Jan. 10, 1967 F. J. WALLACE 3,297,022

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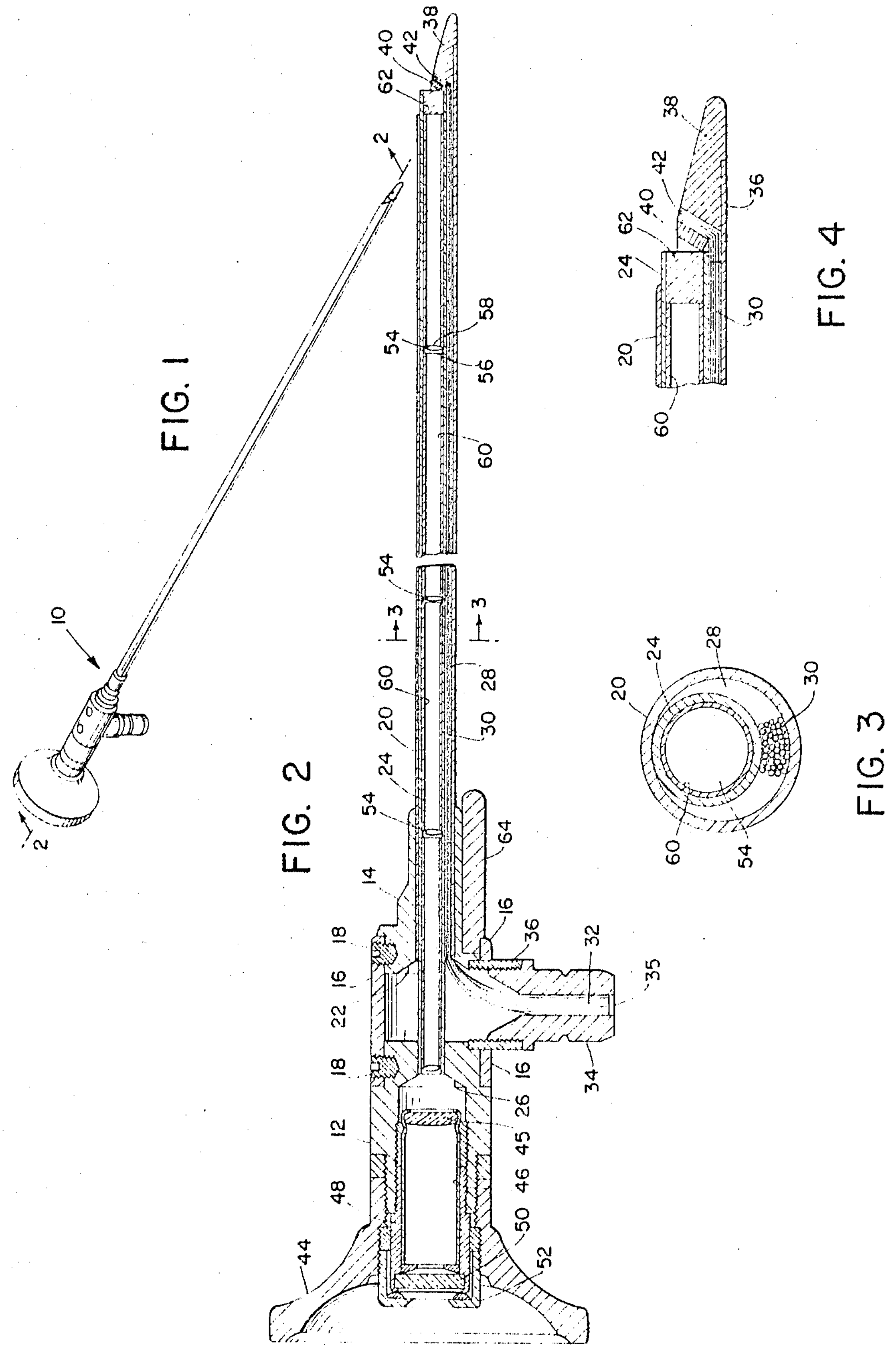
Filed Sept. 27, 1963 4 Sheets-Sheet 1



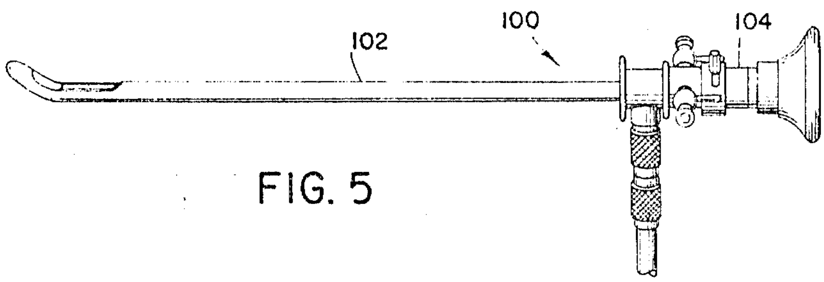


FIG. 5

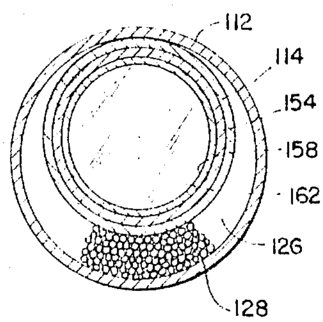


FIG. 8

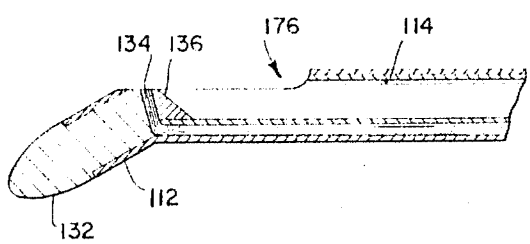


FIG. 9

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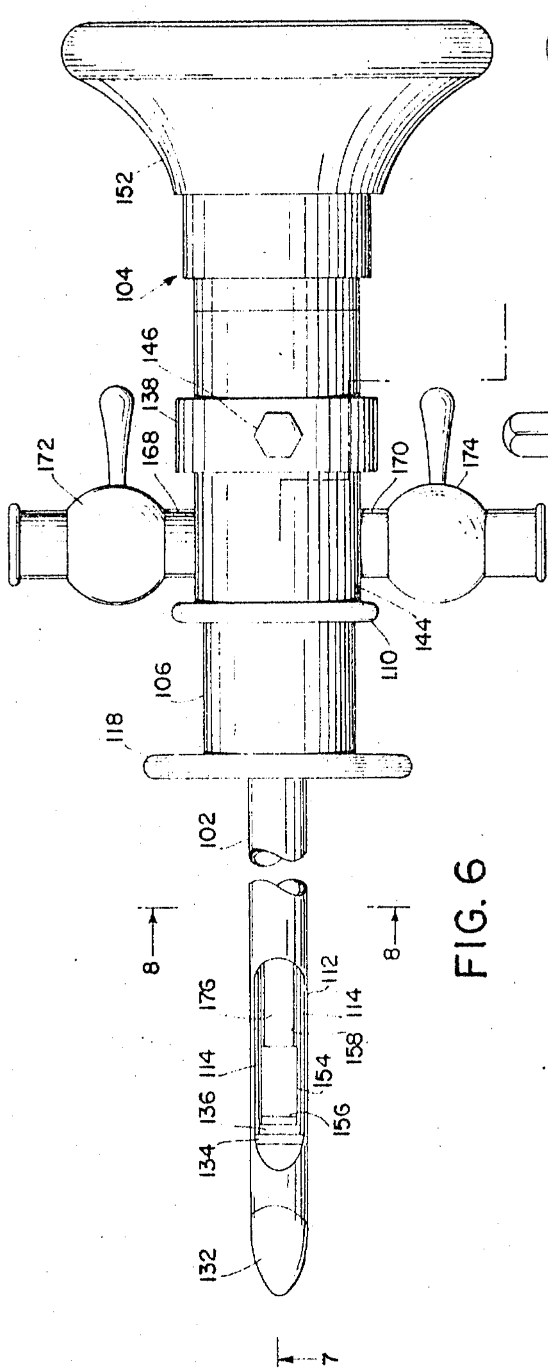

FIG. 6

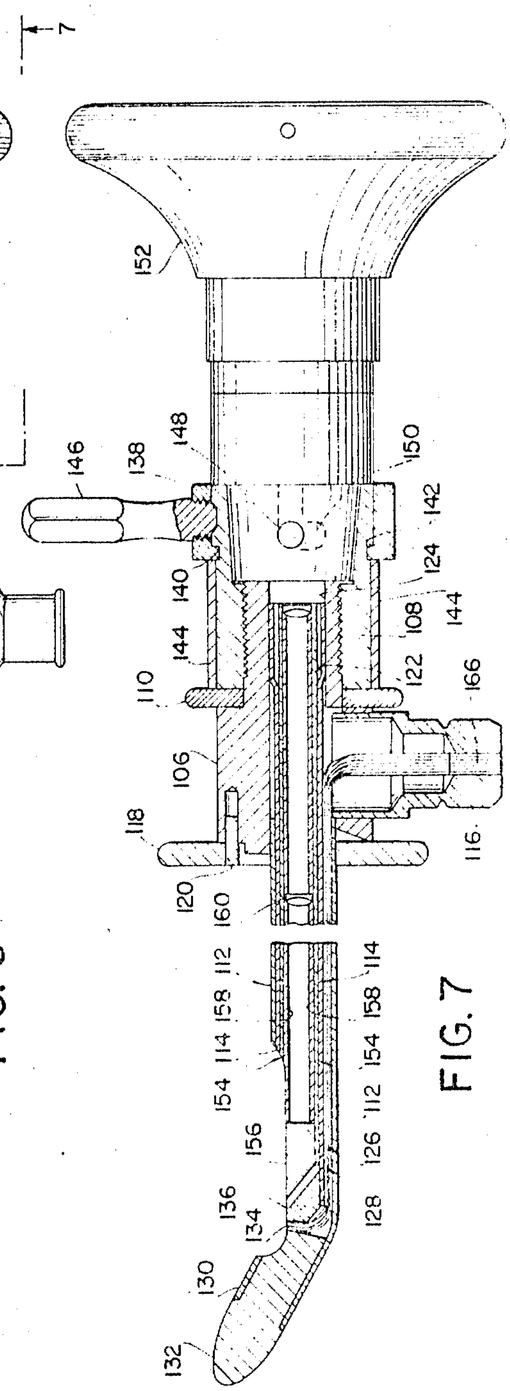

FIG. 7

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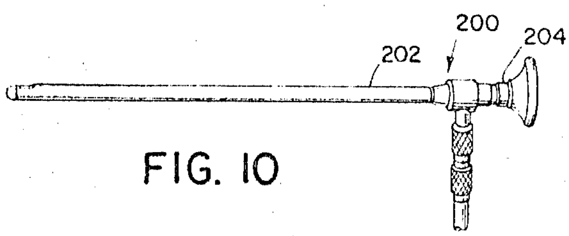

FIG. 10

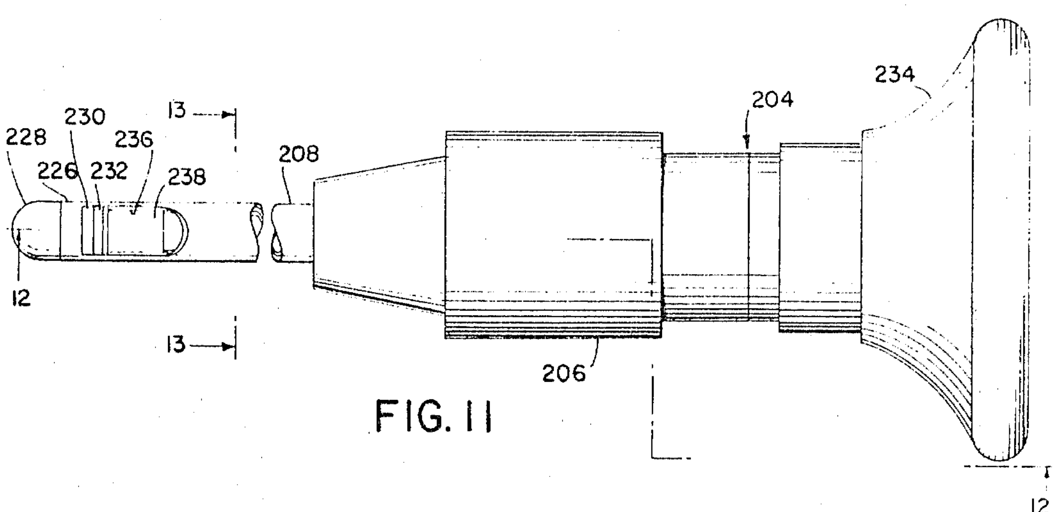

FIG. 11

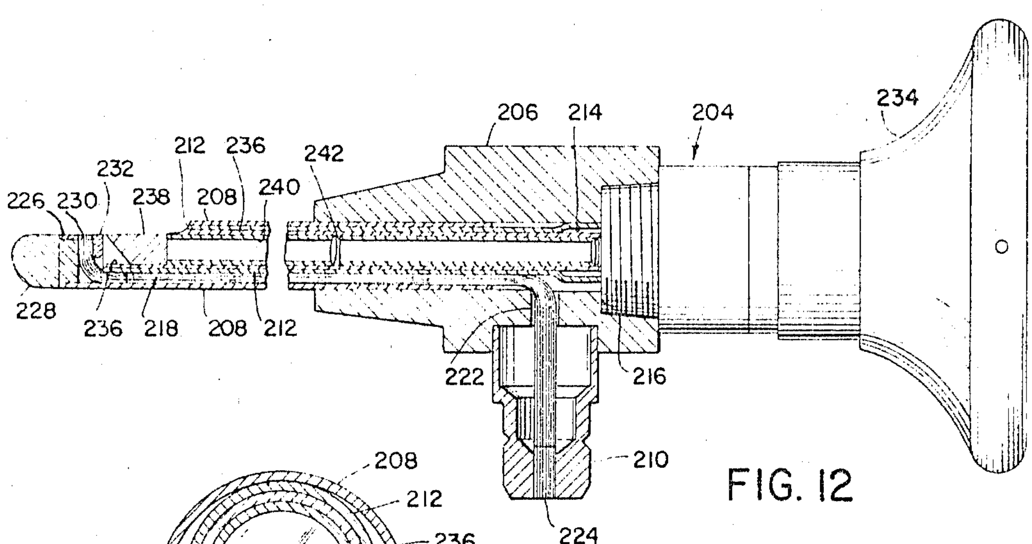

FIG. 12

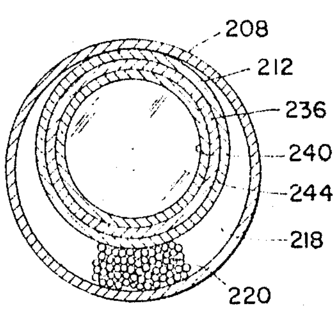

FIG. 13

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Filed Sept. 27, 1963, Ser. No. 312,079

6 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 viewing internal body orifices which means transmit significantly brighter illumination than was heretofore possible and which 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 with 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 yet another object of this invention to provide an improved endoscope, adapted to be used either alone or in association with operative instruments, for the purpose of viewing under illumination interior portions of the genitourinary tract.

It is still another object of the present invention to provide a telescope utilizing as its illumination transmission means a bundle of optic fibers which may be shaped at its distal end to one of a number of configurations especially adapted to the particular use of the telescope and any endescope that may be associated with it.

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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 a perspective view of a telescope constructed in accordance with the present invention;

FIGURE 2 is a transverse cross-sectional view taken generally along lines 2—2 of FIGURE 1;

FIGURE 3 is a cross-sectional view taken generally along lines 3—3 of FIGURE 1;

FIGURE 4 is an enlarged cross-sectional view of the distal end of one embodiment of the telescope of this invention;

FIGURE 5 is a perspective view of a cystoscope constructed in accordance with the present invention;

FIGURE 6 is a top view of a cystoscope embodiment of this invention;

FIGURE 7 is a sectional view taken generally along lines 7—7 of FIGURE 6;

FIGURE 8 is a cross-sectional view taken generally along lines 8—8 of FIGURE 6;

FIGURE 9 is an alternate embodiment of the cystoscope of this invention in which a convex beak is used;

FIGURE 10 is a perspective view of a culdoscope embodying the principles of this invention;

FIGURE 11 is a top view of the culoscope employing the principles of this invention;

FIGURE 12 is a sectional view of the culdoscope of this invention taken generally along lines 12—12 of FIGURE 11;

FIGURE 13 is a cross-sectional view taken generally along lines 13—13 of FIGURE 11.

The objects of this invention may be achieved by utilizing tubular means preferably formed by eccentrically disposing an inner elongated tube within an outer elongated tube. Preferably the outer surface of the inner tube defines a crescent-shaped elongated chamber with the interior surface of the outer tube. A bundle containing a large number of optic fibers is disposed in the crescent-shaped chamber. Preferably, both ends of the bundle are optically polished to improve overall light transmission.

The distal end portion of the outer tube extends beyond the inner tube. The distal end portion of the optic fiber bundle extends partway between the ends of the inner and outer tubes as shown in the drawings. The outer tube is substantially shorter than the inner tube, and at the proximal end the inner tube extends beyond the outer tube. Both the inner and outer tubes are supported in suitable mounting members at their proximal ends. The tubes may be circular in cross-section but for some applications are preferably slightly elliptical and for some applications are preferably tapered.

A polished metallic tip is applied to the extended portion of the distal end of the outer tube. The distal ends of the optic fibers are formed into a rod shape and arranged adjacent the proximal end of the tip. A bridge is inserted across the distal end of the outer tube between the distal end portion of the optic fiber bundle and the distal end of the inner tube and serves to position and protect the distal end portion of the fiber bundle. At the proximal end the optic fiber bundle is gathered into a cylindrical rod at an angle to the axis of the inner and outer tubes, the gathering being aided by the differential length of the tubes. The proximal end of the bundle is supported by a jack which adapts the bundle to be coupled to an external source of light by any suitable means such as, for instance, a flexible fiber optic bundle.

The configuration of the proximal end portion of the optic fibers is preferably rod-like and substantially circular in form. However, any other form may be adopted, if desired. The distal end portion of the optic fibers as shown in the drawings and described herein is for use with optical image-transmitting means such as a forward oblique telescope. It is to be understood that different configurations of the distal end of the optic fiber bundle may be used with other telescope configurations, such as the right angle telscope and the retrospective telescope.

A telscope lens system is disposed within the inner tube. The lens system of the telescope may be of any suitable type, such as, for example, the lens system set forth in Patent No. 1,680,490, issued August 14, 1928. The objective lens of the telescope is disposed at the distal end of the inner tube, thus placing it closely adjacent to the distal end of the optic fiber bundle which is to furnish the illumination for the area under observation.

It is a feature of this invention that, by the use of optic fibers, the distal end portion of the optic fiber bundle may be placed significantly closer to the objective lens than was possible in telescopes utilizing a lamp for illumination. Surprisingly, this feature combined with the high intensity of light which may be transmitted by the optic fiber bundle provides a higher intensity of illumination than any previously before known, such as to enable examinations, diagnosis and surgery to be carried out under conditions never before achievable. The illumination thus provided is so brilliant as to permit motion pictures in color to be taken of the interior of the orifice.

While a preferred embodiment of the present invention comprises having the inner tube eccentric to the outer tube, it is to be understood that the tubes may be concentric, if desired. The eccentric form is preferred because this, like the slightly elliptical tube configuration, ordinarily results in an overall decrease in circumference of the instrument resulting in easier insertion of the endoscope into the orifice and less discomfort to the patient.

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.

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 all types of endoscopic equipment, particularly examining, operating and catheterizing endoscopes. A particular advantage of the present invention is the adaptability of the instrument to small size, for instance, for use in an infant cystoscope.

Rigid endoscopes having annularly disposed fiber optics 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. 3,236,110, issued February 22, 1966, continuous strands of fiber optics 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. This flat sheet is rolled together and inserted in the crescent-shaped chamber between the tubes.

If the tubes are nearly concentric, the inner tube of the endoscope may be brought into contact with the flat sheet, and the flat sheet rolled onto the inner tube in an even number of revolutions sufficient to produce the thickness of the annular bundle that is desired. Because the resin that was applied is tacky, the sheet sticks readily to the tube, and successive convolutions stick to each other. The inner tube and optic bundle may be inserted in the outer tube.

The proximal ends of the fibers may be formed into a rod by pulling the fibers together. If necessary a solvent is used to soften the resin. After forming, the rod may be inserted through a terminal fitting which supports it, and epoxy resin may be added to the rod end and also to the annular distal end. Finally the entire assembly may be baked to cure the resin and produce a hard, rigid endoscopic tube.

If it is desired to produce a bend in the tube, the fibers may be inserted as above and the bend made after the outer tube is applied, but before baking. The presence of the fibers between the two tubes aids in maintaining the tubes concentric. The resin may be made soft enough to permit the bundle to bend without breaking the fibers.

A preferred embodiment of the invention is an illuminated telescope. Such a telescope may be used alone but preferably is used in conjunction with a sheath and is useful in conjunction with a number of endoscopic instruments which do not have an integral means of illumination. In the embodiment shown in FIGURES 1–4 the lens system and the optic fibers are formed into a unit which is not ordinarily separable. In the embodiments of FIGURES 5–13 the lens system is easily separable from the optic fibers.

Turning now to FIGURES 1–4, telescope 10 is comprised of annular mounting members 12, 14 held in relative position to each other by annular ring 16 and screws 18. Outer tube 20 is connected to annular mounting member 14, the proximal end of outer tube 20 being substantially coextensive with shoulder 22 of member 14. Inner tube 24 is eccentrically disposed within outer tube 20 and is supported at its distal end by annular mounting member 12, the proximal end of inner tube 24 being substantially coextensive with the distal end of shoulder 26 of member 12. Inner tube 24 forms crescent-shaped chamber 28 with outer tube 20. Optic fibers 30 are disposed within the crescent-shaped space. The proximal end portion of optic fibers 30 is formed into a substantially cylindrical rod 32 which is supported by jack 34. Jack 34 is threadably connected to sleeve 36 which is connected to annular ring 16 and mounting members 12 and 14. The proximal end of rod 32 is substantially coextensive with the end of jack 34 but may be protected by a flat glass plate 35, if desired.

The distal end of telescope 10 is best shown in FIGURE 4. Outer tube 20 is cut on an angle, one side being longer than the other The long side 36 of outer tube 20 forms a support for tip 38, which may be made of polished metal or any suitable material. Bridge 40 is disposed across outer tube 20 as shown in FIGURE 4. Inner tube 24 extends adjacent to the bridge 40. Optic fibers 30 are formed into a solid distal end portion 42.

The forward oblique telescope configuration is shown in FIGURE 4. At its proximal end, the telescope is comprised of eyepiece 44 which is threadably connected to annular mounting member 12. Contained within the eyepiece is an ocular comprised of lens 45 supported in sleeve 46 which is in turn retained within a sleeve 48 that supports lens 50 and is threadably connected to mounting member 12. Protective member 52 is threadably connected to the eyepiece and serves to protect lens 50 from mechanical injury Permanently positioned inside of inner tube 24 is a telescope system made up of middle lenses 54 which may be composed of two elements 56 and 58 to render them achromatic. The lenses are spaced apart by lens spacers 60. Objective lens 62 is located at the distal end of inner tube 24. A locating pin 64 provides for registration of the telescope within a sheath, etc.

In operation, the telescope is ordinarily used with a sheath for maximum visualization of the internal orifice. The sheath with a suitable obturator may be inserted into the body orifice. Then the obturator is removed and the telescope is inserted within the sheath and connected to an external source of light, for instance, by means of a flexible light carrier coupling to jack 34 and to the light source. The portions of the orifice immediately adjacent to the objective lens may be brilliantly illuminated as an aid to examination and treatment.

Turning now to FIGURES 5–9 cystoscope 100 is comprised generally of light carrying sheath 102 and telescope 104 inserted in sheath 102. Sheath 102 is further comprised of annular mounting member 106 which is threadably engaged by mounting member 108. Gasket 110 is inserted between members 106 and 108 and serves to form a tight seal between them in the assembled position.

Sheath 102 is further comprised of outer tube 112 and inner tube 114. The proximal end of outer tube 112 is connected to mounting member 106 and terminates adjacent to jack 116 which is also connected to mounting member 106. Mounting ring 118 forms a tight seal with outer tube 112 and is positioned in relation to mounting member 106 by locating pin 120.

The flared proximal end portion 122 of inner tube 114 is connected to mounting member 106 and opens into channel 124. The proximal end portion of inner tube 114 terminates near the proximal end of mounting member 106, as shown in FIGURE 7. Mounting member 106 supports inner tube 114 in eccentric relation to outer tube 112 so that they form a crescent-shaped chamber 126 between them. Optic fibers 128 are disposed in chamber 126.

The distal end portion 130 of outer tube 112 extends beyond the distal end of inner tube 114 and is preferably bent to form a slight concave angle with the main body of outer tube 112. Polished metal tip 132 is inserted into the distal end portion 130 in order to aid the easy insertion of the cystoscope into the body orifice. Distal end portion 134 of optic fibers 128 is shaped into a solid bar configuration as shown in FIGURE 7 and is disposed between tip 132 and bridge 136 which is mounted on the distal end of inner tube 114.

Telescope 104 is inserted in sheath 102 in engagement with mounting ring 108. Telescope 104 is maintained in fixed position by a locking device made up of annular member 138 which is free to rotate about mounting member 108 but is restrained from longitudinal movement by annular ring 144 and by shoulder 140 on member 138 which engages a corresponding shoulder 142 on member 108. Annular member 138 may be rotated by manipulation of lever 146 to lock a pair of oppositely disposed pins 148 on telescope 104 into slots 150 of member 138, one slot 150 being shown in phantom.

Telescope 104 is further made up of eyepiece 152, an ocular (not shown), and a lens system is disposed within telescope tube 154. Telesocpe tube 154 extends within inner tube 114 and at its proximal end contains objective 156 which is positioned adjacent bridge 136. Spacers 158 maintain a spaced relation between the objective and succeeding internal lenses 160.

The proximal end portion 166 of optic fibers 128 is formed into a solid rod and disposed within and supported by jack 116.

Conduits 168, 170 communicate with channel 124 in mounting member 106 and may be used to introduce or remove fluids from the internal orifice through the inner tube 114. The flow of fluids through conduits 168, 170 is controlled by valves 172, 174, respectively. The fluids may flow through opening 176 in outer tube 112 and inner tube 114.

In operation, the cystoscope may be placed within the internal orifice, using an obturator to close opening 176. Following removal of the obturator, internal fluids may be drained or insufflation fluids may be inserted into the orifice. Telescope 104 may be readily inserted into the interior of inner tube 114 for observation of the internal orifice. The optic fibers, being coupled to an external source of light by means of jack 116, serve to conduct light to the distal end portion of the optic fibers to brilliantly illuminate the internal orifice

If desired, the sheath of this invention may be made in a convex configuration, as shown in FIGURE 9. The arrangement is similar to that as shown in FIGURES 5 through 8 except that outer tube 112 has a convex bend and serves to support tip 132 in a downward position with relation to optic fiber distal end portion 134 and bridge 136.

Culdoscope 200 is comprises of sheath 202 and telescope 204, as shown in FIGURES 10–13. Mounting member 206 supports component parts of sheath 202 and serves to threadably connect to telescope 204. Outer tube 208 is connected to mounting member 206 and terminates at its proximal end adjacent jack 210 which is also connected to mounting member 206. Inner tube 212 is flared at its distal end portion 214 and connected to mounting member 206. As shown in FIGURE 12, the proximal end of inner tube 214 is coextensive with shoulder 216 of mounting member 206.

Inner tube 212 is supported eccentrically adjacent and inside outer tube 208 forming a crescent-shaped chamber 218 therewith. Optic fibers 220 are disposed within the crescent-shaped chamber 218 and extend through the crescent-shaped chamber and through channel 222 in mounting member 206 into jack 210. The proximal end portions 224 of optic fibers 220 are formed into a solid rod and supported by jack 210.

Distal end portion 226 of outer tube 208 extends beyond the distal end portion of inner tube 212 and serves to support beak 228. Distal end portions 230 of optic fibers 220 are formed into a solid rod, as shown in FIGURE 12, which is mounted adjacent tip 228 and bridge 232.

The telescope 204 further comprises eyepiece 234 and an ocular (not shown). Telescope tube 236 extends within inner tube 212 and has its distal end objective 238. Spacers 240 serve to separate the objective lens and middle lenses 242.

In operation, the culdoscope may be inserted into the internal body orifice with the aid of a trocar and cannula, in well known manner. The optic fibers are then connected to a suitable source of external light by coupling to jack 210 and provide a high degree of illumination of the orifice. The telescope may be inserted into the inner tube for observation of the internal orifice.

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.

What is claimed is:

1. An endoscope suitable for use in examining internal cavities, comprising elongated tubular means forming side by side longitudinally extending chambers, said tubular means having a laterally presented opening formed therein adjacent one end thereof, a bridge member extending transversely of said tubular means in said opening, a plurality of light-carrying fibers extending in one of said chambers toward and beyond said bridge member with said fibers passing to one side of said bridge member away from said opening, said fibers adjacent said bridge member being rigidly adhered together and forming an end wall said fibers extending partially about said bridge member with said end wall disposed in said opening, and

said fibers at the end thereof remote from said bridge member being adapted for connection to a source of light, whereby light conducted by said fibers and exiting through said end wall is directed primarily laterally relative to said tubular means.

2. An instrument as set forth in claim 1 wherein said tubular means comprises a pair of tubes, one extending within the other.

3. An instrument as set forth in claim 2 wherein the inner one of said tubes is eccentrically disposed relative to the outer tube, and said one chamber is formed between said tubes.

4. An instrument as set forth in claim 1 wherein optical image-transmitting means in the other of said chambers includes objective means positioned adjacent to said bridge member with said bridge member extending between said objective means and said end wall of said fibers.

5. An instrument as set forth in claim 4 wherein said optical image-transmitting means comprises a telescope including an eyepiece adjacent the end of the inner tube remote from said bridge member.

6. An instrument as set form in claim 5 wherein said telescope is removably mounted in said inner tube.

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DALTON L. TRULUCK, *Examiner.*