

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
14 August 2003 (14.08.2003)

PCT

(10) International Publication Number
WO 03/065920 A1

(51) International Patent Classification⁷: A61C 3/00

(21) International Application Number: PCT/US03/01355

(22) International Filing Date: 17 January 2003 (17.01.2003)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
10/068,103 5 February 2002 (05.02.2002) US
10/068,397 5 February 2002 (05.02.2002) US

(71) Applicant: ULTRADENT PRODUCTS, INC. [US/US];
505 West 10200 South, South Jordan, UT 84065 (US).

(72) Inventors: FISCHER, Dan, E.; 10444 South Dimple
Dell Road, Sandy, UT 84093 (US). MCLEAN, Bruce, S.;
12091 South Millridge Road, Sandy, UT 84094 (US).

(74) Agents: NYDEGGER, Rick, D. et al.; WORKMAN, NY-
DEGGER & SEELEY, 1000 Eagle Gate Tower, 60 East
South Temple, Salt Lake City, UT 84111 (US).

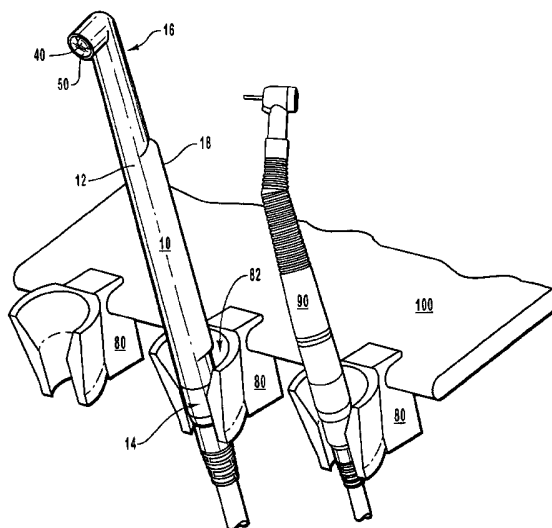
(81) Designated States (*national*): AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States (*regional*): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PT, SE, SI, SK, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— with international search report

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: LIGHTWEIGHT HAND HELD DENTAL CURING DEVICE



(57) Abstract: A dental device (10) configured for curing light-curable compounds includes a slender body (12) having the general configuration of a dental hand piece. The dental device is equipped with finger controls (70, 72, 74) for controlling the emission of light from an LED light source (40) disposed at the distal end (16) of the dental device. The LED light source (40) may include transillumination lenses (50) for protecting the light source, filtering out undesired radiant energy, and/or focusing light emitted by the light source to yield a desired footprint. A remote power supply connected with the dental device provides power to the dental device without increasing the size or weight of the dental device. Alternatively, the dental device may include an internal battery. The body of the dental device may be configured so as to fit within the holding slot (84) of a standard dental hand piece holding tray (100).



WO 03/065920 A1

LIGHTWEIGHT HAND HELD DENTAL CURING DEVICE

5

BACKGROUND OF THE INVENTION

1. The Field of the Invention

The present invention generally relates to the field of light-curing devices and, more specifically, to handheld dental light-curing devices incorporating LED light sources.

2. The Relevant Technology

In the field of dentistry, dental cavities are often filled and/or sealed with photosensitive compounds that are cured when they are exposed to radiant energy, such as visible light. These compounds, commonly referred to as light-curable compounds, are placed within dental cavity preparations or onto dental surfaces where they are subsequently irradiated by a light-curing dental device.

Many light-curing devices are configured with a fiber optic light guide for directing light from a light source into a patient's mouth. The light source may comprise, for example, a lamp, a halogen bulb or a light-emitting diode (LED). One end of the light guide is placed close to the light source so that the light emitted from the light source will be directed into and captured by the light guide. One problem with light guides, however, is that they are relatively heavy and can significantly increase the weight of the light-curing device. This is particularly true when the light guide is composed of a relatively heavy material, such as glass. Light guides also indirectly increase the weight of the light-curing devices, in as much as light-curing devices incorporating light guides often require special reflector assemblies for focusing the desired light into the light guides that can increase the weight of the light-curing devices. Yet another feature that can increase the weight of the light-curing devices is the power supply, such as a battery pack or a transformer for alternating current (AC).

The additional weight of the light-curing devices that is directly or indirectly caused by the light-guide and power supply can make it difficult to manipulate the light-curing device within an operator's hand. Weight can also increase the cost of shipping and hence the overall cost of the device.

Light-guides and integrated power supply units also add bulk to the light-curing devices, thereby increasing the difficulty of gripping and manipulating the light-curing devices by hand. The bulky size of certain existing light-curing devices is also problematic because the bulky size generally prevents the light-curing devices from being held or stored within the holding slots of existing dental hand piece holding trays, which are designed to hold standard dental hand pieces such as ultrasonic tools, three-way syringes, suctioning devices and high and low speed turbines, and the like. Because existing dental light-curing devices are generally too bulky to be securely held within the holding slots of a dental hand piece holding tray, they must be set on a counter or another surface during periods of non-use. It will be appreciated that this, along with the increased weight of the light-curing device, significantly increases the probability of the light-curing device being accidentally dropped or knocked onto the floor.

One method for overcoming the aforementioned limitations of existing light-curing devices incorporating light guides and for generally improving the efficiency of the light-curing devices is to place the light source, such as an LED, directly at the tip of the light-curing device so that a light-guide is no longer needed. This design is also useful because it enables the majority of the light emitted by the LED to be directed within the patient's mouth.

Accordingly, in view of the foregoing, there is currently a need in the art for improved dental light-curing devices and, more particularly, to dental light-curing devices ergonomically configured in size, shape and weight for ease of use and for storage within standard dental hand piece holding trays.

There is additionally a need in the art for improved dental light-curing devices incorporating one or more LEDs and to dental light-curing devices that are configured to focus or channel light emitted from the one or more LEDs into a desired footprint or path of illumination.

SUMMARY OF PRESENTLY PREFERRED EMBODIMENTS

Briefly summarized, presently preferred embodiments of the present invention are directed to improved dental devices configured for curing light-curable compounds. More particularly, the presently preferred embodiments of the present invention are directed to light-curing devices ergonomically configured into the

general shape of standard dental hand pieces for ease of use and for facilitating storage in a dental hand piece holding tray during non-use.

According to one presently preferred embodiment, the dental devices comprise a body extending between a proximal end and a distal end. The body is configured in size, shape and weight to look and feel like a standard dental hand piece and to fit
5 securely within the holding slot of a standard dental hand piece holding tray.

A light source disposed at the distal end of the body emits light from the dental device for predetermined durations when controls on the dental device are manipulated. The controls may include, for example, a button for activating the light
10 source a predetermined duration of time and buttons for increasing and decreasing the duration of time the light source is activated each time the light source is activated. The light source may comprise any light source configured to provide radiant energy. According to one embodiment, the light source comprises at least one LED or LED
array.

The dental device may also include a transilluminating lens that is placed over
15 the light source. The transilluminating lens may be clear or it may be color tinted for filtering out certain unnecessary wavelengths, such as orange, green, or yellow spectrum light generated by the light source. The transilluminating lens can also function as a protective shield for protecting the light source from contaminating
20 elements in the dental environment. The transilluminating lens may also comprise focusing means for focusing or directing the light emitted by the light source in a desired manner.

The focusing means is configured to focus the light emitted from the light source into a desired path of illumination having a desired footprint with minimal
25 dispersion. According to one embodiment, the focusing means comprises a lens or a plurality of lenses configured to refract the light emitted from the light source into the desired path of illumination. The lenses may include, for example, one or more hemispheric lenses concentrically aligned with the individual LED light sources and aspheric lenses concentrically misaligned with the individual LED light sources. The
30 lenses may also be integrally connected into a single lens having hemispheric or aspheric properties. According to the invention, the lenses are configured to be either fixedly connected with or detachable from the dental device.

According to one embodiment, the dental device further comprises a power cord configured to operably connect the dental device with an external power supply, such as an electrical wall socket or an AC/DC converter.

The dental device may also be included as part of a kit that further includes a holder configured to be connected to a dental hand piece holding tray or other device. This embodiment can be particularly useful when the dental device and holder are connected with unconventional or nonstandard dental holding trays because the holder can be customized to fit any desired dental holding tray.

It will be appreciated that the general configuration of the dental devices of the invention are both ergonomic and light weight, thereby enabling the dental device to be handled with minimal effort and for enabling the dental device to be easily stowed away within the holding slot of a dental hand piece holding tray during periods of non-use.

These and other benefits, advantages and features of the present invention will become more fully apparent from the following description and appended claims, or may be learned by the practice of the invention as set forth hereinafter.

BRIEF DESCRIPTION OF THE DRAWINGS

In order that the manner in which the above recited and other benefits, advantages and features of the invention are obtained, a more particular description of the invention briefly described above will be rendered by reference to specific embodiments thereof which are illustrated in the appended drawings. Understanding that these drawings depict only typical embodiments of the invention and are not therefore to be considered limiting of its scope, the invention will be described and explained with additional specificity and detail through the use of the accompanying drawings in which:

Figure 1 illustrates a bottom perspective view of one embodiment of the dental device of the invention that includes a slender body configured in the general shape and size of a dental hand piece, extending from a proximal end to a distal end, with an LED light source disposed at the distal end and a power cord connected at the proximal end;

Figure 2 illustrates a top perspective view of one embodiment of the dental device of Figure 1 that further illustrates controls disposed on a protrusion of the body configured for controlling the illumination of the light source;

Figure 3 illustrates a top perspective view of the dental device of Figure 1 and of a holding slot configured to securely hold the dental device when the dental device is placed within the holding slot;

Figure 4 illustrates a light-curing device according to the invention received within a conventional dental hand piece holding tray;

Figure 5 illustrates a bottom perspective view of one embodiment of the dental device of the invention that includes a body extending from a proximal end to a distal end with a light source and a focusing means disposed at the distal end of the dental device;

Figure 6 illustrates a top perspective view of the dental device shown in Figure 5 and further illustrates controls disposed on the body that can be used to activate the light source;

Figure 7 illustrates a top perspective view of a single lens configured in shape and size to direct light emitted from an LED light source into a desired path of illumination;

Figure 8 illustrates a cross-sectional side view of one embodiment of an LED light source and of a focusing means that includes two hemispheric lenses concentrically aligned with the LEDs of the light source;

Figure 9 illustrates a cross-sectional side view of one embodiment of an LED light source and of a focusing means that includes two aspheric lenses concentrically misaligned with the LEDs of the light source;

Figure 10 illustrates a cross-sectional side view of one embodiment of the light source in which two LEDs are offset by particular angles and distances to direct light emitted from the light source into a desired path of illumination; and

Figure 11 illustrates one embodiment of the dental device of the invention in which the light source is emitting light into a path of illumination having a desired elliptical footprint.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

A detailed description of the dental device of the invention will now be provided with specific reference to figures illustrating preferred embodiments of the invention. It will be appreciated that like structures will be provided with like reference designations.

The term “dental hand piece,” as used herein, generally refers to a handheld dental device that engages rotary instruments for cutting, cleaning, polishing or otherwise treating teeth. The term “dental hand piece” is a term of art well known in the dental industry. Nonlimiting examples of dental hand pieces include high speed
5 turbines, low speed turbines, ultrasonic devices, and 3-way syringes. Dental hand pieces are typically driven by pneumatic, electric, and ultrasonic mechanisms.

The term “dental hand piece holding tray” generally refers to a tray configured with slots or holding devices specifically configured in shape and size for holding conventional dental hand pieces. Dental hand piece holding trays, which are well-
10 known to those skilled in the art, are placed proximate or mounted directly to dental chairs for facilitating access to dental hand pieces held by the holding trays.

The terms “holding slot” and “holder,” which are used interchangeably herein, generally refer to devices configured in size and shape to securely hold a dental hand piece. A holding slot is a typical feature of a dental hand piece holding tray.

The term “footprint,” as used herein, is generally made with reference to the
15 cross-sectional shape of the path of illumination of light emitted from a light source. The dimensions of the footprint will typically vary according to the distance of the footprint from the light source and the angle at which the light is emitted by the light source. The general shape and dimensions of a footprint can generally be identified
20 by placing a flat object in front of a light source and observing the area illuminated by the light source. As described herein, the dental devices of the present invention are configured to focus or collimate light emitted from an LED light source into a path of illumination having a desired footprint. As described below in more detail, the footprint also refers to the area in which light from a plurality of LEDs overlap.

The term “LED light source” includes any light-emitting diode (LED) or LED
25 array. “LED” and “LED array,” which are sometimes used interchangeably herein, include the electrical components of the LED as well as the integral lens or micro lens of the typical LED structure. Accordingly, references made herein to embodiments of dental devices incorporating lenses are made with reference to secondary lenses or
30 lenses that are not otherwise included as part of the LED structure.

The term “focusing,” as used herein, is generally used in reference to focusing means for collimating light and is defined as redirecting light emitted from a light source into a path of illumination having an angle of dispersion that is less than the

angle in which the light was originally emitted from the light source, but which does not focus the light to a discrete focal point. In other words, focusing means for focusing or collimating light provides a collimating effect on the light emitted from the light source. "Focusing" is also generally defined as means for creating a desired footprint that is defined by the overlapping portions of light emitted from each component of the light source. For instance, when the light source comprises two or more LEDs, focusing the light emitted from the light source comprises the act of directing at least a portion of the light emitted from each LED into a desired footprint, where the light from each LED overlaps. Accordingly, focusing means for focusing the light may comprise the particular configurations in which the LEDs are spatially and angularly offset from one another for causing the light emitted from each of the LEDs to overlap within a desired footprint. According to this application, focusing means does not include reflectors configured to collimate the light or to reflect the light into a desired footprint. According to the invention, focusing means also does not include the integral lens of the LED through which light is emitted.

Reference is first made to Figure 1, which illustrates one preferred embodiment of the dental device of the invention. As shown, the dental device 10 has the general configuration of a dental hand piece with a sleek and slender body 12 that extends from a proximal end 14 to a distal end 16. The shape of the body 12 is generally cylindrical, being defined by a circular cross-sectional shape. It will be appreciated, however, that the cross-sectional shape of the body 12 may be configured into other shapes, including, but not limited to, square, triangular, hexagonal, oval, and rectilinear shapes. The body 12 may also include small or slight irregularities or protrusions such as protrusion 18, which is configured with control buttons for controlling the operation of the dental device 10, as described below in reference to Figure 2.

The generally cylindrical shape of the dental device 10 is useful, in the present embodiment, because it is ergonomic. In particular, the generally cylindrical shape of the body 12 enables a dental practitioner to comfortably hold the dental device in various positions. The sleek and slender body 12 of the dental device is also useful for enabling the dental practitioner to easily rotate and move the dental device 10 into various positions during a dental procedure.

According to one embodiment, the proximal end 14 of the dental device 10 is configured in size and shape to be inserted into the holding slot of a dental hand piece holding tray. The proximal end 14 of the body 12 may also be tapered to facilitate insertion of the dental device 10 into a holding slot. Placing the dental device 10 within a holding slot of a dental hand piece holding tray during a dental procedure can be useful for minimizing any chance for the dental device 10 to be accidentally knocked or dropped during periods of nonuse.

As shown, the dental device 10 is also configured to be connected with a power cord 30 at the proximal end 14 of the body 12. Although not shown, the power cord 30 operably connects the dental device 10 with a power supply remotely located away from the dental device 10. The remote power supply may include an electrical wall receptacle, a battery pack, a generator, a transformer, or any other power supply suitably configured for providing an appropriate supply of power to the dental device for illuminating the light source 40 of the dental device 10, which is disposed at the distal end 16 of the dental device 10. Power supply wires 15 communicating between the power supply cord 30 and the light source 40 are advantageously disposed within, and protectively, the body 12.

According to one embodiment, the light source 40 includes an LED configured to emit radiant energy that is suitable for curing light curable compounds. It will be appreciated, however that the light source 40 may also include an LED array, a plurality of LEDs, and other similar light sources. Lens, filters and the like may be used in conjunction with the light source 40.

In particular, the dental devices 10 of the present invention may include external filters or lenses for covering the LED light source 40 for performing a desired optical effect on the light that is emitted from the light source 40, such as for example, focusing or filtering light emitted by the light source 40.

Examples of light curing devices having one or more light sources (*e.g.*, one or more LEDs or LED arrays) disposed at a distal end and which are powered by a remotely located power supply are disclosed in U.S. Patent No. 6,331,111 to Cao. The light curing devices disclosed in Cao, however, are not configured into the general shape and size of a conventional dental hand piece.

According to one embodiment, the dental device 10 of the invention includes a transilluminating lens 50, as shown in Figures 1 and 3-4. The transilluminating lens

50 is preferably color tinted to filter out undesired wavelengths emitted by the light source 40. The transilluminating lens 50 can also function as a shield for protecting the light source 40 from contaminants in the dental environment. As shown in Figure 1, the lens 50 may be detachable from the distal end 16 of the dental device 10, such as with a snap fitting or a friction fitting, for enabling different types of lenses with different functionality to be interchangeably used with the dental device 10 according to need and preference. Alternatively, as shown in Figure 3, the lens 50 may be fixedly connected to the distal end 16 of the dental device 10, such as with an adhesive, by welding, or with mechanical coupling.

10 According to one embodiment, the dental device 10 further includes a heat sink 60 for dissipating heat generated by the light source during use. As shown in Figure 1, the light source 40 is preferably mounted directly onto the heat sink 60 for enhancing the heat dissipating properties of the heat sink 60 through conduction. The heat sink may comprise any heat conductive materials, such as metal, examples of which include aluminum, copper, brass, steel, silver and combinations of the foregoing.

As shown in Figures 1 and 3-4, the light source 40 and the distal end 16 of the dental device 10 are advantageously sized and configured so as to be inserted and rotated within the mouth of a patient. It will be appreciated that this provides an advantage over light curing devices that require special light guides or other protruding and bulky mechanisms to channel the light emitted from a light source into the patient's mouth. In particular, light guides are relatively heavy and protrude away from the light source, thereby increasing the bulkiness of such light curing devices.

Another benefit of the present invention is that the dental device is powered by a remotely located power supply, as mentioned above, which greatly reduces the overall weight of the dental device, thereby increasing the ease of use and ergonomics of the dental device. It will be appreciated, however, that in certain circumstances it may be desirable for the dental device to be configured with an integral power supply, such as a battery. In these circumstances, the dental device may be configured with a battery so long as the body of the dental device remains suitably configured to be held within the holding slot of a dental hand piece holding tray.

30 According to one embodiment, the dental device also includes controls for controlling the emission of radiant energy from the light source. The controls are

advantageously mounted on the body 12 of the dental device 10 for ease of use. By way of example, not limitation, and as shown in Figure 2, the controls may include three different buttons 70, 72, 74. The first button 70, when depressed, activates the light source 40 for a predetermined duration of time, such as for example 15 seconds.

5 The second and the third buttons 72, 74 can be used to increase or decrease the predetermined duration of time by any desired increment of time, such as for example by 5 second increments. It will be appreciated that this embodiment is useful for at least enabling a dental practitioner to use the dental device 10 without having to continuously depress a button during use. The controls communicate with the power supply wires 15 (Figure 1) as needed to complete the electrical circuit.

Attention is now directed to Figure 3. As shown therein, the dental device 10 may be included as part of a kit that further includes a holder 80 configured in size and shape to securely hold the dental device 10 when the proximal end 14 of the dental device 10 is inserted into the holder 80. In particular, the holder 80 includes an inner surface 82 that is sized and configured (*e.g.*, tapered) for frictionally engaging the proximal end 14 of the dental device 10 and for securely holding the dental device 10 in place.

The holder 80 may also include connecting means for connecting the holder 80 with a dental hand piece holding tray or another device or object, such as a counter or shelf. The connecting means can include a recess 84 configured to frictionally engage the edge of a tray, a slot configured to slidably engage a rod, a clamp, an adhesive mounting surface, a screw or bolt and conforming hole formations, and any other suitable means for connecting the holder 80 to a dental hand piece holding tray or other device.

25 Figure 4 illustrates how, according to one embodiment, the holder 80 holds the dental device on a dental hand piece holding tray 100. As shown, the dental hand piece holding tray includes several holders or holding slots configured for holding dental hand pieces. An existing turbine hand piece 90 is placed into one of the holders 80 and the dental device of the invention is held within another of the holders 80.

Reference is first made to Figure 5, which illustrates a bottom perspective view of one embodiment of the dental device 100 of the invention. As shown, the body 102 of the dental device 100 extends from a proximal end 104 to a distal end

106. Although the body 102 is shown to be sleek and slender, it will be appreciated that the body 102 of the dental device 100 may comprise any desired shape and size.

A light source 120 disposed at the distal end 106 of the dental device 100 is configured to emit light suitable for curing light-curable compounds, such as, for example, during dental restoration procedures. The light source 120, as shown, includes two LEDs. Although two LEDs are shown, it will be appreciated that the light source 120 may alternatively include one LED or more than two LEDs. The light source 120 may also include an LED array, a plurality of LED arrays, and any combination of LEDs and LED arrays.

According to the preferred embodiment of the invention, the light source 120 and the distal end 106 of the body 102 are sized and configured so as to be easily inserted into the mouth of a patient, thereby enabling light generated by the light source 120 to be directly emitted into the patients mouth without first passing through an elongated light guide, as required by many conventional light curing devices.

According to the present embodiment, the light source 120 is powered by a remote electrical power supply (not shown), which may include, but is not limited to, the power outlet of a wall receptacle, a battery, a generator, a transformer or any other source capable of supplying power to the dental device. A power cord 122 connected at the proximal end 104 of the dental device 100 operably interconnects the remote power supply with the dental device 100.

According to one alternative embodiment (not shown), the proximal end 104 of the dental device is not connected to a power cord 122, but rather the dental device 100 is equipped with an integral battery pack that is capable of powering the dental device 100 and energizing the light source.

Figure 6 illustrates a top perspective view of the dental device 100 shown in Figure 5 and further illustrates controls that are disposed on the body 102 of the dental device 100. According to this embodiment, the controls are configured to enable a dental practitioner to control the activation of the light source 120. According to this embodiment, the controls preferably include three different buttons 130, 132, 134. The first button 130, when depressed, activates the light source 120 for a predetermined duration of time, such as, for example, 15 seconds, thereby enabling the dental practitioner to use the dental device 100 without having to continuously depress button 130 during use. The second and third buttons 132, 134 may be used to

increase or decrease the predetermined duration of time by a desired increment of time, such as, for example, by 5 second increments. The controls are advantageously ergonomically mounted on the body 102 of the dental device 100 for ease of use. In particular, the controls are advantageously disposed on the body 102 in a manner
5 which enables them to be manipulated by the thumb or finger of the dental practitioner. It will be appreciated, however, that the dental device 100 of the invention is not limited to any particular configuration or type of controls. Rather, the dental devices of the invention may be configured with any type of controls that are attached to the body of the dental device or that are remotely located away from the
10 device, as desired.

As shown in Figure 5, the dental device 100 may also include a focusing means configured to control the manner in which the light is dispersed from the dental device 100. In the present embodiment, the focusing means comprises a single lens 140 sized and configured so as to cover the light source 120 at the distal end 106 of the body 102 and to focus the light that is emitted from the light source 120.
15

Figure 7 illustrates a close-up perspective view of the lens 140 disposed above the two LEDs 42 of the light source 120. According to this embodiment, the lens 140 comprises a single integral lens configured to cover both of the LEDs 142. In embodiments including LED arrays or more LEDs, the lens 140 may correspondingly
20 be configured to cover the additional LEDs and LED arrays. In general, the shape and features of the lens 140 can also be configured to accommodate any desired need or preference. For instance, according to one embodiment the lens 140 may be tinted red, yellow, orange, or another color to filter out undesired radiant energy produced by the LEDs. The shape and curvature of the lens 140 may also be customized to
25 create a desired optical effect. According to one preferred embodiment, the lens 140 includes two hemispherical curvatures 144 concentrically aligned with the two different LEDs 142 for focusing the light emitted from the LEDs 142.

Focusing the light emitted from the LEDs 142 can also be accomplished with other focusing means. For instance, as shown in Figure 8, the focusing means
30 includes two independent hemispherical lenses 150 that are concentrically aligned with the LEDs 142. In other words, the central axis 152 of each hemispherical lens 150 is aligned with the central axis 154 of a different one of the LEDs 142. This

causes the light emitted by the LEDs 142 to be refracted into a path of illumination having a desired footprint, as described below in more detail in reference to Figure 11.

Generally, the desired optical effect of the focusing means is to reduce the angle of dispersion, of about 120° to about 140° , in which light is typically emitted from an LED. By reducing the angle of dispersion, it is possible to collimate the light so that the dental device 100 can efficiently operate within a greater range of distances from the desired application site. By way of example and not limitation, collimating the light enables the dental device 100 to irradiate a desired application site with substantially the same intensity of radiant energy at about 8 mm as at a distance of about 5 mm. It will be appreciated that this is an improvement over existing light curing devices incorporating LEDs that emit light with a wide angle of dispersion.

Figure 9 illustrates another embodiment of the focusing means. As shown, the focusing means comprises two aspheric lenses 160 disposed above and concentrically misaligned with the two LEDs 142 of the light source 120. In other words, the central axis 162 of each aspheric lens 160 is askew to the central axis 154 of the LED 142 to which it corresponds. It has been found that by offsetting the respective axes 162, 154 of the aspheric lenses 160 and the LEDs 142 it is possible to create a desired collimating effect of the light emitted from the LEDs 142, as generally described above.

Figure 10 illustrates yet another embodiment of the focusing means. As shown in the present embodiment, the focusing means does not include a lens. Rather, the focusing means comprises the offsetting configuration of the LEDs 142. In particular, according to the present embodiment, the focusing means for collimating the light into a desired path of illumination comprises offsetting the LEDs 142 at an angle 170 of between about 35° and 45° and at a distance 172 of between about 0.375 inches and about 0.75 inches, although other distances and angles can also be used to create a desired focusing effect.

According to the invention, focusing means for focusing the light emitted from the LEDs 142 can also include any combination of lenses and offsetting LED configurations, which are described above. In general, the desired effect of the focusing means is to concentrate the emitted light so that the dental device is more efficient and also for increasing the range of distances in which the dental device can be efficiently used to cure light-curable compounds during dental procedures.

Figure 11 illustrates a top perspective view of the dental device of the invention emitting light within a path of illumination 180. According to the invention, the light emitted from the dental device is substantially collimated by the focusing means of the dental device 100, as generally described above, but not shown in Figure 11. According to this embodiment the path of illumination 180 comprises a substantially elliptical footprint 190. The elliptical shape of the footprint 190 is useful because it corresponds with the substantially elliptical shape of the dental surfaces where the light is directed during dental restoration procedures, thereby increasing the overall efficiency of the dental device 100. It will be appreciated, however, according to other embodiments that are not shown, the footprint of the light source may also comprise other shapes, such as, for example, shapes generated by light sources that include three or more LEDs.

According to one embodiment, the dimensions of the elliptical footprint 190 fall within the range of about 8 mm to about 14 mm in width and within the range of about 10 mm and 16 mm in length at distances of between about 5 mm and about 8 mm from the light source. According to one preferred embodiment, the elliptical footprint is dimensioned about 10 mm in width and about 12 mm in length at distances between about 5 mm and about 8 mm away from the light source of the dental device 100.

As shown in Figures 7-10, the dental device may also include a heat sink 192 configured to dissipate heat generated by the light source 120. The LEDs 142 of the light source are preferably mounted directly onto, or otherwise located adjacent to, the heat sink to increase the efficiency of the heat sink 192 through conduction. Accordingly, the heat sink is preferably composed of a conductive material, including, but not limited to materials comprising aluminum, copper, brass, steel, silver, gold, and combinations of the foregoing.

In summary, the dental devices of the invention may be configured to have the same general shape, size and weight of conventional dental hand pieces, thereby enabling the dental devices to be securely held within the holders or holding slots of convention dental hand piece holding trays or holding trays of generally small size.

The dental devices of the invention may also include a protective lens or focusing means configured to collimate and focus the light into a desired path of illumination. The lenses may be placed into direct contact with the LEDs or spaced

away from the LEDs. The lenses can also be fixedly connected or removably connected to the distal end of the dental device. For instance, in one embodiment, the lenses are fixedly connected to the distal end of the dental device with an adhesive, a mechanical coupling, chemical bonding or welding. In another embodiment, the
5 lenses are removably connected to the distal end of the dental device with a friction fit or mechanical coupling such as a snap fit.

It will be appreciated that the present claimed invention may be embodied in other specific forms without departing from its spirit or essential characteristics. The described embodiments are to be considered in all respects only as illustrative, not
10 restrictive. The scope of the invention is, therefore, indicated by the appended claims rather than by the foregoing description. All changes that come within the meaning and range of equivalency of the claims are to be embraced within their scope. What is claimed is:

CLAIMS

16

1. A dental device configured for curing light-curable compounds, comprising:
 - a body extending between a proximal end and a distal end, wherein the proximal end of the body is sized and configured to be received by a dental hand piece holding tray that is sized and configured to receive at least one type of dental hand piece and wherein the distal end is sized and configured so as to fit within the mouth of a patient; and
 - a light source disposed at the distal end of the body and configured to emit radiant energy suitable for curing a light-curable compound.
2. A dental device as recited in claim 1, wherein the light source comprises at least one of an LED or an LED array.
3. A dental device as recited in claim 1, further comprising a power cord operably connecting the dental device to a power supply and power supply wires disposed within the body and communicating between the light source and the power cord.
4. A dental device as recited in claim 1, further comprising controls disposed on the body for controlling illumination of the light source, wherein the controls include a first control for activating the light source for a predetermined duration of time and second control for altering the predetermined duration of time.
5. A dental device as recited in claim 1, further including at least one battery disposed at least partially within the body for supplying power to the light source.
6. A dental device as recited in claim 1, further comprising a lens disposed at the distal end of the dental device so that light emitted by the light source passes through the lens.
7. A dental device as recited in claim 6, wherein the lens is configured to filter out undesired wavelengths emitted by the light source.
8. A dental device as recited in claim 6, wherein the lens is fixedly connected to the dental device.
9. A dental device as recited in claim 6, wherein the lens is removably connected to the dental device.
10. A dental device as recited in claim 6, wherein the lens comprises a focusing lens.

11. A dental device as recited in claim 10, wherein the focusing lens comprises a hemispheric lens.

12. A dental device as recited in claim 1, wherein the light source comprises two LEDs offset by a predetermined distance and a predetermined angle such that the light emitted from the two LEDs is channeled into a path of illumination having a desired elliptical footprint.

13. A dental device as recited in claim 12, wherein the predetermined angle comprises an angle within the range of about 34° and about 44° and wherein the predetermined distance comprises a distance within the range of about 0.37 inch and about 0.75 inch.

14. A dental device as recited in claim 12, wherein the desired elliptical footprint comprises a first dimension within the range of about 8 mm to about 14 mm and a second dimension within the range of about 10 mm to about 16 mm at a distance of about 5 mm to about 8 mm away from the two LEDs.

15. A dental device as recited in claim 12, further comprising two lenses disposed adjacent to a different one of the two LEDs and configured to focus light emitted from the two LEDs into the desired elliptical footprint.

16. A dental device as recited in claim 1, wherein the dental device further comprises a heat sink adjacent to the light source and configured to draw away and dissipate heat generated by the light source, the heat sink preferably comprising at least one of aluminum, brass, copper, steel or silver.

17. A dental device as recited in claim 1, wherein the proximal end of the body has a size and shape that approximates the size and shape of a standard dental hand piece, preferably at least one dental hand piece selected from the group consisting of low speed dental turbines, high speed dental turbines, ultrasonic dental devices, 3- way dental syringes, and oral suctioning devices.

18. A dental device as recited in claim 1, wherein the proximal end of the body is configured to securely fit into a holding slot of a standard dental hand piece holding tray that is sized and configured to securely receive at least one type of standard dental hand piece, and wherein the distal end of the body is configured in size and shape to be inserted into the mouth of a patient; and

19. A dental device as recited in claim 1, wherein at least a portion of the body is substantially cylindrical.

20. A dental system comprising:
a dental curing device configured for curing light-curable compounds
and that comprises:

5 a body extending between a proximal end and a distal end, the
distal end being sized and configured so as to fit within the mouth of a
patient; and

a light source disposed at the distal end of the body and
configured to emit light suitable for curing light-curable compounds;
and

10 a holder that comprises an inner surface configured in size and shape to
frictionally engage at least a portion of the proximal end of the dental device
body.

21. A dental system comprising as recited in claim 20, the holder further
comprising connecting means for connecting the holder with another device,
15 preferably a standard dental hand piece holding tray.

22. A dental system as recited in claim 20, wherein the proximal end of the
body is substantially cylindrical.

23. A dental system as recited in claim 22, wherein the holder further
defines a slot through which power cord can freely pass.

20 24. A dental system as recited in claim 20, wherein the holder is connected
to, or is part of, a standard dental hand piece holding tray comprising a plurality of
recesses for holding therein a plurality dental hand pieces, at least one of which is the
dental curing light.

25 25. A dental system as recited in claim 24, further comprising at least one
additional dental hand piece configured to be received within at least one of the
recesses associated with the dental hand piece holding tray, wherein the at least one
additional dental hand piece is selected from the group consisting of low speed dental
turbines, high speed dental turbines, ultrasonic dental devices, 3- way dental syringes,
and oral suctioning devices.

30 26. A dental system as recited in claim 20, wherein the light source
comprises at least one of an LED or an LED array.

27. A dental kit for curing light-curable compounds, comprising:
a light curing device that comprises:

an elongate body extending between a proximal end and a distal end;

a light source disposed at the distal end of the body and configured to emit radiant energy suitable for curing a light-curable compound; and

a heat sink configured so as to draw away and dissipate heat generated by the light source; and

a lens removably attachable to the distal end of the light curing device, the lens being positioned so that light generated by the light source passes through the lens when the light curing light is in use.

28. A dental kit as recited in claim 27, further comprising a holding tray that is sized and configured so as to removably receive the proximal end of the elongate body.

29. A dental kit as recited in claim 27, wherein the light source comprises at least one of an LED or an LED array.

30. A dental kit as recited in claim 27, wherein the light source is positioned adjacent to the heat sink, the heat sink comprising at least one of aluminum, brass, copper, steel or silver.

31. A dental kit as recited in claim 27, wherein the lens protects the light source from contaminants when the light curing device is in use.

32. A dental kit as recited in claim 27, wherein the lens comprises a focusing lens.

33. A dental kit as recited in claim 27, further comprising one or more controls disposed on the elongate body of the light curing device, the one or more controls configured so as to control illumination of the light source.

34. A dental kit as recited in claim 27, further comprising at least one battery disposed at least partially within the elongate body of the light curing device for supplying power to the light source.

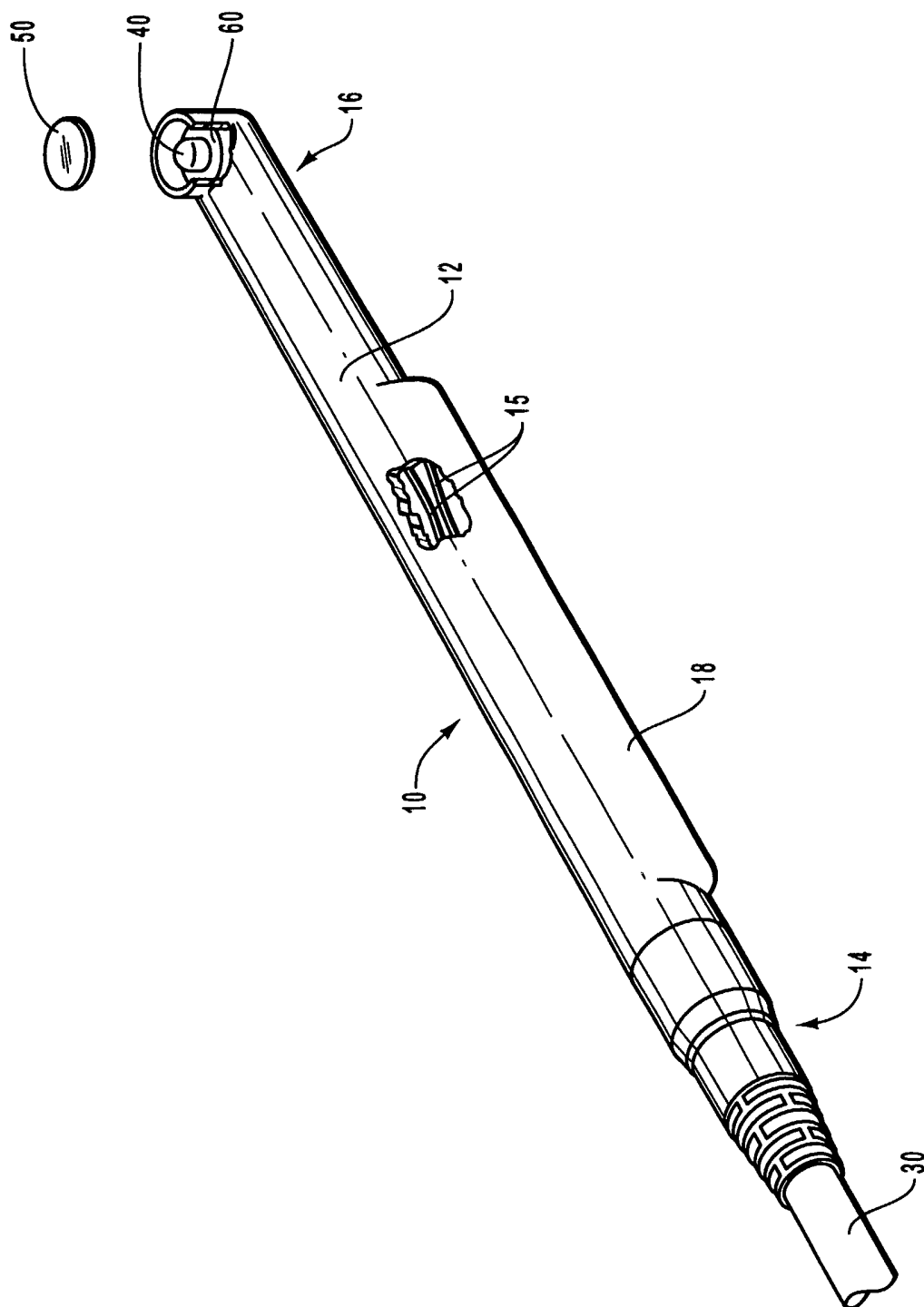


FIG. 1

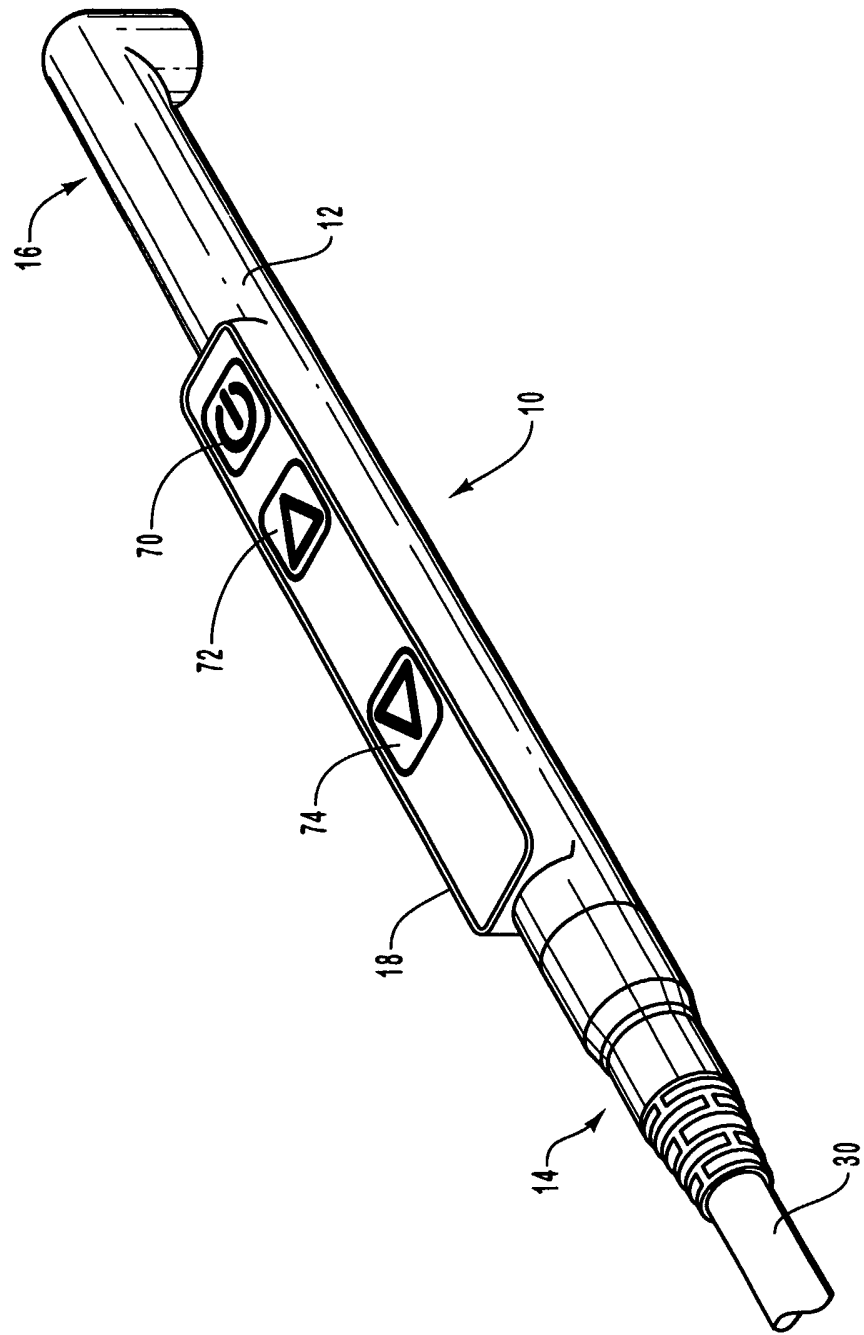


FIG. 2

3 / 11

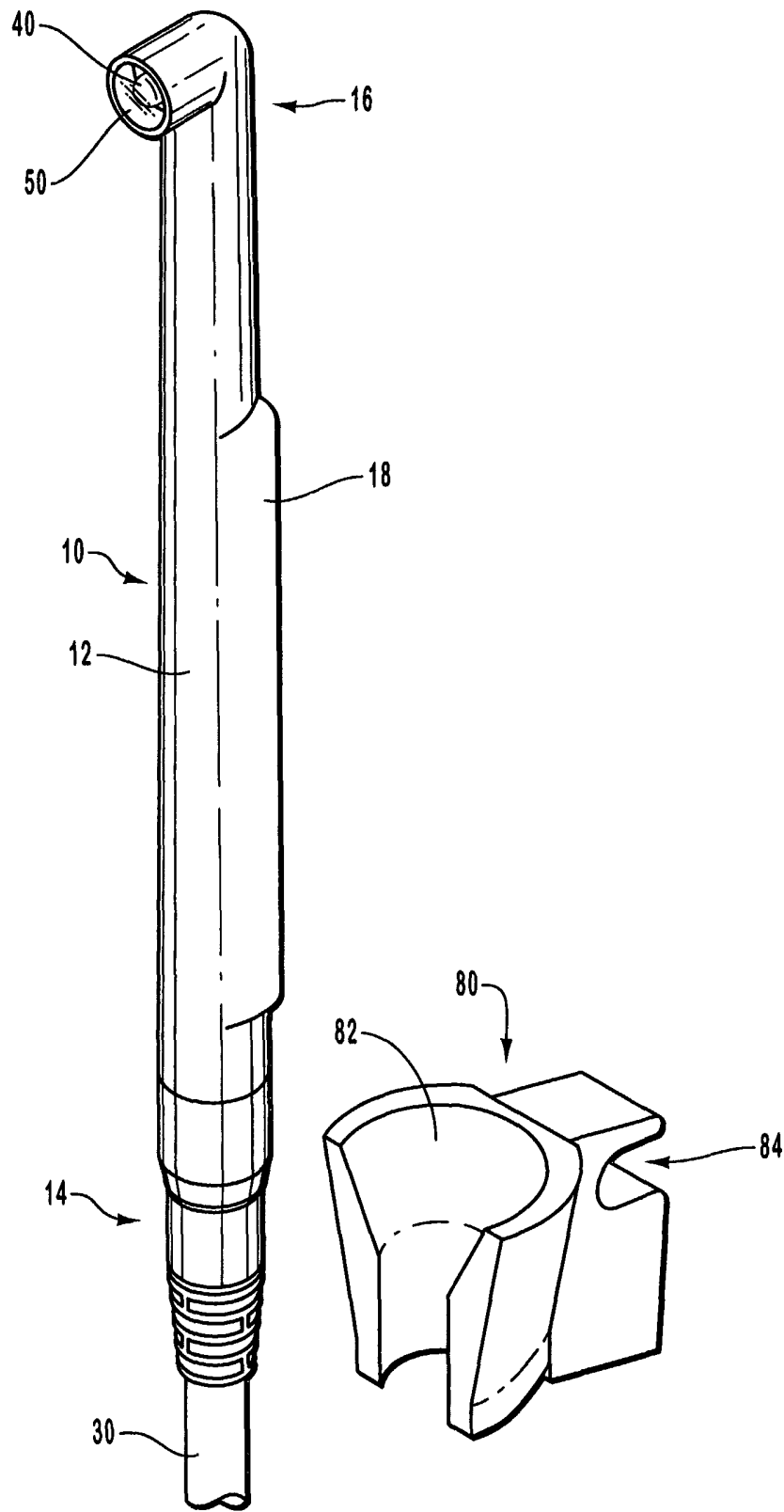


FIG. 3

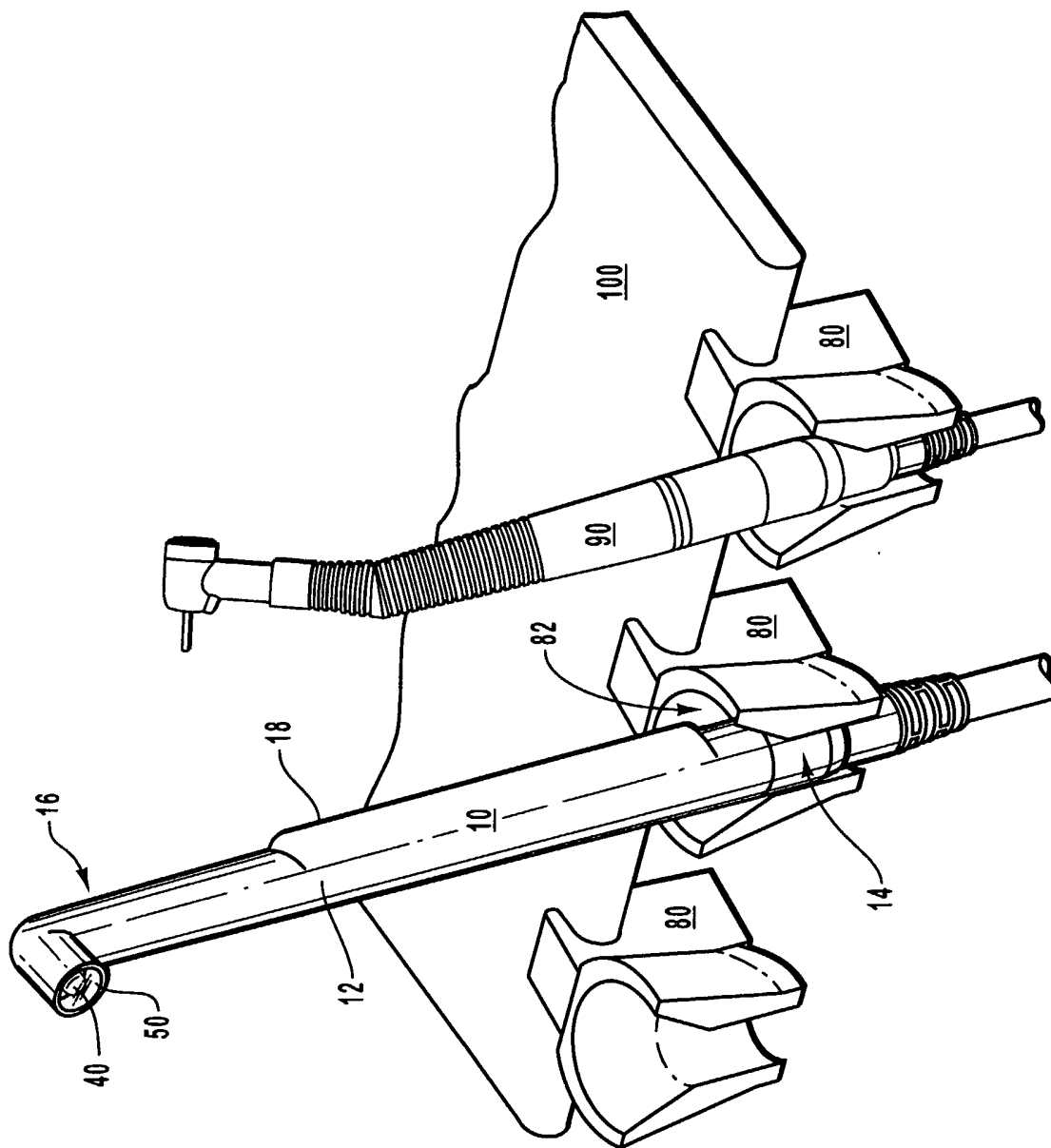


FIG. 4

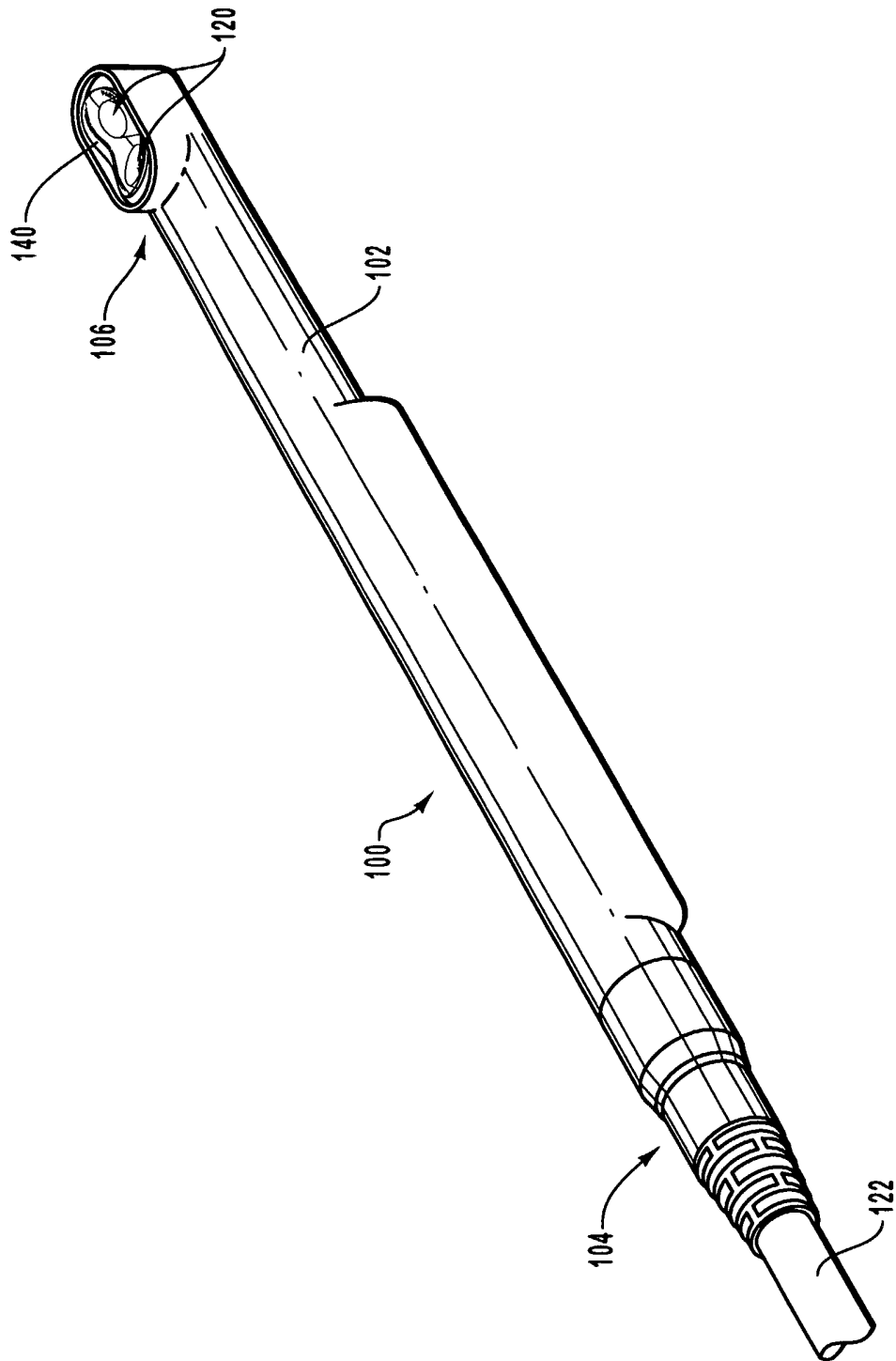


FIG. 5

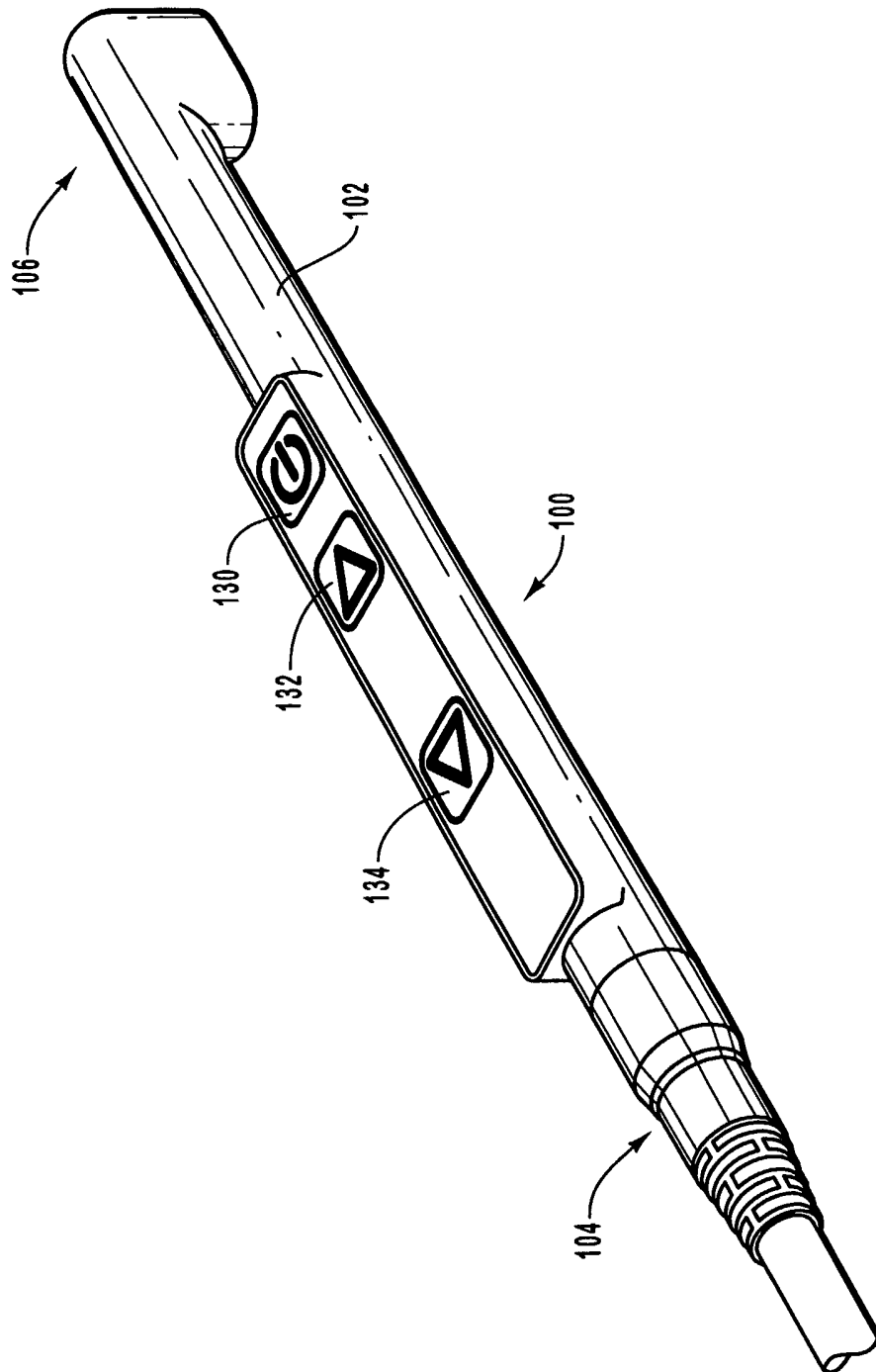


FIG. 6

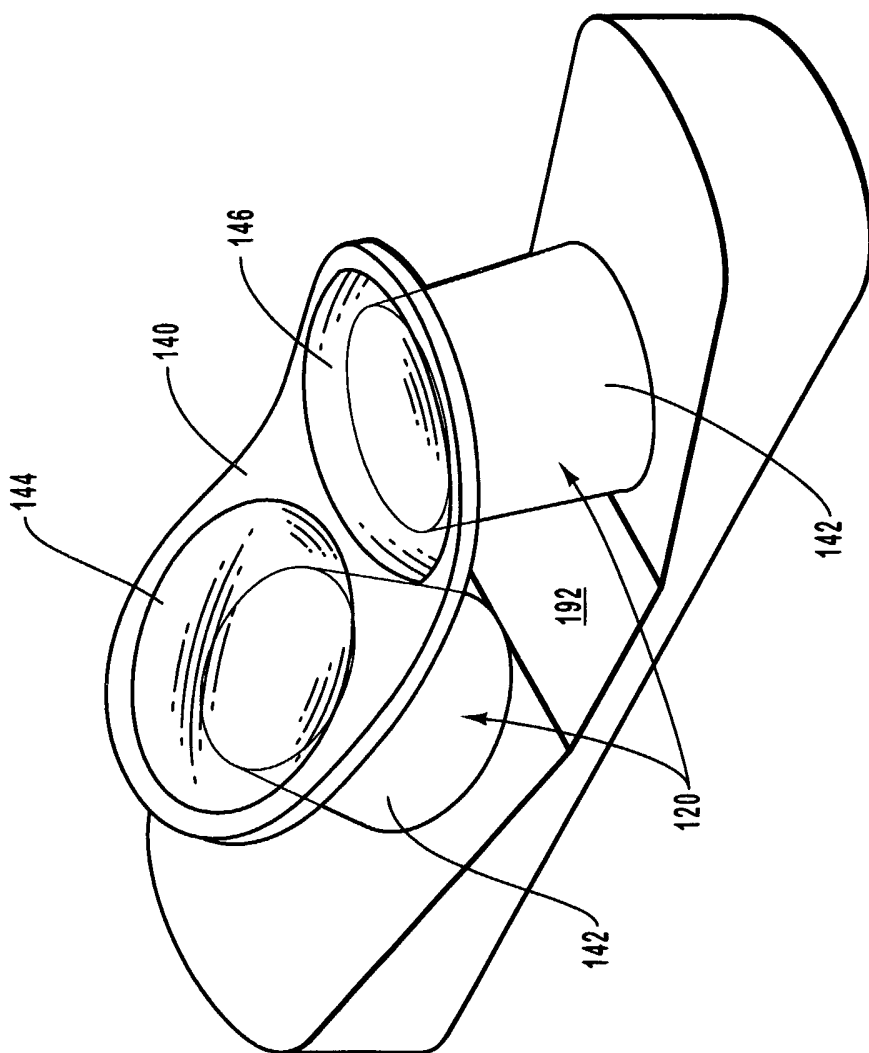


FIG. 7

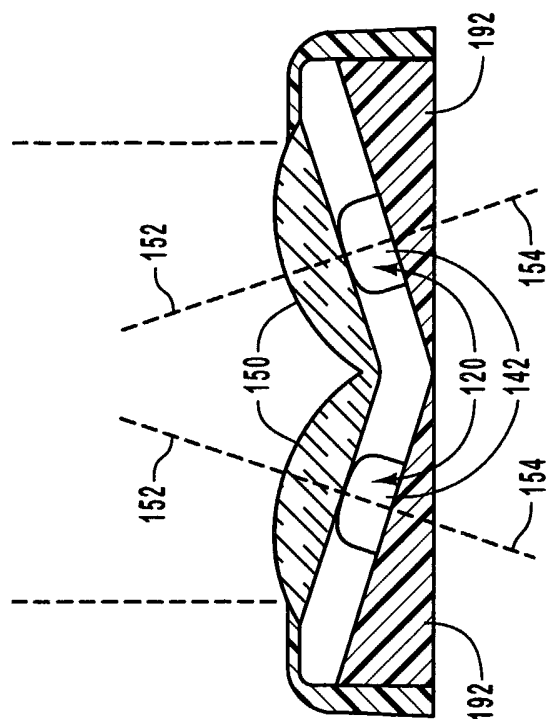


FIG. 8

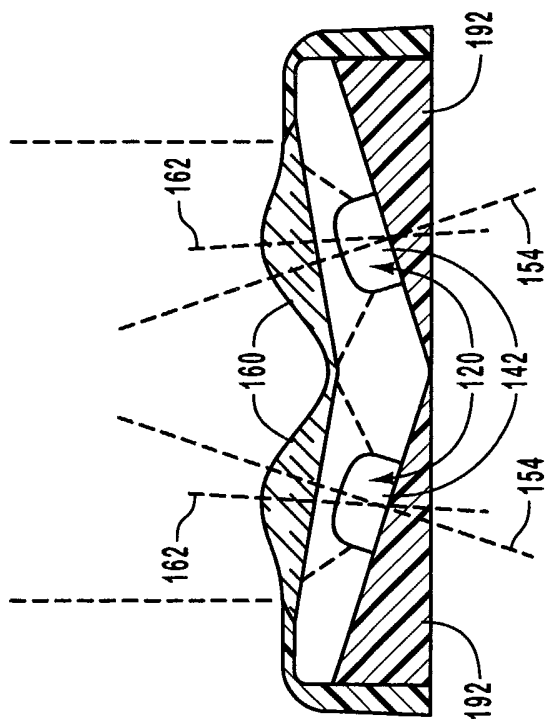


FIG. 9

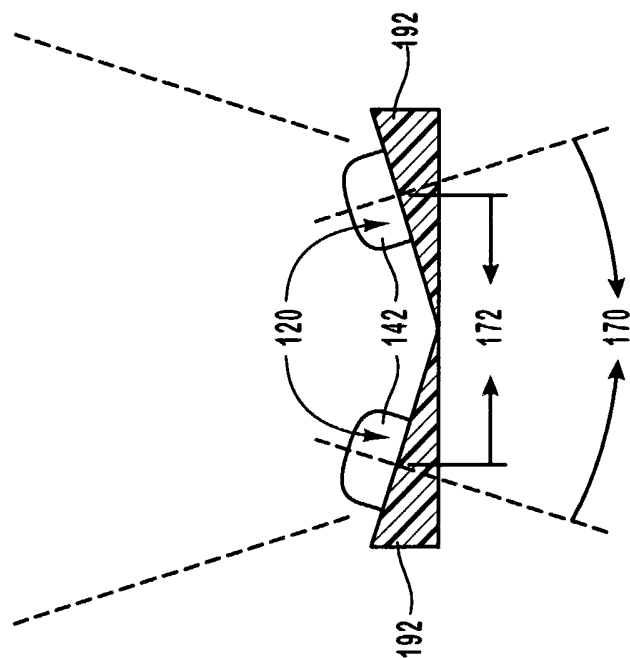


FIG. 10

11 / 11

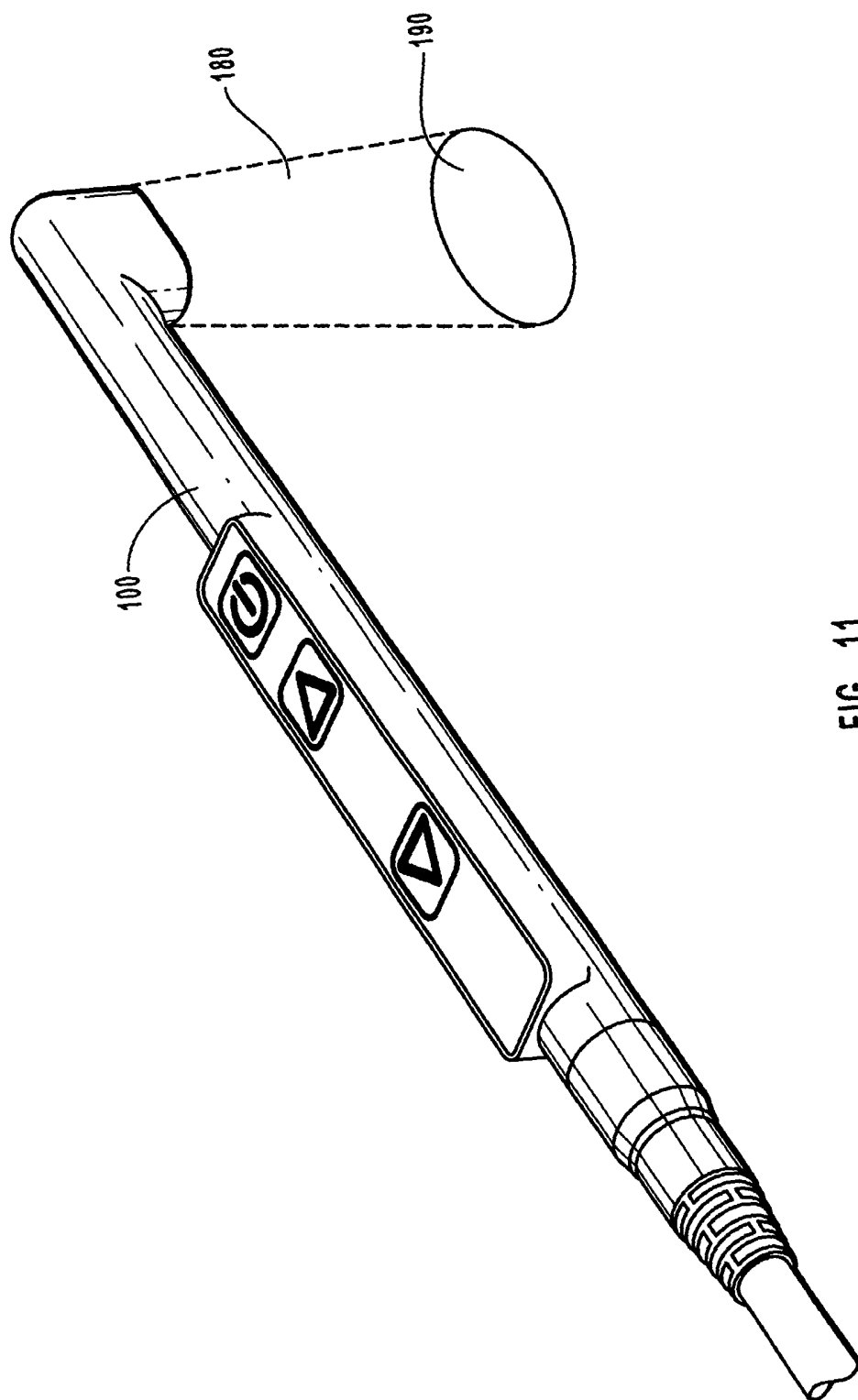


FIG. 11

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US03/01355

A. CLASSIFICATION OF SUBJECT MATTER		
IPC(7) : A61C 3/00		
US CL : 433/29		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols)		
U.S. : 433/29, 77, 78, 79		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) Please See Continuation Sheet		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5,013,240 A (BAILEY et al) 07 May 1991 (07.05.1991), see entire document.	1-34
Y	US 5,634, 711 A (KENNEDY et al) 03 June 1997 (03.06.1997), see entire document.	1-34
Y	US 5,975,895 A (SULLIVAN) 02 November 1999 (02.11.1999), column 6, lines 66 and 67, and column 7, lines 1-12.	4
Y	US 6,068,474 A (SENN et al) 30 May 2000 (30.05.2000), column 5, lines 64-68. column 6, lines 1-4, Fig. 2.	7, 9, 27-29, 31, 33, 34
Y	US 6,331,111 B1 (CAO) 18 December 2001 (18.12.2001), column 13, lines 53-61.	10, 11, 32
Y	US 6,102,696 A (OSTERWALDER et al) 15 August 2000 (15.08.2000), column 4, lines 23-54, Fig. 3.	12-15
Y	US 5,457,611 A (VERDERBER) 10 October 1995 (10.10.1995), column 3, lines 29-35.	16, 30
<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/> See patent family annex.		
* Special categories of cited documents:		
"A" document defining the general state of the art which is not considered to be of particular relevance	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention	
"E" earlier application or patent published on or after the international filing date	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone	
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)	"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art	
"O" document referring to an oral disclosure, use, exhibition or other means	"&" document member of the same patent family	
"P" document published prior to the international filing date but later than the priority date claimed		
Date of the actual completion of the international search	Date of mailing of the international search report	
10 April 2003 (10.04.2003)	08 MAY 2003	
Name and mailing address of the ISA/US	Authorized officer	
Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231	John J. Wilson <i>Diane Smith</i>	
Facsimile No. (703)305-3230	Telephone No. 703-308-0861	

INTERNATIONAL SEARCH REPORT

PCT/US03/01355

Continuation of B. FIELDS SEARCHED Item 3:

BRS

search terms: hand piece, tray, light curing, LED, timer, filter, focus, lens, ellips, aluminum, copper