generating device 177. In alternative embodiments, either or both connections could be fixed attachments.

[0082] The intermediary source waveguide 181 can be any waveguide. The intermediary source waveguide 181 may be formed from hollow metal, a hollow silica-glass tube, a solid-core fiber, solid transparent glass, or solid transparent plastic. The intermediary source waveguide 181 may also include a polymer or halide and metallic layer deposited inside the waveguide.

[0083] In one embodiment, the intermediary source waveguide 181 has a sheath formed from superelastic alloys surrounding an outer surface of the intermediary source waveguide 181, extending substantially between the first and

second ends of the intermediary source waveguide 181 and a housing surrounding each of the first and second ends of the intermediary source waveguide 181. A connector coupled to each of the housings to facilitate attachment to the electromagnetic radiation generating source 179 or the waveguide handpiece 167.

[0084] The inventive subject matter disclosed herein is useful in a number of industries. For example, the waveguide handpiece, hollow fiber optic member and system utilizing the same can be used in medical, dental or veterinary procedures. For example, the waveguide handpiece, hollow fiber optic member and system utilizing the same can disclosed herein can be used for cutting, cauterizing, coagulating, skin dermabrasion, cosmetic procedures, ablation, and the like.

[0085] In the alternative, the waveguide handpiece is useful in other industries. For example, the waveguide handpiece, hollow fiber optic member and system utilizing the same can be used for industrial welding, cutting, ablation, and the like.

[0086] In one embodiment, a user can ablate, cut, coagulate and cauterize tissue wherever he directs the beam emanating from the disposable waveguide tip. This technique can be used all over the body surface as well as in open incisions, where tissue contact is not required. The technique can also be used on animals for veterinarian surgical procedures.

[0087] In alternate embodiments, a user can ablate, cut, coagulate and cauterize inside a body cavity using commonly practiced "least invasive" surgical procedures. Therefore, utilizing the inventive subject matter disclosed herein, many medical procedures are possible including: laparoscopic cholecystectomy,

endoscopic surgical procedures such as bowel tumor removal, gastric bypass, esophageal surgery, and liver resection; gynecological procedures such as polyp removal from the exterior surface of the uterus or fibroid removal from the inner surface; gynecological procedures such as polyp removal from the exterior surface of the uterus or fibroid removal from the inner surface; cosmetic procedures such as the “endo-brow lift” procedure is commonly performed for permanent removal of vertical wrinkles between the eyebrows; and the like.

[0088] Longer endoprobes can be inserted into longer stainless steel sheaths. The present inventive subject matter allows accessibility to the lungs through the trachea by means of a bronchoscope for surgical site visualization. This is accomplished by utilizing an optical fiber that is rigid enough to navigate relatively long channels like the trachea yet flexible enough to negotiate minor curves.

[0089] Referring now to FIG. 6 to FIG. 8, shown are schematic charts with arrows that represent steps used in the operation of the inventive subject matter disclosed herein. The steps are in no particular order and can be preformed in any combination conceivable. In an embodiment, electromagnetic radiation is transmitted.

[0090] Turning now to FIG. 6, shown is a schematic chart with steps that represent a method of transmitting electromagnetic radiation. In the first step shown 187, electromagnetic radiation is generated by an electromagnetic radiation source such as a laser or the like. According the second step shown 189, the electromagnetic radiation is propagated through an intermediary source waveguide to a ferrule. In the

third step shown 191, the electromagnetic radiation is further propagated through the ferrule to a hollow fiber optic member disposed within a waveguide handpiece, wherein the hollow fiber optic member is capable of removal or insertion into the waveguide handpiece.

[0091] In one embodiment, the electromagnetic radiation is infrared radiation.

In an alternate embodiment, the electromagnetic radiation is mid-infrared radiation.

In yet, another embodiment, the electromagnetic radiation is near-infrared radiation.

However, in alternative embodiments the electromagnetic radiation could be short wavelength infrared radiation intermediate infrared radiation, long wavelength infrared radiation, far infrared radiation, and the like.

[0092] With respect to FIG. 7, shown is a schematic chart with steps representing a method of cutting. In the first step shown 193, the electromagnetic radiation is generated. In the second step 195, the electromagnetic radiation is propagated through an intermediary source waveguide to a ferrule. In the third step illustrated 197, the electromagnetic radiation is further propagated through the ferrule to a hollow fiber optic member disposed within a waveguide handpiece, wherein the hollow fiber optic member is capable of removal or insertion into the waveguide handpiece. As shown in the fourth step 199, the electromagnetic radiation is then directed towards an object to be cut.

[0093] In one embodiment the object to be cut is biological tissue. In alternate embodiments the object could be any object such as, for example, metal, wood, stone, and the like.

[0094] In an embodiment, the electromagnetic radiation is infrared radiation. In an alternate embodiment, the electromagnetic radiation is mid-infrared radiation. In yet, another embodiment, the electromagnetic radiation is near-infrared radiation. However, in alternative embodiments the electromagnetic radiation could be short wavelength infrared radiation intermediate infrared radiation, long wavelength infrared radiation, far infrared radiation, and the like.

[0095] Turning finally to FIG. 8, shown is schematic representation of a method of cauterizing. In the first step shown 201, electromagnetic radiation is generated. As shown, in the second step 203, the electromagnetic radiation is then propagated through an intermediary source waveguide to a ferrule. In the third step 205, the electromagnetic radiation is further propagated through the ferrule to a hollow fiber optic member disposed within a waveguide handpiece, wherein the hollow fiber optic member is capable of removal or insertion into the waveguide handpiece. Illustrated in the fourth step 207, the electromagnetic radiation is then directed towards an object to be cauterized.

[0096] In one embodiment the object to be cauterized is biological tissue. In alternate embodiments the object could be any susceptible to cauterization.

[0097] In an embodiment, the electromagnetic radiation is infrared radiation. In an alternate embodiment, the electromagnetic radiation is mid-infrared radiation. In yet, another embodiment, the electromagnetic radiation is near-infrared radiation. However, in alternative embodiments the electromagnetic radiation could be short wavelength infrared radiation intermediate infrared radiation, long wavelength

infrared radiation, far infrared radiation, and the like.

[0098] Although FIG. 6 through FIG. 8 are directed to methods of cutting or cauterizing, other methods utilizing the present inventive subject matter also exist. Methods utilizing a waveguide handpiece having an elongated tubular member having a first end, a second end and an at least partially hollow interior, wherein a hollow fiber optic member is disposed within the at least partially hollow interior of the elongated tubular member and capable of insertion into, or removal from, the at least partially hollow interior of the elongated tubular member include methods of ablating, coagulating, welding, and the like.

[0099] The many features and advantages of the invention are apparent from the detailed specification, and thus, it is intended by the appended claims to cover all such features and advantages of the invention which fall within the true spirit and scope of the invention. Further, since numerous modifications and variations will readily occur to those skilled in the art, it is not desired to limit the invention to the exact construction and operation illustrated and described, and accordingly, all suitable modifications and equivalents may be resorted to, falling within the scope of the invention.

What is claimed:

1. A waveguide handpiece comprising:

an elongated tubular member having a first end and a second end, an outer surface and an at least partially hollow interior capable of receiving a hollow fiber optic member;

a ferrule having a first ferrule end and a second ferrule end, wherein the ferrule is positioned within the at least partially hollow interior of the elongated tubular member;

a hollow tip coupled to the first end of the elongated tubular member, wherein the hollow tip further comprises a collet and a connector; and

a nozzle having an aperture with a diameter sufficient to accommodate the hollow fiber optic member, the nozzle having a complementary connector capable of attachment to the hollow tip at the connector of the hollow tip.

2. A waveguide handpiece comprising:

an elongated tubular member having a first end, a second end and an at least partially hollow interior; and

a hollow fiber optic member disposed within the at least partially hollow interior of the elongated tubular member,

wherein the hollow fiber optic member is capable of insertion into, or removal from, the at least partially hollow interior of the elongated tubular member.

3. The waveguide handpiece of claim 2, further comprising a ferrule having a first ferrule end and a second ferrule end, wherein the ferrule is positioned within the at least partially hollow interior of the elongated tubular member.

4. The waveguide handpiece of claim 3, further comprising a hollow tip, wherein the hollow tip is joined to the elongated tubular member at the second end of the elongated tubular member.

5. The waveguide handpiece of claim 4, wherein the hollow tip further comprises a collet and a connector.

6. The waveguide handpiece of claim 5, further comprising a nozzle having an aperture with a diameter sufficient to accommodate the hollow fiber optic member, and the nozzle having a complementary connector capable of attachment to the hollow tip at the connector of the hollow tip.

7. The waveguide handpiece of claim 2, wherein the hollow fiber optic member has a length that is at least as long as the at least partially hollow interior of the elongated tubular member.

8. The waveguide handpiece of claim 2, wherein the hollow fiber optic member further comprises, a hollow waveguide member having an outer surface, a

first sheath disposed on at least a portion of the outer surface of the hollow waveguide member.

9. The waveguide handpiece of claim 8, wherein the hollow waveguide member further comprises a second sheath disposed on at least a portion of the outer surface of the hollow waveguide member.

10. The waveguide handpiece of claim 8, wherein the hollow waveguide member is flexible.

11. The waveguide handpiece of claim 2, wherein hollow fiber optic member is disposable.

12. The waveguide handpiece of claim 2, wherein the first end of the elongated tubular member further comprises a connector.

13. The waveguide handpiece of claim 2, wherein at least a portion of the outer surface diameter of the elongated tubular member has a grip portion disposed thereon.

14. The waveguide handpiece of claim 3, wherein the ferrule is substantially disposed within the at least partially hollow interior of the elongated tubular member

at the first end of the elongated tubular member.

15. The waveguide handpiece of claim 16, wherein the hollow fiber optic member further comprises, a hollow waveguide member having an outer surface, a first sheath disposed on at least a portion of the outer surface of the hollow waveguide member

16. A waveguide handpiece comprising:
an elongated tubular member having a first end, a second end and an at least partially hollow interior capable of receiving a hollow fiber optic member,
wherein the waveguide handpiece is capable of attachment to a source waveguide.

17. The waveguide handpiece of claim 16, further comprising a ferrule having a first ferrule end and a second ferrule end, wherein the ferrule is positioned within the at least partially hollow interior of the elongated tubular member.

18. The waveguide handpiece of claim 17, further comprising a hollow tip, wherein the hollow tip is joined to the elongated tubular member at the second end of the elongated tubular member.

19. The waveguide handpiece of claim 18, wherein the hollow tip further

comprises a collet and a connector.

20. The waveguide handpiece of claim 18, further comprising a nozzle having an aperture with a diameter sufficient to accommodate the hollow fiber optic member, and the nozzle having a complementary connector capable of attachment to the hollow tip at the connector of the hollow tip.

21. The waveguide handpiece of claim 16, wherein the hollow fiber optic member has a length that is at least as long as the at least partially hollow interior of the elongated tubular member.

22. The waveguide handpiece of claim 16, wherein the hollow fiber optic member further comprises, a hollow waveguide member having an outer surface, a first sheath disposed on at least a portion of the outer surface of the hollow waveguide member.

23. The waveguide handpiece of claim 22, wherein the hollow waveguide member further comprises a second sheath disposed on at least a portion of the outer surface of the hollow waveguide member.

24. The waveguide handpiece of claim 22, wherein the first sheath further comprises stainless steel.

25. The waveguide handpiece of claim 23, wherein the second sheath further comprises polytetrafluoroethylene (PTFE).

26. The waveguide handpiece of claim 22, wherein the hollow waveguide member is flexible.

27. The waveguide handpiece of claim 22, wherein hollow fiber optic member is disposable.

28. The waveguide handpiece of claim 16, wherein the first end of the elongated tubular member further comprises a connector.

29. The waveguide handpiece of claim 16, wherein at least a portion of the outer surface diameter of the elongated tubular member has a grip portion disposed thereon.

30. The waveguide handpiece of claim 17, wherein the ferrule is substantially disposed within the at least partially hollow interior of the elongated tubular member at the first end of the elongated tubular member.

31. The waveguide handpiece of claim 16, wherein the handpiece is

autoclavable.

32. A waveguide system comprising:

a waveguide handpiece having an elongated tubular member having a first end, a second end, an at least partially hollow interior;

a hollow fiber optic member disposed within the at least partially hollow interior of the elongated tubular member, wherein the hollow fiber optic member is capable of insertion into, or removal from, the at least partially hollow interior of the elongated tubular member; and

an electromagnetic radiation energy source capable of being attached and detached to the first end of the elongated tubular member.

33. The waveguide system of claim 32, wherein the electromagnetic radiation source further comprises an electromagnetic radiation generating device having an output and an intermediary source waveguide having a first end and a second end connected to the output at the first end.

34. The waveguide system of claim 33, wherein the waveguide handpiece is capable of being attached and detached to the second end of the intermediary source waveguide at the first end of the elongated tubular member.

35. The waveguide system of claim 34, wherein the intermediary source

waveguide further comprises:

a sheath formed from superelastic alloys and surrounding an outer surface of the intermediary source waveguide and extending substantially between the first and second ends of the intermediary source waveguide;

a housing surrounding each of the first and second ends of the intermediary source waveguide;

and a connector coupled to each housing.

36. A method of transmitting electromagnetic radiation comprising:

generating electromagnetic radiation;

propagating the electromagnetic radiation through an intermediary source waveguide to a ferrule; and

propagating the electromagnetic radiation through the ferrule to a hollow fiber optic member of a waveguide handpiece comprising an elongated tubular member having a first end, a second end and an at least partially hollow interior,

wherein the hollow fiber optic member is disposed within the at least partially hollow interior of the elongated tubular member and capable of insertion into, or removal from, the at least partially hollow interior of the elongated tubular member.

37. The method of transmitting electromagnetic radiation of claim 36,

wherein the electromagnetic radiation further comprises at least one infrared wave.

38. The method of transmitting electromagnetic radiation of claim 36, wherein the electromagnetic radiation further comprises at least one mid-infrared wave.

39. The method of transmitting electromagnetic radiation of claim 36, wherein the electromagnetic radiation further comprises at least one near infrared wave.

40. A method of cutting comprising:
generating at least one infrared wave;
propagating the at least one infrared wave through an intermediary source waveguide to a ferrule; and
propagating the at least one infrared wave through the ferrule to a hollow fiber optic member of a waveguide handpiece comprising an elongated tubular member having a first end, a second end and an at least partially hollow interior,
wherein the hollow fiber optic member is disposed within the at least partially hollow interior of the elongated tubular member and capable of insertion into, or removal from, the at least partially hollow interior of the elongated tubular member;
directing the infrared wave toward an object to be cut.

41. The method of cutting of claim 40, wherein the object to be cut is a biological tissue.

42. A method of cauterizing comprising:

generating at least one infrared wave;

propagating the at least one infrared wave through an intermediary source

waveguide to a ferrule; and

propagating the at least one infrared wave through the ferrule to a hollow fiber

optic member of a waveguide handpiece comprising an elongated tubular member

having a first end, a second end and an at least partially hollow interior,

wherein the hollow fiber optic member is disposed within the at least partially

hollow interior of the elongated tubular member and capable of insertion into, or

removal from, the at least partially hollow interior of the elongated tubular member;

and

directing the infrared wave toward an on an object to be cauterized.

43. The method of cauterizing of claim 21, wherein the object to be cauterized

is a biological tissue.

44. A hollow fiber optic member comprising:

a hollow waveguide member having an outer surface;

a first sheath disposed on at least a portion of the outer surface of the hollow

waveguide member; and

a second sheath disposed on at least a portion of the outer surface of the

hollow waveguide member.

45. The hollow fiber optic member of claim 44, wherein the first sheath further comprises stainless steel.

46. The hollow fiber optic member of claim 44, wherein the second sheath further comprises polytetrafluoroethylene (PTFE).

47. A hollow fiber optic member comprising:
a hollow waveguide member having an outer surface;
a stainless steel sheath disposed on at least a portion of the outer surface of the hollow waveguide member; and
a polytetrafluoroethylene (PTFE) sheath disposed on at least a portion of the outer surface of the hollow waveguide member.

48. A hollow fiber optic member comprising:
a hollow waveguide member having an outer surface; and
a first sheath disposed on at least a portion of the outer surface of the hollow waveguide member.

49. The hollow fiber optic member of claim 48, further comprising a second sheath disposed on at least a portion of the outer surface of the hollow waveguide

member.

50. The hollow fiber optic member of claim 49, wherein the first sheath further comprises stainless steel.

51. The hollow fiber optic member of claim 49, wherein the second sheath further comprises polytetrafluoroethylene (PTFE).

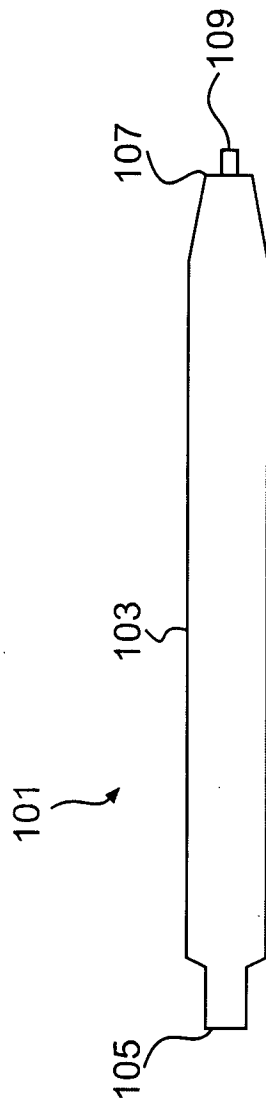


FIG. 1

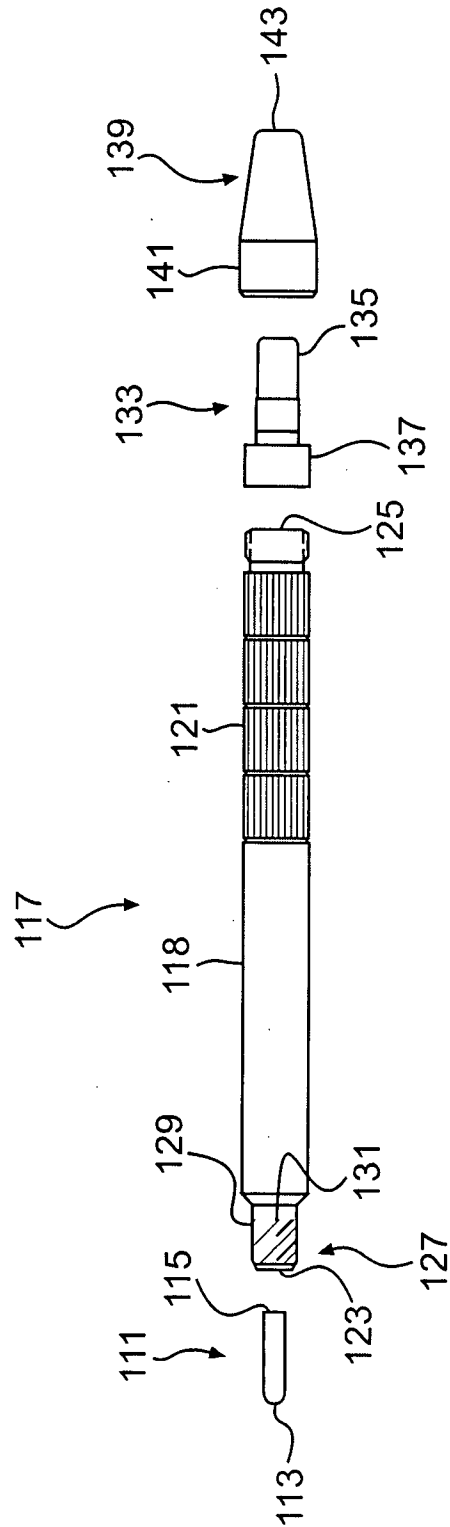


FIG. 2

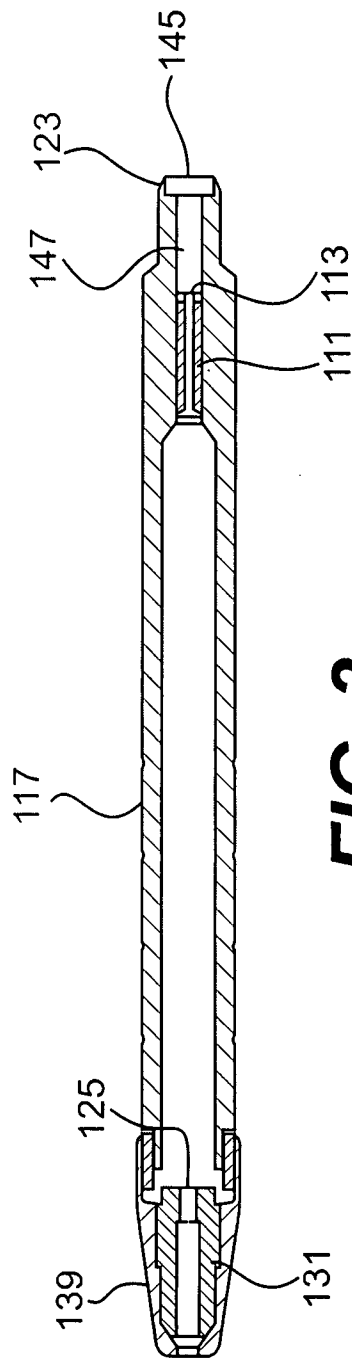


FIG. 3

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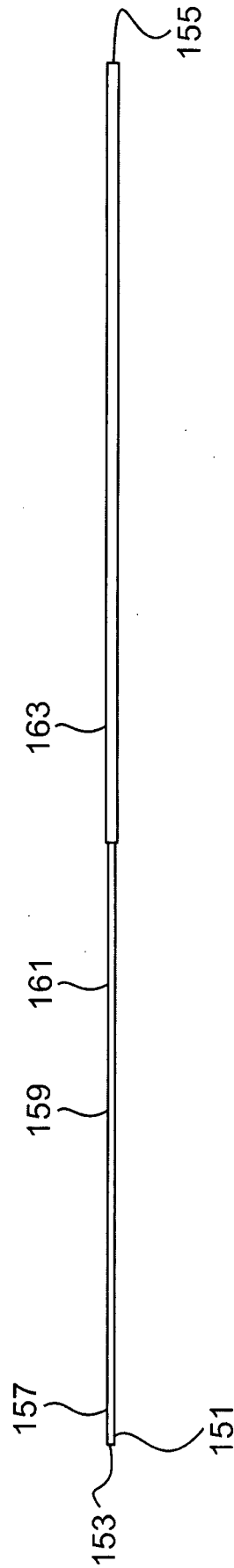
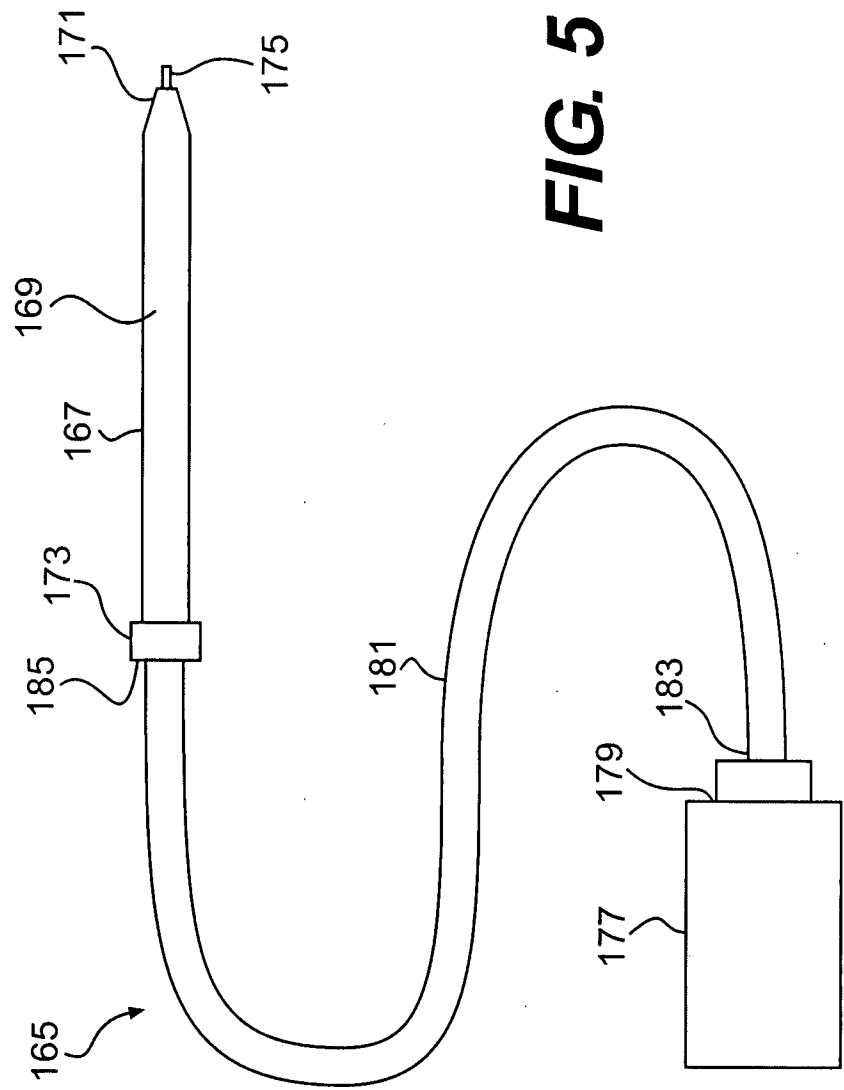
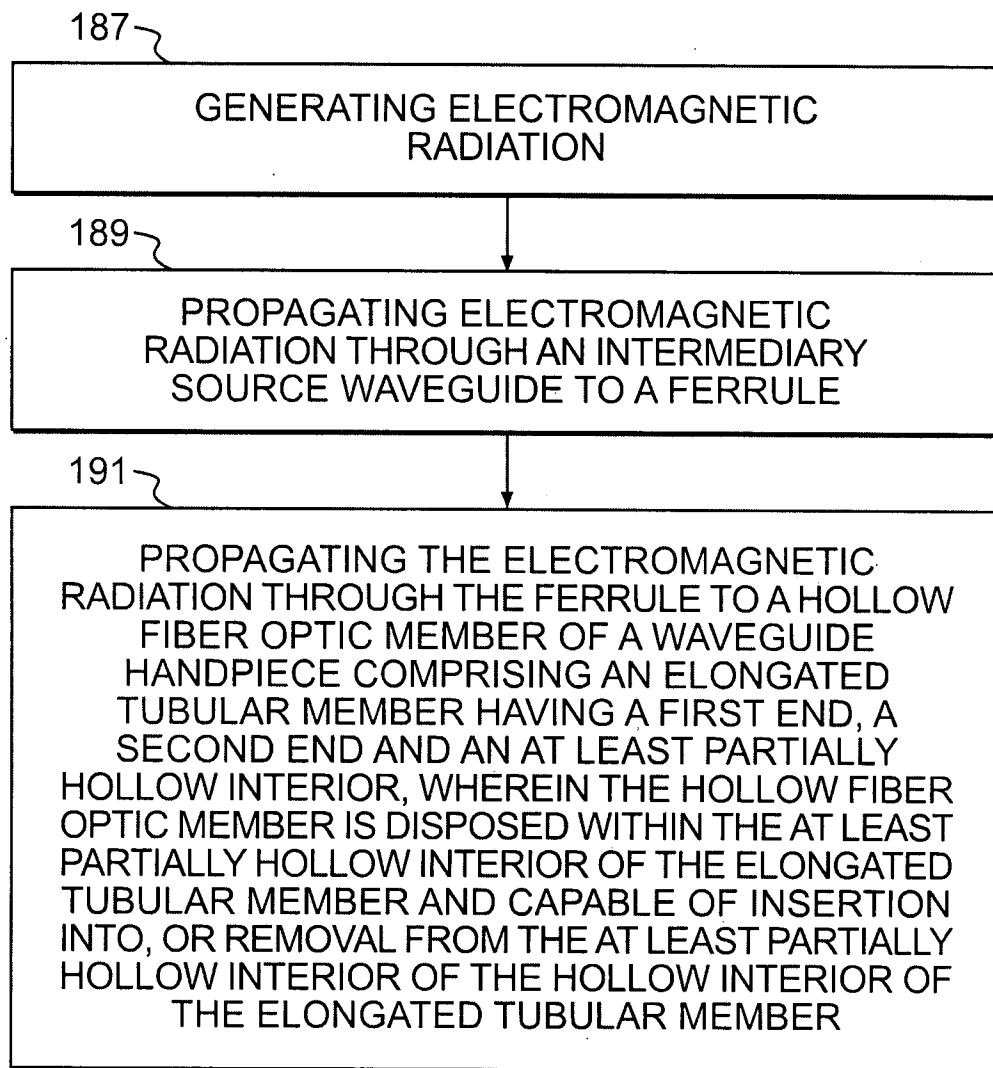
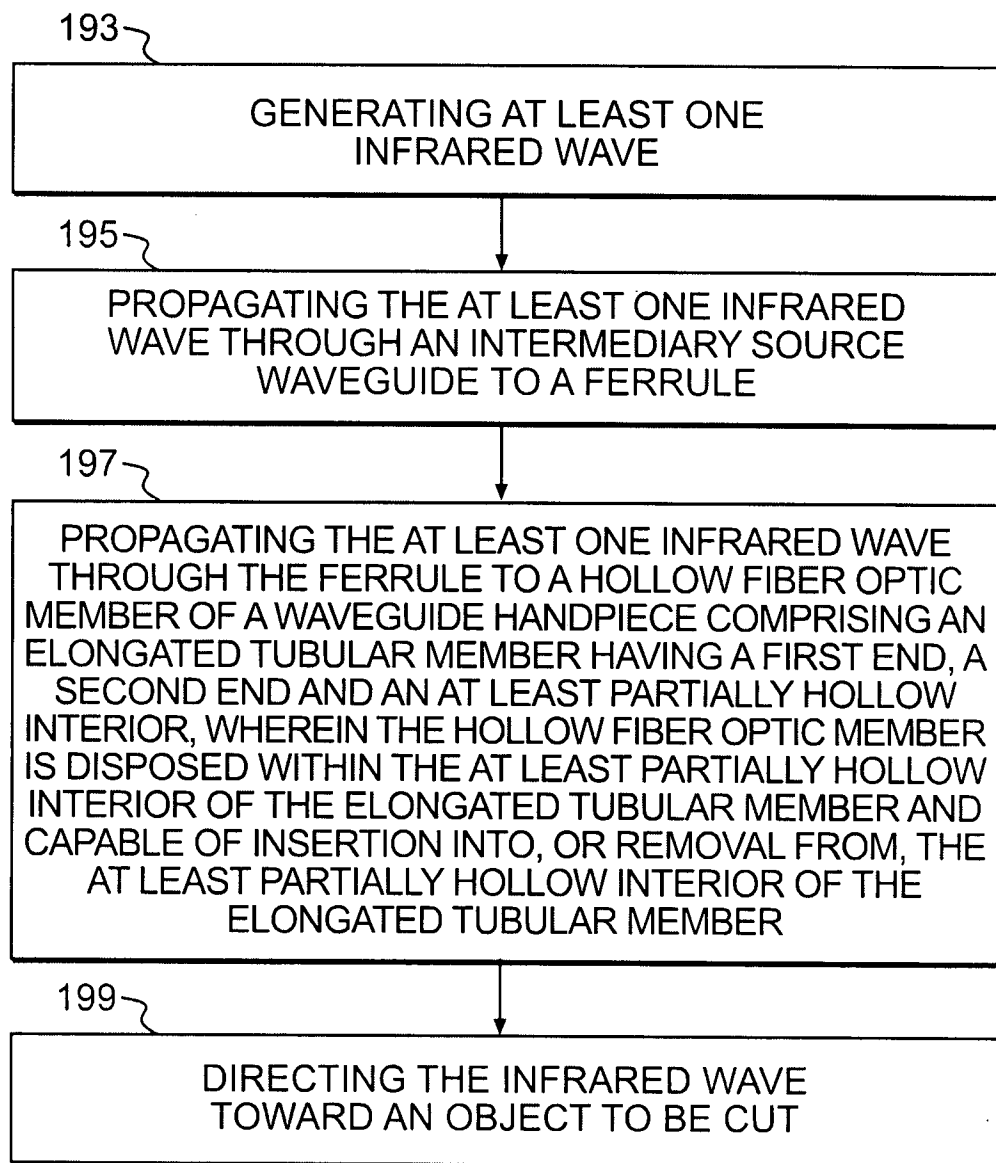
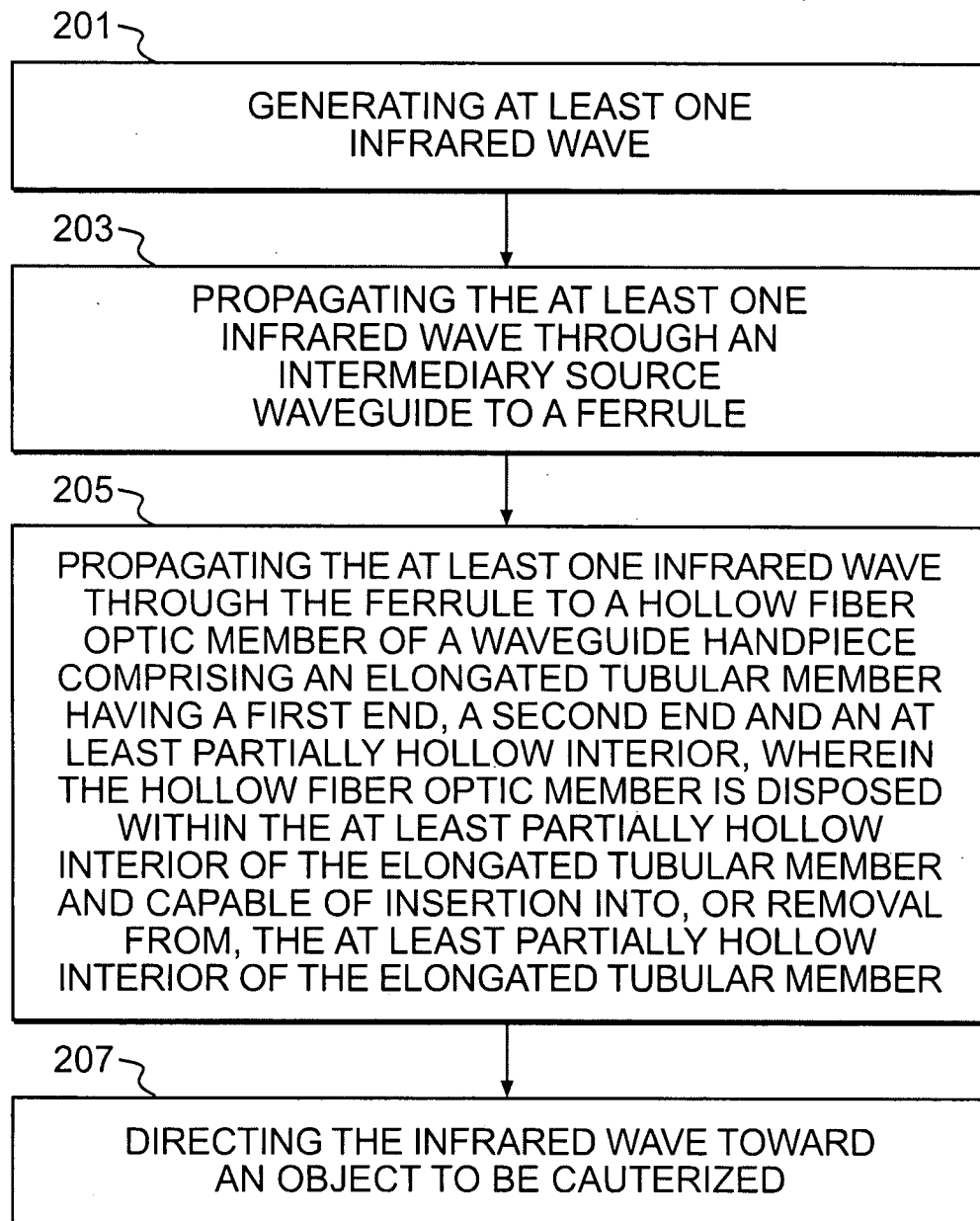


FIG. 4



**FIG. 6**

**FIG. 7**

**FIG. 8**