United States Patent

Reick

[15] **3,638,644**

[45] **Feb. 1, 1972**

[54] ILLUMINATED SURGICAL SPECULUM

[72] Inventor: **Franklin G. Reick,** Westwood, N.J.

[73] Assignees: **Michael Elbert,** Mamaroneck, N.Y.; **Frederick R. Picut,** Mountainside; **Franklin G. Reick,** Westwood, N.J.; **Joseph R. Wilder,** New York, N.Y. , part interest to each

[22] Filed: **Mar. 5, 1969**

[21] Appl. No.: **804,530**

[52] **U.S. Cl.** **128/16**

[51] **Int. Cl.** **A61b 1/06**

[58] **Field of Search** 128/6, 11, 16, 18

[56] **References Cited**

UNITED STATES PATENTS

3,384,076	5/1968	Speelman	128/9
3,417,745	12/1968	Sheldon	128/6
2,885,537	5/1959	Wood, Jr.	128/16 X
1,246,339	11/1917	Smit	128/16
2,186,143	1/1940	Neugass	128/16 X
2,247,258	6/1941	Shepard	128/16
2,289,226	7/1942	Von Foregger	128/11 UX
3,426,749	2/1969	Jephcott	128/11

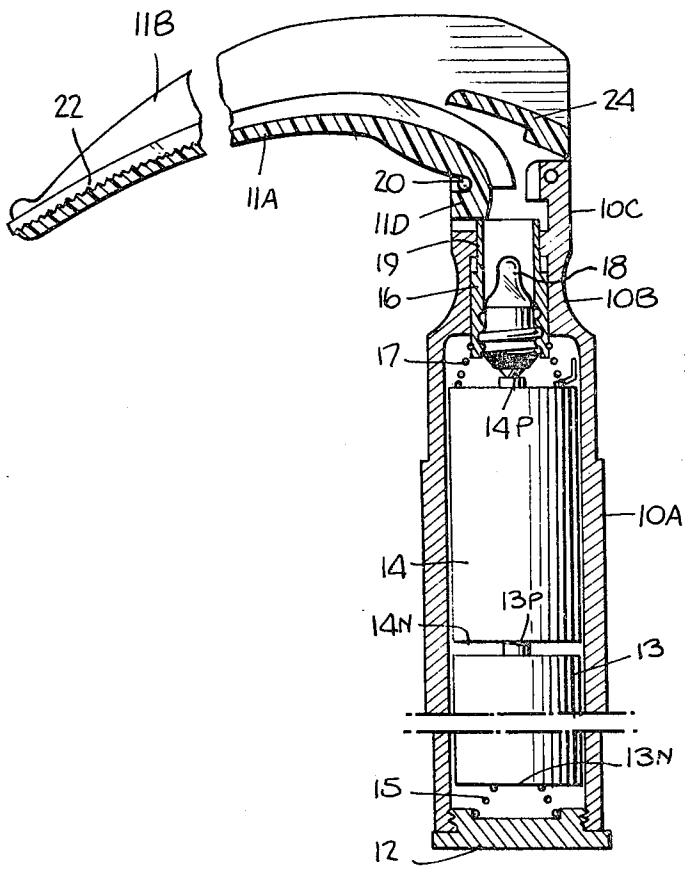
Primary Examiner—Channing L. Pace

Attorney—Michael Ebert

[57] **ABSTRACT**

An illuminated medical appliance for surgical and diagnostic purposes, the appliance including an applicator, such as a tongue depressor or retractor blade, formed of a strong, heat-resistant resin capable of withstanding the mechanical stresses to which the device is subjected when inserted. The inner surface of the applicator is contoured to engage tissue or whatever other organic material forms the wall of the cavity or region of insertion. Detachably mounted on the outer surface of the applicator and conforming to the curvature thereof, is a plastic, light-transmitting strip whose front end portion is adapted to disperse light laterally over a relatively broad zone adequately to illuminate the region of interest, the other end being optically coupled to a light source which is housed and energized in the handle of the appliance.

4 Claims, 9 Drawing Figures



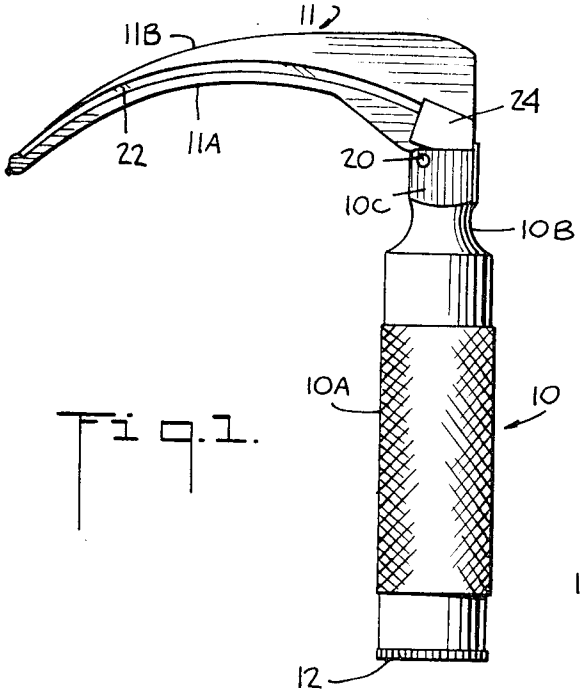


Fig. 1.

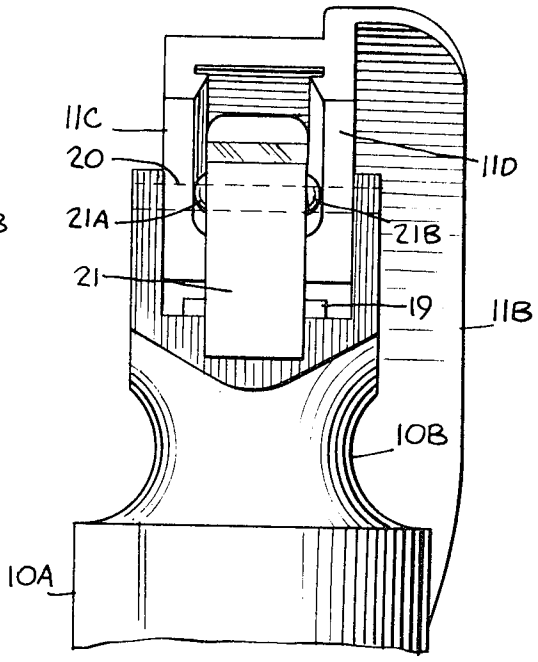


Fig. 2.

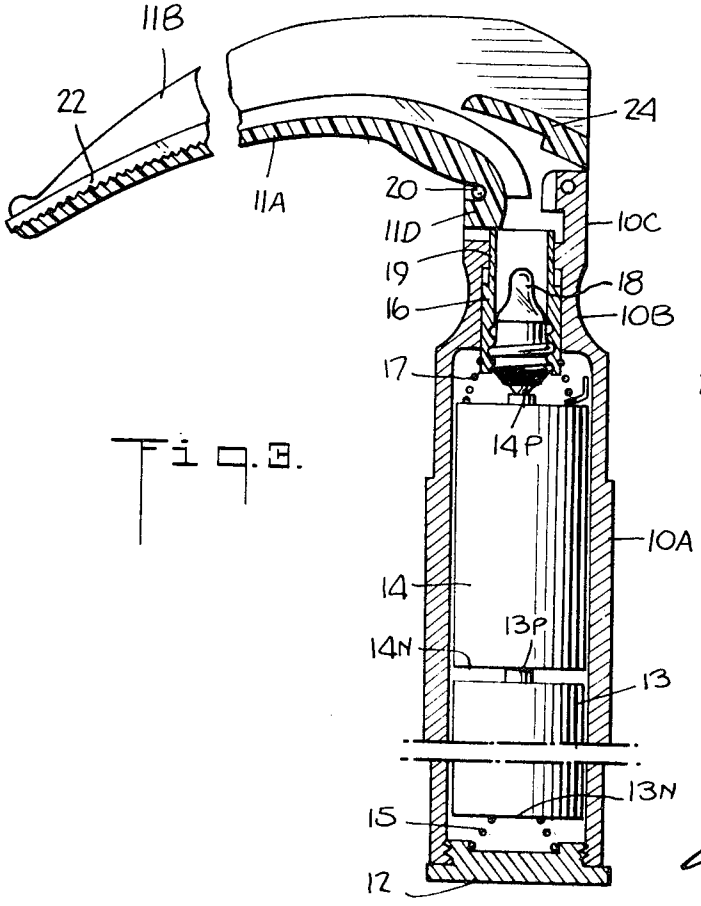


Fig. 3.

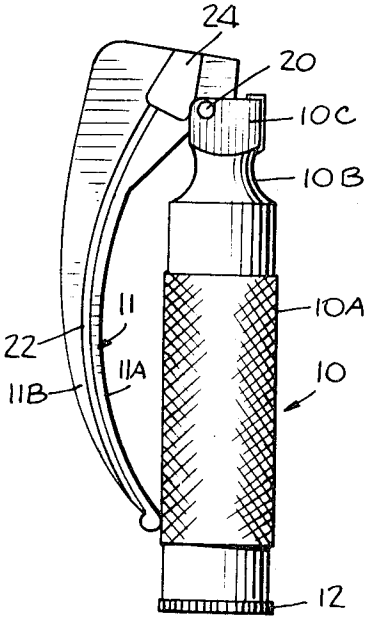


Fig. 4.

INVENTOR.
FRANKLIN G. REICK
BY
ATTORNEY

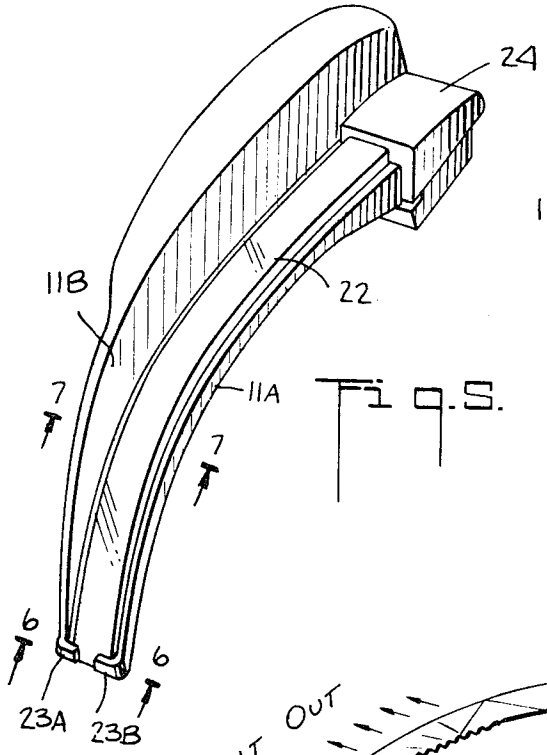


Fig. 5.

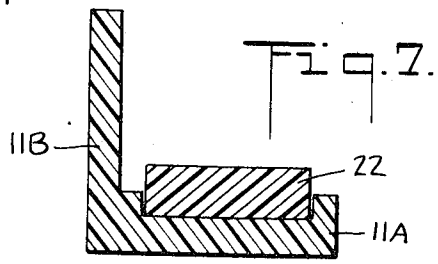


Fig. 7.

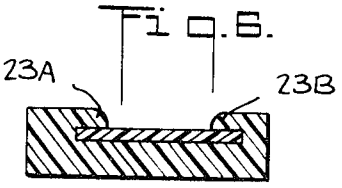


Fig. 6.

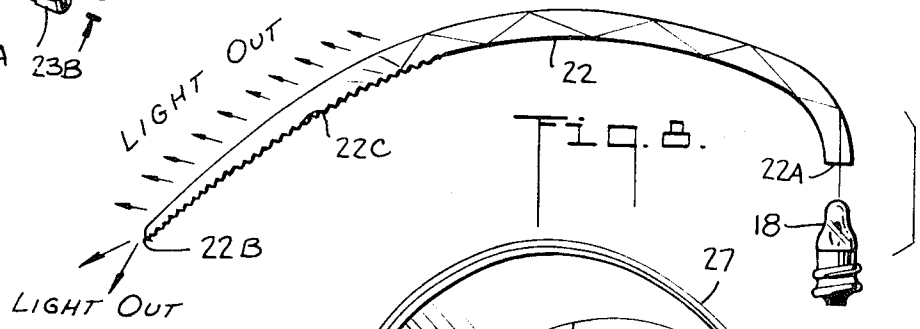


Fig. 8.

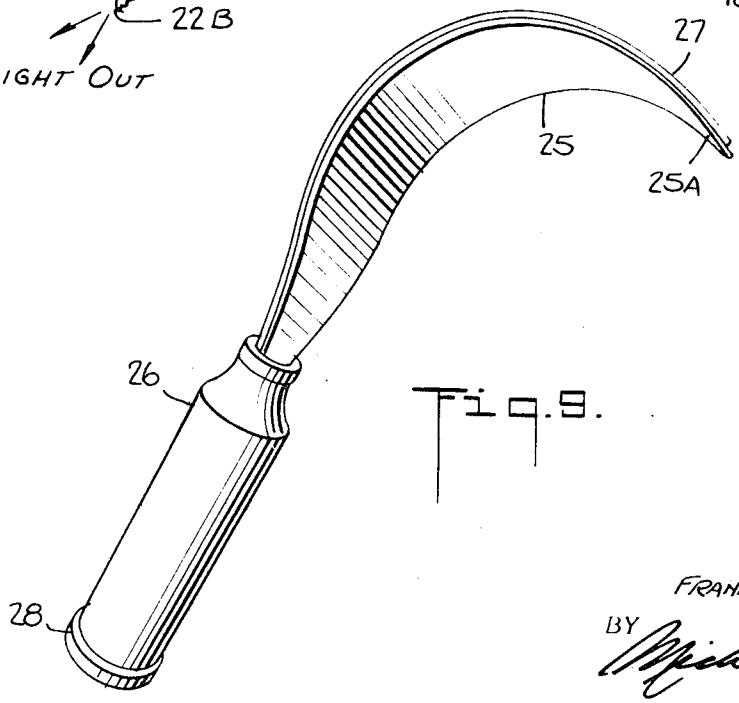


Fig. 9.

INVENTOR
FRANKLIN G. REICK
BY Michael Ebert
ATTORNEY

ILLUMINATED SURGICAL SPECULUM

This invention relates generally to illuminated medical appliances, and more particularly to a surgical or diagnostic instrument which includes an applicator assembly adapted to carry out a predetermined mechanical function in a particular region, as well as to effectively illuminate the region of interest.

In modern medical practice, various forms of illuminated appliances are currently available for diagnostic or surgical purposes. One known type is a laryngoscope which usually consists of a chrome-plated brass tongue depressor to facilitate throat inspection or the insertion of anesthetic apparatus, the depressor being pivotally attached to a hollow handle. Illumination is provided by a small light bulb mounted on the outer surface of the depressor, the bulb being energized by batteries housed in the handle.

A light bulb is a directional light source, and is not effective when the desideratum is fairly uniform illumination throughout a particular region. Thus the naked bulb causes shadowing and makes remote areas difficult to observe. Should one attempt to use a higher intensity lamp to overcome this drawback in conjunction with line voltage rather than batteries, this brings into play other serious shortcomings, for then the heat generated by the lamp will be excessive and the wires and currents around the patient may create a hazardous condition.

Another major disadvantage of standard laryngoscopes, is that the hard, metallic depressor, when inserted, may chip the teeth of the patient. In some instances, fragments of teeth have been known to fall into the lungs of a patient, resulting in complications. Also, chips of chrome plating may be dislodged and enter the patient's body. Moreover, metal depressors are difficult to manufacture and are quite expensive.

Adequate lighting in diagnostic and surgical procedures is of vital importance, for however skillful the doctor, unless he can clearly see what he is doing, his skill and knowledge are of little avail. Typical operating room lighting systems produce as much as 5,000 foot candles above the operating table, but inasmuch as the intensity diminishes as the square of the distance, by the time the light reaches the operating site, its level may have decreased to below 100 foot candles.

Overhead lighting, therefore, leaves much to be desired when localized illumination is necessary to locate certain organs within the shadows of a cavity, particularly since the interposition of medical attendants between the overhead source and the site may further interfere with the illumination.

There has therefore been a long standing need for a "cold" light source which can be inserted directly into a cavity and is adapted to provide dispersed rather than concentrated illumination, particularly in surgical incisions. Human organs are often obscured by each other and by fat and tissue, and are often located in unexpected regions of the body, with great variations in size.

It has therefore been proposed to use light conducting, flexible pipes, coupled to a high-intensity lamp, to provide the desired "cold" illumination of an operating site or cavity. This has the theoretical advantage of not obstructing the surgeon in the restricted interior of an incision, especially in those instances where the light pipe also functions as a retractor.

But substances having light-transmitting characteristics, such as acrylic resin or "Lucite," while possessing the requisite optical characteristics, are markedly deficient in their mechanical properties. Lucite is a brittle material, and has a tendency toward glassy fracture at inopportune moments, the material being subject to stress cracking as it ages. Moreover, Lucite cannot be sterilized by boiling water, for it softens at this temperature, making it necessary to sterilize with chemicals such as ethylene oxide. Consequently, the exploitation of a light conductor formed of a material having the desired optical properties to also perform the mechanical function of an applicator is dangerous and highly inadvisable.

In view of the foregoing, it is the main object of this invention to provide a medical appliance which includes an applicator assembly fully capable of performing its proper mechanical functions and having a detachable light conduit mounted on the outer surface thereof to illuminate the region of use.

More specifically, it is an object of this invention to provide an appliance of the above-identified type in which the applicator blade is of a structurally strong and heat-resistant resin capable of being steam sterilized, the light conduit being fabricated of a relatively fragile plastic material having the optimum optical properties.

A significant advantage of the invention is that mechanical stresses are imposed entirely on the applicator blade, thereby avoiding the possibility of breaking the light conduit. Moreover, since both the blade and conduit are formed of low-cost plastic material, the assembly thereof may be discarded after a single or several uses. Also, since the conduit is readily separable from the blade, it can be replaced if it becomes damaged or scratched, or it can be polished to renew its surface luster.

A further object of the invention is to provide an applicator assembly in which the dimensions and contour of the blade are appropriate to the diagnostic or surgical function to be performed thereby, and in which the light conduit is in the form of a strip which conforms to the curvature of the blade and is safely locked thereto so that it is not removable therefrom when the applicator is in use.

Briefly stated, these objects are accomplished by a medical appliance for surgical or diagnostic purposes, having an applicator assembly constituted by a blade and a light conductive optical pipe or strip, the blade being formed of a strong, heat-resistant resin capable of withstanding the mechanical stresses encountered by the applicator. The inner surface of the blade is contoured to engage tissue or whatever other organic material it makes contact with, the optical strip being detachable mounted on the outer surface of the blade and conforming to the surface thereof. The front end portion of the strip is adapted to disperse light transmitted thereto uniformly over a broad area, the other end being optically coupled to a light source which may be housed and energized in the hollow handle of the appliance.

For a better understanding of the invention, as well as other objects and further features thereof, reference is made to the following detailed description to be read in conjunction with the accompanying drawing, wherein:

FIG. 1 is a side elevational view of a foldable laryngoscope in accordance with the invention;

FIG. 2 is a rear view of the head section of the handle;

FIG. 3 is a longitudinal section taken through the laryngoscope;

FIG. 4 shows the laryngoscope in the folded, inoperative state;

FIG. 5 is a perspective view of the applicator assembly;

FIG. 6 is a transverse section taken in the plane indicated by line 6—6 of FIG. 5;

FIG. 7 is a transverse section taken in the plane indicated by line 7—7 in FIG. 5;

FIG. 8 separately shows the light strip in a side view; and

FIG. 9 illustrates, in perspective, an illuminated surgical retractor in accordance with the invention.

Referring now to the drawing, and more particularly to FIGS. 1 to 4, there is shown a foldable laryngoscope in accordance with the invention, the main components of which are a handle 10 and an applicator assembly, generally designated by numeral 11, the assembly being pivotally connected to the handle whereby it may be folded into a more compact form when not in use.

Handle 10 is preferably formed of metal such as brass or aluminum, and is constituted by a hollow cylindrical casing section 10A, a neck section 10B, and a head section 10C. The casing 10A is provided with a closure in the form of a threaded cap 12. A pair of replaceable batteries 13 and 14 is housed within the casing and is urged toward the neck section 10B by a conductive spring 15 which also provides electrical contact

between the negative terminal 13N of battery 13 and the casing. It will be seen that the positive terminal 13P of battery 13 makes contact with the negative terminal 14N of battery 14 so that the batteries are connected in series.

Flotably supported within neck section 10B is an open-ended, threaded sleeve 16, the lower end of which is securely held within the upper loop of a spirally shaped conductive spring 17 whose lower loop engages the interior wall of casing 10A, thereby providing an electrical connection between sleeve 16 and the casing, which connection in turn leads to the negative terminal battery 13 through spring 15.

Received within sleeve 16, which functions as a socket, is a small electric light bulb 18, preferably of the type having a lens at its tip, such as the type GE 222. This bulb is energized only when the central contact 18A thereof makes contact with the positive terminal 14P of battery 14. Spring 17, however, acts normally to maintain sleeve 16 in a raised position within the neck 10B so that contact 18A is then out of engagement with battery terminal 14P and the bulb is deenergized.

Secured to the upper end of sleeve 16 is a small collar 19 which is engaged by the legs of the applicator assembly when the assembly is extended to its operative position, as will be later explained in greater detail, the legs pushing down on collar 19 and thereby bringing about engagement between the bulb contact and the battery terminal 14P, to complete the electrical circuit and energize the bulb.

The depressor blade of the applicator assembly 11 is fabricated from a strong, heat-resistant resin capable of withstanding heavy mechanical stresses. A preferred resin for this purpose is polycarbonate, which is a thermoplastic material having excellent heat-resistance, outstanding impact strength, and good dimensional stability.

Chemically, polycarbonate is characterized by being stable to water and to mineral and organic acids. This resin can be fabricated by more methods than most other plastics, including all molding techniques such as injection and blow molding, thermoforming, machining, hot and cold staking, and fluidized bed coating. It is available in many colors, as well as in transparent formulations. Polycarbonate resin neither stains, tarnishes, pits nor corrodes. Its tensile and flexural modulus may be enhanced by glass reinforcement.

The high-impact resistance of polycarbonate is so great that when used as a handle for a hammer having a steel head and subjected to destruction tests, the steel head will split while the handle remains unharmed.

The depressor blade is constituted by an arcuate strips portion 11A and a reinforcing sidewall 11B, the curvature of the strip being such as to facilitate insertion in the upper part of the trachea. In practice, the blade is made in various sizes to accommodate adults and children. The undersurface of the blade engages the wall of the trachea, whereas the upper surface is used as the support for a light pipe to illuminate the area of interest.

The base of the blade is provided with a pair of spaced feet 11C and 11D which, as best shown in FIG. 2, are pivoted to the head section 10C of the handle by a pivot pin 20, the feet having slots therein to accommodate the pin, whereby the entire applicator assembly may be readily detached from the handle. Head section 10C is provided with a rear abutment 21 having detent balls 21A and 21B on either side thereof which fall into complementary recesses formed in feet 11C and 11D when the blade is in its operative position, thereby latching the blade in place. In this position, feet 11C and 11D engage collar 19 above light socket 16, and press the collar 19 downwardly to cause contact 18A of the light bulb 18 to connect with the positive contact 14P of the battery 14 to complete the electrical circuit and thereby energize the bulb. Thus only when the applicator assembly is extended to its operative position, is illumination provided.

Inasmuch as the tip of light bulb 18 lies within collar 19, the bulb is inaccessible except on top, and cannot be manually screwed in and out of socket 16 in the usual way. Hence it is necessary to provide a special tool for this purpose. This tool need be nothing more than a rod having a handle at one end and a rubber suction cup at the other adapted to engage the tip of the bulb, whereby it then becomes possible to turn the bulb to screw it in or out of the socket.

The light conduit or pipe 22, as best seen in FIGS. 5 to 8, is formed from a light-conducting strip of plastic material, the strip being curved to conform to the upper surface of the applicator blade and being of progressively diminishing thickness, thereby constituting an optical wedge. The thicker edge 22A of conduit 22 lies at the foot thereof, the curvature of the conduit being such that this edge lies in a plane perpendicular to the optical axis of the light bulb 18 to receive maximum light therefrom.

Conduit 22 is fabricated from a light-transmitting acrylic plastic, such as Lucite or Plexiglass, which conducts light by total internal reflection. To pipe a majority of internal light within a curved acrylic piece, the minimum inside radius must be at least twice the thickness of the part, otherwise many rays will be lost through the outer surface because they strike it at an angle at which reflection does not occur.

Any ray of light within acrylic plastic which encounters an air interface at the critical angle (42.2° off the normal) or greater, will not be transmitted, but will be totally reflected back into the material at an equal and opposite angle, this total reflection being the physical basis for light piping.

In the wedge construction shown, light enters conduit 22 at the thick edge 22A and is transmitted through the conduit toward the thin edge 22B thereof. In transmission, the light is reflected back and forth between the principal surfaces. However, at each reflection, the angle of incidence becomes progressively closer to normal until it is less than 42.2°, at which point the light pierces the air interface to escape from the conduit at both faces of the wedge.

In the present arrangement, the taper of conduit 22 is made such as to cause light decollimation and emission at the front end zone where the bottom face 22C is roughened and painted white. The white paint acts to scatter the light back through the conduit as a random flux, this effect being enhanced by roughening the surface, which serves to destroy the polish of the reflecting surface to cause the light rays to scatter as they strike the roughened zone. Thus a relatively uniform illuminating flux emanates from the exposed side of the front-end zone of the light conduit to light up the cavity in which the depressor is inserted.

Referring now to FIGS. 5, 6 and 7, it will be noted that the curved strip portion 11A of the depressor blade is provided on its upper face with a groove to accommodate the light conduit 22, the front end of the conduit being retained within the groove by a pair of inwardly extending fingers 23A and 23B formed on the polycarbonate blade. The rear end of the conduit runs through a glare cover 24 which prevents direct radiation from the bulb, the rear end touching the inner wall of abutment 21, which acts as a stop to prevent removal of the conduit when the device is in use.

Thus the laryngoscope illustrated above includes a depressor blade assembly constituted by a polycarbonate blade of high strength which performs the requisite diagnostic functions and acts as a protective support for a relatively fragile light conduit that uniformly illuminates the area of interest, the depressor blade assembly being pivoted to the handle and being rendered electrically operative only when the blade assembly is raised from its folded to its extended position.

A similar applicator assembly may be used in other diagnostic or surgical instruments. Thus FIG. 9 shows a retractor having a curved blade 25 and a handle 26, the blade being profiled to engage tissue in an operating site. The blade is formed of polycarbonate, and includes a channel in the upper face, as in the case of the laryngoscope, to receive a light conduit 27 whose curvature conforms to that of the blade and whose width is tapered to provide an illumination zone at the front end 25A of the retractor blade, in the manner previously described.

In this instance, the applicator assembly is not pivoted, but is removable attached to handle **26** which incorporates a battery and light bulb to illuminate the thick edge of the light conduit. The handle includes a twistable cap **28** which acts as an electrical switch to open and close the bulb circuit, as desired. In practice, the upper end of the handle may be provided with a suitable socket to receive replaceably or disposable retractor assemblies of different types having an appropriate plug construction adapted to be received securely in the socket.

It is important to note that since the applicator assembly, whatever the instrument in question, is formed of low-cost plastic elements and may therefore be discarded after a single use to avoid the need for resterilization.

What I claim is:

1. An illuminated laryngoscope insertable into the larynx, the laryngoscope, after insertion, being pulled toward the teeth and being subjected to relatively heavy mechanical stresses, said laryngoscope comprising:

A. a hollow handle having a light source therein and a battery for energizing said source, and

B. an applicator assembly pivotally attached to said handle so that it may be folded against the handle or extended into an operative position at approximately a right angle to the handle, said assembly being constituted by a depressor blade formed of a relatively high-strength resin, whose strength is comparable to metal and being capable of withstanding the mechanical stresses to which the blade is subjected when in use without causing injury to teeth engaged thereby, said blade having a curvature to facilitate entry into the larynx and defining a concave underface and a convex upper face, the underface of the blade being contoured to engage the organic substance which forms the wall of the area of insertion, and a light-transmitting conduit having optical properties mounted on the upper face of the blade and conforming to the curvature thereof, said conduit being formed of a material which is fragile relative to the material of the blade and having one end thereof positioned in light-receiving relation to the light source in the handle when the assembly is extended, the other end terminating on said blade at a point adjacent the free end thereof to emit light for illuminating the larynx.

2. A laryngoscope as set forth in claim **1** wherein said blade has feet thereon at the end thereof adjacent said handle, and said light source is a bulb received in a spring mounted socket normally disposed above the terminal of one of said batteries, the feet engaging and depressing said socket when the blade is extended, the bulb having a contact which is caused to engage said terminal of one of said batteries only when the blade assembly is extended to cause said feet to press down on the socket.

3. A laryngoscope as set forth in claim **1** wherein said blade is formed of polycarbonate.

4. A laryngoscope as set forth in claim **1** wherein said conduit is in strip form and nests within a groove formed in the upper face of the blade, the front end of the strip being held in the groove by fingers formed on said blade, and a glare guard disposed above said one end of conduit to prevent glare from the light source in said handle.

* * * * *