US 20020022762A1

(19) United States

(12) Patent Application Publication (10) Pub. No.: US 2002/0022762 A1

Beane et al. (43) Pub. Date: Feb. 21, 2002

(54) DEVICES AND METHODS FOR WARMING AND CLEANING LENSES OF OPTICAL SURGICAL INSTRUMENTS

(76) Inventors: **Richard Beane**, Hingham, MA (US); **Demetrius Litwin**, Westboro, MA (US); **Steven Ek**, Bolton, MA (US); **Allison Niemann**, Burlingame, CA (US); **Melinda Taylor**, North Grafton, MA (US)

Correspondence Address:
J. PETER FASSE
Fish & Richardson P.C.
225 Franklin Street
Boston, MA 02110-2804 (US)

(21) Appl. No.: **09/788,033**

(22) Filed: **Feb. 16, 2001**

Related U.S. Application Data

(63) Non-provisional of provisional application No. 60/183,467, filed on Feb. 18, 2000.

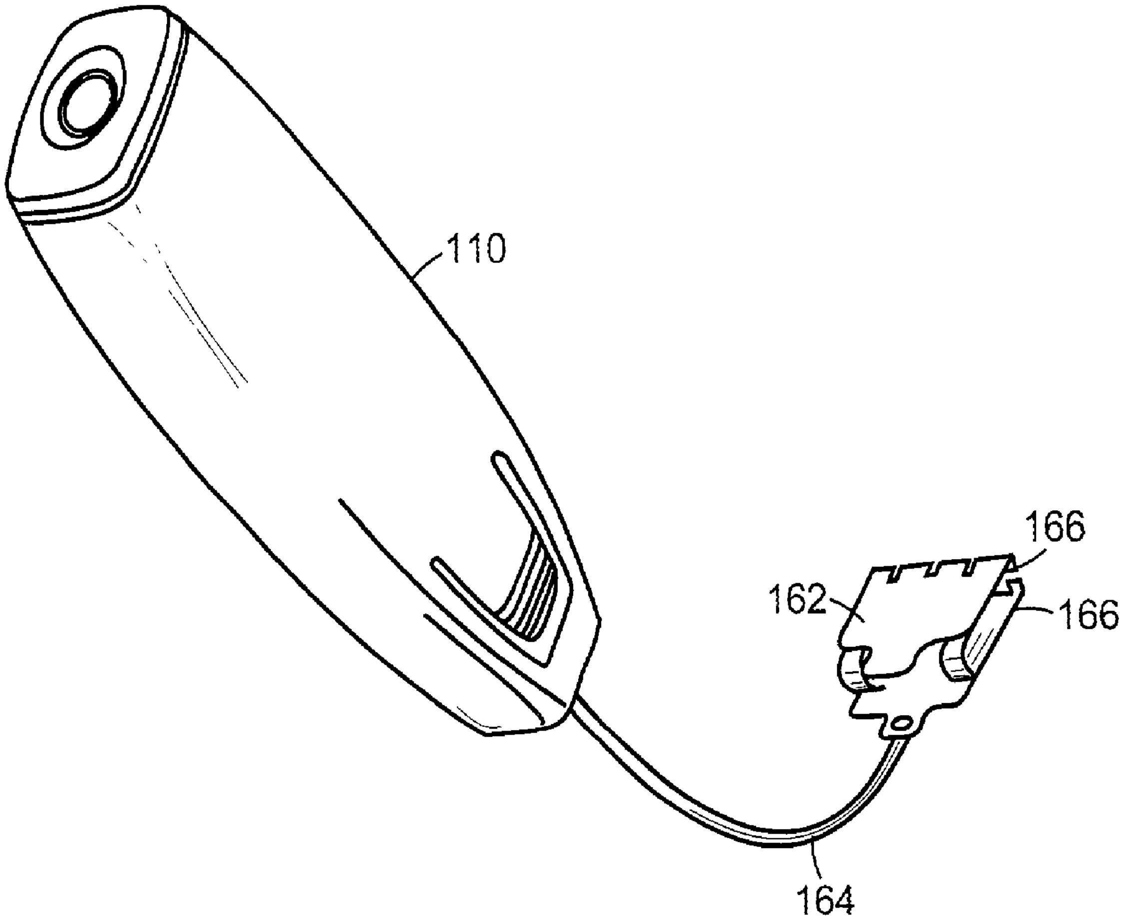
Publication Classification

(51) **Int. Cl.**[7] **A61B 1/00**

(52) **U.S. Cl.** **600/101**

(57) **ABSTRACT**

A lens warming and cleaning device for use with an optical surgical instrument is disclosed. The device includes a heat-conducting tube sized and shaped to receive the lens portion of the instrument, a heating element thermally coupled to an exterior of the tube, and a cleaning member disposed within the tube. The cleaning member is disposed such that when the lens portion of the instrument is inserted into the tube, the lens portion contacts the cleaning member.



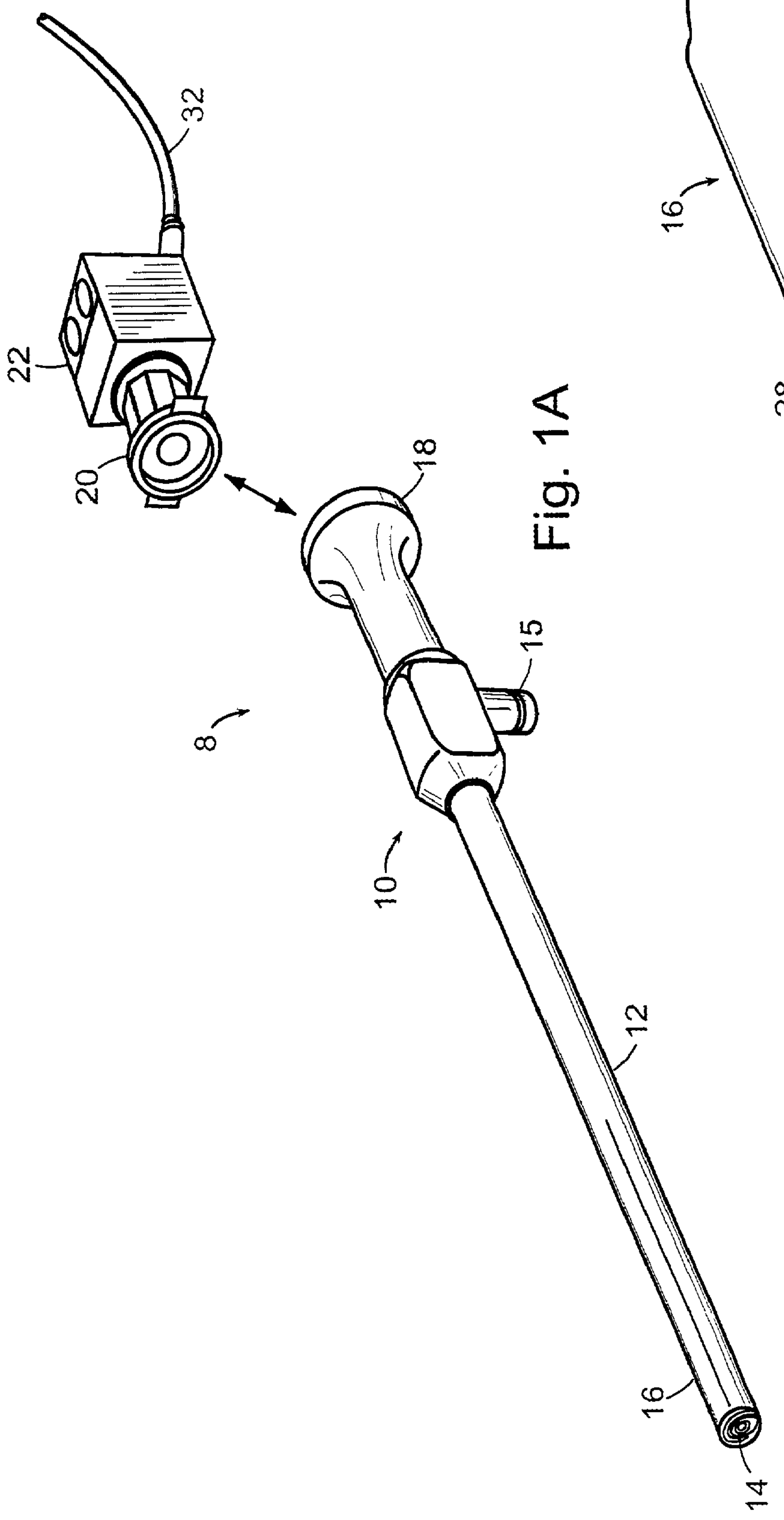


Fig. 1A

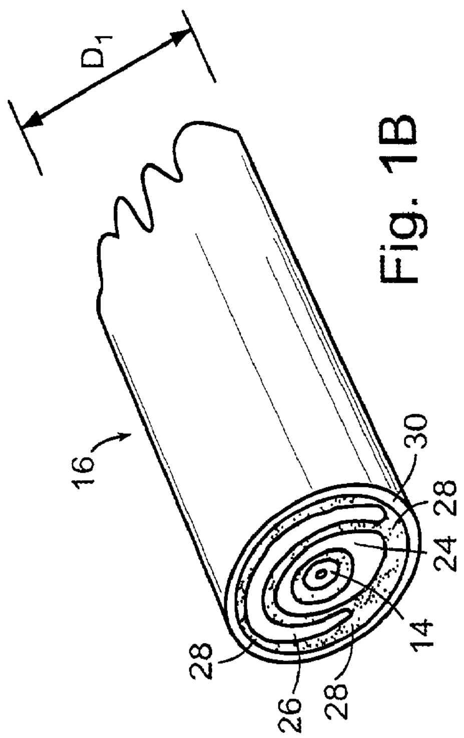


Fig. 1B

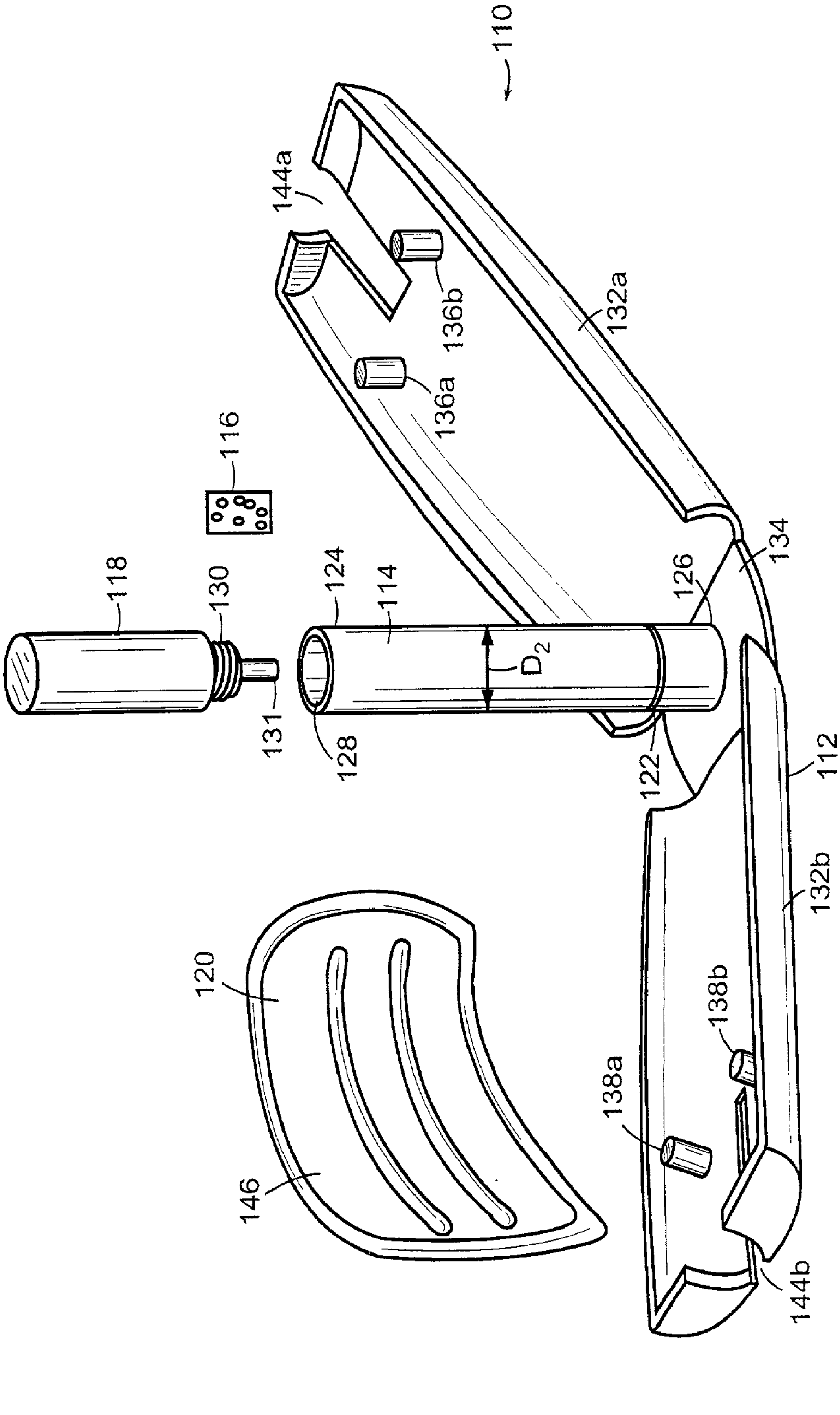

110
144a
136b
132a
136a
116
118
130
124
114
126
134
D2
131
128
122
112
120
132b
138b
138a
146
144b

Fig. 2A

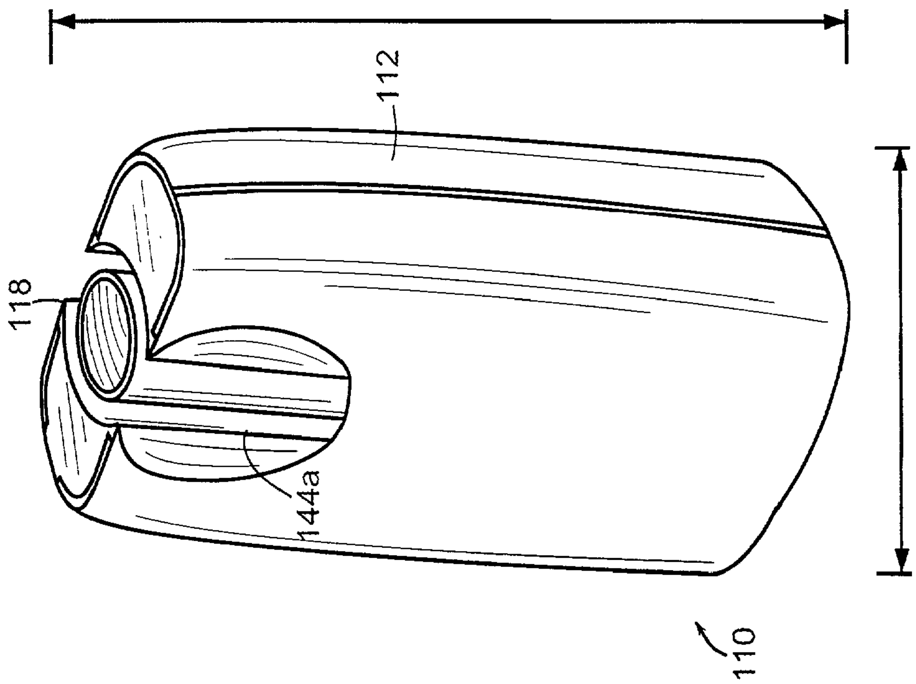


Fig. 2C

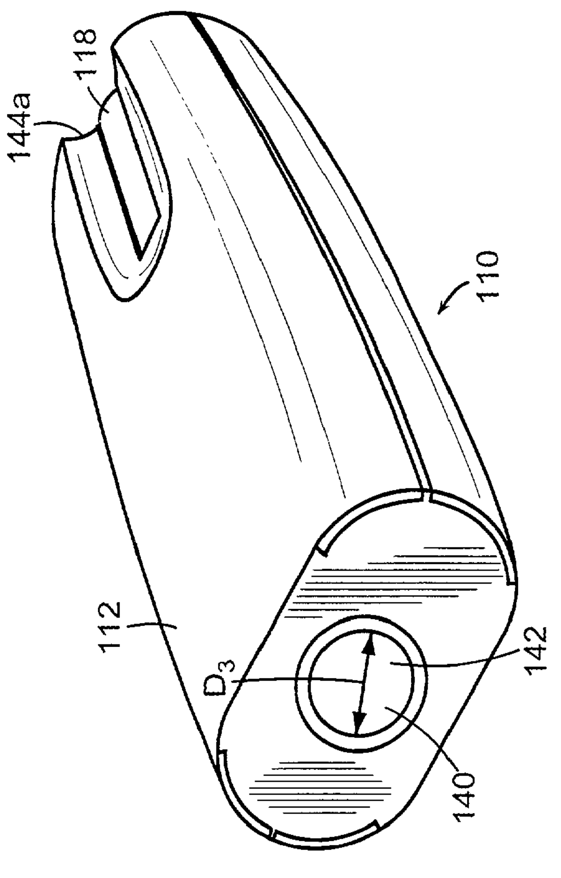


Fig. 2B

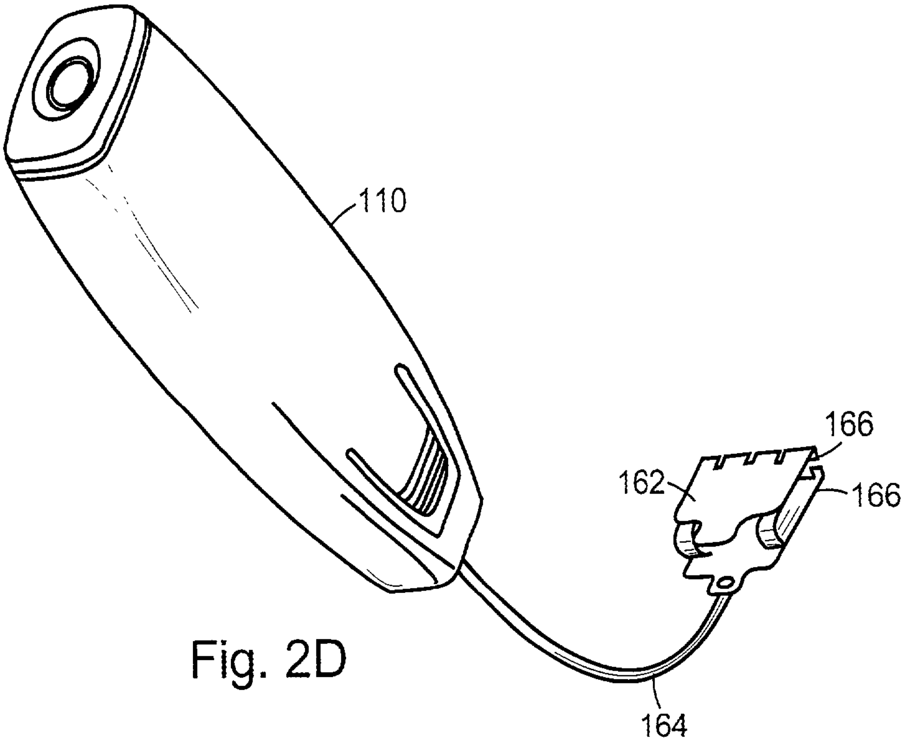


Fig. 2D

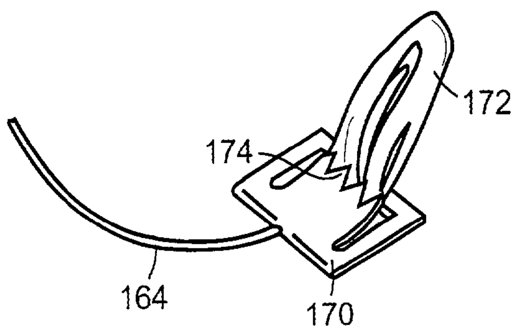


Fig. 2E

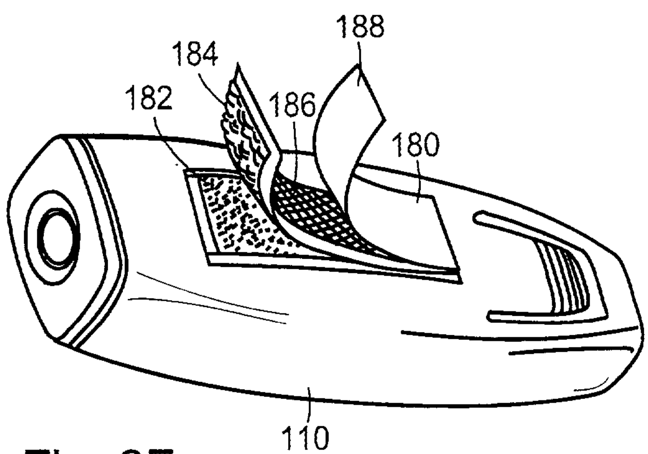


Fig. 2F

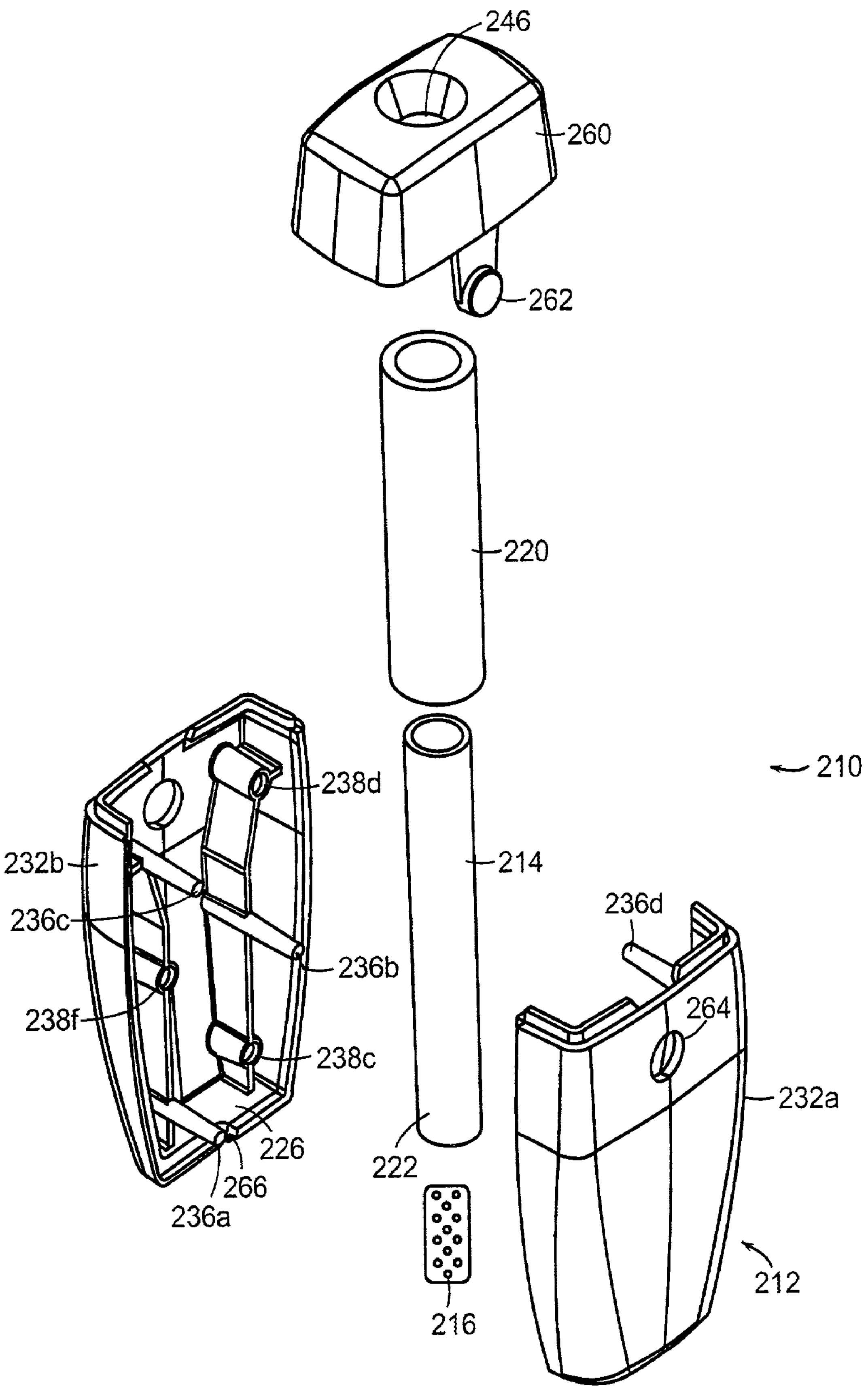

246
260
262
220
210
238d
232b
214
236c
236d
236b
264
238f
238c
232a
226
222
266
236a
212
216

Fig. 3A

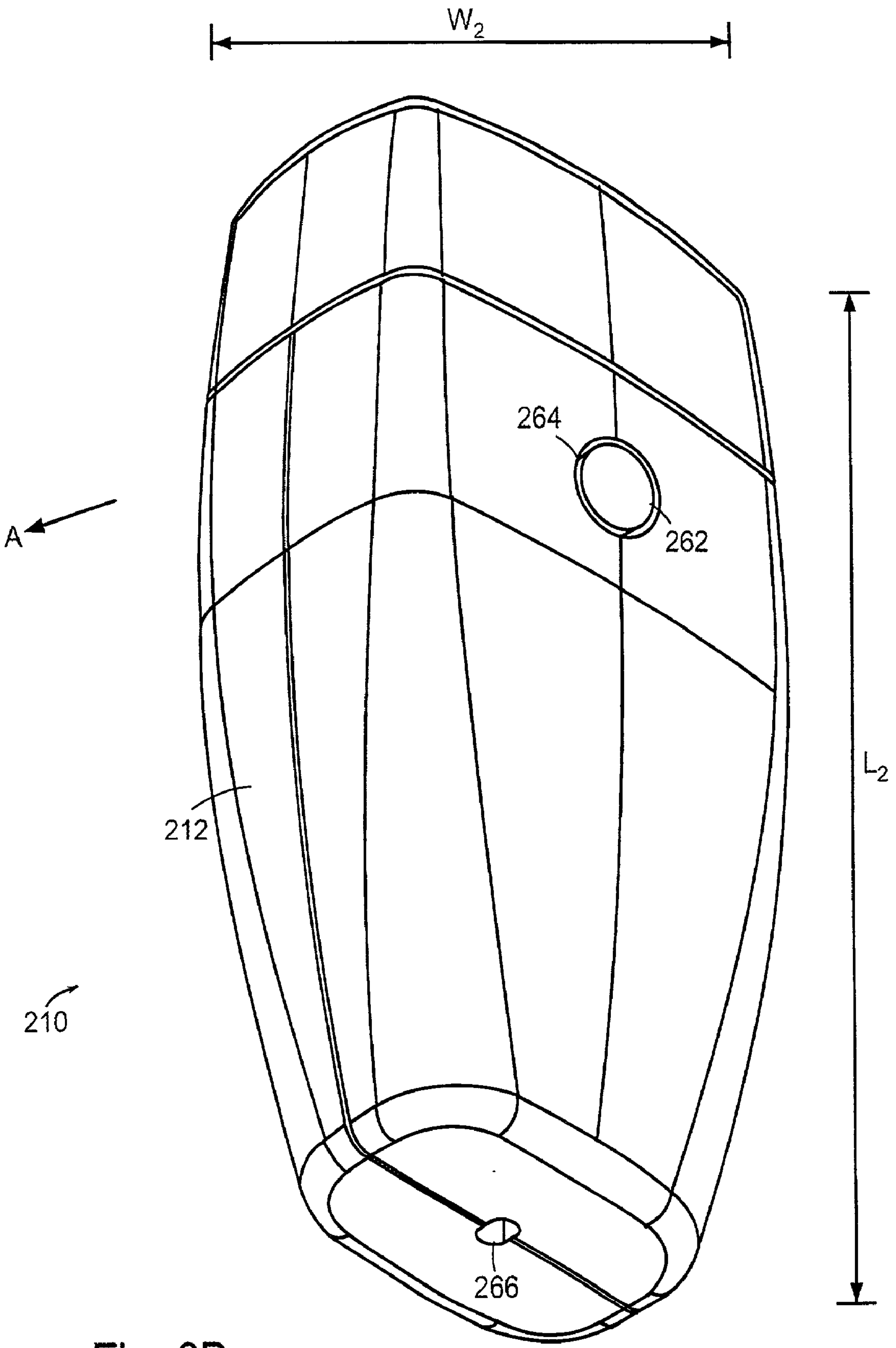


Fig. 3B

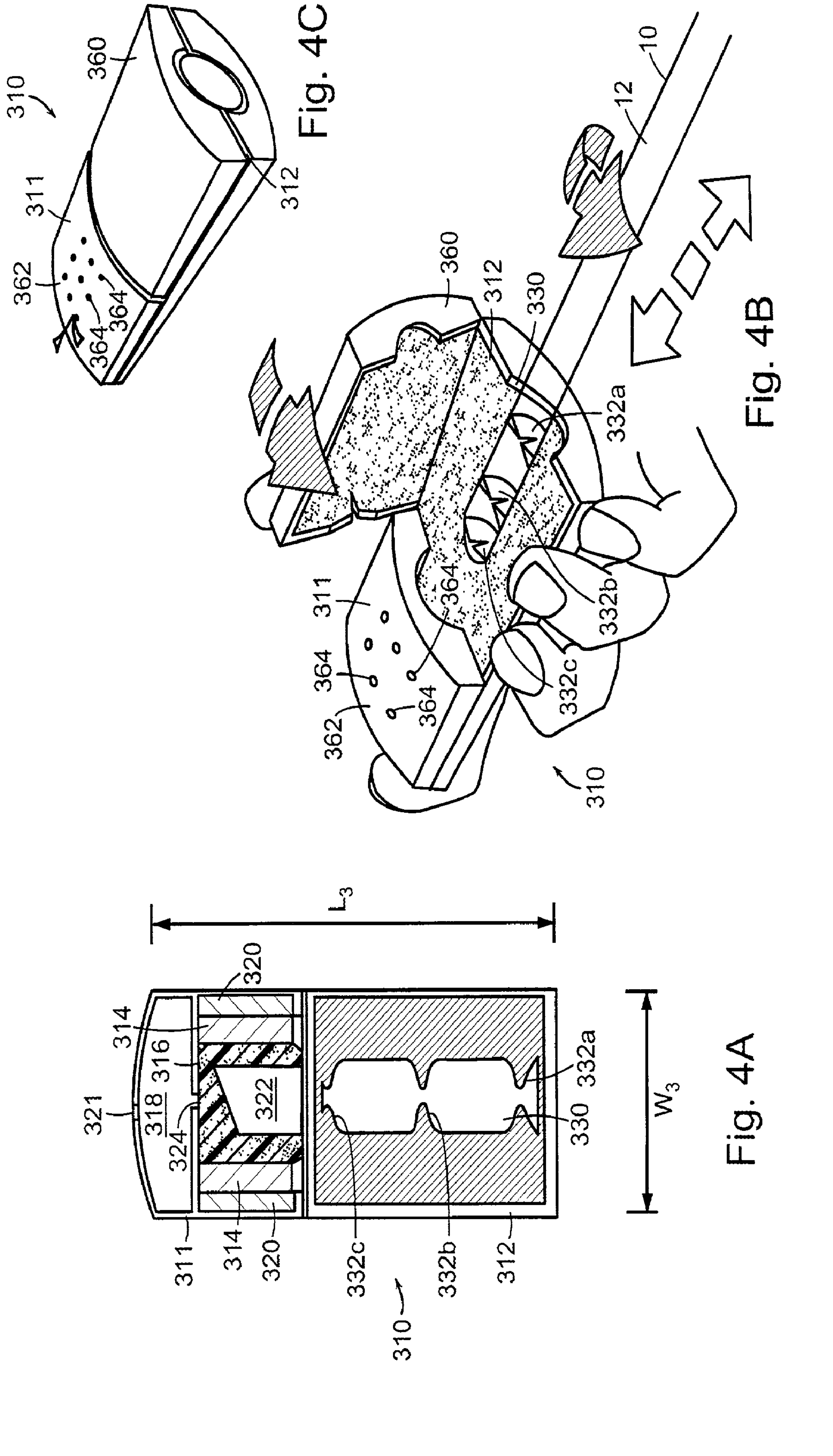


Fig. 4C

Fig. 4B

Fig. 4A

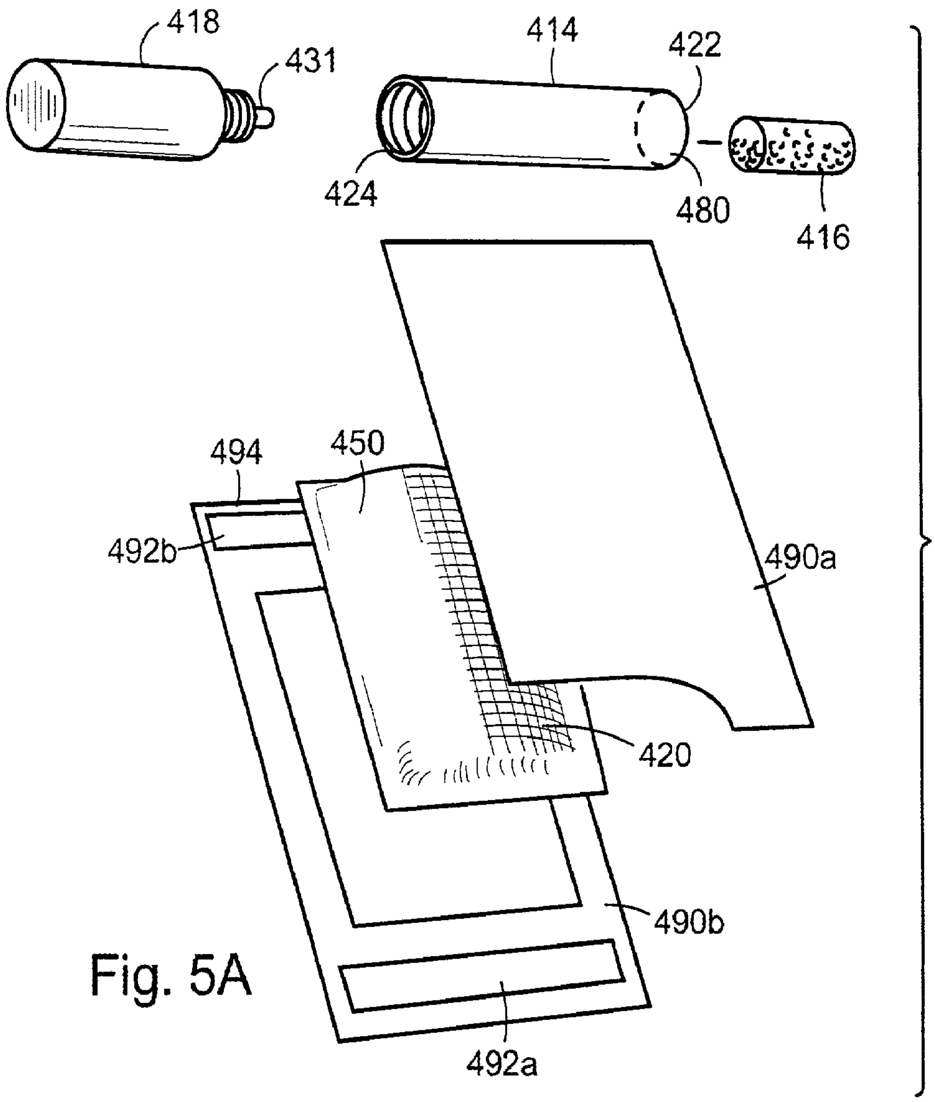

418
431
414
422
424
480
416
450
494
492b
490a
420
490b
492a

Fig. 5A

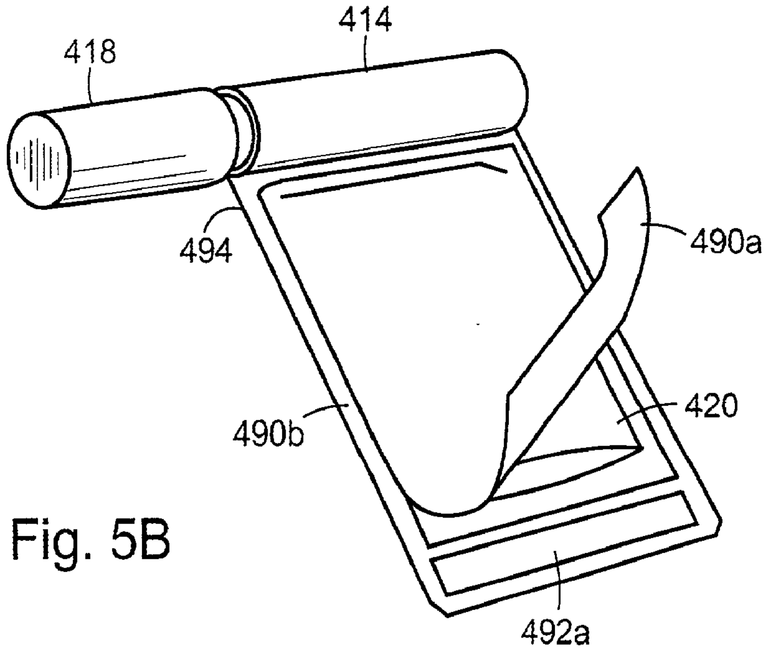

418
414
494
490a
490b
420
492a

Fig. 5B

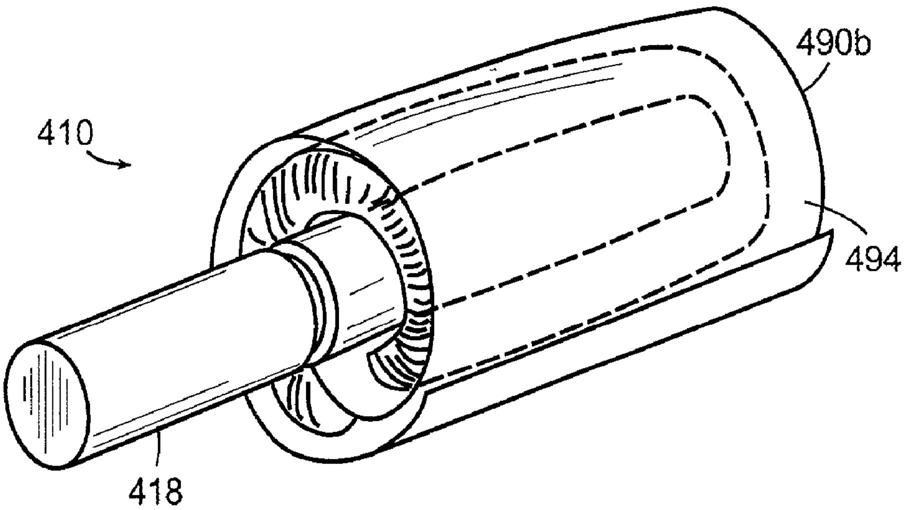


Fig. 5C

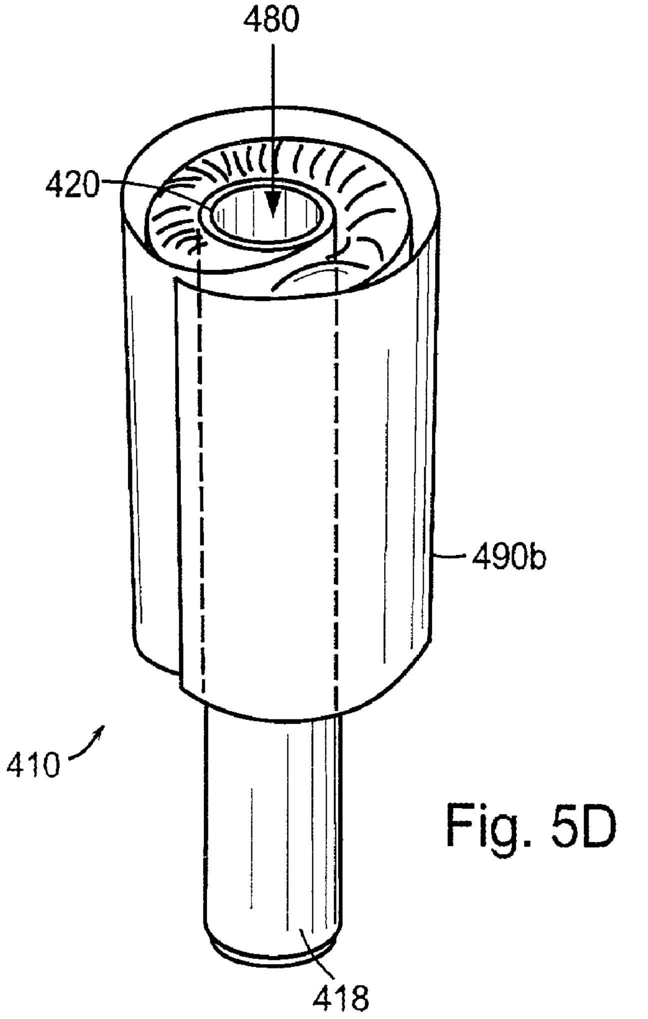


Fig. 5D

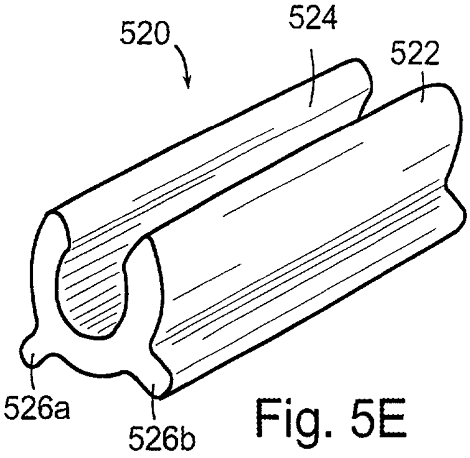


Fig. 5E

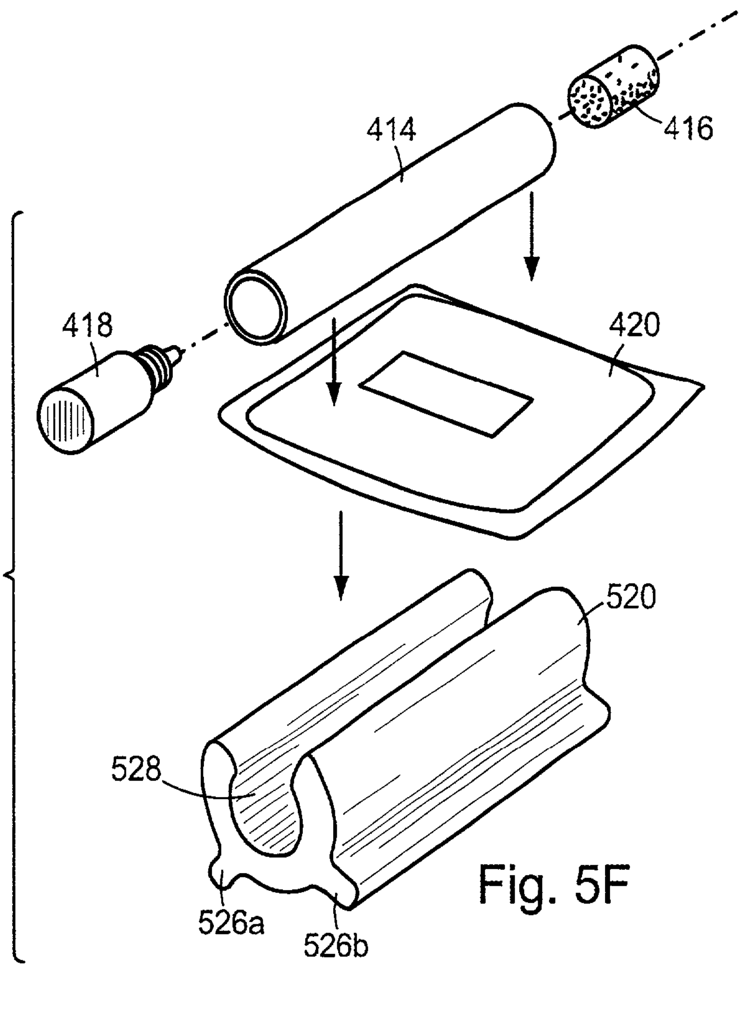


Fig. 5F

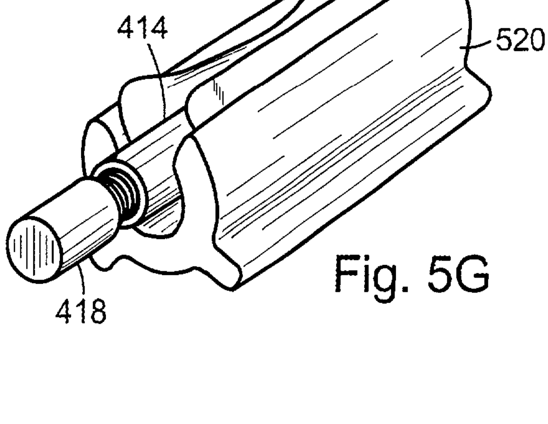


Fig. 5G

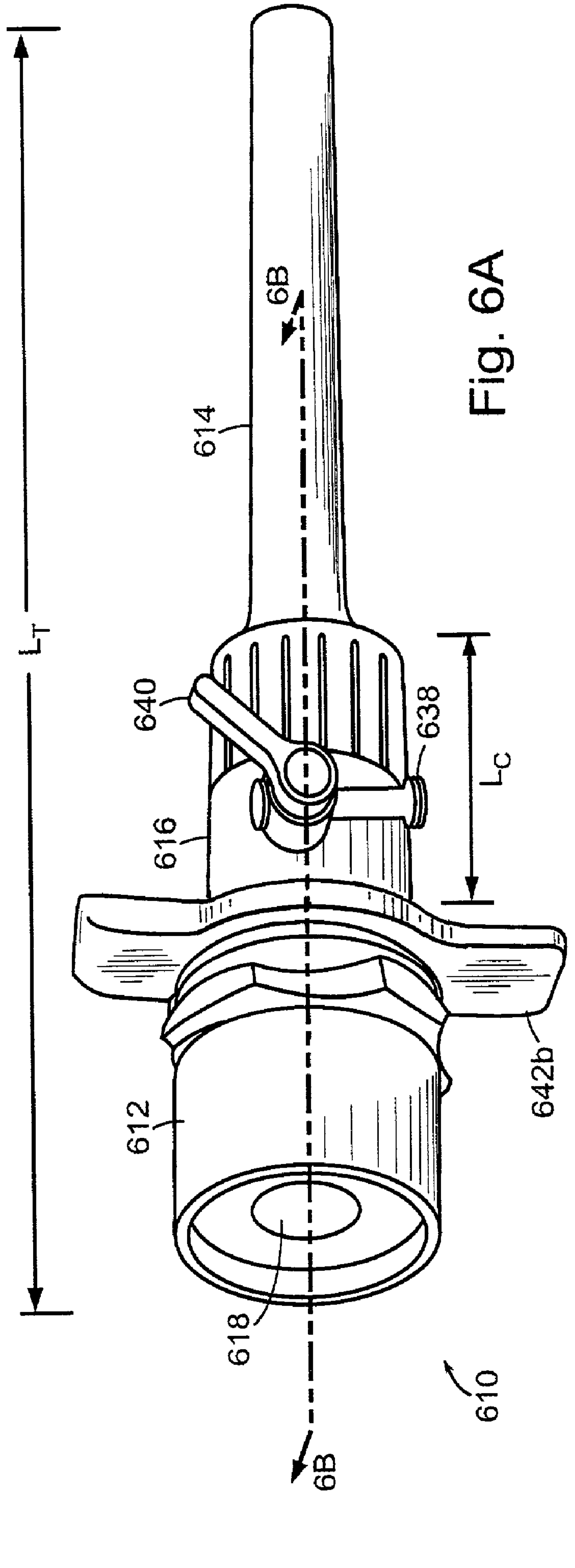


Fig. 6A

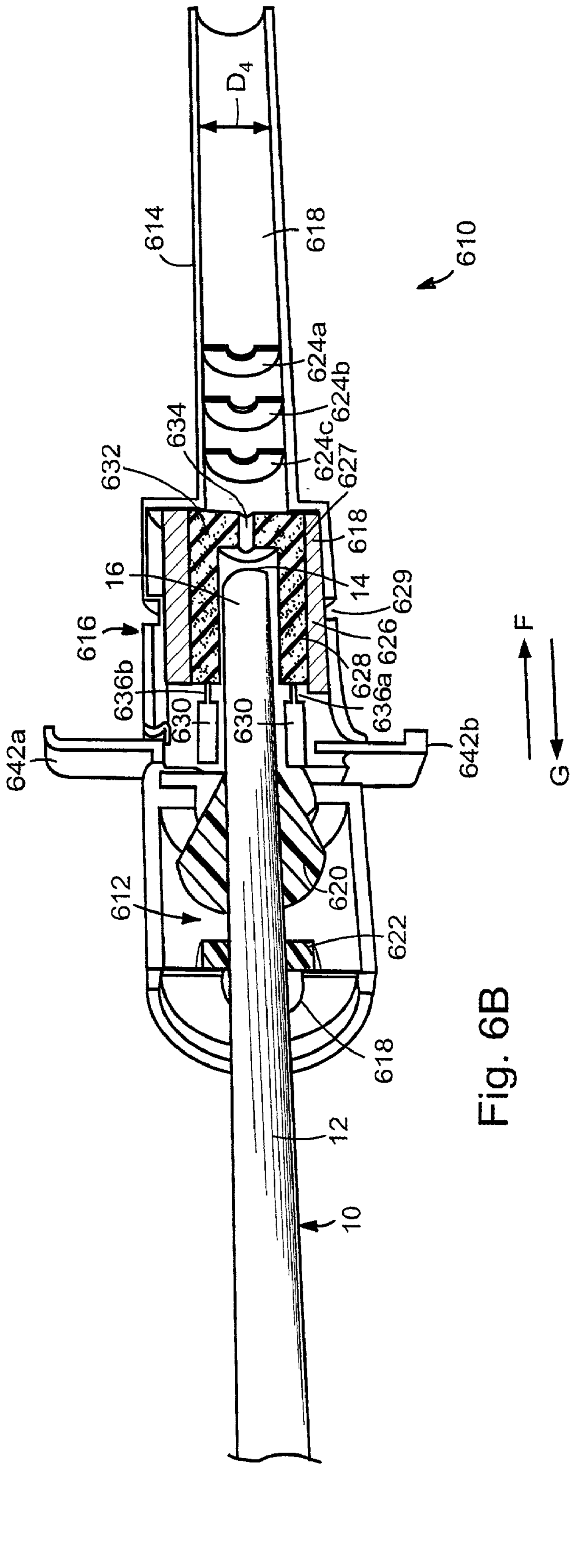

D4
614
618
610
624a
624b
624c
627
634
632
618
16
14
629
616
626
628
636b
636a
630
630
642a
642b
F
G
612
620
622
618
12
10

Fig. 6B

DEVICES AND METHODS FOR WARMING AND CLEANING LENSES OF OPTICAL SURGICAL INSTRUMENTS

CROSS-REFERENCES TO RELATED APPLICATION

[0001] This application claims priority from U.S. provisional Application Ser. No. 60/183,467 filed on Feb. 18, 2000, which is incorporated herein by reference in its entirety.

FIELD OF THE INVENTION

[0002] The invention relates to devices used to warm and clean optical surgical instruments, such as laparoscopes or endoscopes.

BACKGROUND OF THE INVENTION

[0003] In minimally invasive surgical procedures, surgical operations are performed using elongated instruments introduced through one or more small incisions. To allow a surgeon to visualize the operating field, an elongated lens and lighting system, such as a laparoscope or an endoscope, is inserted into the operating field through a separate small incision. The optical instrument's lens is typically coupled to a camera head that relays the scope's image to a television monitor. Since the monitor provides the surgeon's only view of the operating field, a clear, well-defined image is essential.

[0004] A common problem in minimally invasive surgical procedures is fogging of the lens on the laparoscope or endoscope. When a lens is inserted into a body cavity, e.g., an insufflated abdomen, the lens is at room temperature. The body cavity, however, is saturated with water vapor escaping from internal tissue and organs. Since the water vapor is typically at or near body temperature, microdroplets of water condense on the colder scope lens, obscuring the surgeon's view of the operating field. When the lens fogs, the surgeon must remove the instrument, clean the lens, and then reinsert the instrument into the operating field, where fogging begins again.

[0005] To combat fogging, surgeons often warm the optical instrument by partly immersing the instrument in a warm saline bath both before surgery and during each cleaning. Immersing the instrument can be time consuming, however, since the surgeon must wait for the bath to warm the instrument to a temperature warm enough to prevent condensation, e.g., 37-60° C. In addition, the temperature of saline baths can be difficult to control.

[0006] In addition to fogging, a surgeon's view of the operating field can be obscured by bodily fluids, such as blood and tissue collecting on the lens of the optical instrument. Like fogging, covering of the lens with blood or tissue requires that the surgeon remove and clean the instrument, which can cool the instrument and accelerate fogging.

SUMMARY OF THE INVENTION

[0007] The invention relates to devices that both warm and clean only the lens and/or distal portion of an optical instrument, e.g., a laparoscope or endoscope, during minimally invasive surgery. Since the devices warm and clean only the lens bearing distal portion of the instrument, they are compact and inexpensive, and they warm the lens more quickly than a saline bath. The devices can be self-contained units, or can be incorporated into a cannula of a trocar-cannula system.

[0008] In general, in one aspect, the invention features a lens warming and cleaning device for use with an optical instrument that has a lens portion. The device includes a heat-conducting tube sized and shaped to receive the lens portion of the optical instrument, a heating element thermally coupled to an exterior of the tube, and a cleaning member disposed within the tube. The cleaning member is disposed such that when the lens portion of the optical instrument is inserted into the tube, the lens portion contacts the cleaning member.

[0009] Embodiments of this aspect of the invention can include one or more of the following features. The heat conducting tube can be sized and shaped to receive the lens portion of a laparoscope or an endoscope, and the tube can be constructed from aluminum.

[0010] The heating element can include a substance that, when triggered, generates an exothermic reaction. For example, the substance can be a mixture of compounds that generates an exothermic reaction triggered by exposure to oxygen. The heating element can generate sufficient heat to warm the lens portion of the optical instrument to between about 45° C. and 60° C.

[0011] The heating element can be a flexible pad that surrounds at least a portion of the tube that receives the lens portion of the optical instrument. The pad can include an attachment mechanism, such as an adhesive, that secures the pad around the tube.

[0012] The cleaning member can be a sponge disposed within a distal end of the tube. The device can also include a moistening mechanism, such as a squeezable liquid bottle, that moistens the sponge. The liquid bottle can contain a saline solution with an additive such as an anti-fogging additive or a surfactant.

[0013] The device can further include a housing that encases the tube and the heating element. The housing can define an opening configured for insertion of the lens portion of the optical instrument.

[0014] In another aspect, the invention features a method of warming and cleaning a lens of an optical instrument. The method includes: (a) obtaining the warming and cleaning device described above; (b) withdrawing the optical instrument from an operating field; (c) inserting a lens portion of the optical instrument into the tube such that the lens contacts the cleaning member; and (d) moving the lens while the lens is in contact with the cleaning member to remove fog and debris from a surface of the lens.

[0015] Embodiments of this aspect of the invention can include one or more of the following features. The inserting step can include inserting only a distal, lens-bearing portion of the optical instrument into the tube.

[0016] The method can further include removing the optical instrument from the tube, reintroducing the optical instrument into the operating field, and then repeating the withdrawing, inserting, and removing steps when the lens portion again requires cleaning.

[0017] In another aspect, the invention features a lens warming device that includes a heat-conducting tube sized and shaped to receive a lens bearing portion of an optical surgical instrument, an absorbent member disposed within the tube, and a heating element thermally coupled to the tube.

[0018] In another aspect, the invention features a cannula that includes a body that has a distal end and a proximal end, and that defines a bore for passage of an optical instrument therethrough. Disposed within the bore is a cleaning portion. The cleaning portion has a cleaning member and a heating element. The cleaning member is positioned in the bore such that when the optical instrument is passed through the bore, a lens of the instrument contacts the cleaning member, and the heating element is positioned such that it thermally couples to the lens when the lens is within the bore.

[0019] Embodiments of this aspect of the invention can include one or more of the following features. The cleaning member can be a sponge, and the cannula can further include a wetting mechanism, such as a fluid reservoir, arranged to moisten the sponge. The heating element can be a substance that, when triggered, generates an exothermic reaction. The heating element can surround the cleaning member.

[0020] In another aspect, the invention features a method of cleaning a lens on an optical surgical instrument. The optical surgical instrument has a distal portion that includes the lens, and the method includes: (a) providing the cannula described above; (b) inserting the distal end of the cannula into a surgical field; (c) passing the distal portion of the optical surgical instrument through the bore of the cannula, into the operating field, and, when the lens becomes covered with fog, fluid, or tissue; (d) withdrawing the distal portion of the instrument from the surgical field into the cleaning portion of the cannula, such that the lens contacts the cleaning member; (e) moving, e.g., rotating, the lens while the lens is in contact with the cleaning member to clean the lens; and (f) reintroducing the distal portion of the instrument into the surgical field.

[0021] Different aspects of the invention may include one or more of the following advantages. The self-contained devices are inexpensive to manufacture and sterilize using standard techniques, and can be discarded after a surgical procedure. The devices that use an exothermic chemical heating pad do not require an external power source or a battery, and provide sufficient heat for a sufficient length of time, e.g., for two, four, or six hours or more. The self-contained devices can be pre-assembled. The cannula that includes an integrated cleaning device obviates fully removing the optical instrument from the operating field for cleaning.

[0022] As used herein, the term "optical surgical instrument" or "optical instrument" means any instrument used to view an internal portion of a body during a surgical or diagnostic procedure.

[0023] Two items that are "thermally coupled" are arranged such that heat can flow from one item to the other. For example, a heating element is thermally coupled to a metal tube if the tube and the heating element are in direct contact, or are in sufficiently close proximity to allow the heating element to heat the tube. The heating element and tube would also be thermally coupled if heat flows from the heating element to the tube through an intermediary heat sink or other heat transfer medium, such as liquid, or heat transfer system.

[0024] Unless otherwise defined, all technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this invention belongs. Although methods and materials similar or equivalent to those described herein can be used in the practice or testing of the present invention, suitable methods and materials are described below. All publications, patent applications, patents, and other references mentioned herein are incorporated by reference in their entirety. In case of conflict of terminology, the present specification, including definitions, will control. In addition, the materials, methods, and examples are illustrative only and are not intended to be limiting.

[0025] Other features and advantages of the invention will be apparent from the following detailed description, and from the claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0026] **FIG. 1A** is a perspective view of a laparoscope, with an associated camera and video coupler.

[0027] **FIG. 1B** is an enlarged, perspective view of a distal portion of the laparoscope of **FIG. 1A**.

[0028] **FIG. 2A** is an exploded view of a lens warming and cleaning device.

[0029] **FIGS. 2B and 2C** are perspective views of the device of **FIG. 2A**.

[0030] **FIG. 2D** is a perspective view of the device of **FIG. 2A** with a spring clip attached.

[0031] **FIG. 2E** is a perspective view of a drapery grabber for use with the device of **FIG. 2A**.

[0032] **FIG. 2F** is a perspective view of the device of **FIG. 2A** with a hook and loop fastener assembly for attaching the device to a surgical table.

[0033] **FIG. 3A** is an exploded view of a second lens warming and cleaning device.

[0034] **FIG. 3B** is a perspective view of the device of **FIG. 3A**.

[0035] **FIG. 4A** is a sectional view of a third lens warming and cleaning device.

[0036] **FIG. 4B** is a perspective view of the device of **FIG. 4A**, showing the device's hinged top open, and illustrating use of the device.

[0037] **FIG. 4C** is a perspective view of the device of **FIG. 4A**, showing the device's hinged top closed.

[0038] **FIG. 5A** is an exploded view of a fourth lens warming and cleaning device.

[0039] **FIG. 5B** is a perspective view of the device of **FIG. 5A**, illustrating assembly of the device.

[0040] **FIGS. 5C and 5D** are perspective views of the device of **FIG. 5A**, showing the device fully assembled.

[0041] **FIG. 5E** is a perspective view of a shell for containing the device of **FIG. 5A**.

[0042] **FIG. 5F** is an exploded view of the device of **FIG.** 5A and the shell of **FIG.** 5E, showing insertion of the device into the shell.

[0043] **FIG. 5G** is a perspective view of the device of **FIG. 5A** fully inserted into the shell of **FIG. 5E**.

[0044] **FIG. 6A** is a perspective view of a trocar that includes an integrated lens warming and cleaning compartment.

[0045] **FIG. 6B** is a sectional view of the trocar of **FIG.** 6A, taken along the line B-B of **FIG. 6A**.

DETAILED DESCRIPTION

[0046] The new warming and cleaning devices are used with standard optical instruments. Referring to **FIG. 1A, a** typical laparoscope system **8** includes a laparoscope **10**, a video coupler **20**, a camera **22**, and a video display (not shown). Laparoscope **10** includes a shaft **12**, a lens **14**, a light source input coupler **15**, and a proximal end **18** for coupling to the camera.

[0047] **FIG. 1B** provides an enlarged view of a distal portion **16** of shaft **12**, and illustrates the positioning of lens **14** within the laparoscope. As shown in **FIG.** 1B, lens **14** is located in the center of shaft **12**, and is surrounded by an end plate **24** and a fiber optic ring **26**. An epoxy potting material **28** separates end plate **24** from fiber optic ring **26**, and separates the fiber optic ring from the stainless steel shell **30** of shaft **12**. The potting material **28** tends to thermally isolate lens **14** from shell **30** of shaft **12**. Distal portion **16** has an overall diameter D_1.

[0048] In operation, video coupler **20** is attached to proximal end **18** of laparoscope **10**, allowing camera **22** to receive images from lens **14**. A cable **32** connects camera **22** to the video display (not shown). During surgery, laparoscope **10** is inserted, distal portion **16** first, into an intracorporeal operating field, such as an insufflated abdomen. Laparoscope **10** delivers images of the operating field captured by lens **14** to camera **22**, and ultimately to the video display, allowing a surgeon to visualize the field. Endoscopes and other optical instruments have similar features.

[0049] The new devices for warming and cleaning lens **14** of laparoscope **10** (or similar optical instruments) can be compact, self-contained units, or can be integrated into a trocar-cannula system. In either case, they can be manufactured using standard medical device manufacturing technologies. The devices can be manufactured under sterile conditions, or can be sterilized after manufacture and before or after packaging using standard techniques.

[0050] Self-Contained Warming and Cleaning Devices

[0051] **FIGS.** 2A to 5F illustrate four different embodiments of the new compact, self-contained devices for warming and cleaning lens **14** of laparoscope **10** or other optical instruments.

[0052] Referring to **FIGS. 2A** to 2C, a device **110** includes a housing **112**, a heat-conducting tube **114**, a sponge **116**, a squeezable container or bottle **118**, and a heating element such as a heating pad **120**. Tube **114** has an open proximal end **122**, an open distal end **124**, and an internal diameter D_2. Diameter D_2 is slightly larger than diameter D_1 of distal portion **16** of laparoscope **10**, so that tube **114** can receive distal portion **16**.

[0053] Distal end **124** is attached to bottle **118**, and proximal end **122** is attached to a stem **126** on housing **112**. Distal end attaches to bottle **118** via complementary screw threadings **128** (inside tube **114**) and **130** (on bottle **118**). Alternatively, bottle **118** and distal end **124** can be attached by an interference or press fit, using, e.g., an O-ring. Proximal end **122** is similarly attached to stem **126** using, e.g., complementary screw threadings, an insert mold, or an interference fit.

[0054] Sponge **116** is disposed within tube **114**, near distal end **124**. Sponge **116** is held snugly within tube **114** by, e.g., glue, grooves, or intrusions within tube **114**, or an interference or press fit. A dispensing tip **131** of bottle **118** rests against sponge **116**.

[0055] Housing **112** includes opposing sides **132***a*, **132***b*, a base **134**, and stem **126**. Opposing sides **132***a*, **132***b* are held together by, e.g., interference fits between plugs **136***a*, **136***b* and plug receivers **138***a*, **138***b*, respectively. Base **134** defines a circular opening **140** that has a diameter D_3 approximately equal to or slightly larger than internal diameter D_2 of tube **114**. Opening **140** leads to the interior of tube **114** via a bore **142** in stem **126**. Bore **142**, like opening **140** and tube **114**, has a diameter slightly larger than diameter D_1 of distal portion **16**.

[0056] Opposing sides **132***a*, **132***b* of housing **112** define slits **144***a*, **144***b* respectively. Slits **144***a*, **144***b* allow a surgeon to squeeze bottle **118**. Bottle **118** is filled with a cleaning liquid, e.g., water or a biocompatible saline solution. The solution can also contain an anti-fogging element or a surfactant. When the surgeon squeezes bottle **118**, the bottle dispenses the saline solution to, moisten sponge **116**.

[0057] Heating pad **120** in this embodiment includes a flexible, air-permeable outer bag **146** that encases a chemical mixture. The chemical mixture, when activated, generates an exothermic reaction. The chemical mixture can be, e.g., a mixture of iron powder, water, cellulose, vermiculite, activated carbon, and salt. Exposing the mixture to atmospheric oxygen triggers an exothermic reaction that warms pad **120** to a temperature of about 60° C., and sustains that temperature for about six hours.

[0058] Other types of known exothermic reaction mixtures can be used. For example, the mixture can consist of iron powder, a chloride or sulfate of a metal having a tendency of ionization greater than iron, active carbon, and water. See, e., Yamashita et al., U.S. Pat. No. 3,976,049. Alternatively, the chemical mixture can be a super-cooled, supersaturated aqueous solution of sodium acetate. See, e.g., Stanley et al., U.S. Pat. No. 4,077,390. Pad **120** can also employ other types of exothermic chemical reactions to generate heat, or it can include a resistance heater powered by, e.g., a battery or an external source of electricity.

[0059] Pad **120** is wrapped around tube **114** inside of housing **112**. Pad **120** can be attached to tube **114** using any standard fastening methods, e.g., glue. Alternatively, pad **120** can be secured to tube **114** by attaching opposite ends **148***a*, **148***b* of pad **120** together using, e.g., an adhesive or hook and loop fasteners, after wrapping pad **120** around tube **114**.

[0060] Device **110** is assembled by first attaching tube **114** to stem **126**. Sponge **116** is then inserted into distal end **124** of tube **114**, and bottle **118** is attached to distal end **114** by engaging screw threads **130** with threads **128**. Heating pad **120** is removed from a protective seal, and wrapped around tube **114**. Pad **120** is secured to tube **114** using, e.g., an adhesive, hook and loop fasteners, sleeves, or a rubber band. Sides **132***a*, **132***b* of housing **112** are then snapped together by engaging plugs **136***a*, **136***b* with plug receivers **138***a*, **138***b*. The entire device **110** is then quickly sealed in a cellophane wrapper (or other suitable, air tight container) to prevent oxygen from reaching pad **120** and continuing the exothermic reaction. Device **110** is generally pre-assembled and pre-sealed at manufacture. To prevent any oxygen from reaching pad **120** during assembly, device **110** can be assembled in, e.g., a nitrogen environment. However, so long as device **110** is sealed in cellophane shortly after pad **120** is removed from its own protective wrapper, a pure nitrogen environment is not necessary.

[**0061**] Housing **112** can be made from, e.g., a hard, inexpensive plastic such as polyethylene or polypropylene. Tube **114** is made from, e.g., aluminum, or some other heat-conducting material. Sponge **116** can be, e.g., porous polyethylene, urea formaldehyde, or other suitable porous material. Alternatively, sponge **116** can be replaced by other types of cleaning members, including other absorbent materials, such as cotton, or a jet spray system. Squeezable bottle **118** can be a suitable plastic, off-the-shelf liquid dispenser.

[**0062**] Device **110** has an overall length L_1 of, e.g., about 5.0-5.5 inches, and an overall width W_1 of, e.g., about 1.0-1.75 inches. Diameters D_1, D_2, and D_3, are, e.g., about 0.4 inches, 0.5 inches, and 0.5 inches respectively. The dimensions of different components in device **110** can be altered to accommodate different types of optical surgical instruments. For example, opening **140**, bore **142**, and tube **114** need not be cylindrical. The dimensions can also be adjusted to accommodate optical surgical instruments other than those used in minimally invasive procedures.

[**0063**] Device **110** can be used to warm and clean laparoscope **10** in the following manner. First, at the beginning of the surgical procedure, a surgeon or an assistant removes device **110** from its cellophane wrapper, allowing oxygen to reach pad **120** and trigger the exothermic reaction. Sponge **116** is moistened by squeezing bottle **118** to dispense liquid through tip **131** to sponge **116**. Laparoscope **10** is then pre-warmed by inserting distal portion **16** of the scope into device **110** through hole **140** and bore **142**, until lens **14** abuts sponge **116**. Laparoscope **10** is left inside device **110** until the surgeon is ready to insert the scope into the patient.

[**0064**] During a surgical or diagnostic procedure, when lens **14** of laparoscope **10** becomes fogged or covered with fluid or tissue, the surgeon removes the laparoscope from the patient and inserts distal portion **16** of laparoscope **10** through hole **140** and bore **142**, until lens **14** abuts sponge **116**. The surgeon then gently rubs lens **14** against sponge **116**, e.g., by rotating laparoscope **10** about its longitudinal axis, to clean and warm lens **14**. Contacting lens **14** against sponge **116** for about 5-60 seconds, e.g., 15-30 seconds will warm lens **14** to a temperature of, e.g., about 45-60° C., a temperature warm enough to prevent condensation, but not so hot that tissue is damaged.

[**0065**] After cleaning, the surgeon withdraws laparoscope **10** from device **110** and reintroduces laparoscope **10** into the intracorporeal operating field. The process can be repeated each time lens **14** becomes fogged or dirty. If necessary, sponge **116** can be re-wetted by again squeezing bottle **118**.

[**0066**] Referring to **FIGS. 2D** to 2F, to simplify access to device **110** during surgery, the device can be attached to a surgical drape, a tray, or a table using, e.g., a clip or hook and loop fasteners. Referring first to **FIG. 2D, a** spring clip **162** is attached to device **110** by a tether **164**. The clip **162** includes teeth **166** for gripping surgical drapery. Referring to **FIG.** 2E, rather than a clip, a drape grabber **170** can be attached to the device. In use, a portion of the drapery **172** is drawn through grabber **170**, so that the grabber's teeth **174** hold the drapery fold **172** in place. Referring to **FIG. 2F, a** hook and loop assembly **180** can be used to attach the device to an operating table. The assembly **180** includes a hook sheet **182** attached to device **110**, and a loop sheet **184**. Loop sheet **184** has an adhesive backing **186** for attaching the loop sheet to an operating table. A cover **188** covers adhesive backing **186** prior to use. In use, cover **188** is removed from loop sheet **184**, and adhesive backing **186** is attached to the table. During surgery, device **110** can be attached to the table by coupling hook sheet **182** to loop sheet **184**.

[**0067**] Device **110** can also be modified in other ways. For example, moistening mechanisms other than a squeezable bottle, e.g., a fluid reservoir built into the device can be used to wet sponge **116**. Heating pad **120** can be replaced by other types of heating elements, including resistance powered heaters thermally coupled to heat conducting tube **114**.

[**0068**] **FIGS. 3A and 3B** illustrate a second lens warming and cleaning device that has a three piece housing with an easily removable top, and no integrated saline bottle. Referring to **FIGS. 3A and 3B**, device **210** includes a housing **212**, a heat-conducting tube **214**, a sponge **216**, and a heating pad **220**. Tube **214**, sponge **216**, and pad **220** are similar to tube **114**, sponge **116**, and pad **120** described above. Housing **212** has three components: sides **232***a* and **232***b*, and top **260**. Sides **232***a*, **232***b* attach together by engaging plugs **236***a*, **236***b*, **236***c*, **236***d*, and two additional plugs (not shown), with plug receivers **238***d*, **238***e*, **238***f*, and three additional plug receivers (not shown). Unlike housing **112**, housing **212** does not include a stem **126** for engaging a proximal end **222** of tube **214**. Instead, proximal end **222** rests against a floor **226** of sides **232***a* and **232***b*.

[**0069**] Top **260** fits over sides **232***a* and **232***b*, and attaches to side **232***a* by engaging button **262** with button hole **264**. The engagement of button **262** with button hole **264** is easily reversible by simply pressing button **262** inward, in the direction of arrow A, as shown in **FIG. 3B**. Top **260**, therefore, can be easily removed, allowing replacement of individual components of device **210**, such as tube **214**, pad **220**, or sponge **216**. Device **210**, therefore, need not be entirely discarded when pad **220** loses its heat, or sponge **216** becomes inaccessible or dirty.

[**0070**] Device **210** does not include an integral solution bottle. Instead, floor **226** defines a liquid hole **266** in communication with sponge **216**. A user, therefore, can wet sponge **216** by squirting, pouring, or dripping liquid through hole **266**. Alternatively, device **210** can have a solid bottom (no hole **266**), and sponge **216** can be wetted by pouring liquid through hole **240**.

[**0071**] In operation, distal portion **16** of laparoscope **10** is inserted through opening **240** until lens portion **14** of the laparoscope abuts sponge **216**. The lens is then cleaned and warmed in the manner described above with reference to device **110**.

[0072] Device **210** has an overall length L_2 slightly shorter than length L_1 of device **110**, since device **210** lacks a solution bottle **118**. The width W_2 of device **210** is approximately equal to width W_1 of device **110**.

[0073] **FIGS. 4A** to 4C illustrate a third embodiment of the lens warming and cleaning device that includes separate wiping and cleaning compartments. Device **310** has a cleaning compartment **311** and a wiping compartment **312**. Cleaning compartment **311** includes a heating pad **320**, a sponge **316**, and a fluid reservoir **318**. A corked or otherwise re-sealable hole **321** allows access to reservoir **318**, so that fluid in the reservoir can be replenished.

[0074] Sponge **316** has a generally cylindrical shape, defining a bore **322** for receiving distal portion **16** of laparoscope **10**. A port **324** connects fluid reservoir **318** to sponge **316**, so that fluid from reservoir **318** keeps sponge **316** moist. Pressing distal portion **16** of scope **10** against sponge **316** draws fluid from reservoir **318** to sponge **316**, by capillary action. Heating pad **320** and sponge **316** are separated by a heat-conducting tube **314**.

[0075] Wiping compartment **312** defines a wiping groove **330**. Groove **330** includes rubber wipers **332***a*, **332***b*, and **332***c* for wiping fluid and tissue from shaft **12** of laparoscope **10**, as shown in **FIG. 4B**. Wiping compartment **312** includes a hinged top **360** that opens, providing access to wiping compartment **312**. Opening hinged top **360** allows a user to gain access to the interior of compartment **312**, e.g., to clean wipers **332***a*, **332***b*, and **332***c*.

[0076] A cover **362** for cleaning compartment **311** defines apertures **364**, which allow oxygen to reach heating pad **320**, triggering the exothermic reaction described above with reference to pad **120**.

[0077] Device **310** has an overall length L_3 slightly longer than devices **110** and **210**. Length L_3 is, e.g., about seven inches. Device **310** has an overall width W_3 similar to widths W_1 and W_2 of devices **100** and **210**.

[0078] FIGS. **5A-5G** illustrate a simplified, inexpensive warming and cleaning device **410** that lacks an enclosed external housing. Referring first to FIGS. **5A-5D**, device **410** includes a heat-conducting tube **414**, a sponge **416**, a squeezable saline bottle **418**, and heating pad **420**. Like tube **114** of FIGS. 2A-2C, tube **414** includes an open proximal end **422** and an open distal end **424**. Opening **480** of open proximal end **422** is sized and shaped to receive distal portion **16** of laparoscope **10**, and open distal end **424** is configured to attach to bottle **418**. Sponge **416** is disposed within tube **414**, near distal end **424**, touching a dispensing tip **431** of bottle **418**.

[0079] Unlike devices **110**, **210**, and **310**, the heating pad of device **410** is generally not attached to the device at the time of manufacture. Instead, the user attaches heating pad **420** immediately prior to use. Referring to **FIGS. 5A and 5B**, prior to assembly by a surgeon or an assistant, pad **420** is enclosed by two seals, **490***a* and **490***b*. Seals **490***a*, **490***b* are attached to each other by double-sided adhesive strips **492***a*, **492***b*.

[0080] Just before surgery, the surgeon or an assistant removes seal **490***a*, exposing air-permeable cover **450** of pad **420** to the air. Oxygen penetrates cover **450**, triggering the exothermic reaction described above with reference to pad **120**.

[0081] After removing seal **490***a*, the surgeon or assistant rolls pad **420** and seal **490***b* around tube **414**, as shown in **FIG. 5B**. As pad **420** and seal **490***b* are rolled around tube **414**, adhesive **492***b* attaches to tube **414**, and adhesive **492***a*, attaches to a far end **494** of seal **490***b*, trapping pad **420** in place against tube **414**.

[0082] The fully rolled device of **FIGS. 5C and 5D** is ready for immediate use. However, in some situations, it may be preferable to insert the rolled device **410** into a shell to stabilize pad **420** against tube **414** and shield the pad from the exterior. **FIGS. 5E** to 5G illustrate use of such a shell. Referring to **FIG. 5E, a** shell **520** has a generally cylindrical body **522**, an open top **524** and two wings **526***a*, **526***b*. Wings **526***a*, **526***b* prevent device **410** from rolling when the device is placed on a flat surface, such as an operating table. Shell **520** is made from a flexible material, e.g., polypropylene, allowing open top **524** to be expanded by pulling wings **526***a*, **526***b* apart.

[0083] Referring to **FIG.** 5F, the fully rolled device **410** is inserted into shell **520** by pulling wings **526***a*, **526***b* apart, and inserting device **410** into shell **520**'s cylindrical interior. Alternatively, Shell **520** can be made from a rigid plastic. In a rigid embodiment, rolled device **410** is inserted by sliding device **410** into an open end **528** of shell **520**. **FIG. 5G** shows device **410** fully inserted into shell **520**.

[0084] Seals **490***a*, **490***b* can be made from, e.g., foil, cellophane, or from thin sheets of plastic such as polyethylene or polypropylene, or polyvinylchloride. The remaining components of device **410** can be made from the same materials described above with reference to device **110**.

[0085] During surgery, device **410** is used in essentially the same manner as device **110**. When lens **14** of laparoscope **10** fogs or becomes dirty, the surgeon inserts distal portion **16** through opening **480**, into tube **414**, until lens **14** abuts sponge **416**. After cleaning and warming lens **14** against sponge **416**, the surgeon withdraws laparoscope **10** and reintroduces it into the intracorporeal operating field.

[0086] Warming and Cleaning Device Integrated into a Cannula

[0087] Trocar-cannula systems create channels for introducing instruments, such as laparoscope's or endoscopes, into an intracorporeal operating field. A trocar-cannula system includes a trocar, which is a sharp, pointed surgical instrument that punctures the body, and a cannula. The cannula has a distal end that enters the operating field through the hole formed by the trocar, and a proximal end that remains outside the body. The cannula defines a bore or channel that extends from an opening at the distal end to an opening at the proximal end. Other instruments, such as a laparoscope, are introduced into the surgical field through the channel in the cannula.

[0088] Referring to **FIGS. 6A and 6B**, a cannula **610** includes a proximal region **612**, a distal shaft **614**, and a cleaning compartment **616**. Proximal region **612**, cleaning compartment **616**, and distal shaft **614** all define a continuous longitudinal channel **618** for passing surgical instruments, e.g., laparoscope **10**, into an intracorporeal operating field.

[0089] Proximal region **612** includes a distal seal **620** and a proximal seal **622**. Distal seal **620** has a generally conical shape, and is oriented to remove fluid from shaft **12** of laparoscope **10** as laparoscope **10** is moved in the direction of arrow G. Proximal seal **622** has a generally circular shape, and acts to remove fluid and debris from shaft **12** as it is moved in the direction of either arrow F or arrow G. Proximal seal **622** can be, e.g., an O-ring. Seals **620** and **622** can be made from, e.g., silicone or various thermal-plastic rubbers.

[**0090**] Distal shaft **614** includes three interior wipers **624***a*, **624***b*, and **624***c*. Wipers **624***a*, **624***b*, and **624***c* wipe fluid and tissue from distal tip **14** as laparoscope **10** is pulled in the direction of arrow G.

[**0091**] Cleaning compartment **616** includes a heating pad **626**, a sponge **628**, and a fluid reservoir **630**. Sponge **628** has a generally cylindrical shape, surrounding distal portion **16** when the distal portion is inside compartment **616**. Sponge **628** includes a circular wall **632**. Wall **632** contacts lens **14** as distal portion **16** is moved in the direction of arrow F, out of cleaning compartment **616**. A slit **634** in wall **632** allows passage of shaft **12** into and out of cleaning compartment **616**.

[**0092**] Fluid reservoir **630** contains, e.g., a saline solution, and acts to keep sponge **628** moist. Ports **636***a*, **636***b* allow movement of fluid from reservoir **630** to sponge **628**.

[**0093**] Heating pad **626** is similar to the heating pads for the self-contained devices described above. Pad **626** surrounds sponge **628**, directly contacting an exterior of sponge **628**. To delay activation of pad **626** until surgery, pad **626** is sealed in a permeable membrane **627**. Immediately prior to surgery, membrane **627** is punctured by inserting a sharp instrument through access hole **629**, thereby exposing pad **626** to oxygen. Alternatively, instead of including a membrane **627**, the entire cannula **610** can be sealed in a cellophane wrapper prior to surgery, in the same manner device **110** is sealed.

[**0094**] Cannula **610** also includes an insufflation port **638** and stop cock **640**. Insufflation port **638** allows an inert gas to be pumped into an operating field, e.g., an abdominal cavity, to expand the field, making room for surgical instruments. Wings **642***a*, **642***b* on cannula **610** limit cannula **610**'s penetration into the patient.

[**0095**] Cannula **610** has an overall length L_T of about 6-12, e.g., 7, 8, 9, or 10 inches, and cleaning compartment **616** has a length L_C of about 2-5 inches, e.g., 2, 3, 4, or 5 inches. Channel **618** has an internal diameter D_4 slightly larger than diameter D_1 of shaft **12** of laparoscope **10**, e.g., 0.5-1.0 inches.

[**0096**] In use, membrane **627** of heating pad **626** is punctured, and distal shaft **614** is inserted into an intracorporeal operating space. If necessary, the operating field can be expanded using insufflation port **638**. Laparoscope **10** is then inserted into the operating field through bore **618**. When lens **14** of laparoscope **10** becomes fogged or dirty, distal portion **16** is withdrawn from the patient, in the direction of arrow G, until distal portion **16** is within cleaning compartment **616**, as shown in **FIG. 6B**. Moving distal portion **16** past wipers **624***a*, **624***b*, and **624***b* removes most fluid and tissue from portion **16**. Lens **14** is then cleaned and warmed by rubbing lens **14** against wall **632** of sponge **628**. Once clean, lens **14** is reintroduced into the patient through distal shaft **614**.

[**0097**] A number of features of cannula **610** can be varied. For example, a heat-conducting tube can be inserted between sponge **628** and pad **626**, in the manner described above with reference to the self-contained devices. Cleaning compartment **616** can be reduced in size, or can be disposed entirely within shaft **614**, thus reducing the length of the cannula protruding out of the body during use. Alternative mechanisms for wetting sponge **628** can be used, including an external squeezable bottle connected to sponge **628** through an opening in the cannula.

Other Embodiments

[**0098**] It is to be understood that while the invention has been described in conjunction with the detailed description thereof, the foregoing description is intended to illustrate and not limit the scope of the invention, which is defined by the scope of the appended claims. Other aspects, advantages, and modifications are within the scope of the following claims.

What is claimed is:

1. A lens warming and cleaning device for use with an optical instrument having a lens portion, the device comprising:

a heat-conducting tube sized and shaped to receive the lens portion of the optical instrument;

a heating element thermally coupled to the tube; and

a cleaning member disposed within the tube, such that when the lens portion of the optical instrument is inserted into the tube, the lens portion contacts the cleaning member.

2. The device of claim 1, wherein the heat conducting tube is sized and shaped to receive the lens portion of an optical instrument selected from the group consisting of a laparoscope and an endoscope.

3. The device of claim 1, wherein the tube is constructed from a material comprising aluminum.

4. The device of claim 1, wherein the heating element comprises a substance that, when triggered, generates an exothermic reaction.

5. The device of claim 4, wherein the substance comprises a mixture of compounds, and the exothermic reaction is triggered by exposing the substance to oxygen.

6. The device of claim 1, wherein the heating element comprises a flexible pad.

7. The device of claim 6, wherein the pad surrounds at least a portion of the tube that receives the lens portion of the optical instrument.

8. The device of claim 7, wherein the pad comprises an attachment mechanism, the attachment mechanism securing the pad to the tube.

9. The device of claim 8, wherein the attachment mechanism comprises an adhesive.

10. The device of claim 1, wherein the heating element generates sufficient heat to warm the lens portion of the optical instrument to between about 45° C. and 60° C.

11. The device of claim 1, wherein the cleaning member comprises a sponge.

12. The device of claim 11, wherein the sponge is disposed within a distal end of the tube.

13. The device of claim 11, further comprising a moistening mechanism that moistens the sponge.

14. The device of claim 13, wherein the moistening mechanism comprises a squeezable bottle containing a liquid.

15. The device of claim 14, wherein the liquid is a saline solution

16. The device of claim 15, wherein the saline solution comprises an anti-fogging agent, a surfactant, or both.

17. The device of claim 1, further comprising a housing that encases the tube and the heating element.

18. The device of claim 17, wherein the housing defines an opening configured for insertion of the lens portion of the optical instrument.

19. The device of claim 17, further comprising an attachment mechanism coupled to the housing, the attachment mechanism having a member configured to removably attach the device to a table or to a surgical drape.

20. The device of claim 19, wherein the member comprises a clip.

21. The device of claim 20, wherein the attachment mechanism further comprises a tether that connects the clip to the housing.

22. The device of claim 19, wherein the attachment mechanism comprises a hook and loop fastener system, the system having a first sheet attached to the housing, and a second sheet attached to a table or to a surgical drape, the first sheet comprising one of hooks or loops, and a second sheet comprising the other of hooks or loops.

23. A lens warming and cleaning device for use with an optical instrument having a lens portion, the device comprising:

a heat-conducting tube sized and shaped to receive the lens portion of the optical instrument;

a flexible heating pad wrapped around at least a portion of the tube, the heating pad comprising a substance that, when triggered, generates an exothermic reaction; and

a sponge disposed within a distal end of the tube, such that when the lens portion of the optical instrument is inserted into the tube, the lens portion contacts the sponge.

24. The device of claim 23, further comprising a wetting mechanism arranged to moisten the sponge.

25. A method of warming and cleaning a lens of an optical instrument, the method comprising:

obtaining the device of claim 1;

withdrawing the optical instrument from an operating field;

inserting a lens portion of the optical instrument into the tube such that the lens contacts the cleaning member; and

moving the lens while the lens is in contact with the cleaning member to remove fog and debris from a surface of the lens.

26. The method of claim 25, wherein the inserting step includes inserting only a distal portion of the optical instrument into the tube, the distal portion comprising the lens.

27. The method of claim 25, further comprising:

removing the optical instrument from the tube; and

reintroducing the optical instrument into the operating field, and then repeating the withdrawing, inserting, and removing steps when the lens portion again requires cleaning.

28. A cannula comprising:

a body having a distal end and a proximal end, the body defining a bore for passage of an optical instrument therethrough; and

a cleaning portion disposed within the bore between the distal end and the proximal end, the cleaning portion comprising a cleaning member and a heating element, wherein the cleaning member is positioned in the bore such that when the optical instrument is passed through the bore, a lens of the instrument contacts the cleaning member, and wherein the heating element is positioned such that it thermally couples to the lens when the lens is within the bore.

29. The cannula of claim 28, wherein the cleaning member comprises a sponge.

30. The cannula of claim 28, further comprising a wetting mechanism arranged to moisten the sponge.

31. The cannula of claim 30, wherein the wetting mechanism comprises a fluid reservoir in fluid communication with the sponge.

32. The cannula of claim 28, wherein the heating element comprises a substance that, when triggered, generates an exothermic reaction.

33. The cannula of claim 28, wherein the heating element surrounds the cleaning member.

34. A method of cleaning a lens on an optical surgical instrument, the optical surgical instrument having a distal portion that includes the lens, and the method comprising:

providing the cannula of claim 28;

inserting the distal end of the cannula into the operating field;

passing the distal portion of the optical surgical instrument through the bore of the cannula, into the operating field, and, when the lens becomes covered with fog, fluid, or tissue;

withdrawing the distal portion of the instrument from the surgical field into the cleaning portion of the cannula, such that the lens contacts the cleaning member;

moving the lens while the lens is in contact with the cleaning member to clean the lens; and

reintroducing the distal portion of the instrument into the surgical field.

35. The method of claim 34, wherein the cleaning member comprises a sponge.

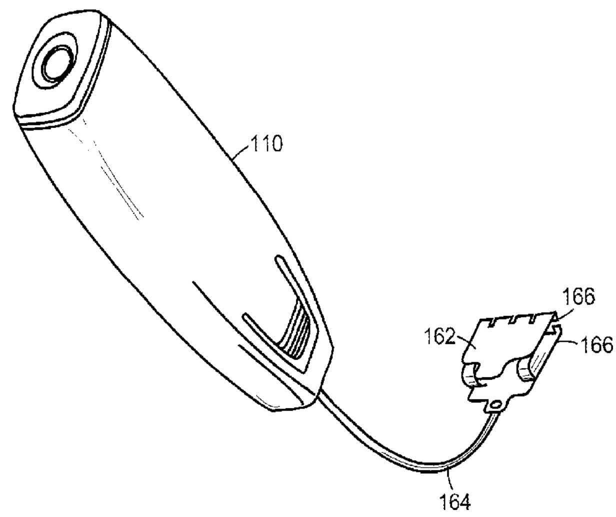
* * * * *

patsnap

专利名称(译)	用于加热和清洁光学手术器械的镜片的装置和方法		
公开(公告)号	US20020022762A1	公开(公告)日	2002-02-21
申请号	US09/788033	申请日	2001-02-16
[标]申请(专利权)人(译)	比恩RICHARD 利温德米特里 EK史蒂芬 NIEMANN ALLISON TAYLOR MELINDA		
申请(专利权)人(译)	比恩RICHARD 利温德米特里 EK史蒂芬 NIEMANN ALLISON TAYLOR MELINDA		
当前申请(专利权)人(译)	比恩RICHARD 利温德米特里 EK史蒂芬 NIEMANN ALLISON TAYLOR MELINDA		
[标]发明人	BEANE RICHARD LITWIN DEMETRIUS EK STEVEN NIEMANN ALLISON TAYLOR MELINDA		
发明人	BEANE, RICHARD LITWIN, DEMETRIUS EK, STEVEN NIEMANN, ALLISON TAYLOR, MELINDA		
IPC分类号	A61B1/00 A61B1/313 A61B17/34 A61B19/00		
CPC分类号	A61B1/122 A61B1/127 A61B1/313 A61B17/3421 A61B17/3462 A61B19/34 A61B2019/343 A61B1/00131 A61B1/128 A61B90/70 A61B2090/701		
优先权	60/183467 2000-02-18 US		
外部链接	Espacenet USPTO		

摘要(译)

公开了一种与光学手术器械一起使用的镜片加温和清洁装置。该装置包括导热管，其尺寸和形状适于容纳器械的透镜部分，加热元件热耦合到管的外部，以及清洁构件，其设置在管内。清洁构件设置成使得当仪器的镜头部分插入管中时，镜头部分接触清洁构件。


110
166
162
166
164