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ENDOSCOPE WITH RIGID FIBERSCOPE MEANS ILLUMINATING

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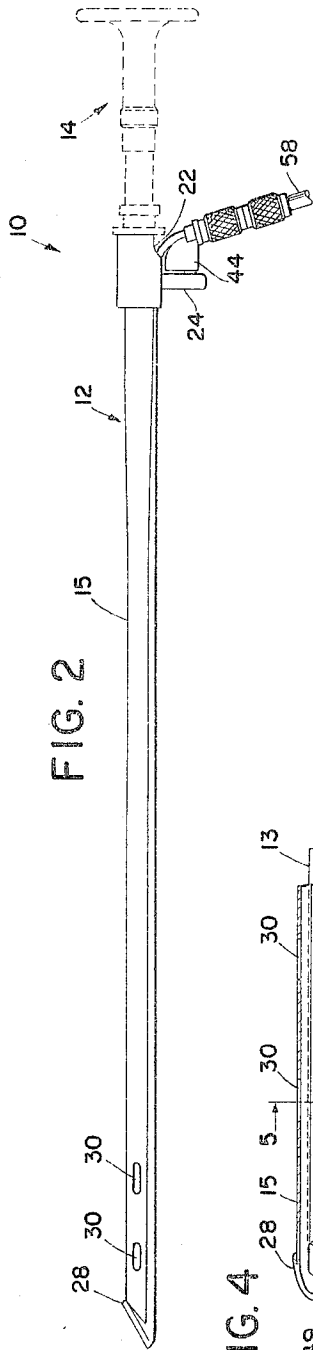


FIG. 2

FIG. 4

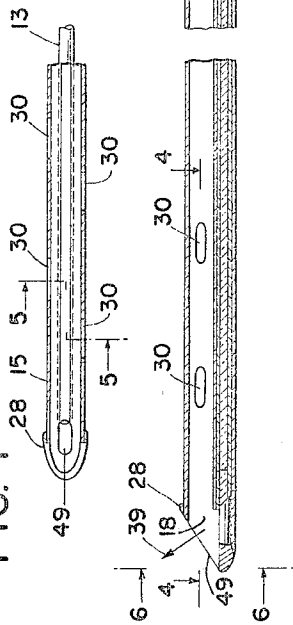


FIG. 3

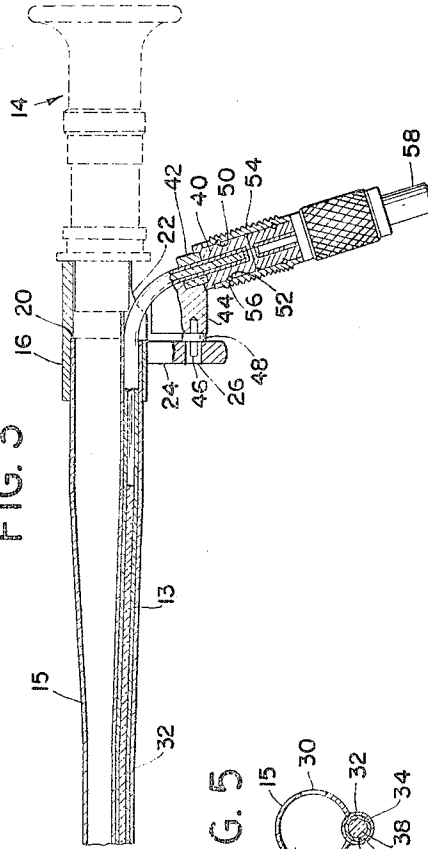


FIG. 6

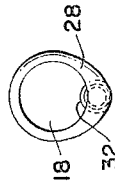


FIG. 5

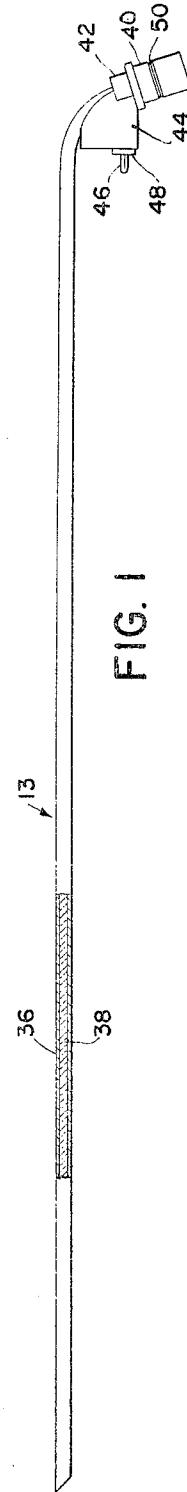
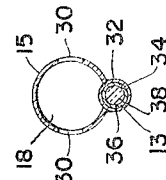


FIG. 1

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**ENDOSCOPE WITH RIGID FIBERSCOPE
ILLUMINATING MEANS**

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7 Claims. (Cl. 128—6)

This application is a continuation-in-part of application Serial No. 305,304, filed August 29, 1963.

This invention relates to endoscopic instruments for the examination of internal body orifices, and more particularly relates to such instruments which utilize optic fibers for illumination of the internal orifices.

An endoscope must meet limitations of size and shape dictated by the anatomical structure of the orifice in which it is to be used. Also, an endoscope must provide for light, vision and operating instruments or high frequency electrodes. For precision in diagnosis or other procedure, a fine, brilliant image that is accurate in regard to both color and definition is essential to the operator. Within the relatively small lumen or space inside the tubular portion of known endoscopes, there is a complete electrical circuit of which a lamp is a part. The lamp circuit requires an insulated conductor or wire to carry current from a contact near the proximal end, to the lamp frequently located at the distal end. The circuit must function perfectly under water and must not be affected by other solutions during sterilization, a requirement most difficult to fulfill in any electrical structure. While the instruments are water-tight when they leave the factory, due to the fact that they must be opened for the replacement of lamps, their ability to exclude moisture is almost entirely dependent upon the care exercised by the user in again sealing the instruments.

In known endoscopic instruments most premature burning out of lamps results from attempts to obtain unusually brilliant illumination. The extent of illumination is limited by the filament of the lamp itself. It is the practice to make use of a current regulator and observe the lamp filament closely while gradually increasing the current. The limit of safe current is reached when the definite reddish tint of the lamp suddenly becomes white. Further increase in illumination by increasing the current beyond this point results in premature burning out of the lamp. Once the lamp burns out it is necessary to remove it, thus introducing the possibility of the problems described above.

Problems also arise from the disinfection of parts of the endoscope containing lamps. It is not practicable to boil or autoclave any part of the endoscope which contains lamps. The usual chemical disinfectants may not be used or leaks and short circuits in the wiring may follow. As a result it is necessary to use special disinfectant methods and solutions in cleaning known endoscopes.

It is an object of the present invention to provide means for illuminating internal orifices which means provides significantly brighter illumination than was heretofore possible and may be sterilized by boiling, autoclaving or chemicals without deleterious results.

It is another object of the present invention to provide endoscopic instruments having illuminating means which may be easily and quickly removed from the instrument and which illuminating means have an expected life, equivalent to that of the rest of the instrument, which means do not require maintenance or replacement of parts in normal use.

It is still another object of the present invention to

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provide particular endoscopic instruments utilizing as an illuminating means a rigid bundle of optic fibers which may be shaped to configurations adapted to the particular use of the instrument.

5 It is another object of this invention to provide an optic fiber bundle for the illumination of internal orifices which bundle is in a form rigid enough for removable insertion into an outer sheath.

Further objects as well as advantages in the present invention will be apparent from the following description and the accompanying drawings, in which:

FIGURE 1 is an elevational view, partly broken away, of the light carrying rod of the present invention;

15 FIGURE 2 is a side elevational view of a bronchoscope utilizing the rigid light carrier of the present invention;

FIGURE 3 is a longitudinal cross-sectional view of a bronchoscope utilizing the present invention;

20 FIGURE 4 is a cross-sectional view of the end portion of a bronchoscope taken generally along lines 4—4 of FIGURE 3;

FIGURE 5 is a transverse cross-sectional view taken generally along lines 5—5 of FIGURE 4; and

25 FIGURE 6 is an end view of a bronchoscope utilizing this invention taken generally along lines 6—6 of FIGURE 3.

In the practice of this invention a light carrying rod comprising a small diameter tube containing a bundle of optic fibers is utilized. A preferred embodiment of this invention is a bronchoscope comprising a sheath having a small passageway forming part of its perimeter. The light carrying rod slidably engages the inner surface of the passageway and, while substantially rigid, is sufficiently flexible to conform to small curves in the passageway and may be removed for sterilization and the like. The preferred form of the passageway is that defined by a substantially cylindrical tube soldered or otherwise suitably connected to the perimeter of the sheath and forming a part of the perimeter. However, if desired, the passageway may be made up of a series of inwardly protruding fingers within the sheath. The sheath is substantially circular in cross section except for the protrusion due to the passageway. For some applications, the sheath may preferably be slightly elliptical and also for some applications may desirably be slightly tapered.

The optic fiber bundle is preferably a solid rod the proximal end of which is of a suitable configuration, preferably cylindrical, for coupling to a source of light. Because endoscopes are shaped to conform to the orifice being examined, the distal end of the bundle may be formed into one of a variety of shapes, a preferred shape being a solid cylindrical rod. Preferably both ends of the optic fiber bundle are optically polished to provide better light dissemination, and a protective lens may be placed over each of the polished ends of the bundle, if desired. Using a cylindrical rod configuration at the distal end of the bundle, light is transmitted through the bundle to provide high intensity, cold illumination in a circular pattern, permitting ready observation of internal areas.

High intensity illumination is possible using the present invention. Intensities up to 2000 foot candles or more at a working distance of one-half inch and up to 400 foot candles or more at four inches may be obtained by connecting the device to a fiber optic light source by means of a fiber optic light carrying bundle. Typically the illumination produced by the optic fiber bundle is fifteen times greater than that produced by an incandescent lamp commonly used in the same size of endoscope.

70 Other features of the present invention are the elimination of wires and the elimination of rotating contacts

on the instruments which were necessary in prior art instruments in order to provide electrical connections for the internal lamp circuit. The present invention may be made applicable to a wide variety of endoscopic equipment, particularly examining, operating, and catheterizing endoscopes. A particular advantage of the present invention is the adaptability of the instruments to small size, for instance, for use in an infant bronchoscope.

The rigid light rods may be prepared by the following procedure. First, using the method described in the application of Lawrence E. Curtiss, Serial No. 76,868, filed December 19, 1960, now Patent No. 3,074,084, continuous strands of glass-coated glass fibers are wound on a Mylar (polyethylene terephthalate) sheet which is disposed around a drum. As each successive layer of fibers is laid on the drum, a layer of thermosetting resin is placed upon them. The resin is allowed to dry but is not cured; thus it remains tacky but does not become hard and stiff. The sheet is then cut parallel to the axis of the cylinder, and a flat sheet of Mylar having well oriented fibers is obtained.

Second, a bundle of fibers having the desired length and thickness is cut from the sheet and is inserted into the tube of the light carrying rod. When necessary, as in forming a small diameter light carrying rod where space is limited, the Mylar backing may first be removed. To facilitate inserting the bundle into the light rod, a sheet of suitable material, such as thin Mylar, may be wrapped around the optic fiber bundle to prevent adhesion of the tacky resin to the interior of the tube.

The light-conducting fibers are substantially coextensive with the tube of the light rod. The proximal end of the light rod is inserted through a terminal fitting which supports it, and, if desired, epoxy resin may be added to both ends of the optic fiber bundle to a depth of about one-half inch from each end. Finally, the entire assembly is baked to cure the resin and produce a substantially rigid light rod.

Turning now to the drawings in detail, a bronchoscope 10 utilizing this invention comprises a sheath 12, a light carrying rod 13 and may be used with or without a telescope. A proximal type telescope 14 is shown in phantom but the construction of the telescope 14 forms no part of this invention. The sheath 12 comprises a tapered elongated member 15 connected at its proximal end to a mounting member 16 and defines an aperture 18 extending through the complete length of the sheath. The proximal end of the sheath 12 is positioned against a shoulder 20 of the mounting member 16. The mounting member 16 is substantially cylindrical in configuration, except that it contains a cut-out segment 22 through which the light carrying rod passes and which permits air to pass into the instrument so that the patient can breathe while the bronchoscope is in position. A bracket 24 is connected to the mounting member 16 and has an aperture 26 which aids in positioning the light carrying rod as is further described below.

At its distal end, the sheath 12 is cut at an angle as shown in FIGURES 2 and 3 and is provided with a smoothly rounded rim 28 to facilitate insertion into the internal orifice. Near its distal end the sheath 12 contains ports 30 through which air may freely pass as the patient breathes. As best shown in FIGURE 4, the ports 30 are not directly opposite one another, but are staggered to provide better distribution of air to the bronchi.

As best seen in FIGURES 3 and 5, a tube 32 is attached to the sheath 12 and with it defines aperture 18. The tube 32 contains a passageway 34 into which the light rod 13 is inserted.

Light rod 13 is made up of an outer tube 36 and contains a plurality of light-conducting, glass-coated glass fibers 38. As best indicated in FIGURE 3, light rod 13, though rigid, is sufficiently flexible to pass through the large radius arcuate portions of passage 34. At its proximal end the light rod 13 is surrounded by jack 40 which

is connected to annular mounting member 42. Mounting member 42 and jack 40 are also connected to block 44 which has an irregular shape, as best shown in FIGURES 1 and 3. Block 44 has an arcuate recess conforming to the outer surface of tube 36 where they are connected together as by soldering. On the distally presented surface of block 44 is a spacer 43 from which projects a locating pin 46 positioned to register with and seat in the aperture 26 formed in bracket 24.

The arrangement ensures accurate alignment and positioning of the light rod 13 with the sheath 12 and the telescope when one is used. In particular, positive accurate alignment of the vertical axes (as viewed in the drawings) of the light rod 13 and sheath 12 are maintained. This is important where, as in the present instance, the distal end face of the light-conducting bundle is not perpendicular to the longitudinal axis of the instrument and forms an acute angle, about 45° in the embodiment shown, with the vertical axis. It will also be noted that the planes in which the fenestra 49 and the end face of the light rod 13 extend intersect at an angle of about 90°. When the exit end faces of the light-conducting fibers do not extend normal to the longitudinal axes of the fibers the resulting prism effect causes the exiting light to follow a path indicated generally by the arrow 39 in FIGURE 3. Thus, in spite of the fact the light rod 13 is positioned to one side of the sheath 12, the light exiting therefrom illuminates the entire field of view directly ahead of the fenestra 49 and at an angle upwards. The field may be visualized by the unaided eye, through the proximal type of telescope 14, through a straightahead viewing telescope or through an oblique viewing telescope.

Jack 40 contains an annular groove 50 which is adapted to receive spring 52. Connector 54 contains a corresponding groove 56 which is adapted to coact with spring 52 and removably connect flexible light carrier 58 to jack 40. If desired, the light carrier 58 may have a jack, groove and spring similar to those described above.

In operation, the bronchoscope is inserted into the bronchus of the patient utilizing an obturator, in well known manner, and the light rod 13 is inserted into the tube 32 and positioned by means of pin 46. The light rod may then be connected by means of jack 40 and flexible light carrier 58 to a source of light. When desired, a telescope may be inserted into the bronchoscope in order to assist in examining the bronchi.

The terms and expressions which have been employed are used as terms of description and not of limitation, and there is no intention in the use of such terms and expressions of excluding any equivalents of the features shown and described or portions thereof, but it is recognized that various modifications are possible within the scope of the invention claimed.

I claim:

1. A bronchoscope for insertion into and for examining the bronchi in the lungs of a patient, comprising a tubular sheath forming a channel through which a field of view presented to a fenestra formed at the distal end of said sheath may be visualized, means forming a passageway extending along the perimeter of said sheath from adjacent the distal end to adjacent the proximal end thereof, a light rod removably disposed within said passageway, said light rod comprising an outer tube and a plurality of light-conducting fibers disposed within said tube, said fibers being formed into a solid substantially rigid rod-shaped bundle extending from adjacent the proximal end to adjacent the distal end of said sheath, the proximal end of said rod being adapted for connection to an external light source for illuminating the bronchi of a patient.

2. A bronchoscope for insertion into and for examining the bronchi in the lungs of a patient, comprising a rigid tubular sheath through which a field of view presented to a fenestra formed at the distal end of said sheath may be visualized, a first tube mounted in the wall of said sheath

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and forming part of the perimeter thereof, said first tube having a passageway formed therethrough, a light rod slidably disposed within said passageway, said light rod comprising a second tube extending from adjacent the proximal end to adjacent the distal end of said sheath, a plurality of light-conducting fibers disposed within said second tube and extending adjacent to said fenestra at the distal end of said sheath, and means for connecting the proximal end of said light rod to an external source of light for illuminating the bronchi of a patient.

3. A bronchoscope as set forth in claim 2, comprising means for aligning a predetermined transverse axis of said light rod with the corresponding axis of said sheath, and said fenestra and the distal end face of said light-conducting fibers extending in planes inclined toward each other and relative to said axes.

4. A bronchoscope as set forth in claim 3, wherein said planes intersect at an angle of about 90° and form angles of about 45° with said axes.

5. A bronchoscope for insertion into and for examining the bronchi in the lungs of a patient, comprising a rigid tubular sheath through which a field of view presented to a fenestra formed at the distal end of said sheath may be visualized, means including a mounting member for receiving and locating a telescope and connected to the proximal end of said sheath, a first tube mounted in the wall of said sheath and forming part of the perimeter thereof, said first tube having a passageway formed therethrough communicating with a slot formed in said mounting member, a light rod slidably disposed within said passageway and extending in said slot, said light rod comprising a second tube, a substantially rigid elongated

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bundle of a plurality of light-conducting fibers disposed within said second tube and extending from adjacent the proximal end of said sheath adjacent to said fenestra at the distal end of said sheath, means for connecting the proximal end of said light rod to an external source of light for illuminating the bronchi of a patient, a bracket connected to said mounting member, a mounting block connected to said light rod adjacent to the proximal end thereof, and means on said mounting block and said bracket for aligning said light rod with said sheath.

6. A bronchoscope as set forth in claim 5, wherein said bracket extends in the plane of a predetermined transverse axis of said sheath, and said fenestra and the distal end face of said light-conducting fibers extend in planes inclined toward each other and relative to said axis.

7. A bronchoscope as set forth in claim 6, wherein said planes intersect at an angle of about 90° and form angles of about 45° with said axis.

References Cited by the Examiner

UNITED STATES PATENTS

2,235,979	3/1941	Brown	128—6
2,479,237	8/1949	Held	128—6
2,544,914	3/1951	Cameron	128—6
2,699,770	1/1955	Fourestier et al.	128—6
2,932,294	4/1960	Fourestier et al.	128—6
3,089,484	5/1963	Hett	128—6

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