United States Patent

Keller

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[54] DENTAL APPARATUS UTILIZING FIBER OPTICS

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[73] Assignee: **Fiber-Photics, Inc.**, Santa Cruz, Calif.

[22] Filed: **Apr. 2, 1969**

[21] Appl. No.: **812,823**

Related U.S. Application Data

[63] Continuation of Ser. No. 674,706, Oct. 9, 1967, abandoned.

[52] **U.S. Cl.**.....**240/41.15**, 32/69, 350/96 B, 240/1 EL, 240/2 MT, 240/4.2

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

[58] **Field of Search**.....240/41.15, 1 EL, 2 E, 2 MT, 240/2.18, 6.46, 47, 4.2; 350/96 B; 128/6, 11, 13, 16, 22, 398; 32/26, 27, 69

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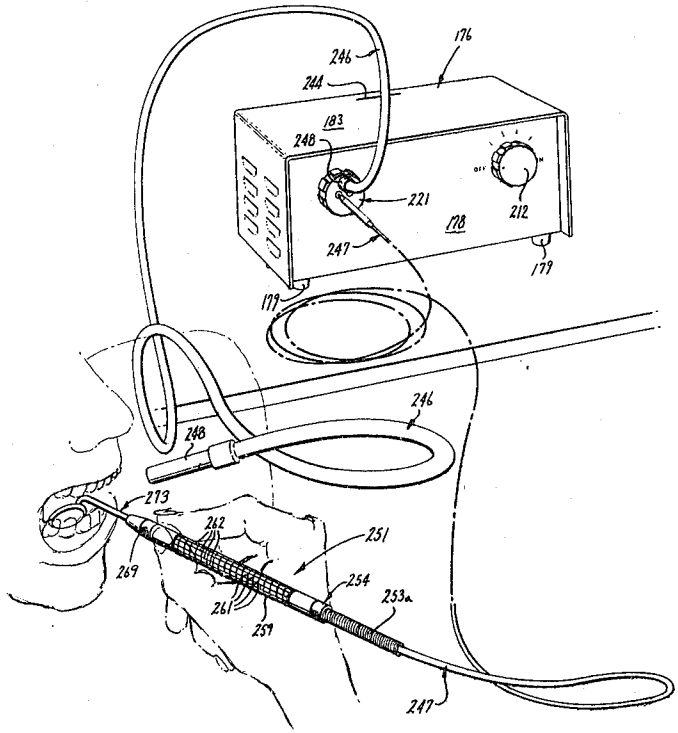
[57] **ABSTRACT**

Dental apparatus having a case with a lamp mounted in the case and producing a focused source of light at a predetermined focal point. A socket assembly is mounted in the case in the vicinity of the lamp. The socket assembly has at least first and second openings therein with the first opening being substantially larger than the second opening. A first large fiber optics cable is provided and has one end mounted in the first opening in the socket assembly so that it faces the focused source of light. The other end of the large fiber optics cable is adapted to be positioned to provide general illumination of a predetermined area. A second small fiber optics cable is provided and has one end mounted in the second opening in the socket assembly and also facing the focused source of light. A tool is mounted on the other end of the second cable so that the second cable provides a beam of light to provide localized illumination for use of the tool. The tool can be in the form of a hand dental mirror having a headlike substrate with a reflecting surface thereon and handle means secured to the substrate and connected to the second fiber optics cable. The hand dental mirror includes means for causing substantially all the light passing from the fiber optics cable connected to the handle means to pass from the substrate in a direction generally perpendicular to the reflecting surface and from a generally localized area with respect to the substrate.

16 Claims, 25 Drawing Figures



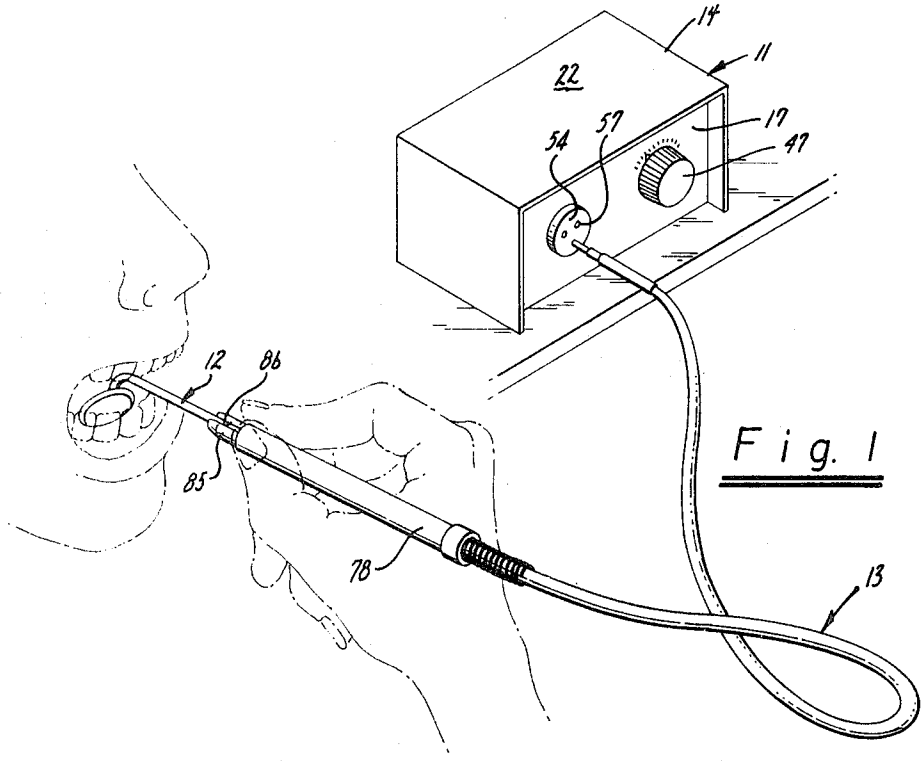
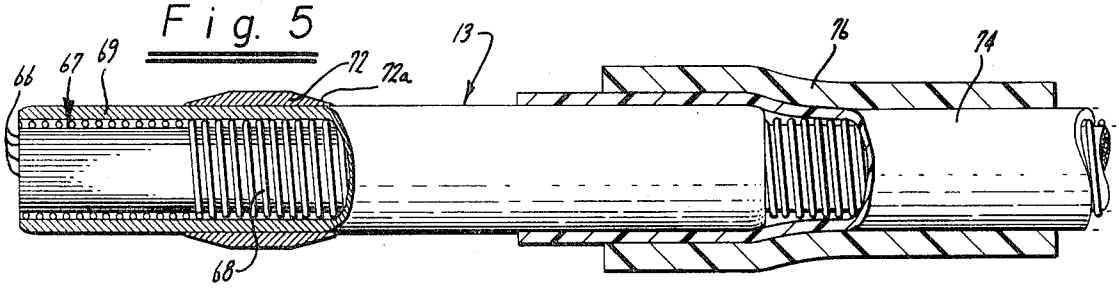


Fig. 1

Fig. 5



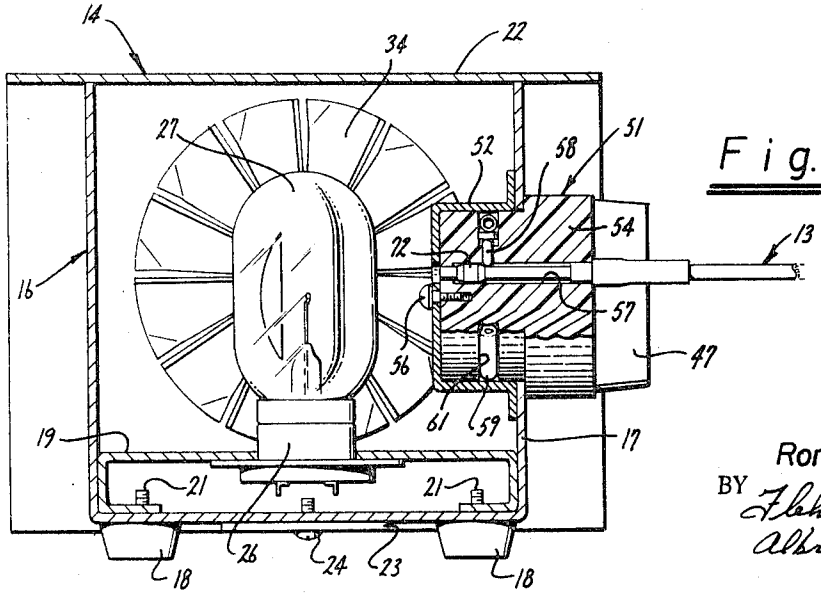


Fig. 3

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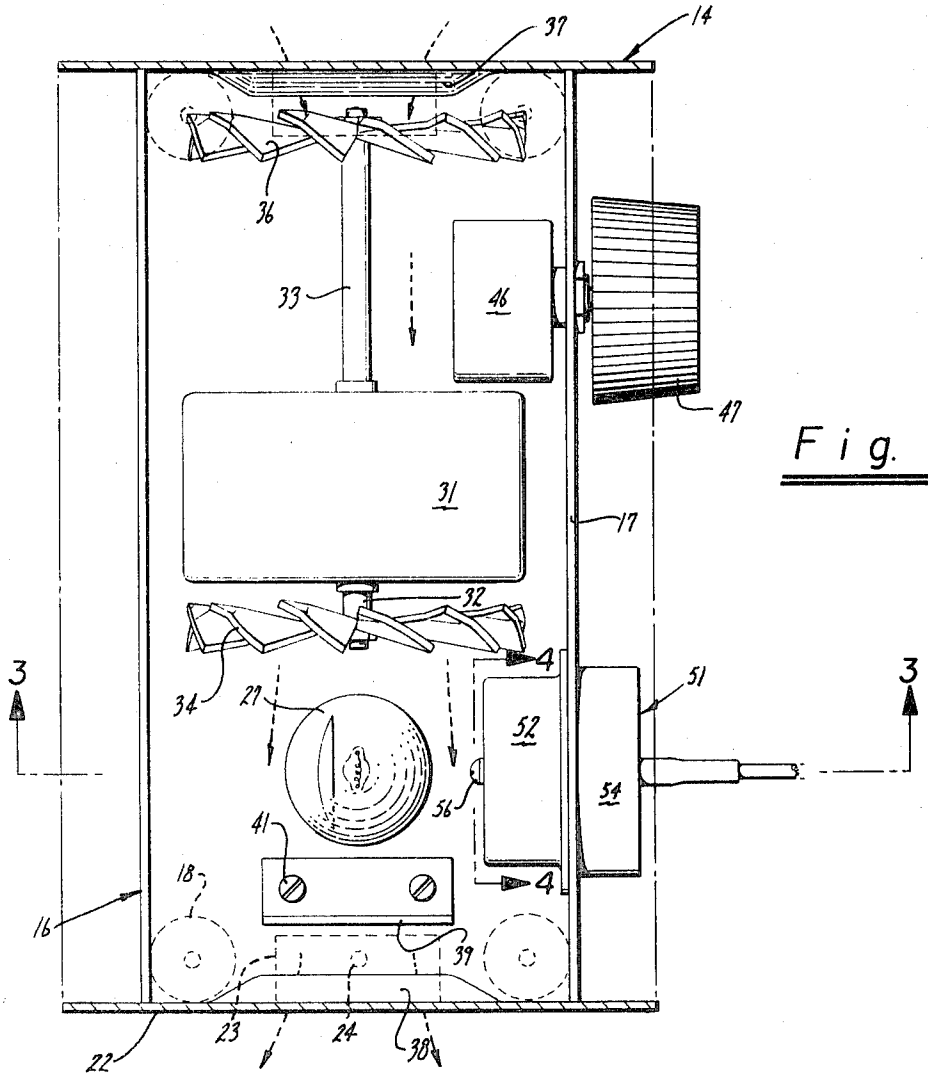

Fig. 2

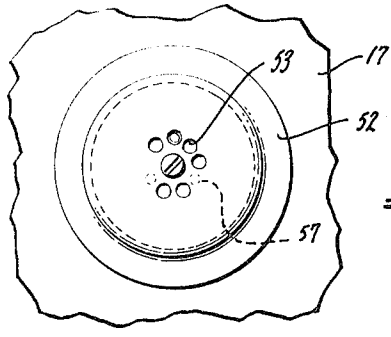

Fig. 4

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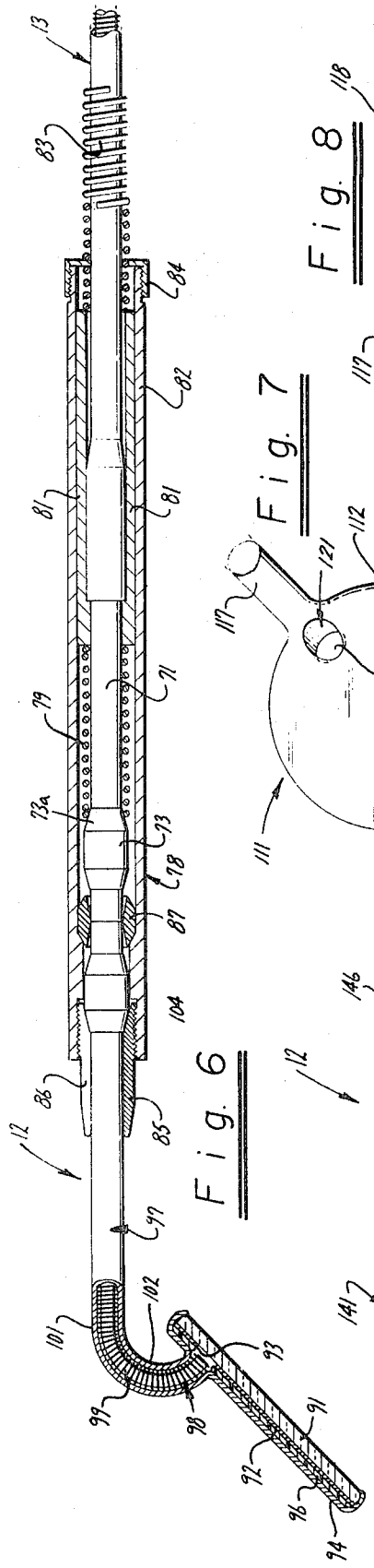

Fig. 6

Fig. 8

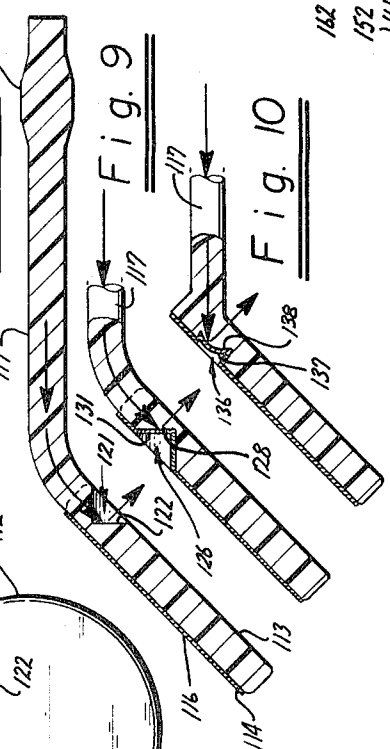

Fig. 9

Fig. 10

Fig. 11

Fig. 12

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Fig. 13

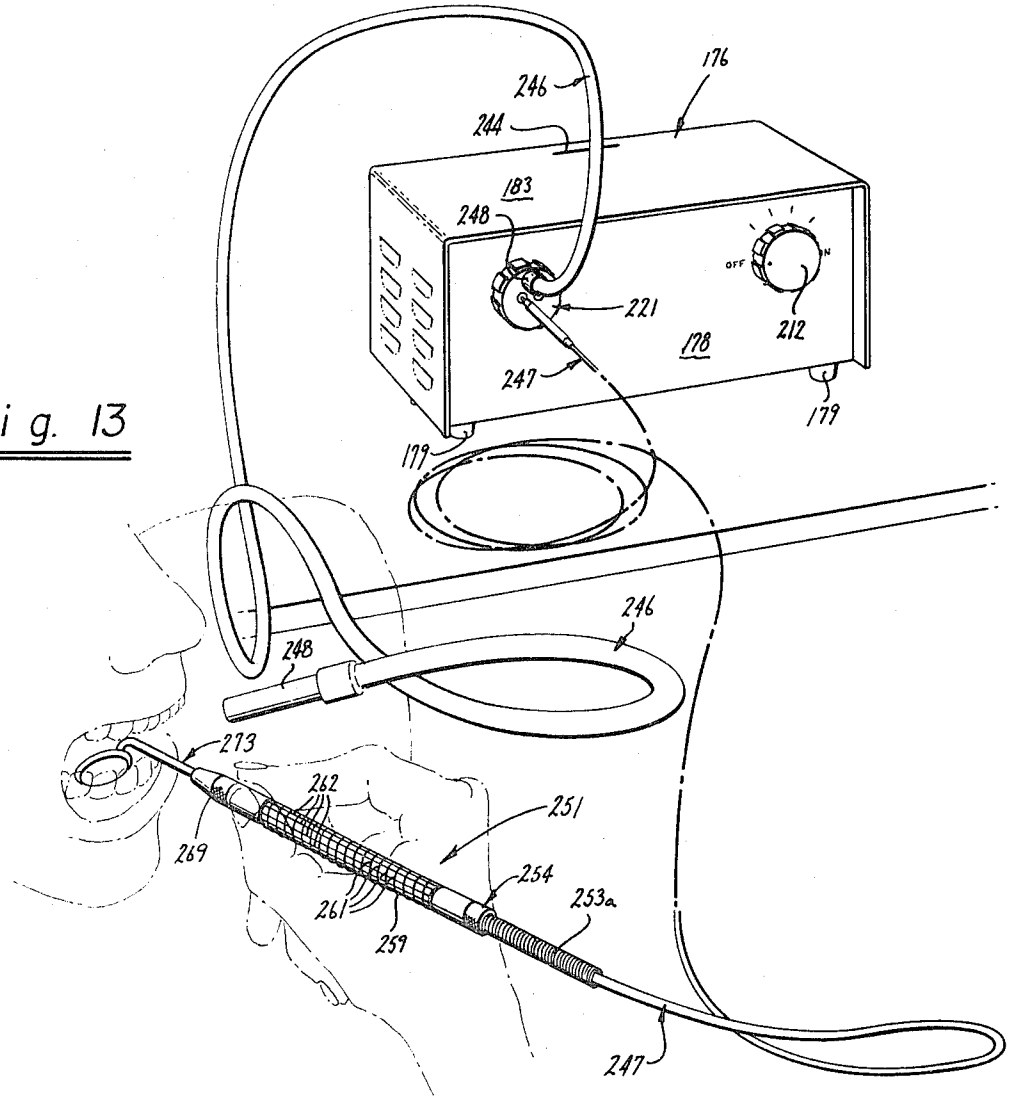
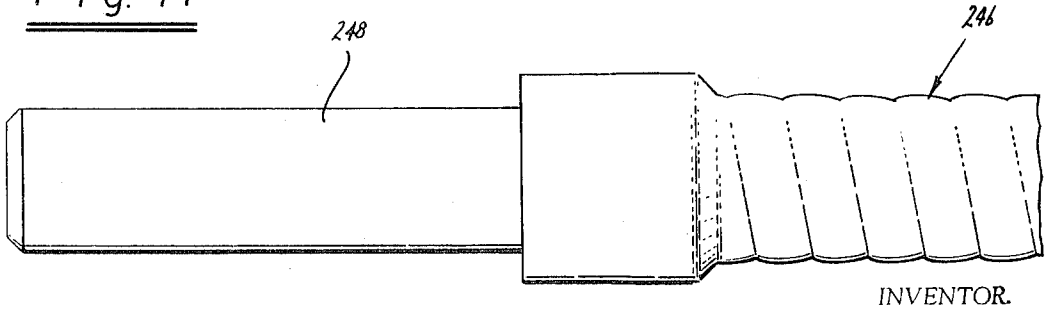


Fig. 14



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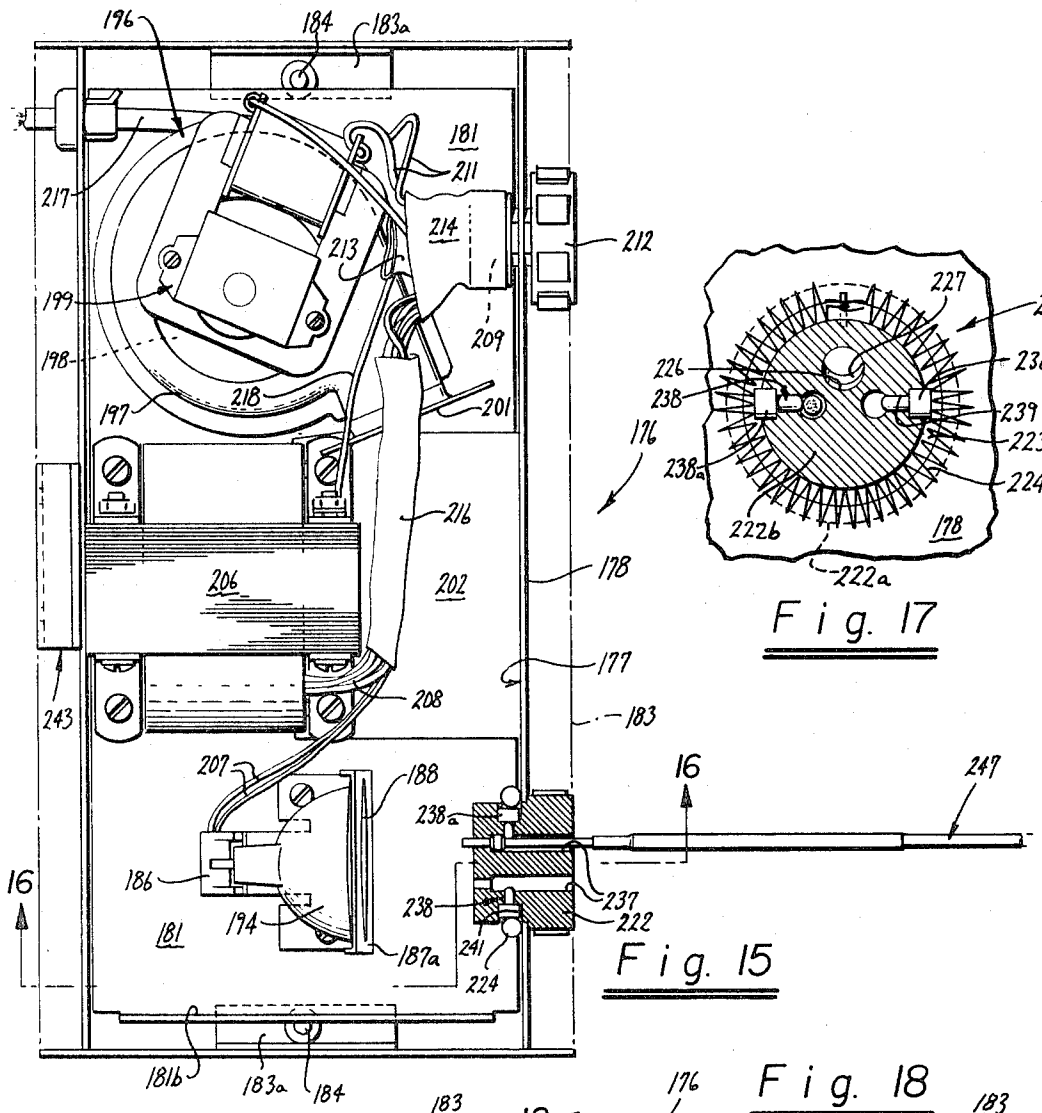

Fig. 15

Fig. 17

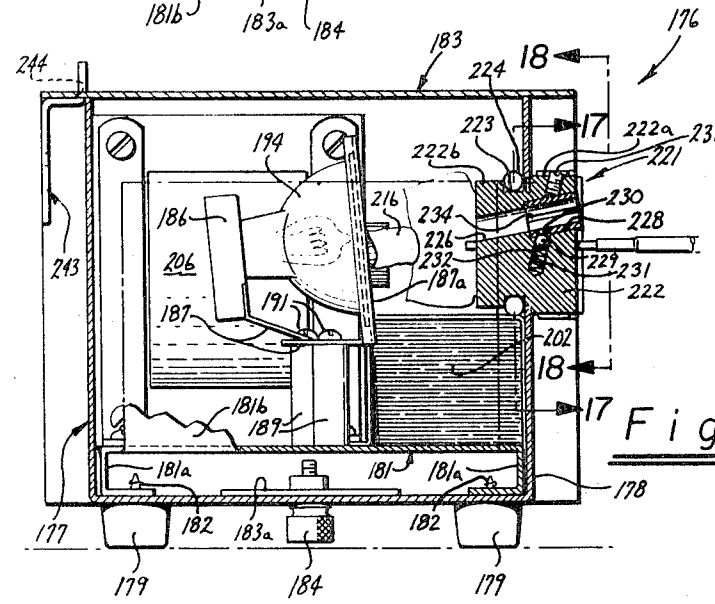

Fig. 16

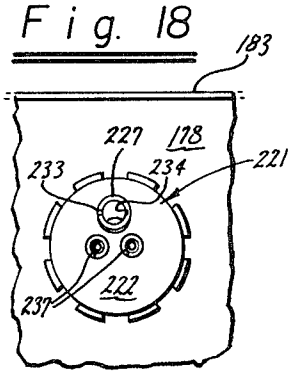

Fig. 18

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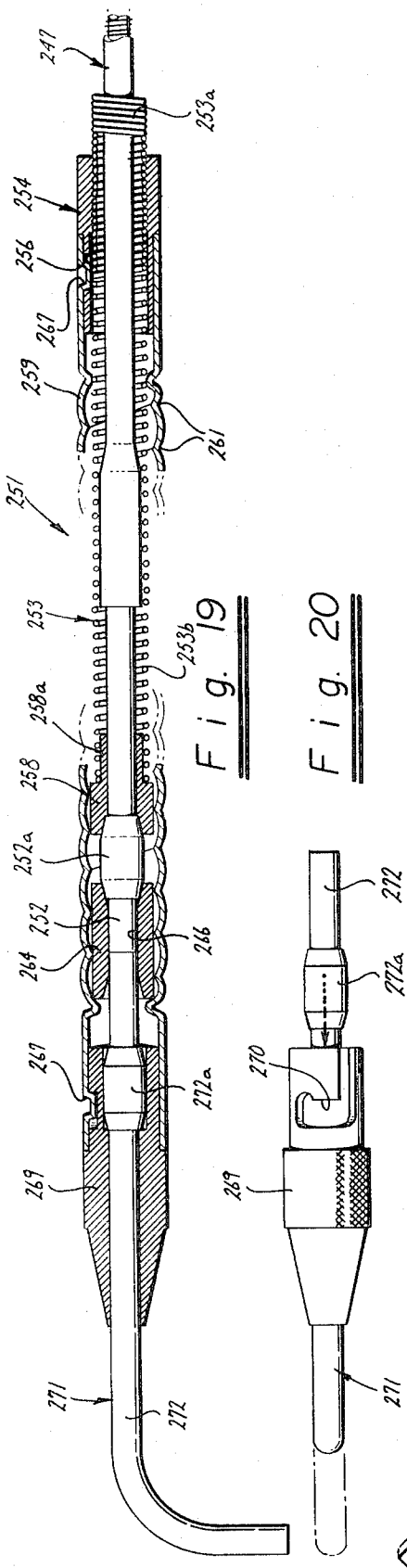

Fig. 19

Fig. 20

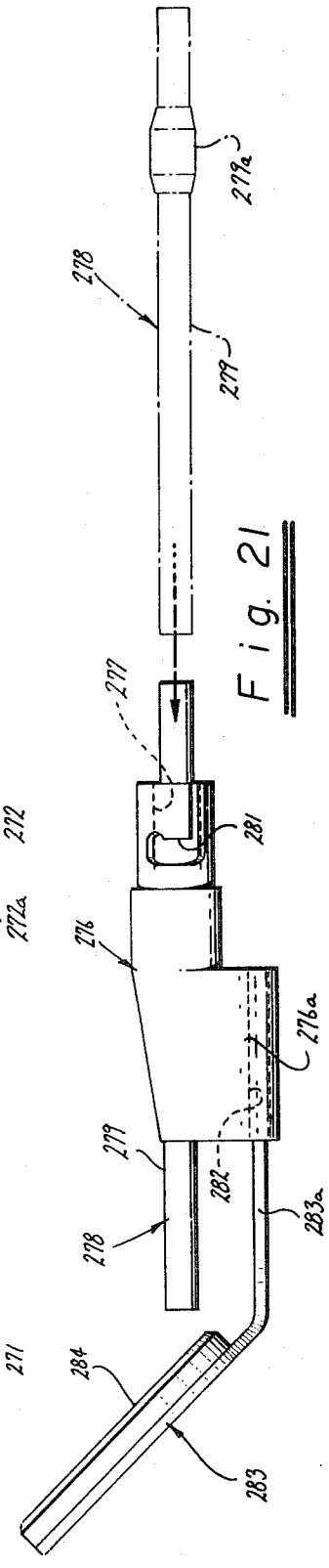

Fig. 21

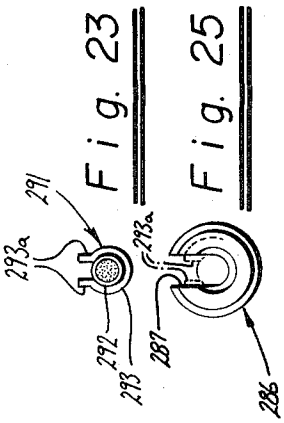

Fig. 23

Fig. 25

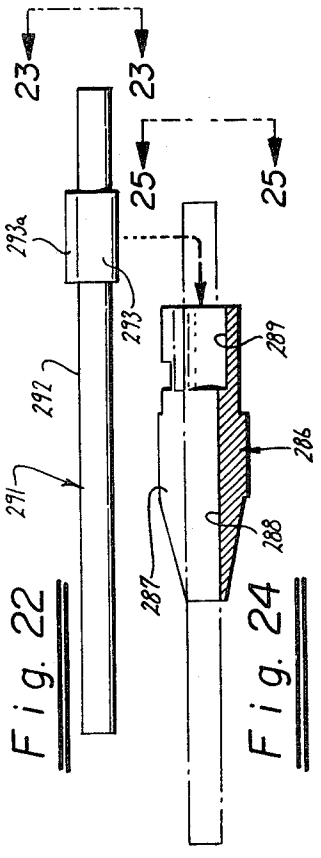

Fig. 22

Fig. 24

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DENTAL APPARATUS UTILIZING FIBER OPTICS

This application is a continuation-in-part of application Ser. No. 674,706, filed Oct. 9, 1967 now abandoned.

BACKGROUND OF THE INVENTION

This invention relates to dental apparatus. Heretofore in dental apparatus, it has been the practice to provide illumination by the use of a light source and a large curved mirror for reflecting a relatively large beam of light onto the patient's head and, in particular, in the area of the mouth in which the dental work is to be performed. Such illumination has not been entirely satisfactory because the hands and the instruments often shade the area in which work is being performed and, therefore, it is necessary for the dentist to handle the tools being utilized in such a manner that they do not shadow the work area.

SUMMARY OF THE INVENTION AND OBJECTS

The dental apparatus consists of a source of light and a dental tool. A flexible fiber optics cable is provided which has one end facing the source of light and which has the other end secured to the dental tool and carries light to the dental tool and throws a beam of light in the vicinity of said dental tool and onto the area in which work is to be performed.

In general, it is an object of the present invention to provide a dental apparatus in which illumination is provided in the vicinity of the dental tool and onto the area in which work is to be performed by the use of a flexible fiber optics cable.

Another object of the invention is to provide a dental apparatus of the above character which is particularly useful for handtools utilized in dental procedures.

Another object of the invention is to provide a dental apparatus of the above character which is relatively light and compact.

Another object of the invention is to provide a dental apparatus of the above character in which the flexible cable utilized is very light and flexible and does not impede use of the handtools.

Another object of the invention is to provide a dental apparatus of the above character which can be readily and economically manufactured.

Another object of the invention is to provide a unique flexible fiber optics cable and method for making the same.

Additional objects and features of the invention will appear from the following description in which the preferred embodiment is set forth in conjunction with the accompanying drawing.

BRIEF DESCRIPTION OF THE DRAWING

FIG. 1 is a perspective view of a dental apparatus incorporating the present invention and in particular showing its use in connection with a dental mirror.

FIG. 2 is a top plan cross-sectional view of the light source shown in FIG. 1.

FIG. 3 is a cross-sectional view taken along the line 3—3 of FIG. 2.

FIG. 4 is a cross-sectional view taken along the line 4—4 of FIG. 2.

FIG. 5 is a greatly enlarged cross-sectional view of one end of the flexible fiber optics cable utilized in the dental apparatus shown in FIG. 1 and, in particular, shows the end which is to be connected to the light source.

FIG. 6 is a cross-sectional view with certain portions broken away of the dental mirror and the other end of the flexible fiber optics cable.

FIGS. 7 and 8 show respectively a partial exterior view and a cross-sectional view of another embodiment of a dental mirror which can be used in the dental apparatus shown in FIGS. 1–6.

FIGS. 9 and 10 are cross-sectional views of additional embodiments of dental mirrors which can be utilized in the dental apparatus shown in FIGS. 1–6.

FIG. 11 is a side elevational view with certain portions broken away showing a diagnostic tool which can be utilized in the dental apparatus shown in FIGS. 1–6.

FIG. 12 is a side elevational view with certain portions in cross section showing the manner in which a high-speed turbine handpiece can be utilized in conjunction with the dental apparatus shown in FIGS. 1–6.

FIG. 13 is a perspective view of another embodiment of a dental apparatus incorporating the present invention and showing use of the same.

FIG. 14 is an enlarged view of the large fiber optics bundle shown in FIG. 13 and used for general illumination of the mouth.

FIG. 15 is a top plan view in cross section of the dental apparatus shown in FIG. 13.

FIG. 16 is an end elevational view in cross section taken along the line 16—16 of FIG. 15.

FIG. 17 is a cross-sectional view taken along the line 17—17 of FIG. 15.

FIG. 18 is a cross-sectional view taken along the line 18—18 of FIG. 16.

FIG. 19 is an enlarged view in cross section of a fiber optics cable utilized in conjunction with the general apparatus shown in FIG. 13.

FIG. 20 is a view at right angles to the view shown in FIG. 19 of a portion of the cable assembly shown in FIG. 19.

FIG. 21 shows an attachment whereby a conventional dental mirror can be utilized in conjunction with the dental apparatus.

FIG. 22 is a side elevational view of a probe utilized in the dental apparatus.

FIG. 23 is an end elevational view taken along the line 23—23 of FIG. 22.

FIG. 24 is a side elevational view of a socket utilized in conjunction with the dental apparatus.

FIG. 25 is a view looking along the line 25—25 of FIG. 24.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The dental apparatus shown in FIGS. 1–6 consists of a light source 11 and a dental tool 12. A fiber optics cable 13 is provided which connects the light source to the dental tool 12. The dental tool 12 can be of any desired type. However, in FIGS. 1–6, it is shown as a dental mirror.

The light source 11 consists of a housing or case 14 of a suitable type as, for example, a sheet metal case. The case is formed of a U-shaped member 16, one side of which forms a front panel 17. Rubber feet 18 are mounted on the bottom side thereof. A baseplate 19 is mounted within the U-shaped member 16 and is secured to the baseplate by the screws 21 provided in the rubber feet 18. A top U-shaped coverplate 22 is mounted over the top of the U-shaped member 16 and is provided with inwardly turned portions 23 which are secured to the bottom of the U-shaped member 16 by screws 24.

A socket 26 is mounted in the baseplate 19 and carries a projection bulb 27 of a suitable type such as a Sylvania DLH 250 watt, 120 volt. As is well known to those skilled in the art, the projection bulb 27 provides a focused beam of light of relatively high intensity.

Means is provided for cooling the bulb 27 and consists of an electric motor 31 mounted upon the baseplate 19 and which is provided with dual output shafts 32 and 33. Fans 34 and 36 are mounted on the shafts 32 and 33 are driven by the shafts. As can be seen from FIG. 2, fans 34 and 36 draw air through louvered openings 37 provided in one end of the U-shaped cover 22 and draw the same over the motor to cool the motor and then force the air over the projection bulb and out through louvered openings 38 provided in the other end of the U-shaped cover 22. A light shield 39 is mounted on the baseplate 19 by screws 41 and serves to prevent the escape of light from the bulb 27 through the louvered openings 38.

A light dimmer 46 of a conventional type which utilizes an SCR circuit is mounted upon the front side 17 of the U-shaped

member **16** and is provided with a control knob **47** so the intensity of the lamp or bulb **27** can be controlled by adjustment of the knob **47**.

A socket assembly **51** is also mounted on the front side **17** of the U-shaped member **16**. The socket assembly consists of a female cup-shaped receptacle **52** which is mounted on the rear side of the U-shaped member **16** and is secured thereto in a suitable manner. The cup-shaped receptacle **52** is provided with a plurality of holes **53** (see FIG. **4**), for a purpose hereinafter described, in which three of the holes are provided in 120°; two holes are provided in another 120°; and only one hole is provided in the other 120° of the 360° circle in which the holes **53** are disposed. A male plug **54** is rotatably mounted in the cup-shaped receptacle **52** and is held therein by a screw **56** threaded into the member **54**. The plug **54** is provided with three holes **57** which are spaced 120° apart and which extend through the plug in a direction which is parallel to the axis of rotation for the plug and which are adapted to be moved into registration with the holes **53** provided in the plug. By rotation of the plug **54** within the cup-shaped socket member **52**, a single hole **57** can be moved into registration with one of the holes **53** provided in the plug or, alternatively, two of the holes **57** or three of the holes **57** can be moved into registration with holes **53** so that by choice either one of the holes, two of the holes, or three of the holes **57** can be aligned with the holes **53** and receive light from the projection bulb **27**.

The socket assembly **51** is provided with means for retaining the fiber optics cable **13** in the plug with one end of the fiber optics cable in registration with one of the holes **53** in the socket assembly and disposed facing the bulb **27** in the light source **11**. Such means consists of a detent **58** for each of the holes **57** provided in the plug and which is slidably mounted in the plug at right angles to the holes **57** so that it can enter the hole and engage one end of the fiber optics cable **13** as shown particularly in FIG. **3**. Yieldable means is provided for yieldably urging the detent into engagement with the end of the cable **13** and consists of a resilient O-ring **59** mounted in an annular groove **61** of the male plug **54**.

The fiber optics cable **13** consists of a plurality of fiber optic elements such as glass fibers **66** which are formed into a bundle **67**. The fibers **66** are preferably formed of glass and they can have any suitable dimension as, for example, from one-half to 3½ thousandths of an inch. By way of example, glass fibers having a diameter of 3 mils and having a length of 6 feet were utilized. Approximately 250 to 300 of the glass fibers were used to form a bundle having a diameter of 0.065 of an inch. After the fibers had been formed into the bundle, the bundle was impregnated with the suitable lubricant such as sucrose acetate manufactured by Eastman Kodak and were then slid into an elongate helical spring **68** having a suitable length so that the spring extends over along the entire length of the bundle. The spring is formed so that the bundle **67** substantially fills the space within the spring. The spring can be formed of any suitable material such as piano wire having a diameter of 0,006 of an inch. However, piano wire ranging from 0.004 to 0.014 of an inch can be utilized, although the best range would be from 0.006 to 0.012 of an inch. The spring **68** was wound in such a manner that the gap between each turn of the spring was substantially equal to the diameter of the wire forming the spring. As is well known to those skilled in the art, this can be identified as a spring having a 100 percent gap. If desired, the gap can be either increased or decreased.

After the bundle **67** has been inserted in the spring **68**, the ends of the spring **68** are cut off so they are flush with the ends of the bundle. Metal end pieces **69** and **71** formed of a suitable material such as brass are mounted on the ends of the bundle **67** and the spring **68**. By way of example, the brass end pieces could have an inside diameter of 0.111 and an outside diameter of 0.125 of an inch. The spring **68** preferably should have a diameter which is slightly greater than the inner diameter of the end pieces **71**. Thus, by way of example, the spring **68** could have an outside diameter dimension of 0.113 to 0.114 of an inch. In mounting the end pieces **69** and **71**, the ends of the spring **68** are then threaded into the end pieces until they are flush with the end pieces as shown in FIG. **5**. Swaged members **72** and **73** are mounted on the end pieces **69** and **71** but are spaced from the ends of the bundle **67**. As can be seen from FIGS. **5** and **6**, the swaged members **72** and **73** have tapered end portions **72***a* and **73***a*—, respectively.

The bundle **67** with the spring **68** and the end pieces **69** and **71** thereon are then slipped into suitable protective tubing **74**. Preferably, the tubing should be a shrink tubing such as that made out of Teflon, RNS or vinyl. By way of example, ⅛-inch vinyl can be used. After the tubing **74** has been placed over the spring **68** and the end pieces **69** and **71**, the assembly is placed in an oven to shrink the tubing onto the spring **68**. This can be accomplished in a suitable manner such as by placing the assembly in an oven at 300° C. for a period of 5 minutes. The ends are then additionally reinforced by additional tubelike shrink members **76** formed of the same material as the tubing **74** and which are placed over the inner ends of the end pieces **69** and **71** and over the adjacent portions of the spring **68** extending out of the end pieces **69** and **71**. These are also shrunk into place at the same time when the assembly is placed in the oven.

After this has been completed, the ends of the bundles of fiber are impregnated with a suitable material such as an epoxy with a syringe. After the resin or epoxy has hardened, the ends can be cut off so they are square, and thereafter the ends are ground and polished so that the ends of the fibers **66** lie in a plane and are adapted to be exposed to a source of light.

A holder **78** is then mounted on one end of the fiber optics cable which has been formed. This holder **78** consists of a coil spring **79** which is mounted on the brass end piece **71** and has one end engaging the swaged member **73** and has the other end engaging a split sleeve **81** which encompasses the tubular member **76** and which is disposed within a larger tubular member **82**. Another spring **83** is mounted on the cable **13** and engages the other end of the split sleeve **81** and is retained in engagement with the split sleeve by a cap **84** which is threaded onto one end of the tubular member **82**.

A ferrule **85** is threaded into the other end of the tubular member **82** and is provided with a large slot **86** which is adapted to receive the dental tool **12** as hereinafter described. Another ferrule **87** is mounted in the tubular member **82** adjacent the end and in which the ferrule **85** is threaded and is adapted to receive the end of the cable **13**. The ferrule **87** is of such a size that the swaged member **73** cannot pass through the same and, therefore, the ferrule **87** serves as a stop to prevent the spring **79** from urging the end of the cable **13** through the tubular member **82**.

As hereinbefore explained, the dental tool **12** which is shown in FIGS. **1–6** is in the form of a dental mirror. The dental mirror is constructed of a circular glass mirror **90** which consists of a glass substrate **91** which is provided with a surface, such as a rear or front surface, which is coated with a layer **92** of a suitable material such as silver or aluminum. A small opening **93** is provided in the layer **92** adjacent one edge. This can be accomplished by making a hole in the layer **92** after it has been placed on the glass substrate **91**, or means can be provided for preventing the deposition of the metal in this area forming the opening **93**.

A mirror holder **94** formed of a suitable material such as brass is provided. As can be seen from FIG. **6**, the outer margin of the holder **94** is turned over the edge of the glass substrate **91**. A gasket **96** is provided for forming a tight fit between the glass substrate **91** and the holder. The tool is provided with a light-transmitting handle **97** which is secured to the mirror holder. As can be seen from FIG. **6**, the handle **97** includes a bundle **68** of glass fibers of the type hereinbefore described which are mounted in a spring **99**. The bundle **98** with the spring **99** are mounted in a tube **101**. The dimensions of the bundle **98**, the spring **99** and the tube **101** are similar to

the bundle 67, the spring 68 and the end pieces 71. Thereafter, the tube 101 is bent to form a relatively sharp bend or gooseneck 102 by placing the tube in a bending fixture. It has been found that the spring 98 prevents the tube 101 from collapsing and, in addition, it serves to keep a constant outside diameter for the tube 101 throughout the bend. After this has been accomplished, the ends of the bundle 98 are impregnated with an epoxy and after the epoxy hardens, the ends are ground and polished in the manner hereinbefore described.

As soon as the ends of the handle 97 are completed, the handle is secured to the mirror holder 94 so that the end of the bundle is in alignment with the opening 93 provided in the mirror. The handle 97 is then affixed to the holder by suitable means such as silver solder. The tool is mounted in the holder 78 by grasping the tool and placing it in the slot 86 of the ferrule 85. The ferrule 85 with the tool therein is threaded into the holder 78 so that the tool engages the end of the cable 13 and urges it to the right as viewed in FIG. 6 to establish a good contact between the tool and the cable. In place of the threaded ferrule 85, a bayonet-type fitting can be utilized.

Use of the dental apparatus may now be briefly described as follows. Let it be assumed that it is desired to use the apparatus for inspecting the teeth of a patient as shown in FIG. 1. The light source 11 is connected to a suitable source of power such as 110 volts AC so that the bulb 27 is lit. The bulb is adjusted to the proper intensity by rotation of the knob 47. If it is desired to utilize only one dental tool at a time, the plug 54 is rotated so that only one of the holes 57 is in registration with one of the holes 53 provided in the cup-shaped female receptacle 52. The end of the cable 13 not carrying the holder 78 is inserted into the hole 57 until the end of the cable is adjacent the bulb 27 and so that the swaged member 72 is pressed beyond the detent 58 whereby the end of the cable is retained within the plug 54. The dental tool which is to be used, assuming it is the dental mirror, is then inserted in the ferrule 85 which is provided with slot 86. The ferrule 85 is threaded into the tubular member 82 so that the end of the dental mirror engages the other end of cable 13. The dental apparatus is then ready for use. Light from the bulb 27 passes through the holes 53 and into the fibers 66 and is carried with very high efficiency through the cable 13 and into the light fibers carried by the dental tool. Light is emitted from the end of the light bundle of the tool and passes through the opening provided in the silver on the mirror 90 and forms a cone of light which shines directly onto the area being inspected. Light reflected from the teeth onto the mirror permits the dentist to clearly see the area being examined.

It has been found that the dental apparatus has a great advantage in that the light is always directed towards the area which is being inspected by the dental mirror to always ensure that there is more than adequate light to perform the inspection. Since the area of the mirror through which the light passes is relatively small and is offset to one side, there is substantially no disadvantage from having the light enter and pass through the mirror in this manner. The fiber optics cable 13 is constructed in such a manner so that it is very flexible and does not impede movement of the dental mirror. The light is transmitted by the cable with very high efficiency and also readily passes through the bend 102 provided in the dental mirror. Because of the use of the spring which extends the entire length of the bundle of fibers, it is possible to bend the cable 13 into relatively sharp bends without any danger of breaking the glass fibers which are being utilized. The cable is relatively small and compact and, therefore, does not impede use of the dental mirror by the dentist. In addition, the cable is constructed in such a manner so that it can withstand relatively rough usage without danger of breaking the same.

Another embodiment of the dental mirror is shown in FIGS. 7 and 8. In this embodiment of the dental mirror, the entire dental mirror is formed of a suitable light-transmitting plastic material such as Lucite which has been molded into the proper shape. Thus, the dental mirror takes the form of Lucite body 111 which is provided with a circular portion 112 having surfaces 113 and 114. The surface 114 is provided with a coating 116 of silver which forms a reflective surface. The body is also provided with a tubular handle portion 117 that is formed integral with the portion 112 and which is provided with an enlarged portion 118 near the end of the same which has the same configuration as the swaged member 72 provided in the previous embodiment hereinbefore described. The portion 112 of the body 111 is provided with a V-shaped recess 121 on the surface 113 adjacent the point at which the handle portion 117 adjoins the portion 112. The recess is provided with two inclined surfaces 122 and 123 which form the recess 121. The surface 122 is disposed at a suitable angle as, for example, an angle of 45° with respect to the longitudinal axis of the handle portion 117 so as to reflect light being carried down the handle portion out of the portion 112 in a direction which is substantially perpendicular to the surface 113. It has been found that this plastic dental mirror can be used in the same manner as the dental mirror shown in FIGS. 1–6. It can be utilized with the same cable 13 and the holder 78 carried by the cable. It can be mounted in the ferrule 85 and placed in the holder 78 in the same manner as hereinbefore described. Light then passes from the light source 11 through the cable 13, through the Lucite handle portion 117 until it strikes the surface 122 and is reflected from that surface into the area which is being inspected. The silver surface 114 then acts to form the mirror in the same manner as the mirror 90 to permit inspection of the area on which the light is being shone by the dental mirror. Again, as can be seen from FIGS. 7 and 8, the recess 121 is positioned so that it does not materially affect the area of the mirror used for viewing.

In the embodiment of the invention shown in FIGS. 7 and 8, the recess is formed in the front side of the mirror. In the embodiment of the invention shown in FIG. 9, a recess 126 is formed on the rear side of the portion 112. The surface 128 is provided with a silver coating 131 which forms an angle of approximately 45—° with respect to the longitudinal axis of the handle portion 117 and serves to reflect light travelling down the handle portion into the area to be inspected in the same manner as described in conjunction with FIGS. 7 and 8.

Another embodiment of the invention is shown in FIG. 10 which also is formed of a suitable light-transmitting plastic such as Lucite. However, in this case, a recess 136 is formed on the surface 114 and the area within the recess is coated with a silver coating 137 to provide a parabolic reflecting surface 138 which is adapted to gather light as it passes from the handle portion 117 and to generally focus the light onto the area being inspected with the dental mirror.

In all of the embodiments of the dental mirror, the dental mirror can be utilized with the same cable 13 and light source 11.

Other dental tools can be utilized in conjunction with the light source 11 can the cable 13. For example, a dental tool which can be called a transilluminator 141 is provided in FIG. 11. The transilluminator 141 is formed in a manner similar to the dental mirror. A bundle 142 of fibers is mounted in a spring 143 and the spring and bundle are carried within a tube 144. A swaged member 146 is mounted on the tube adjacent one end thereof. The other end of the tube is provided with a right-angle bend 147 as shown in FIG. 6. The ends of the bundle 142 are then filled with an epoxy and ground and polished in the manner hereinbefore described. This transilluminator 141 can be utilized with the cable 13 and the holder 78 in the same manner as the dental mirrors hereinbefore described. The transilluminator can be utilized for shining directly onto the teeth a relatively sharp beam of light to permit inspection of the teeth with the light shining through the teeth. The teeth are relatively translucent and, therefore, a dentist is able to determine whether cavities are present in the teeth without resorting to the use of X-rays.

Still another dental tool which can be utilized with the light source 11 and the fiber optics cable 13 is shown in FIG. 12 and consists of a high-speed turbine handpiece 151 of a suitable

type such as one manufactured by the Star Dental Manufacturing Co., Inc. of Philadelphia, Pa. Such a high-speed handpiece, well known to those skilled in the art, is provided with an air tube **152** and a water tube **153**. It is also provided with a turbine head **154** which carries a shaft **156** which is driven by a turbine **157**. The shaft carries the burr (not shown) which is used for drilling in the teeth. A fiber optics cable **161** similar to the fiber optics cable **13** is provided and is formed as an integral part of the handpiece **151**. The cable **161** is provided with a bundle **162** which is mounted in a spring (not shown). The bundle **162** and the spring are mounted in heat-shrinkable tube **163**. The cable is provided with an end **166** which is adjacent the head **154** and is adapted to shine light onto the area in which the dentist is working with the handpiece. The other end of the cable **161** can be constructed in the same manner as the cable **13** and connected to the light source **11** in the same manner.

Another embodiment of the dental apparatus is shown in FIGS. 13–18 and consists of a housing or case **176**. The case **176** consists of a U-shaped member **177**, one side of which serves as a front panel **178**. Rubber feet **179** are mounted upon the bottom side of the U-shaped member **177**. The bottom of the U-shaped member **177** is provided with louvered openings (not shown). A baseplate **181** is mounted within the U-shaped member **177** and is provided with downwardly depending and inwardly extending leg portions **181***a* which are secured to the U-shaped member **177** by screws **182** that are utilized for securing the feet **179** to the U-shaped member **177**. It can be seen from FIG. **16** that the leg portions **181***a* space the baseplate **181** a substantial distance above the bottom of the U-shaped member **177** to permit air to flow therebetween.

A cover **183** is mounted over the top of the U-shaped member **177** and is provided with inwardly turned portions **183***a* which are secured to the bottom of the U-shaped member **177** by thumbscrews **184**. The baseplate **181** is provided with an upturned portion **181***b* (see FIG. **15**) for a purpose hereinafter described.

A socket **186** of a conventional type is mounted in a bracket **187** which is also of a conventional type. The bracket **187** is formed of metal and is provided with a frontal portion **187***a* which has a large hole **188** therein. The bracket **187** is mounted upon a pair of metal posts **189** by screws **191**. The posts **189** are secured to the baseplate **181** by screws **192**. A lamp **194** of a suitable type, such as a G.E.-type EKN axial quartz iodine lamp, is mounted in the socket **186** and engages the frontal portion **187***a* of the bracket **187**. The lamp **194**, as is well known to those skilled in the art, has an external reflector which is referenced with respect to the socket **186** so that the focused light which is emitted by the lamp **194** is always focused at the same spot or focal point. This is true because the reflector of the lamp **194** is always positioned in the same manner in the socket **186**. Thus, when the lamp **194** is replaced, it still will reflect light to the same predetermined focal point. This is important because it is the positioning of the reflector rather than the filament of the lamp which determines where the light will be focused. The lamp **194** produces a focused beam of light of relatively high intensity.

Means is provided for cooling the lamp **194** and consists of a centrifugal fan **196** which is mounted within the housing **197**. The fan **196** is mounted upon the baseplate **181** which has a hole (not shown) therein through which air is drawn into the housing **197** by a fan **198**. The fan **198** is driven by a small electric motor **199** mounted on the housing **197**. The fan **198** discharges the air through a discharge outlet **201**.

From FIG. **15** it can be seen that the lamp **194** is mounted on one side of the baseplate **181**, whereas the fan assembly **196** is mounted on the other end of the baseplate. The air which is discharged from the discharge outlet **201** of the fan assembly is directed slightly upwardly by an inclined ramplike plate **202** mounted upon the baseplate **181** between the fan assembly **196** and the lamp **194**. One end of the plate **202** is at a point which is below the discharge outlet **201**, whereas the other end of the plate is adjacent the lower extremity of the lamp **194**. From the arrangement shown, it can be seen that the cooling air will be directed over the frontal portion of the lamp **194** to cool the same.

A transformer **206** is provided for supplying power to the lamp **194** and to the motor **199** and is secured to the baseplate **181** to the rear of the inclined plate **202**. The transformer is provided with wires **207** which connect the transformer to the socket **186** for the lamp **194**. Additional wires **208** from the transformer **206** are connected to a rotary switch **209** which is provided with two decks. The control switch **209** is mounted on the front panel **178** of the U-shaped member **177** and is provided with a control knob **212** which is accessible on the front of the panel. One deck is connected to the motor **199** by wires **211** and the other deck is provided for supplying various voltages to the lamp **194**. Thus, for example, the switch **209** can be provided with five steps through operation of the control knob **212** for supplying five different voltages to the lamp **194** so that light beams of differing intensities can be provided from the lamp **194**. Two pieces **213** and **214** of heat-shrinkable tubing are provided which cover the two separate decks of the control switch **209** to insulate the same from each other. Another piece **216** of heat-shrinkable tubing is provided on the leads **208**. The two decks of the control switch **209** are connected so that the motor **199** is operating at all times that the lamp **194** is lit. A power cord **217** which is connected to a conventional source of supply such as 110-volts 60-cycle AC is also connected to the two decks of the control switch **209**. This power cord **217** is provided with a ground wire **218** which is connected to the transformer **206**.

A socket assembly **221** is mounted in the front panel **178** of the U-shaped member **177**. The socket assembly **221** consists of a generally cylindrical member **222** which is provided with one portion **222***a* of a larger diameter and a portion **222***b* of a smaller diameter. An annular groove **223** is provided in the portion **222***b* and has a helical spring **224** disposed therein. As can be seen from FIG. **17**, the ends of the helical spring are connected so that the spring **224** is tensioned within the groove **223** and serves to retain the member **222** within the front panel **178**. A bore **226** is provided in the cylindrical member **222** and extends through the same. As can be seen from FIG. **16**, the bore **226** is inclined downwardly to the rear and opens through the member **222** at a point which is adjacent to and preferably exactly at the focal point of the beam which emanates from the lamp **194**. A split sleeve **227** is mounted within a larger bore **228** axially aligned with bore **226** and has an inner diameter which is the same as the inner diameter of the bore **226**. Detent means is provided for retaining the sleeve **227** within the bore **226** and consists of a ball **229** urged upwardly into engagement with a hole **230** provided in the sleeve by a spring **231** seated in a well **232** provided in the member **222**. The sleeve **227** is provided with a slit **233** and a recess **234** which is diametrically opposed from the slit **233**. The recess **234** serves as a relief to permit the sleeve to be squeezed together in the region of the slit **233** by means of the setscrew **236** threaded into the member **222**.

The cylindrical member **222** is also provided with a pair of smaller bores **237** which extend straight through the member **222** and are disposed generally below and slightly to opposite sides of the bore **226** as can be seen from FIG. **18**. Detent means is provided for each of the bores **237** and consists of a pin **238** slidably mounted in a bore **239** which enters the bore **237** at right angles thereto as can be seen from FIG. **17**. The pin **238** is provided with a head portion **238***a* which is slidably mounted in a larger axially aligned bore **241**. The pin **238** is yieldably urged in a direction towards the bore **237** by the spring **231** which engages the head portion of the pin **238**.

A large fiber optics cable **246** is adapted to be mounted in the large hole **226**, whereas smaller fiber optics cables **247** are adapted to be mounted in the bores **237**. The cables **246** and **247** are constructed in a manner similar to that hereinbefore described. The principal difference being that the larger cable **246** is provided with a substantially greater number of glass

fibers. The cable **246** is provided with tubular metal fittings **248** at each end into which the glass fibers extend. Either end of the cable **246** may be placed in the large bore **226** and secured therein by tightening the setscrew **236** which clamps the sleeve **227** about the fitting **248** to retain the same therein. The cable **247** is substantially identical to the cable **13**.

A Z-shaped bracket **243** is provided for mounting the housing or case **176** upon a wall or other suitable structure. One portion of the bracket extends through a slot **244** provided in the cover **183**. The bracket **243** is provided with holes which can receive screws or the like for fastening the bracket to a wall.

A holder **251** somewhat different than the holder **78** provided in the embodiments previously described is mounted on the end of the cables **247**. The end of the fiber optics bundle of the cable **247** is mounted in an end fitting **252** of a suitable material such as stainless steel and which is provided with a swaged portion **252***a*. A helical coil spring **253** is mounted on the cable **247** below the fitting **252** and is provided with one portion **253***a* which is tightly compressed and which serves as a tension spring and another portion **253***b* which has been stretched to provide a compression spring. A knurled ferrule **254** is threaded onto the tension spring portion **253***a* of the spring **253**. The ferrule **254** has a slot **256** formed therein which serves as the female portion of a bayonet-type connector. A split retainer **258** is mounted on the other end of the spring **253** and is provided with a portion **258***a* which is adapted to fit within the spring portion **253***b* as shown in FIG. **19**. The retainer **258** engages the swaged portion **252***a* of the fitting **252** and prevents the spring from coming off of the cable **247**. An elongate tube **259** formed of a suitable material such as stainless steel is mounted over the end of the cable **247** and over the spring **253**. The tube **259** has an outer surface which has the appearance of alligator hide. This is formed by a helical groove **261** which extends substantially the entire length of the tube and by circumferentially spaced, longitudinally extending grooves **262**. This exterior surface which is provided on the tube **259** serves to facilitate gripping of the holder **251** by the dentist. An alignment and retainer bushing **264** is mounted within the tube adjacent one end of the same and is held in place by the helical grooves **261** formed in the tube. The bushing **264** is provided with a central bore **266** which is chamfered at both ends as can be seen from FIG. **19**. A dimple or indentation **267** is provided at each end of the tube **259**. When placing the tube **259** on the cable **247**, the tube is positioned so that the fitting **252** enters the tube and seats in the bore **266**. Thereafter, the tube **259** is pushed downwardly toward the ferrule **254** to compress the spring portion **253***b* until the dimple passes into the slot **256** of the ferrule **254** and is locked in place. The compression spring portion **253**—*b* ensures that the fitting **252** is firmly urged into the bore **266**. The tension spring portion **253***a* serves as a strain relief for the cable **247**.

A tapered and knurled ferrule **269** is mounted on the other end of the tube **259**. The ferrule **269** is also provided with a slot **270** identical to the slot **256** which is adapted to receive the dimple **267** at the other end of the tube **259** and to retain the ferrule within the tube **259**. The ferrule **269** carries an appropriate dental tool as, for example, a transilluminator **271** which is similar to the transilluminator **141**. As previously described, it includes a bundle of fibers which are mounted within a fitting **272** which has a swaged portion **272***a* that is mounted in the tapered ferrule **269**.

Operation and use of the dental apparatus shown in FIGS. **13–18** is very similar to that hereinbefore described. The principal difference is that in the present apparatus a large or main cable **246** is provided which can be looped over the patient's shoulder, as shown in FIG. **13**, and directed so that the light emanating from the fitting **248** provided at the end of the cable is directed into the patient's mouth to provide general illumination within the patient's mouth. Thus, it is possible for the dentist to utilize such means for supplying the necessary illumination to the mouth to perform his dental operations. If the dentist sees fit, this can be utilized as the sole means for illuminating the mouth and then the conventional dental instruments can be utilized if the dentist so desires. However, since the light source is available, the dentist can readily use the dental tools of the type hereinbefore described which are provided with auxiliary illumination. Thus, there is shown a dental mirror **273** similar to that hereinbefore described and which is mounted in a manner similar to the manner in which the transilluminator **271** is mounted as shown in FIGS. **19** and **20**.

With the arrangement shown in FIG. **13**, it can be seen that the dentist can peer into the patient's mouth without any danger of his head blocking the light entering the patient's mouth since the illumination will be supplied by the cable **246** immediately adjacent to the mouth and the illumination which may be provided with the dental tools that are utilized by the dentist.

A dental tool as shown in FIG. **21** makes possible the use of a conventional dental mirror. It consists of a cone-shaped socket member **276** formed of suitable material such aluminum which is provided with a central passage **277** extending longitudinally therethrough and which is adapted to receive a straight fiber optic member **278**. The member **278** is formed of a stainless steel tube **279** which has a fiber optic bundle therein and which is provided with a swaged portion **279***a* adapted to seat within the socket member **276**. The fiber optic member **278** is adapted to be inserted in an alignment bushing **264** of the type hereinbefore described and which can be mounted in a holder **251** of the type also hereinbefore described. For this purpose, the cone-shaped socket member **276** is provided with a slot **281** similar to the slot **270** in FIG. **20** to permit locking the handle in place. The cone-shaped bushing **276** is provided with an outwardly extending portion **276***a* which is provided with a small threaded bore **282** into which is threaded the shank portion **283***a* of a holder **283** which carries a mirror **284**. Thus, it can be seen that the mirror **284** with its holder can be threaded into the portion **276** in such a manner that the light emanating from the straight fiber optic bundle member **278** will be directed onto the mirror **284** to provide the desired illumination for the dentist.

From the foregoing it can be seen that a number of dental tools can be constructed in such a manner that they can be readily mounted in the holder **251**.

An alternative arrangement is shown in FIGS. **22–25** which shows a different manner for mounting the dental tools. Thus, there is shown a cone-shaped socket member **286** which is provided with a split **287** extending longitudinally of the same. Alternatively, if desired, the split socket member **286** could be termed a split ferrule. The socket member or ferrule **286** is provided with a passage **288** which extends longitudinally through the same and which opens into a larger bore or passage **289**. A straight fiber optics member **291** is provided which is formed of a suitable material, such as a stainless steel tube **292**, that carries the fibers. A clip **293** is secured to the tube **292** adjacent one end of the same and has a pair of spaced, generally parallel upstanding wing portions **293***a*. The clip **293** is adapted to seat within the bore **289** and the upstanding wings seat within the split **287** to prevent rotation of the fiber optics member **291**.

It should be appreciated that alternatively, if desired, the fiber optics member can be provided with clips which can be utilized for securing the fiber optics member to the dental tool in the appropriate place.

It is apparent from the foregoing that the flexible light cables can be utilized in conjunction with the light source to provide the necessary illumination for the dentist to conduct his operations. Thus, as hereinbefore described, a main cable can be utilized for providing general illumination within the mouth and then additional illumination can be provided by connecting small cables to the light source and connecting the light cables to the dental tools or instruments in such a manner that they provide additional or auxiliary illumination in the immediate location where the tool is being held.

It is also apparent that the teaching herein can be incorporated in other types of instruments as, for example, medical instruments where it is difficult to obtain sufficient illumination. For example, such a light source and cable could readily be used with otoscopes and protoscopes.

The construction of the light cable is particularly advantageous because the spring prevents crushing of the fiber in the fiber optic bundle as the bundle is bent. The spring also generally limits the angle to which the cable can be bent without destroying its flexibility. The light source is constructed in such a manner that it is relatively compact and can be readily moved from one location to another.

I claim:

1. In a dental apparatus, a source of light, a dental tool, a flexible fiber optics cable having one end facing the source of light and having the other end secured to the dental tool and throwing a beam of light in the vicinity of said tool, said dental tool being in the form of a hand dental mirror having a headlike substrate with a major planar reflecting surface thereon, and handle means secured to the substrate and connected means independent of the major planar reflecting surface for causing substantially all of the light passing from the fiber optics cable connected to the handle means to pass from the substrate in a direction generally perpendicular to the major planar reflecting surface and from a generally localized area with respect to the major planar reflecting surface and solely in front of the major planar reflecting surface.

2. Apparatus as in claim 1 wherein said dental mirror is formed of plastic.

3. Apparatus as in claim 1 wherein the means independent of the major planar reflecting surface consists of at least one surface extending at an angle with respect to the major planar reflecting surface of the mirror.

4. Apparatus as in claim 3 wherein said at least one surface is formed by a recess in the back side of the substrate.

5. Apparatus as in claim 3 wherein said at least one surface is formed by a recess in the front side of said substrate.

6. Apparatus as in claim 3 wherein said at least one surface has a substantially parabolic shape.

7. Apparatus as in claim 1 wherein said handle includes a fiber optics cable extending through the same and wherein said fiber optics cable includes a spring extending the length of the cable.

8. In a dental apparatus, a source of light, a dental tool, a flexible fiber optics cable having one end facing the source of light and having the other end secured to the dental tool for throwing a beam of light in the vicinity of the dental tool, said dental tool including a holder, said holder comprising a tube, a retainer carried by the tube and having a bore therein, said fiber optics cable having a fitting thereon adapted to be fitted in the hole in said retainer, said fitting having an enlarged portion preventing the same from passing through the hole, spring means mounted on the cable and adapted to engage said enlarged portion of said fitting and cooperative locking means carried by the spring means for engaging one end of said tube for retaining said spring means and said cable in said tube and for yieldably urging said fitting into the hole in said retainer, a ferrule, a fitting mounted in said ferrule and carrying a fiber optics bundle and extending through the ferrule, said fitting in said ferrule having an enlarged portion between the ends of the same preventing said fitting in said ferrule from being pushed out of said ferrule, and cooperative means carried by the ferrule adapted to engage the other end of the tube, said fitting extending into said retainer in said tube and having a length such that when said cooperative means carried by the ferrule is in engagement with the end of the tube, the fitting carried by the ferrule is in engagement with the fitting carried by the cable to urge the fitting on the cable in a direction out of the retainer against the force of the spring means so that good contact is maintained between said fitting so that light carried by one fitting is passed to the next fitting.

9. A dental apparatus as in claim 8 wherein said dental tool is in the form of a ferrule having a passage extending therethrough, said ferrule having an extension, a mirror holder mounted in said extension, a mirror carried by said mirror holder, said ferrule extension having a passage therethrough, a fiber optics member mounted in said passages and extending through the same to a position in front of the mirror, and means connecting said fiber optics member to said cable.

10. A dental apparatus as in claim 9 wherein said dental tool includes a ferrule having a split therein and having a bore extending longitudinally therethrough and opening into a larger bore, a tubular fiber optics member, a clip mounted on said fiber optics member and having portions thereof extending upwardly beyond the fiber optics member, said fiber optics member being disposed in said split ferrule so that said portions of said clip are positioned in said split in said ferrule to prevent rotation of the fiber optics member with respect to the ferrule.

11. In apparatus utilizing fiber optics, a case, a lamp mounted in said case, said lamp producing a focused source of light at a predetermined focal point, a socket assembly mounted in said case in the vicinity of said lamp, said socket assembly having at least first and second openings therein with the first opening being substantially larger than the second opening, a first large fiber optics cable having one end mounted in the first opening in the socket assembly and facing the focused source of light from said lamp generally at the focal point of the lamp, the other end of the large fiber optics cable being adapted to be positioned to provide general illumination of a predetermined area, a second smaller fiber optics cable having one end mounted in the second opening in the socket assembly and facing the focused source of light from said lamp generally at the focal point of the lamp and a tool mounted on the other end of said second cable, said second cable providing a beam of light in the vicinity of said tool to provide localized illumination for use of said tool.

12. Apparatus as in claim 11 together with separate detent means for retaining said first and second cables in said socket assembly.

13. Apparatus as in claim 11 wherein said first opening is inclined with respect to the second opening so that said openings terminate at points which are generally in relatively close proximity to the focal point of the lamp.

14. Apparatus as in claim 11 together with control means for controlling the intensity of the light emanating from the lamp.

15. Apparatus as in claim 12 wherein one of said separate detent means includes a pin slidably mounted in said socket assembly and extending into said second opening, and a yieldable member encircling said socket assembly and engaging said pin.

16. Apparatus as in claim 11 wherein said first and second fiber optics cables each includes a spring extending the length of the fiber optics cable.

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