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(54) Title: INTRAORAL ILLUMINATION DEVICE			
(57) Abstract			
<p>The present invention involves an intraoral illumination device (20), and method for illuminating the interior cavity of a patient's mouth during a medical procedure. The illumination device (20) includes a bite block (26) adapted to be engaged by a patient's teeth for resting the patient's jaw during the medical procedure and fixing the bite block (26) within the patient's mouth. An arcuate light dispersion piece (24) is connected to the bite block (26) so that, in use, the light dispersion piece (24) is oriented in a rear, central part of the oral cavity of the patient's mouth so that dispersed light can be transmitted outward from the rear, central part of the cavity. A tongue, and cheek retractor (22) is adapted to retract, to protect the patient's tongue, and adjacent cheek tissue during the medical procedure. Multiple fluid evacuation channels (58) are carried by the device (20), and are adapted to communicate with the interior of the patient's mouth for removing fluids from the oral cavity during the medical procedure.</p>			

INTRAOURAL ILLUMINATION DEVICE

Field of the Invention

The invention relates, in general, to dental appliances, and, in particular, to dental appliances for illuminating the mouth of a dental patient for examination and/or operative purposes.

Background of the Invention

Illuminating the interior of a dental patient's mouth during dental examination and/or operation is difficult because the patient's mouth must be illuminated through a narrow opening, i.e., the patient's mouth, and the dentist must work in close proximity to the mouth, often blocking the light source. Proper illumination is essential for dental examination and/or operation.

The oral cavity is typically illuminated by a focused light source mounted approximately two to three feet above a dental chair that the patient rests on. The light source is configured to direct light onto and into the patient's mouth. The amount of light entering the oral cavity using this type of lighting is somewhat limited due to the fact that the light source is remote from the patient's mouth. Additionally, the dentist or oral surgeon must often position oneself or his or her instruments between the light source and the patient's mouth to properly view the patient's mouth, blocking light from entering the mouth. The blocking of light casts an effective shadow in the patient's mouth or in areas of the patient's mouth such as certain teeth.

In order to inhibit this blocking or shadowing, fiber optic lighting has been incorporated into handheld dental instruments. Typically, one or two fiber optic strands extend longitudinally along the instrument and include a light outlet end configured to direct light towards the end of the instrument. However, this type of lighting has a number of drawbacks. Light is only directed on a limited area in the mouth and does not provide illumination for the entire oral cavity. Additionally, the presence of this type of lighting, typically as an add-on feature on the instrument interferes with the comfortable and proper use of the instrument. The fiber optic bundles also degrade over time because the fiber optics and instrument go through autoclaving numerous times. Components of the

instrument, e.g., turbines, may be easily changed once degraded, but the fiber optic bundles can not.

Other devices have been designed specifically for illuminating a patient's teeth, but these devices suffer from any or all of the following drawbacks: inadequate illumination of the patient's teeth, and interference with other dental instruments used during the examination and/or operation.

It is the object of the present invention to substantially overcome or at least ameliorate one or more of the prior art disadvantages.

Summary of the Invention

10 The present invention provides an intraoral illumination device for illuminating the interior cavity of a patient's mouth, the device comprising:

a bite piece adapted to be engaged by a patient's teeth to hold the device within the patient's mouth;

15 a light dispersion piece of substantially arcuate construction connected to said bite piece so that in use said light dispersion piece generally wraps around a rear part of the interior cavity of the patient's mouth from one side of the mouth to the other.

The present invention involves an intraoral illumination device for illuminating the interior cavity of a patient's mouth during a medical procedure that substantially eliminates or at least ameliorates the problems with shadowing mentioned above. The 20 preferred embodiment of the illumination device includes a bite block adapted to be engaged by a patient's teeth for resting the patient's jaw during the medical procedure and fixing the device within the patient's mouth. An arcuate light dispersion piece is connected to the bite block so that, in use, the light dispersion piece is orientated in a rear, central part of the interior cavity of the patient's mouth so that dispersed light can be 25 transmitted outward from the rear, central part of the oral cavity. The preferred embodiment includes a tongue and cheek retractor which is adapted to retract and protect the patient's tongue and adjacent cheek tissue during the medical procedure. Multiple fluid evacuation channels are carried by the preferred device and are adapted to communicate with the interior cavity of the patient's mouth for removing fluids from the 30 oral cavity during the medical procedure.

An additional embodiment of the invention includes an intraoral illumination device having a bite piece adapted to be engaged by a patient's teeth to hold the device within the patient's mouth, a light dispersion piece adapted to be optically coupled to the

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light source and pivotally connected to the bite piece so that in use the light dispersion member is orientated in a rear, central part of the interior cavity of the patient's mouth so that dispersed light can be transmitted outward from the rear, central part of the interior cavity, and a tongue and cheek retractor at least partially surrounding the light dispersion piece.

Another embodiment of the invention includes a method for illuminating the interior cavity of a patient's mouth during a medical procedure. The method includes providing a device for illuminating the interior cavity of a patient's mouth, the device

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including a bite piece adapted to be engaged by a patient's teeth, a light dispersion piece with a substantially entire arcuate construction connected to the bite block so that in use the light dispersion piece generally wraps around a rear part of the interior cavity of the patient's mouth from one side of the mouth to the other, a tongue and cheek retractor carried by the dispersion piece; providing means for transmitting light; providing a light source; applying the bite piece between the patient's teeth so that when a patient bites down on the bite piece, the light dispersion piece is held, generally wrapped around a rear part of the interior cavity of the patient's mouth from one side of the mouth to the other; coupling the intraoral illumination device to the light-transmitting means; coupling the light-transmitting means to the light source; and illuminating the interior cavity of the patient's mouth during the medical procedure by transmitting light from the light source to the light dispersion piece, through the light-transmitting means.

In an implementation of the embodiment of the invention described immediately above, the tongue and cheek retractor includes multiple fluid evacuation channels and the light-transmitting means includes at least one vacuum lumen. The method further comprises providing a vacuum source, coupling the at least one vacuum lumen to the vacuum source, and removing fluids from the inner cavity of the patient's mouth during the medical procedure by sucking fluid from the multiple fluid evacuation channels, through the at least one vacuum lumen, to the vacuum source.

A further embodiment of the invention includes a method of manufacturing an intraoral illumination device for illuminating the interior cavity of a patient's mouth during a medical procedure. The method includes providing a mold including a first mold having a first cavity and a second mold having a second cavity; molding a light dispersion piece in the first and second mold cavities; removing the second mold; providing a third mold having a third mold cavity with the first mold; molding a tongue and cheek retractor in the first and third mold cavities; and creating fluid evacuation channels in the tongue and cheek retractor

In an implementation of the embodiment of the invention described immediately above, the step of creating fluid evacuation channels includes creating fluid evacuation channels by introducing a gas in the tongue and cheek retractor.

Other, more particular features and advantages of the inventions are set forth in the following detailed description and drawings.

Brief Description of the Drawings

The drawings illustrate both the design and utility of preferred embodiments of the present invention, in which similar elements are referred to by common reference numbers, wherein:

Fig. 1 is a front perspective view of a preferred embodiment of the intraoral illumination device of the present invention shown inside a patient's mouth;

Fig. 2 is a front perspective view of the components of the intraoral illumination device illustrated in Fig. 1 in a disassembled state;

Fig. 3 is a front perspective view of the intraoral illumination device illustrated in Fig. 1;

Fig. 4 is a rear perspective view of the intraoral illumination device illustrated in Fig. 1;

Fig. 5 is a top plan view of the intraoral illumination device illustrated in Fig. 1;

Fig. 6 is a front elevational view of the intraoral illumination device illustrated in Fig. 1;

Fig. 7 is an end view of the intraoral illumination device illustrated in Fig. 1;

Figs. 8A and 8B are cross-sectional views of the intraoral illumination device illustrated in Fig. 1 and illustrate the evacuation of fluids through the evacuation system of the device;

Fig. 9 is a front perspective view of an alternative preferred embodiment of the intraoral illumination device;

Fig. 10 is a rear perspective view of the intraoral illumination device illustrated in Fig. 9;

Fig. 11a is a partial perspective view of an alternative embodiment of an integrated light carrier and vacuum tube connector;

Fig. 11b is a partial perspective view of an alternative embodiment of an integrated light carrier and vacuum tube that the integrated light carrier and vacuum tube connector illustrated in Fig. 11 may be connected with;

Fig. 12 is a front perspective view of an alternative preferred embodiment of the intraoral illumination device and shows the intraoral illumination device in conjunction with a preferred embodiment of a multi-lumen tube;

Fig. 13 is a rear, top perspective view of a preferred embodiment of a light dispersion piece that may be used with the intraoral illumination device illustrated in Fig. 12;

Fig. 14 is a cross sectional view of a connection section of the intraoral illumination device and an end portion of the multi-lumen tube;

Fig. 15 is a cross sectional view of the multi-lumen tube taken along lines 15-15 of Fig. 14;

Fig. 16 is a perspective view of an embodiment of a transition mechanism that may be used to transition a separate light carrier and vacuum tube into the single multi-lumen tube; and

Fig. 17 is perspective view of an embodiment of a connector that may be used to couple the transition mechanism to the multi-lumen tube.

Description of the Preferred Embodiments

With reference to Figs. 1 and 2, a preferred embodiment of an intraoral illumination device, indicated generally by the reference numeral 20, will now be described. The intraoral illumination device 20 generally includes a tongue and cheek retractor 22, a dispersion piece 24, and a bite block or piece 26. The tongue and cheek retractor 22 is a disposable piece, and the dispersion piece 24 and bite piece are sterilizable for reuse. The dispersion piece 24 is coupled to a light carrier such as a fiber optic bundle 28 and extraoral light source 30 for illuminating the dispersion piece 24. A fluid evacuation tube 32 is in communication with the bite block 26 and a fluid evacuation system 34 of the device 20 for evacuating fluids from a patient's mouth 36.

The intraoral illumination device 20 will now be described generally in use. The patient opens his or her mouth 36 and a health care provider inserts the device 20 into an intraoral cavity 38 of the patient's mouth 36 between the patient's upper jaw 40 and lower jaw 42. The patient rests his or her jaws 40, 42 during the process to be performed by gently biting on the bite block 26 with his or her rear teeth 44. To help isolate the area of the mouth 36 being worked on and protect the patient's mouth from being injured by the dental tools, the tongue and cheek retractor 22 urges the patient's cheek and tongue away from the area of isolation. Fluids produced in the patient's mouth 36 during the process are removed through the fluid evacuation system 34 of the device 20 and vacuum

tube 32. Light transmitted through the light carrier 28 to the dispersion piece 24 is dispersed outward from the dispersion piece 24, towards the front of the patient's mouth, from a rear, central part of the intraoral cavity 38 flooding the patient's mouth with light. Illuminating the area of interest in the patient's mouth in this manner eliminates the aforementioned problems with blocked light or shadowing.

Although this invention has been described in connection with illuminating, isolating, and removing fluids from a patient's mouth for dentistry, it will be readily understood by those skilled in the art how the present invention may have other mouth-related applications where illumination in the mouth is required other than dentistry such as, but not by way of limitation, oral surgery.

With reference to Figs. 1-7, each of the components of the device 20 will now be described.

The tongue and cheek retractor 22 is made of a single molded piece of soft, flexible, biocompatible material such as Pebax, santoprene, or a molded vinyl material. However, it will be readily understood by those skilled in the art that other soft, flexible materials could be used. The tongue and cheek retractor 22 is preferably produced by a gas-assist injection molding process in order to produce the internal vacuum channels described below. However, it will be readily understood by those skilled in the art that other molding processes such as an injection molding process could also be used. As discussed in more detail below, the tongue and cheek retractor 22 may be a separate piece that can be easily added to or removed from the dispersion piece 26. The tongue and cheek retractor 22 also may come in two different main configurations, depending on the side of the mouth being examined and/or operated on, i.e., left side, right side, and different sizes for different size and shaped mouths. The retractor 22 has an inner surface 46 and an outer surface 48. The retractor 22 includes a curved main body portion 50 and a cheek retractor portion 52.

The main body portion 50 includes an upper roof portion 54 configured to rest against the roof of the patient's mouth 36 during use and a lower tongue retractor portion 56 to keep the tongue protected and retracted. The lower tongue retractor portion 56 helps to isolate the area of interest in the mouth 36 and protect the tongue from instruments such as dental drills during the dental procedure. The tongue retractor portion 56 includes internal evacuation channels 58. Evacuation holes 60 on both the inner

surface 46 and outer surface 48 of the tongue retractor portion 56 communicate with the evacuation channels 58. The evacuation channels 58 terminate at an upper part of the tongue retractor portion 56 at a main receiving channel 62. The main receiving channel 62 includes a lip 64 for slidably receiving the dispersion piece 24. A pair of shallow evacuation channels 66 extend along a portion of the main receiving channel 62. Evacuation holes 66 allow communication of the evacuation channels 58 with the outer surface 48 of the retractor 22.

The cheek retractor portion 52 has a curved, fish-tail shape and includes a pair of evacuation channels 68 exposed to the outer surface 48 of the retractor 22 that communicate with the evacuation channels 66. The cheek retractor portion 52 protects adjacent cheek tissue during the dental procedure and helps to isolate the area of interest of the mouth 36 during the dental procedure by retracting the cheek tissue.

The dispersion piece 24 is an illumination member and is preferably made of a single, injection-molded piece of light-dispersive, biocompatible, sterilizable material. The dispersion piece 24 may be made of a rigid material such as acrylic or a flexible material such as a molded flexible urethane. However, it will be readily understood by those skilled in the art that other clear, flexible or rigid materials may be used. The dispersion piece 24 preferably has an arcuate, semi-circular shape and includes a generally U-shaped dispersion lens 70, a fluid evacuation portion 72, and a pivot portion 74.

The dispersion lens 70 includes a flange 76 that is slidably received by the lip 64 of the main receiving channel 62 for attaching the dispersion piece 24 to the tongue and cheek retractor 22. The dispersion lens 70 may have a composition that is varied, e.g., graduated, to control the amount of dispersion in different areas of the lens 70 and evenly distribute the overall lumination. This helps prevent "hot spots" in the dispersion lens 70, i.e., areas of the lens 70 that emit a greater concentration of light. These "hot spots" make it difficult to for the health care provider to observe the patient's mouth. For example, in the area where the fiber optic bundle 28 connects with the dispersion lens 70, there may be a less textured composition to inhibit the breaking up of internal reflections, and a progressively more textured composition as one approaches the opposite end of the lens 70. It will be readily understood by those skilled in the art that the tongue and cheek retractor 22 or other covering may have a similar varied composition to control dispersion of light in a similar manner. The dispersion lens 70 optically communicates with the light

carrier 28 through a stem 78 and a separate connector 79. The light carrier 28 is preferably adapted to be directly connected to a commercially available illumination source as those found in most dentist offices or adapted to be connected to such sources through a connector or transition mechanism (not shown). Alternatively, the stem 78 and connector 79 may be a single integrated molded piece. The stem 78 serves as a light coupling between the light carrier 28 and dispersion lens 70.

In use, light shines outward from the lens 70 and is scattered by the lens 70 to illuminate the patient's mouth 36. When in place, the configuration of the device 20 causes light to be transmitted by the dispersion lens 70 from a central, rear part of the intraoral cavity, substantially between the patient's rear teeth 44. The U-shaped dispersion lens 70 has a generally 180° arcuate shape. This generally 180° arcuate shape and the dispersive qualities of the lens 24 spreads the total area of illumination. Illuminating the mouth from the central, rear part of the intraoral cavity and the above-described attributes of the lens 24 eliminates shadows caused by a single-point light source, and shadows caused by the health care provider or equipment used by the health care provider. The intraoral illumination device 20 may replace or be used with dental instruments including fiber optic lighting.

The fluid evacuation portion 72 includes a first main evacuation channel 80 and a second main evacuation channel 82 for evacuating fluids from the device 20.

The pivot portion 74 includes a first well 84 and a second well 86 that respectively communicate with the first and second main evacuation channels 80, 82. A first recess 88 and second recess 90 are used to further communicate the wells 84, 86 with the fluid evacuation tube 32 in a manner to be described. Respective pivot pins 92 extend from each well 84, 86.

The bite block 26 is made of a single piece of biocompatible, sterilizable material such as rubber. The bite block 26 may be formed by a compression molding process, a transfer molding process, a casting process, an injection molding process, or similar process. The bite block 26 includes ribs 94 and ridges 96 along opposite faces 98 of the bite block 26. The ribs 94 and ridges 96 help to prevent the bite block 26 from slipping between the molar and bicuspid teeth 44 of the patient. When held or engaged between the patient's teeth, the bite block 26 functions to hold the dispersion lens 70 in a

rear, central part of the interior cavity of the patient's mouth so that light can be transmitted outward therefrom for illuminating the interior cavity.

A pivot portion 100 of the bite block 26 includes opposite receiving grooves 102. The receiving grooves 102 receive the pivot pins 92 of the dispersion lens 70 for pivotally connecting the dispersion piece 24 and tongue and cheek retractor 22 to the bite block 26. This pivoting ability allows the health care provider to adjust, i.e., swivel, the dispersion piece 24 and tongue and cheek retractor 22 to accommodate patients with different arch widths.

The intraoral illumination device 20 may also come in different sizes and to accommodate different mouth sizes and shapes.

In an alternative embodiment of the device (Figs 9, 10, 12), the dispersion piece 24 and bite piece 26 are not pivotally connected to each other, i.e., the connection is fixed. If the connection is fixed, it is especially important to provide the intraoral illumination device 20 in different configurations and sizes to accommodate the different mouth sizes and shapes. Likewise, if the device (Figs. 9, 10, 12) is disposable it is important to provide the device in different configurations and sizes to accommodate the different mouth sizes and shapes. Likewise, if the device (Figs. 9, 10, 12) is disposable it is important to provide the device in different configurations and sizes to accommodate the different mouth sizes and shapes.

The bite block 26 includes an internal evacuation channel 104 in communication with the first and second main evacuation channels 80, 82 through the first and second recesses 88, 90, respectively, for evacuation fluids from the patient's mouth 36 during the procedure. The recesses 88, 90 are sized to allow constant sealed communication of the internal evacuation channel 104 with the main evacuation channels 80, 82, regardless of the pivoted position or articulation of the dispersion piece 24 and tongue and cheek retractor 22. External evacuation channels 106 are located on the outside of the bite block 26 and are in communication with the internal evacuation channel 104 for further removal of fluids from the mouth 36. Fluids are vacuumed from the internal evacuation channel 104 of the bite block 26 through an exit port 108.

During use, the patient rests his or her jaws 40, 42 on the faces 98 of the bite block 26, eliminating the need to strain one's jaw muscles to keep the mouth open. This resting of the jaws 40, 42 causes the bite block 26 to hold the dispersion piece 24 and

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tongue and cheek retractor 22 in the rear, central part of the oral cavity. The bite block 26 also serves as an evacuation exit for fluids and as a means for positioning and holding the dispersion piece 24 and tongue and cheek retractor 22 in the oral cavity.

Before inserting the intraoral illumination device 20 in the patient's mouth 36, the health care provider ensures that the intraoral illumination device 20 is configured for examining and/or operating on the specific area of the patient's mouth of interest, i.e., right side, left side. If the device 20 includes a replaceable tongue and cheek retractor 22, the tongue and cheek retractor 22 used with the device 20 should be the proper configuration and size for the area of the patient's mouth of interest. A tongue and cheek retractor 22 specific to the size and area of the mouth of interest is added to the dispersion piece 24 by sliding the flange 76 of the dispersion lens 70 into the main receiving channel 62 of the tongue and cheek retractor 22. Alternatively, if the device is disposable (Figs. 9, 10, 12), a device specific to the size and area of the mouth of interest is used. The device is then inserted into the patient's mouth 36 in the manner described above. If the provider desires to examine the opposite side of the patient's mouth 36, the health care provider removes the device 20 from the patient's mouth, removes the tongue and cheek retractor 22 from the dispersion piece 24 by sliding the retractor 22 off of the flange 76, flips the bite block 26 and dispersion piece 24, which are common for both sides of the mouth 36, adds a new tongue and cheek retractor 22 configured for use with the opposite side of the mouth 36, and places the device 20 back into the patient's mouth 36 so that bite block 26 resides in the opposite side of the patient's mouth 36. Alternatively, if the device is disposable, the health care provider must ensure that a device adapted for use with the size and side of the mouth being examined is used. After use of the intraoral illumination device 20, the tongue and cheek retractor 22 is disposed and the bite piece 26 and dispersion piece 24 are autoclaved or sterilized by a similar method. If a disposable intraoral illumination device is used, the device is simply disposed of in a proper biohazardous receptacle.

With reference to Figs. 8A and 8B, the fluid evacuation system 34 of the intraoral illumination device 20 will now be described in greater detail. During dental examination and/or operation, a number of fluids, e.g., saliva from the parotid gland, blood, water from the dental equipment, are produced in the patient's mouth 36. It is important to remove these fluids for the comfort of the patient, to prevent fluids and

material from being aspirated into the throat or lungs of the patient, and to assist the health care provider in observing and/or operating within the patient's mouth 36. The fluid evacuation system 34 removes fluids from all areas of the mouth, e.g., operating side, vestibule area on the operation side, the lingual vestibule (along the side of the tongue), contra-lateral side vestibule, eliminating the need for constant patient mouth rinsing and the need for a dental assistant to aspirate debris.

The fluid evacuation system 34 is comprised of the aforementioned evacuation channels and holes located in fluid evacuation members such as the tongue and cheek retractor 22, dispersion piece 24, and bite block 26. As used herein, the term "fluid evacuation member" refers to a piece that includes one or more evacuation channels for removing fluids from the patient's mouth. For example, as illustrated in Figs 8A and 8B, fluid is drawn from the tongue area through the evacuation holes 60 and evacuation channels 58 in the tongue retractor portion 56. This fluid is further drawn through the second main evacuation channel 82 of the dispersion piece 24, and the bite block 26, and out the vacuum tube 32. The suction drawing the fluids and debris out the vacuum tube 32 is provided by a vacuum source 110 (Fig. 1).

With reference to Figs. 9 and 10, an intraoral illumination device 112 constructed in accordance with an alternative preferred embodiment of the invention will now be described. Elements of the intraoral illumination device 112 similar to those described above with respect to the intraoral illumination device 20 are referred to by common reference numbers, but with an "a" suffix, e.g., dispersion piece 24a. The intraoral illumination device 112 is similar to the intraoral illumination device described above, except it is adapted for use as a disposable unit, eliminating the need for sterilization and the associated costs and spread-of-disease risks. The device 112 includes an integrated bite block and light carrier/fluid evacuation tube connector 114. The connector 114 is an over-molded piece, has a bi-lumen configuration, and is configured to extend significantly outside of the mouth of the patient where it connects with a combined bi-lumen light carrier and vacuum tube 116. Because this connection between the connector 114 and combined light carrier and vacuum tube 116 is substantially outside of the patient's mouth, the combined light carrier and vacuum tube 116 can be re-used, i.e., does not have to be disposable and does not need to be autoclaved, avoiding degradation, especially of the light carrier, e.g., fiber optic bundle. As discussed above, the bite block

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26a and dispersion piece 24a may be fixed relative to each other. Alternatively, as discussed above, the dispersion piece 24a may be pivotally connected to the bite block 26a in order to accommodate different size arch widths. Regardless, the bite block 26a, dispersion piece 24a, and tongue and cheek retractor 22a together form a single, integrated disposable piece.

With reference to Figures 11A and 11B, an alternative embodiment of an integrated bite block and light carrier/fluid evacuation connector 118 and combined light carrier and vacuum tube 120 are shown. In this embodiment, the light carrier portions and fluid evacuation portions are coaxially aligned.

With reference to Figs. 12 and 13, an intraoral illumination device 122 constructed in accordance with an additional preferred embodiment of the invention will now be described. Elements of the intraoral illumination device 122 similar to those described above with respect to the intraoral illumination devices 20, 112 are referred to by common reference numbers, and with a "b" suffix. Similar to the intraoral illumination device 112 described above, the intraoral illumination device 122 is adapted for use as a disposable unit, eliminating the need for autoclaving and the associated costs and spread-of-disease risks. The device 112 preferably has a two-piece, integrated construction. The device includes a dispersion piece 124 surrounded by a tongue and cheek retractor 126.

The dispersion piece 124 is preferably made of single, rigid, light-dispersive material such as acrylic or a flexible material such as a molded flexible urethane. However, it will be readily understood by those skilled in the art that other clear, flexible or rigid materials may be used. The dispersion piece 124 has an arcuate, light-dispersing section 128, a bite block section 130, and an optical connection section 132. The light-dispersing section 128 is received within a main receiving channel 134 of the tongue and cheek retractor 126. The light-dispersing section 128 may have a composition that is varied, e.g., graduated, to control the amount of dispersion in different areas of this section 128 and evenly distribute the overall illumination. The bite block section 130 includes a generally rigid support structure for the bite block. The optical connection section 132 is configured to optically connect the light-dispersing section 128 to the light source through a light carrier such as a fiber optic bundle.

The tongue and cheek retractor 126 includes a main body section 50b, a cheek retractor portion 52b, an upper roof portion 54b, and a tongue retractor portion 56b.

Fluid evacuation channels (not shown) within the tongue and cheek retractor 126 communicate with the outside of the tongue and cheek retractor (such as through evacuation holes 60b) to remove fluids from the patient's mouth. The fluid evacuation channels communicate with the main evacuation channel 134. The tongue and cheek retractor 126 includes a bite block 136 and a connection section 138. The connection section 138 is configured to extend outside of a patient's mouth and attach to a multi-lumen tube 140. The connection section 138 includes a retention barb 142. The connection section 138 also houses a pair of fluid evacuation channels 144 and the optical connection section 132.

The multi-lumen tube 140 includes fluid evacuation lumens 146 in order to communicate the fluid evacuation system in the device 122 with a vacuum source and a light carrier 148 in order to optically couple the dispersion piece 124 with a light source. The multi-lumen tube 140 includes a connector 150 for attaching the intraoral illumination device to the multi-lumen tube 140. A slot 152 in the connector 150 is configured to receive and retain the retention barb 142 when the connection section 138 is fully engaged with the multi-lumen tube 140.

With reference to Fig. 16, an embodiment of a transition mechanism 154 to transition a pre-existing light carrier 156 and a vacuum tube 158 at the health care provider's into the single, multi-lumen tube 140 is shown. The transition mechanism 154 includes the appropriate connections for attachment to pre-existing light carriers 156 and vacuum tubes 158 or may include separate connectors for interfacing between light carriers 156 and vacuum tubes 158 and the transition mechanism 154. In an alternative pre-embodiment, the transition mechanism 154 may include a light source and/or a vacuum source, eliminating the need to connect with a light carrier 156 and/or vacuum tube 158. With reference to Fig. 17, a special connector 160 may interface between the transition mechanism 154 and the multi-lumen tube 140 to further transition the transition mechanism 154 into the multi-lumen tube 140. However, it will be readily apparent to those skilled in the art how transitioning devices such as the special connector 160 may be located within the transition mechanism 154, eliminating the need for a special connector.

Together, the intraoral illumination device 122, multi-lumen tube 140, transition mechanism 154, and light source form an intraoral illumination system and the intraoral illumination device 122 in conjunction with one or more of the following form an

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intraoral illumination kit: the multi-lumen tube 140, the transition mechanism 154, the light source, the vacuum source, the special connector 160, and separate connector(s) for attaching light carrier 156 and/or vacuum tube 158 to the transition mechanism 154

The method of manufacturing the intraoral illumination device will now be described. The intraoral illumination device is manufactured in a two-step process known as multi-shot injection molding. The acrylic dispersion piece 124 is molded first in a two-piece mold including a first mold having a first mold cavity and a second mold having a second mold cavity, and, then, the second mold is removed. The second mold is replaced by a third mold having a third mold cavity that has the details of the tongue and cheek retractor 126. Next, rubber is injected over the dispersion piece 124 to form the tongue and cheek retractor 126. A gas-assist injection molding process is then used to produce the fluid evacuation channels and cavities within the tongue and cheek retractor 126. Fluid evacuation holes are created in various locations of the tongue and cheek retractor 126 to provide specific area suction within a patient's mouth. The fluid evacuation holes may be created by a laser cutting process, or similar cutting process.

The multi-lumen tube 140 is extruded with the light tube 148 enclosed within the tube 140. The light tube 148 is made from a semi-flexible, solid-core plastic, optical material such as a fiber optic bundle and is covered with a cladding such as Teflon before extrusion. With reference to Figure 15, the multi-lumen tube 140 is extruded so as to have an elliptical shape with the light tube 148 in the center. The tube 140 is extruded so that a portion of the light tube 148 extends beyond the distal end of the multi-lumen tube 140. After extrusion, the multi-lumen tube 140 is over-molded with a custom connector 150. Alternatively, the connector 150 may be a separate piece made of a material such as stainless steel and fixed to the end of the tube 140. The connector 150 is configured to inhibit leakage and ensure a tight connection with the connection section 138 of the intraoral illumination device 122.

Thus, the intraoral illumination device of the present invention eliminates the problem of shadowing resulting from an overhead light sources, single-point light sources, or other illumination sources of the past by transmitting dispersed light outwards from a rear, central part of the intraoral cavity, generally between the patient's rear teeth. The generally 180° arc of the dispersion piece spreads the area of illumination, eliminating shadows caused from a single point light source. The fluid evacuation system of the

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device vacuums oral fluids, water delivered by a dental handpiece, and debris. The fluid evacuation system prevents these fluids and debris from being aspirated or swallowed down the throat of the patient, improves the comfort of the patient, eliminates the need of the patient to continually rinse his or her mouth, and reduces the amount of spray emitted from the patient's mouth. The tongue and cheek retractor retracts and protects the cheek and tongue of the patient, helping to reduce interference between these parts of the mouth and the procedure. The bite block allows the patient to rest the muscles of mastication, eliminating the need to strain to keep his or her mouth open. Because the device simultaneously removes fluids and debris, isolates the area of interest in the mouth, and illuminates the area of interest, the time of the procedure and the need for an assistant is greatly reduced.

Although this invention has been described in terms of certain preferred embodiments, other embodiments apparent to those of ordinary skill in the art are also within the scope of this invention. Accordingly, the scope of the invention is intended to be defined only by the claims that follow.

The claims defining the invention are as follows:

1. An intraoral illumination device for illuminating the interior cavity of a patient's mouth, the device comprising:

5 a bite piece adapted to be engaged by a patient's teeth to hold the device within the patient's mouth;

a light dispersion piece of substantially arcuate construction connected to said bite piece so that in use said light dispersion piece generally wraps around a rear part of the interior cavity of the patient's mouth from one side of the mouth to the other.

2. The intraoral illumination device of claim 1, further comprising:

10 a curved main body portion to generally wrap around a rear part of the interior cavity of the patient's mouth, the light dispersion piece extending along the curved main body portion.

15 3. The intraoral illumination device of claim 2, wherein the main body portion and the dispersion piece comprise a single, integrated piece of similar composition to control dispersion of light in a similar manner.

4. The intraoral illumination device of claim 2 or 3, further comprising:

a cheek retractor portion at the opposite end of the curved main body portion from the bite piece and integral therewith.

5. The intraoral illumination device of claim 3, wherein the bite piece, the main body portion and the dispersion piece comprise a single, integrated piece.

20 6. The intraoral illumination device of claim 2, 3, 4 or 5, wherein the curved main body portion includes an evacuation channel to be in fluid communication with the patient's mouth.

7. The intraoral illumination device of claim 6, further comprising:

25 a light carrier/fluid evacuation tube connector coupled with the light dispersion piece and the evacuation channel.

8. The intraoral illumination device of claim 7, wherein the device is a single-use, disposable unit.

9. The intraoral illumination device of claim 6, wherein the curved main 30 body portion includes a plurality of the said evacuation channel to be in fluid communication with the patient's mouth.

10. An intraoral illumination device substantially as hereinbefore described with reference to Figs. 1 to 8B; Figs. 9 and 10; Figs. 9 to 11b; or Figs. 12 to 17 of the accompanying drawings.

Dated 18 February, 2002

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Thomas R. Hirsch

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FIG. 1

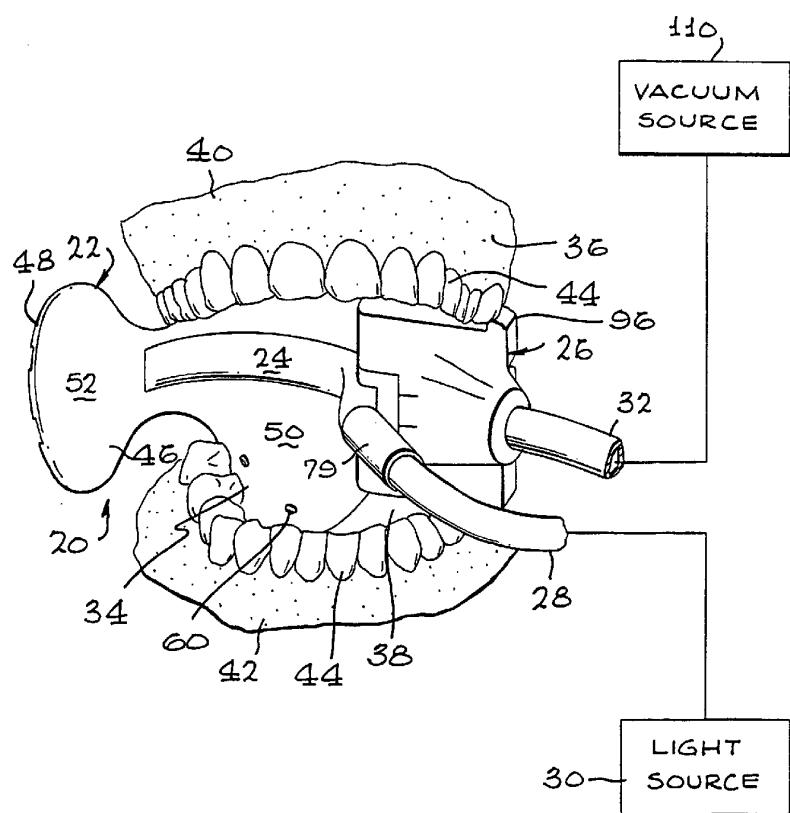


FIG. 3

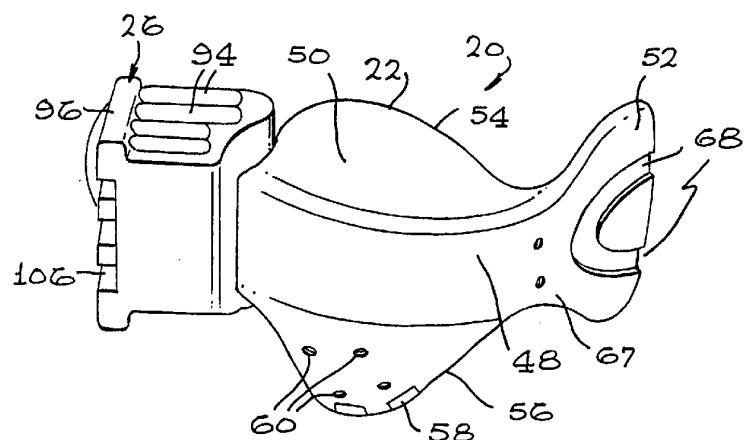
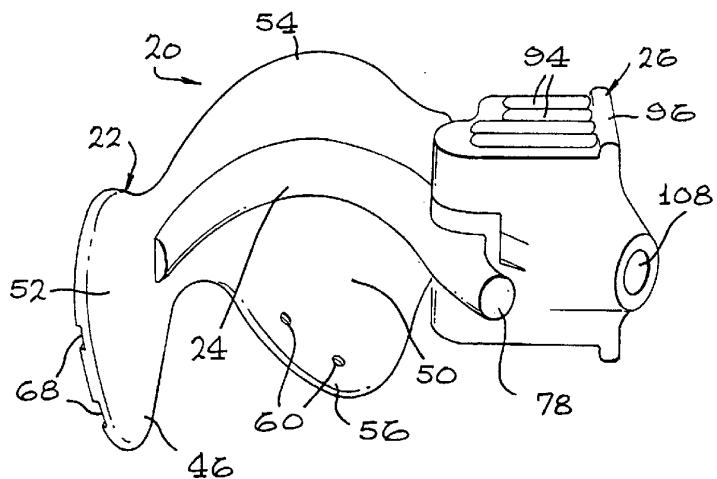
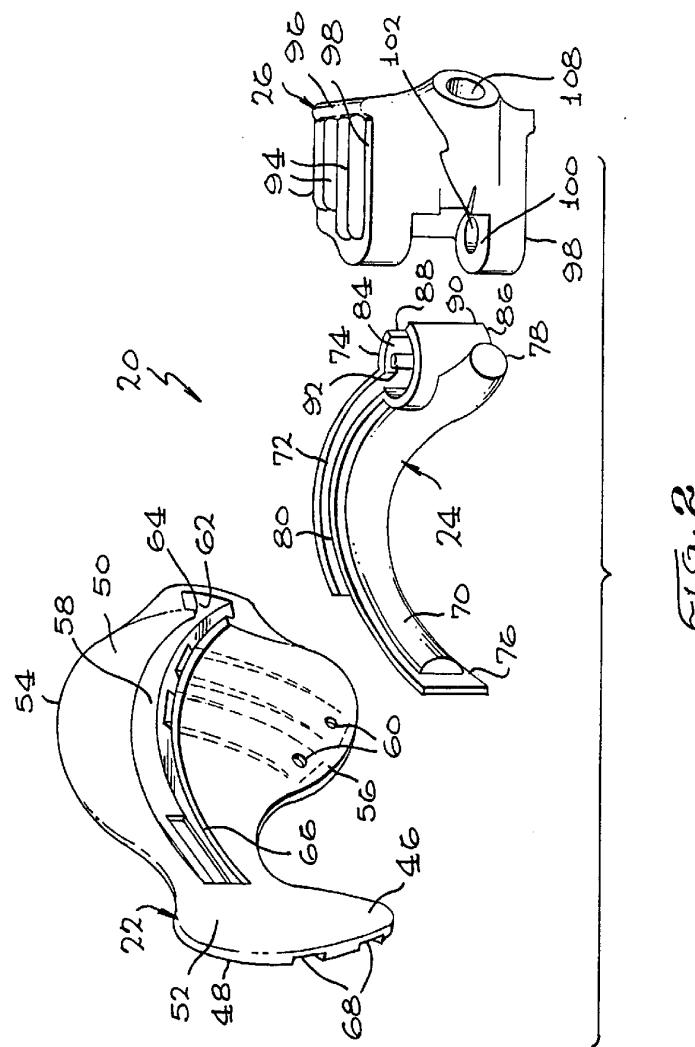


FIG. 4



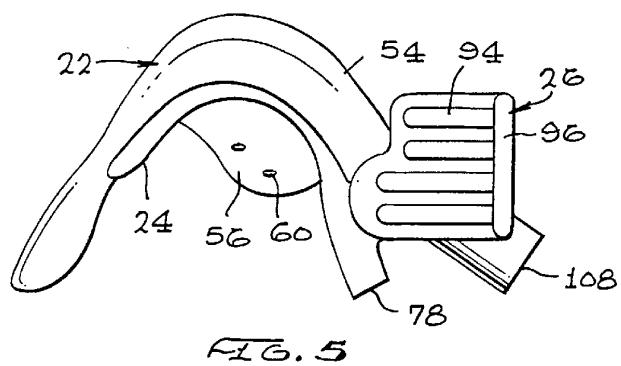


FIG. 5

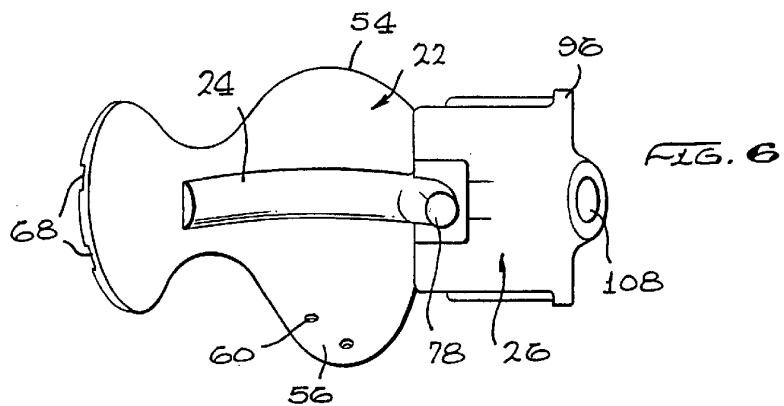


FIG. 6

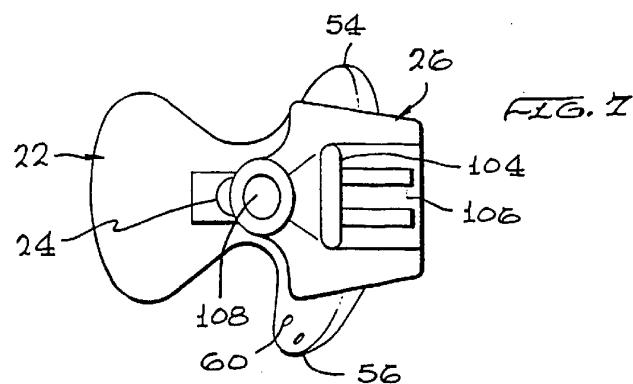


FIG. 7

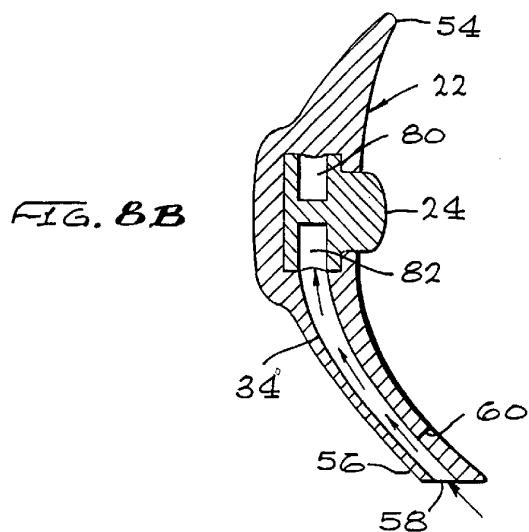
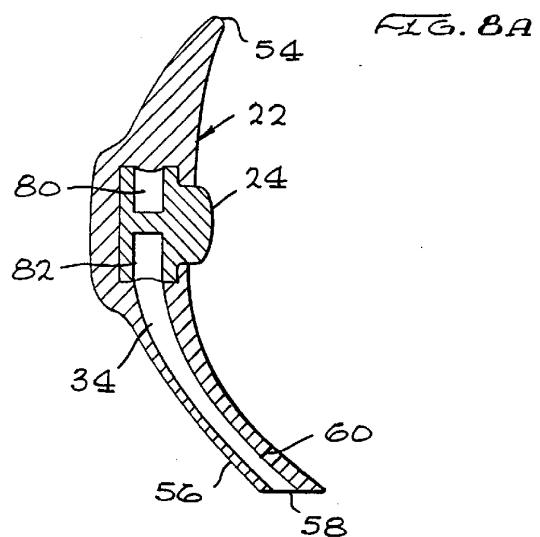


FIG. 9

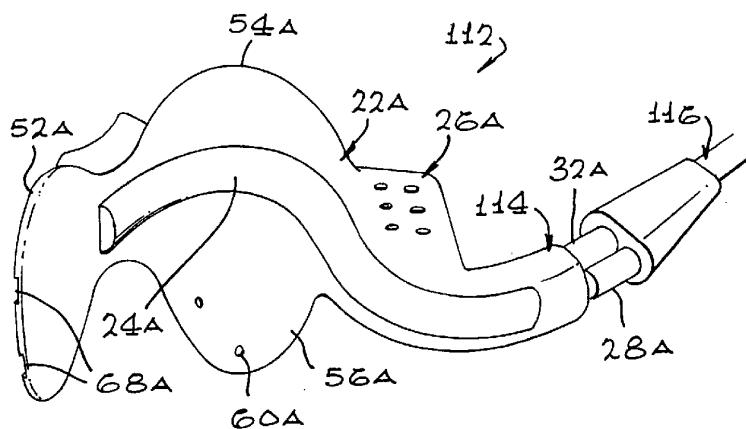


FIG. 10

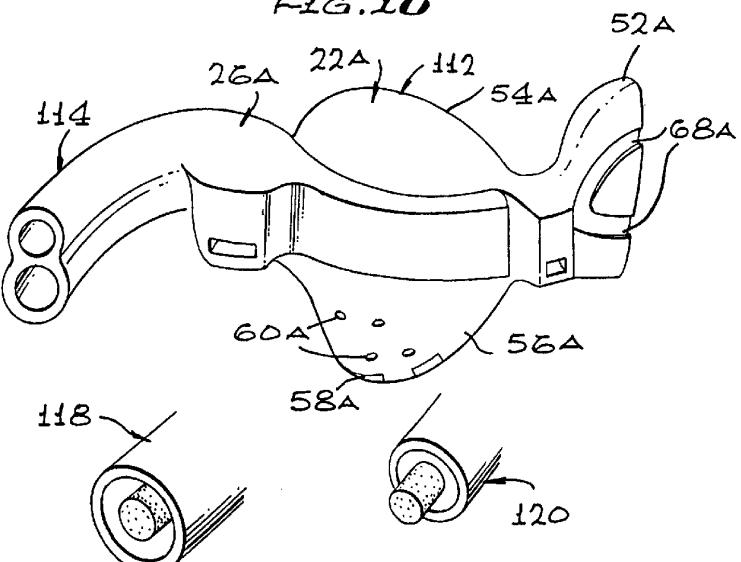
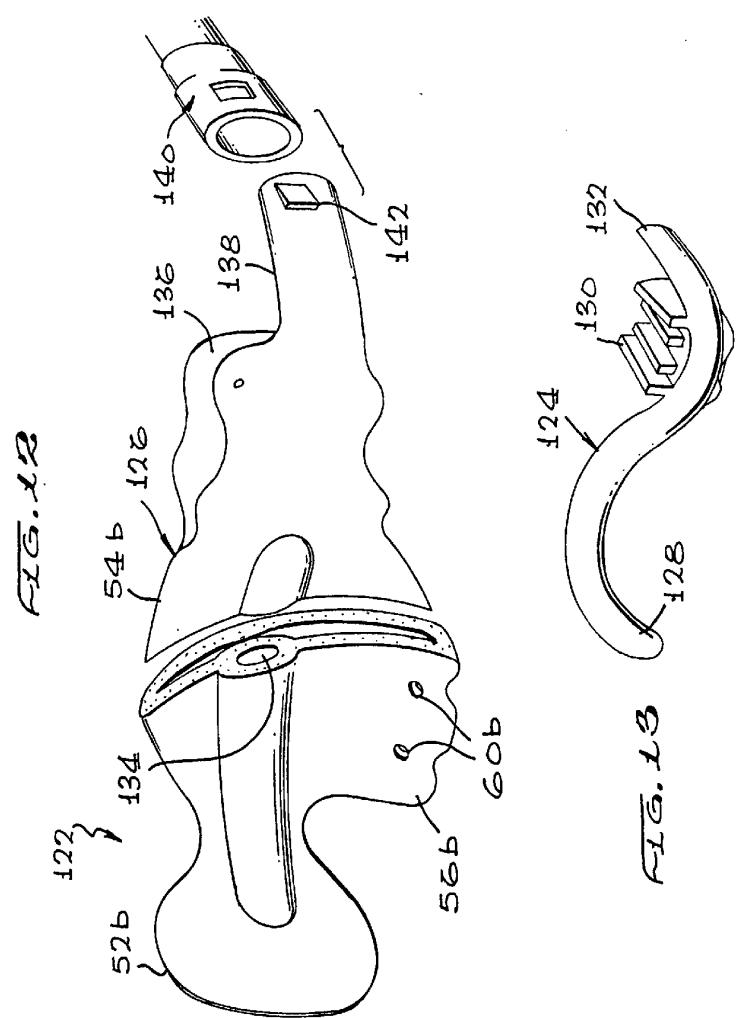


FIG. 11A

FIG. 11B



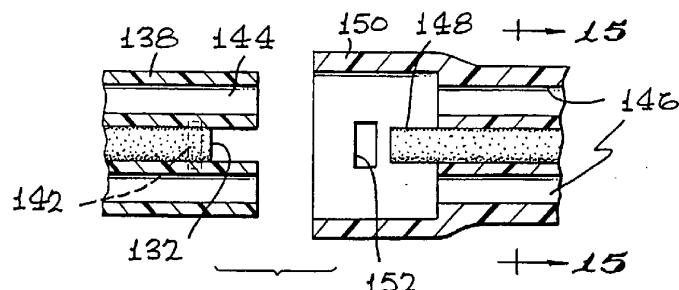


FIG. 15

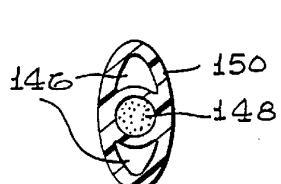


FIG. 16

