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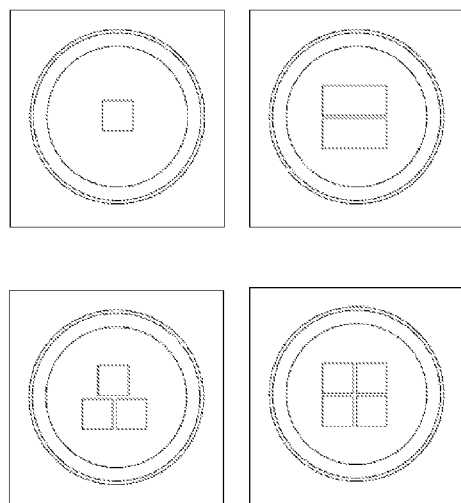
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(54) Title: DENTAL LIGHT CURING SYSTEM WITH WIRELESS CHARGING STRUCTURE THEREOF

FIG. 1



(57) Abstract: The inventions relate to the field of dental light curing system for curing composite materials by light. One aspect of the present invention is to provide a light curing system that uses a light emitting diodes (LED's) source to produce light capable of curing composite materials. Curing composite materials involves polymerizing monomers into durable polymers. Another aspect of the present invention provides a light curing system having multiple LED chips to provide well distributed heat through the guide to reduce the heat and deformation of the light guides. The present invention also relates to a wireless charging structure in a wireless device, and more specifically, a wireless charging structure in a wireless device that provides stable charging by maintaining a temperature of a receiving module at a low temperature when charging a wireless device with a long and small cross-sectional area.



DENTAL LIGHT CURING SYSTEM WITH WIRELESS CHARGING STRUCTURE THEREOF

CROSS-REFERENCE TO RELATED APPLICATIONS

5 This application claims benefit of priority from U.S. Provisional Patent Application 62/334,781, filed May 11, 2016, and Korean Patent Application 10-2016-0109013 filed August 26, 2016, the contents of each of which are incorporated herein by reference.

FIELD OF THE INVENTION

10 The inventions relate to dental light curing systems for curing composite materials by light and wireless charging structures.

BACKGROUND

15 Medical devices, especially small pen type medical devices became a class of devices with high utility due to their portability including wireless power supply. However, there still a need to maintain safety of the devices such as maintaining the temperature of the device for the use.

 In the field of dentistry, dental cavities are often filled and/or sealed with photosensitive compounds that are cured by exposure to radiant energy, such as visible light.
20 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 light. The radiated light causes photosensitive components within the compounds to polymerize, thereby hardening the light-curable compounds within the dental cavity preparation or another desired location.

25 Existing light-curing devices are typically configured with a light source, such as a quartz-tungsten-halogen (QTH) bulb or an LED light source. QTH bulbs are particularly useful because they are configured to generate a broad spectrum of light that can be used to cure a broad range of products. In particular, a QTH bulb is typically configured to emit a continuous spectrum of light in a preferred range of about 350 nm to about 500 nm. Some
30 QTH bulbs may even emit a broader spectrum of light, although filters are typically used to limit the range of emitted light to the preferred range mentioned above.

One reason it is useful for the QTH bulb to emit a broad spectrum of light is because many dental compounds cure at different wavelengths. For example, camphorquinone is a common photo-initiator that is most responsive to light having a wavelength of about 460 nm to about 470 nm. Other light-curable products, however, including many adhesives are cured when they are irradiated by light wavelengths in the 350 nm to 400 nm range. Accordingly, QTH bulbs can be used to cure both camphorquinone initiated products as well as adhesives.

One problem with QTH bulbs, however, is that they generate a relatively high quantity of heat, making it impractical to place QTH bulbs on the portions of the light-curing devices that are inserted within the mouth of a patient. In particular, if the QTH bulbs were disposed at the tips of the light-curing devices, the heat generated by the QTH bulbs could burn or agitate the sensitive mouth tissues of the patient. Accordingly, the QTH bulbs are typically disposed remotely from the portion of the light-curing device that is inserted within a patient's mouth. The heat generated by QTH bulbs also represents wasted energy, which increases the power requirement to achieve a desired light intensity.

To channel and direct the light emitted by a QTH bulb to the desired location within a patient's mouth, existing light curings must utilize light guides, such as fiber optic wands and tubular light guides, or special reflectors. Although fiber optic wands and reflectors are useful for their intended purposes, they are somewhat undesirable because they can add to the cost and weight of the equipment, thereby increasing the overall cost and difficulty of performing the light-curing dental procedures.

In an attempt to overcome the aforementioned problems, some light-generating devices have been manufactured using alternative light generating sources, such as light-emitting diodes (LEDs) which are generally configured to only radiate light at specific wavelengths, thereby eliminating the need for special filters and generally reducing the amount of input power required to generate a desired output of radiation.

In view of the foregoing, there exists a need to develop dental light curings including multiple LEDs capable of providing more even intensities of any given wavelength across the full footprint of light emitted. It would be a further improvement to provide a dental light curing capable of better blending different wavelengths across the full footprint of light emitted in order to provide a broader spectrum of light across the full footprint.

As the field of electronic technology has developed dramatically, wireless devices using wireless charging has been diversified and the use has been increased. While the wireless devices is not connected to the power via cable, the wireless devices contain rechargeable battery, which would be charged wirelessly. Recently, wireless charging manners are widely used in wireless devices such as smart phones.

A magnetic induction type wireless charging manner includes an electric power receiving module built in the wireless device, embeds an electric power transmitting module within a charger, and charges a battery by transmitting an electric power by means of a magnetic induction. To this end, a reception coil (RX coil) and a transmission coil (TX coil) are provided inside of the wireless device and the charger, respectively. In the magnetic induction process for wireless charging, considerable heat is generated in the receiving module. When the temperature of the receiving module is increased, the resistance is increased, and a lot of heat is generated. If a lot of heat is generated, a charging performance reduces and it is a loss due to the heat.

Among the wireless devices, a pen type wireless device with a long length and a small cross-sectional area is usually configured to place a receiving module on a bottom surface for charging. In this case, the receiving module is configured to shape a small diameter according to a cross-sectional shape of the wireless device. Accordingly, during a wireless charging process, a heat is concentrated in a small area and a large amount of heat is generated.

Among the wireless devices, a light curing device, a dental charger, etc. used in dentistry must satisfy an electrical and electronic medical device standard that a temperature of a part contacting human skins should not exceed 41°C.

However, when a magnetic induction wireless charging manner, as mentioned above, is employed to a conventional light curing device or a dental charger, etc., there is a problem that the electrical and electronic medical device standard cannot be satisfied because the heat generated by the receiving module causes a temperature of an outer surface to rise to 50-60°C.

Alternate to the existing method, there is still a need for a technology to keep the wireless medical devices such as dental light curing system within the applicable temperature for medical use.

SUMMARY OF THE INVENTION

One aspect of the present invention is to provide a light curing system that uses a light emitting diodes (LED's) source to produce light capable of curing composite materials.

Curing composite materials involves polymerizing monomers into durable polymers.

5 Another aspect of the present invention provides a light curing system having multiple LED chips to provide well distributed heat through the guide to reduce the heat and deformation of the light guides. Additional points of difference between the inventions and the prior art will become apparent upon reading the text below in conjunction with the appended drawings.

Another aspect of the present invention provides a wireless charging structure in a
10 wireless device, and more specifically, a wireless charging structure in a wireless device that provides stable charging by maintaining a temperature of a receiving module at a low temperature when charging a wireless device with a long and small cross-sectional area. The wireless charging structure in a wireless device of the present invention quickly releases the heat generated by a receiving module and provide stable wireless charging while applying a
15 wireless charging manner.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are incorporated in and form a part of this specification and in which like numerals depict like elements, illustrate embodiments of the
20 present disclosure and, together with the description, serve to explain the principles of the disclosure.

Fig. 1 provides examples of LED emission chip arrangement in the prior art using LED light curing.

Fig. 2 provides an example of the prior art containing a lens covering the chips.

25 Fig. 3 presents diagram of LES.

Fig. 4 presents an example of the present invention using a single wavelength.

Fig. 5 presents an example of array of emitting chips using two or more wavelength.

Fig. 6 present an example of the present invention.

Fig. 7 presents a graph for light intensity and temperature compared between prior art
30 and the present invention.

FIG. 8 is an exploded perspective view of a wireless dental curing light device containing the array of emitting chips and the wireless charging structure of the present invention.

FIG. 9 is an exploded perspective view of the selected section of the wireless dental
5 curing light device containing the array of emitting chips.

FIG. 10 is a perspective view of a wireless device having the wireless charging structure of the present invention with a charger.

FIG. 11 is an exploded perspective view of a wireless device with the wireless charging structure of the present invention and the charger.

10 FIG. 2 is an exploded perspective view of a wireless device having the wireless charging structure of the present invention.

FIG. 13 is an exploded perspective view of one example of charger according to the present invention.

FIG. 14 is a cross-sectional view of a wireless device having the wireless charging
15 structure of the present invention in a charger.

FIG. 15 is a perspective view of a first example of a wireless dental curing light device containing the array of emitting chips and the wireless charging structure of the present invention.

FIG. 16 is an exploded perspective view of the first example of a wireless dental
20 curing light device containing the array of emitting chips and the wireless charging structure of the present invention.

FIG. 17 is an exploded perspective view of the first example of a wireless dental curing light device containing the array of emitting chips and the wireless charging structure of the present invention.

25 FIG. 18 is an exploded perspective view of a charger of the first example according to the present invention.

FIG. 19 is a cross-sectional view illustrating a state of a wireless device having the wireless charging structure of the present invention in a charger.

FIG. 20 is a perspective view illustrating a second example of a wireless dental curing
30 light device containing the array of emitting chips and the wireless charging structure of the present invention.

For a better understanding of the present invention, a preferred embodiments of the present invention are described with reference to the accompanying drawings. The embodiments of the present invention can be modified in various forms and the scope of the present invention should not be construed as being limited to the embodiments described in detail below. The present embodiments are provided to enable those skilled in the art to more fully understand the present invention. Therefore, the shapes and the like of the elements in the drawings can be exaggerated in order to emphasize a clearer explanation. It should be noted that in the drawings, the same members may be denoted by the same reference numerals. Detailed descriptions of well-known functions and constructions that may unnecessarily obscure the gist of the present invention are omitted.

DETAILED DESCRIPTION

Examples of various embodiments are illustrated and described further below. It will be understood that the description herein is not intended to limit the claims to the specific embodiments described. On the contrary, it is intended to cover alternatives, modifications, and equivalents as may be included within the spirit and scope of the present disclosure as defined by the appended claims.

It will be understood that, although the terms "first", "second", "third", and so on may be used herein to describe various elements, components, regions, layers and/or sections, these elements, components, regions, layers and/or sections should not be limited by these terms. These terms are used to distinguish one element, component, region, layer or section from another element, component, region, layer or section. Thus, a first element, component, region, layer or section described below could be termed a second element, component, region, layer or section, without departing from the spirit and scope of the present disclosure.

It will be understood that when an element or layer is referred to as being "connected to", or "coupled to" another element or layer, it can be directly on, connected to, or coupled to the other element or layer, or one or more intervening elements or layers may be present. In addition, it will also be understood that when an element or layer is referred to as being "between" two elements or layers, it can be the only element or layer between the two elements or layers, or one or more intervening elements or layers may also be present.

Spatially relative terms, such as “beneath,” “below,” “lower,” “under,” “above,” “upper,” and the like, may be used herein for ease of explanation to describe one element or feature’s relationship to another element s or feature s as illustrated in the figures. It will be understood that the spatially relative terms are intended to encompass different orientations of the device in use or in operation, in addition to the orientation depicted in the figures. For example, if the device in the figures is turned over, elements described as “below” or “beneath” or “under” other elements or features would then be oriented “above” the other elements or features. Thus, the example terms “below” and “under” can encompass both an orientation of above and below. The device may be otherwise oriented for example, rotated 90 degrees or at other orientations, and the spatially relative descriptors used herein should be interpreted accordingly.

The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of the present disclosure. As used herein, the singular forms “a” and “an” are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms “comprises”, “comprising”, “includes”, and “including” when used in this specification, specify the presence of the stated features, integers, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, operations, elements, components, and/or portions thereof. As used herein, the term “and/or” includes any and all combinations of one or more of the associated listed items. Expression such as “at least one of” when preceding a list of elements may modify the entire list of elements and may not modify the individual elements of the list.

Unless otherwise defined, all terms including technical and scientific terms used herein have the same meaning as commonly understood by one of ordinary skill in the art to which this inventive concept belongs. It will be further understood that terms, such as those defined in commonly used dictionaries, should be interpreted as having a meaning that is consistent with their meaning in the context of the relevant art and will not be interpreted in an idealized or overly formal sense unless expressly so defined herein.

In the following description, numerous specific details are set forth in order to provide a thorough understanding of the present disclosure. The present disclosure may be practiced without some or all of these specific details. In other instances, well-known process

structures and/or processes have not been described in detail in order not to unnecessarily obscure the present disclosure.

As used herein, the term "substantially," "about," and similar terms are used as terms of approximation and not as terms of degree, and are intended to account for the inherent
5 deviations in measured or calculated values that would be recognized by those of ordinary skill in the art. Further, the use of "may" when describing embodiments of the present disclosure refers to "one or more embodiments of the present disclosure."

Dental Light Curing System

10 The present invention is directed to a dental light curing including an elongate wand having a proximal end and a distal end, a plurality of LEDs mounted by the Chip on Board (COB) technology. COB (Chips on Board) is a technology of LED packaging for LED light engine. Multi LED chips are packaged together as one lighting module. While LED (light emitting diode) is a technology with advantage of saving energy and very long lifespan, it
15 can also generate large amount of heat which affects the durability of the apparatus where the light is applied.

In one embodiment of the present invention, the plurality of LED is configured to emit light having a first peak wavelength. The plurality of surface mount LEDs may be configured to emit light having a second peak wavelength different from the first peak
20 wavelength.

One preferred embodiment includes substrate mount LED configured to emit light having a first peak wavelength (e.g., blue) while the plurality of surface mount LEDs are configured to emit light having a second peak wavelength different from the first peak wavelength (e.g., UV).

25 According to one such implementation, light emitted by the main through mount LED and the plurality of surface mount LEDs is emitted so as to form substantially complete overlapping of footprints of first and second peak wavelengths within about five to fifteen millimeters of the plurality of LEDs, preferably within about three to five millimeters of the plurality of LEDs, and more preferably within about one to five millimeter of the plurality of
30 LEDs.

In another aspect of the present invention, the light curing procedure uses blue color light at wavelength of 400-480 nm. The present invention employs LED as the light source either by arraying one or more emission chips for a single wavelength or by mixing emission chips for different wavelength of about 400 nm. For example, the present invention utilize
5 one emission chip for 405 nm and two or more of chips for 465 nm.

FIG.1 provides examples of LED emission chip arrangement in the prior art using LED light curing. The prior art also contain a lens covering the chips as shown in FIG. 2.

As shown in Fig. 1 and Fig. 2, most of the previous attempts placed the emission chips in the center of the substrate. Most of them also utilized a lens, which is usually a
10 dome shape to collect and focus the emitted lights to enhance the light intensity.

As shown in the FIG. 1, regardless of the number of the LEDs it can be seen that they are arranged intensively in the middle. Using a converging central lens, such as a dome-shaped or plano-convex lens, is a way to obtain a high light intensity.

However, as the light intensity is enhanced, the radiant heat is also increased,
15 resulting in high temperature within the mouth of the patient. The high temperature during the dental procedure would not only expand the resin but also potentially cause pain and heat on the treatment region or even cause burns in the oral cavity or oral nerve system.

Also, because radiant heat is increased as the light intensity increases when the focus is also increased, the result is often high radiation instead of simply obtaining a high light
20 output when focusing through the lens, which is a problem when the light emitted to the teeth is accompanied by a high temperature. High temperature may cause burns and lesions and expansion during resin polymerization as the resins getting hot, which may cause the dental patients feel pain, or worse, experience damage to nerve tissue inside the tooth.

The light emitting surface is the part of the chips where the LEDs are affixed.

25 In one preferred embodiment, the diameter of the light emitting surface (LES) is between 5-15 mm. A light guide is used to transfer the light from the source to the treatment region. The light guide may have a proximal end wide enough to at least fully cover the LES and a tapered distal. For example, an 8 mm diameter LES might be paired with a light guide having a 12-mm wide proximal end and an 8-mm wide distal end.

30 In another preferred embodiment, the diameter of the distal end of the light guide is same as the diameter of the LES.

In another embodiment, some light curing equipment radiates the light directly on the treating region without light guide. However, it would be difficult to manage considering the diameter of the LES and the patient's oral cavity.

The present invention would provide a solution to these problems by eliminating the lens not to collect or focus the light but distribute the emission chips evenly and spread them on the surface of the substrate. The present invention also employs horizontal or expanded lens to evenly emit the LED lights.

In the present invention, the light distribution of the light source was modeled based on a light-emitting diode which is a point light source using a Chip on Board (COB) type LED technology.

As shown in FIG. 3, the array is dispersed, rather than focusing LEDs in the center, in order to evenly spread the light without condensing the heat generated by using multiple small array chips.

In one embodiment of the present invention, the array can be used without any part to collect the lights by removing the lens, i.e. a concentrating lens, or by using a horizontal lens that does not centrally concentrate the light, or other similar means.

FIG. 4 presents an example of the present invention using a single wavelength.

FIG. 5 presents an example of array of emitting chips using two or more wavelength.

The emission chips are evenly distributed throughout the surface of the LES. The number of emission chips would be 5- 15, preferably, 7-11, more preferably 8-9.

The present invention also provides a dental cure light apparatus comprising:
a handle;

a light source part comprising LES; and

a light guide,

wherein the LES contains a plural emission chips evenly spread through the surface of the LES.

The dental cure light apparatus further comprising charging station. The dental cure light apparatus can be directly powered electronically or can contain rechargeable battery which can be charged by the charging station.

The present invention provides at least two significant advantages.

First, the present invention evenly spreads the radiation of the light instead of centralizing or focusing on a spot. For example, light guides having diameters of 8-11 mm and the centrally focused light do not provide enough light on the outer edge of the light guide, while the center portion of the guide receives excessive lights. By providing evenly spread light, the present intention can provide improved efficiency in the use of the light as the light guide receives and delivers evenly distributed light which can radiate the whole treating region to efficient curing.

Second, the present invention eliminates excess heat focused on the center of the guide. The focused light can make the resin to expand excessively with high temperature and can create a gap between the resin and the gum or tooth, upon cooling and shrinking process. As the thermal expansion coefficient of the resin and the gum or tooth are different, there can be a problem if the curing procedure involves excessive expansion or shrinking. In addition, the high heat generated from the centrally focused light can affect the oral cavity. The heat can cause pain and even damage the pulp of tooth. The present invention reduces the heat by spreading the centrally focused light to reduce the peak temperature generated by curing procedure improve the outcome of the dental treatment. Overly centralized light and heat can also cause deformation of the light guide itself, necessitating replacement light guides and additional costs.

The following is an example prepared by the present invention.

An aluminum substrate of 0.9 mm thickness was coated with an aluminum reflecting plate and 9 emission chips were arrayed on the surface of the aluminum reflecting plate. The diameter of the LES was 8.5 mm, which was designed to be optimum light guide having an 8 mm diameter distal end. The emission chips were arrayed to have three (3) 405 nm chips connected in a series circuit side by side in the middle and three (3) 465 nm chips in a series circuit on both sides, as total six (6) on both sides. The three sets of three (3) chips are connected in a parallel circuit. See FIG. 6.

FIG. 7 shows the resultant light intensity and temperature generated by the conventional light curing device using centrally focused light emission method and also shows the resultant light intensity and temperature generated by the present invention utilizing evenly spread emission chips. The former shows that the light intensity and the temperature increase closer to the center to have a parabola graph. On the other hand, the

light curing device using the evenly spread emission chips as in the present invention shows three sign waves having peaks at three positions where the emission chips are located, but the peaks are much lower than the peak of the parabola graph of the centrally focused light emission method.

5 FIGs. 8 and 9 show a dental light curing device containing the multiple diode chips in the present invention.

Wireless Charging Structure

A wireless charging structure in a wireless device of the present invention includes a
10 battery; a wireless device having an electric power receiving module electrically coupled to the battery; a charger, wherein the charger comprises an insertion groove into which the wireless device is inserted and supported, and an electric power transmitting module for transmitting wireless electric power to the electric power receiving module using magnetic induction process, wherein the wireless device includes a battery casing configured to
15 accommodate functional modules therein, formed of a metal material having a high heat transfer efficiency; and a battery module configured to be accommodated inside of the battery casing, and to embed the battery, wherein the battery module includes a battery housing configured to surround the battery, the electric power receiving module placed on a bottom of the battery, and a receiving module; and an insulation plate configured to be placed
20 one end of the receiving module, wherein the insulation plate includes one or more insulation arms to transmit the heat of the receiving module by extending between the battery casing and the battery housing and contacting the battery casing, on both ends of the insulation plate.

According to one embodiment of the present invention, the battery housing includes
25 an arm exposing hole configured to expose the insulation arms to the outside, to correspond to the number of the insulation arms, and to form a shape allowing passing through.

According to one embodiment of the present invention, the battery housing includes a plurality of vent holes configured to release the heat of the receiving module to the outside, and to form a shape allowing passing through, on a bottom outer periphery of the battery
30 housing.

According to one embodiment of the present invention, the insulation plate is configured to be placed either between the electric power receiving module and the receiving module, or between the electric power receiving module and the battery, and to have a multi-layer structure.

5 A wireless charging structure in a wireless device according the present invention transfers the heat generated by the receiving module to a battery casing having a high heat transfer rate using an insulation plate and the insulation arm. Moreover, the battery casing of the present invention prevents a temperature of the receiving module from rising by quickly transferring the heat to the outside.

10 As an example, when a cylindrical lithium ion battery with a diameter of 18mm and 2400mA/h is charged at 900mA/h using a conventional wireless charging manner, a temperature was raised to 20°C. However, for the wireless charging structure in the wireless device according to the present invention, there is an effect that a temperature is raised to less than 5°C.

15 As a result, the charging efficiency of the battery maintains at high level, and stable wireless charging can be always performed.

Moreover, since a temperature of the receiving module and a temperature of the battery casing remain low, the wireless charging structure of the wireless device according to the present invention can be employed safely to electric devices such as electric toothbrushes, shaver, etc. used in daily life. Also, the wireless charging structure of the wireless device
20 according to the present invention can satisfy the electrical and electronic medical device standard so that it can be employed safely to medical devices such as a light curing device, a root canal charger, etc.

FIG. 10 is a perspective view showing a state of charging a wireless device charging structure 1 according to the present invention, and FIG. 11 is an exploded perspective view of a wireless device 100 and a charger 200 of the wireless device charging structure 1.
25

As shown in the figure, the wireless device charging structure 1 according to the present invention shows a wireless charging structure between the wireless device 100 and the charger 200. Here, the wireless device 100, which may be applied to the present
30 invention, may include various hand pieces used wirelessly and having a narrow receiving

module area such as root canal chargers, light curing devices used in dentistry, and shavers, electric toothbrushes, etc. used in daily life.

When it is charged using a magnetic induction manner, the wireless device charging structure 1 according to the present invention is capable to prevent a temperature of the wireless device 100 from being raised thereby improving a wireless charging efficiency, by transferring a heat generated in a receiving module with a small area to the outside quickly.

FIG. 12 is an exploded perspective view illustrating the configuration of the wireless device 100 in an exploded manner. As shown in the figure, the wireless device 100 includes a battery casing 110 for transferring the heat generated in the receiving module 147 to the outside, a function module 120 coupled to the battery casing 110 for operating the wireless device 100 to perform its functions, an input button 130 for operating the function module 120, and a battery module 140 configured to be accommodated inside of the battery casing 110 and supply an electric power to the function module 120.

The battery casing 110 accommodates the function module 120 therein, and allows a user to use the wireless device 100 while holding it by hand. The battery casing 110 according to the present invention is formed of a metal having high heat transfer efficiency, for example, aluminums, thereby quickly discharging the heat generated in the receiving module 147 for wireless charging to the outside. Accordingly, a temperature of a surface of the battery casing 110 maintains at a low level so that it may be safely used even when it contacts with a patient's lips such as a dental medical device.

The battery casing 110 may be formed in various forms according to the purpose and the function of the wireless device 100. The battery casing 110 includes a button exposing hole 111 configured to expose an input button 130 to the outside and to correspond to a position and a shape of the input button 130.

One end of the battery casing 110 includes a head exposing hole 112 configured to expose a head 123 of the function module 120 to the outside.

The function module 120 implements functions according to the purpose of the wireless device 100. The function module 120 may include the head 123 and a control panel 121 for receiving electric power from the battery module 140 and controlling to operate in accordance with an input signal inputted through the input button 130.

In addition, the function module 120 may include various configurations capable of implementing functions corresponding to a type of related wireless devices. For example, when the wireless device is a dental light curing device, an LED for emitting a light, a light guide tip, etc. may be provided. Further, when the wireless device is a vibrating toothbrush, the function module 120 may include a head configured to couple to a toothbrush, a vibrating means for vibrating the head, etc. When the wireless device is a shaver, the function module 120 may include a blade, a blade drive, etc.

The input button 130 is configured to be exposed to the outside of the battery casing 110 and to receive an input signal from a user to transfer the input signal to the control panel 121.

The battery module 140 is configured to charge an electric power from the charger 200 in a magnetic induction manner and to supply the electric power to a control panel 121. The battery module 140 includes a battery 143 configured to be charged with the electric power, a battery housing 141 for accommodating the battery 143, an electric power receiving module 145 configured to be electrically coupled to the battery 143 and to receive the electric power transmitted from the charger 200 in connection with a receiving module 147 to transfer the received electric power to the battery 143, a receiving module (RX coil) 147 for receiving the electric power using an induction coupling manner based on an electromagnetic induction phenomenon through a wireless electric power signal received from the charger 200, an insulation plate 149 configured to be placed between the receiving module 147 and the electric power receiving module 145 for transferring a heat generated in the receiving module 147 to the battery casing 110.

The battery 143, the electric power receiving module 145, the receiving module 147, and the insulation plate 149 are accommodated inside of the battery housing 141. The battery housing 141 is detachably coupled to the inside of the battery casing 110.

A holding mount 141c is configured to have a diameter larger than an area where the battery 143 is accommodated, and to be contacted with and supported by the battery casing 110, on a bottom of the battery housing 141. Accordingly, as shown in FIG. 11, an upper portion of the battery housing 141 is inserted into the battery casing 110, and a lower portion of the holding mount 141c is exposed to the outside.

An arm exposing hole 141a is configured to expose an insulation arm 149a to the outside of the battery housing 141, and to form a shape allowing passing through, on an upper portion of the holding mount 141c. A plurality of vent holes 141b are configured to form a shape allowing passing through, on a bottom of the holding mount 141c.

5 The arm exposing hole 141a is configured to expose the insulation arm 149a extending from the insulation plate 149 to the outside of the battery housing 141 so that the insulation arm 149a contacts with the battery casing 110.

 The arm exposing hole 141a is configured to correspond to the number and positions of the insulation arms 149a.

10 The plurality of vent holes 141b are configured to form a shape allowing passing through on an outer periphery of the battery housing 141 where the electric power receiving module 145 and the receiving module 147 are located, and to release a heat generated in the receiving module 147 into the atmosphere. The vent holes 141b are configured to contact with the atmosphere as shown FIG. 11, thereby heat-exchanging the heat generated in the
15 receiving module 147 and the air in the atmosphere or transferring the heat to the atmosphere. Accordingly, the temperature rise of the receiving module 147 can be reduced since a part of the heat generated in the receiving module 147 is directly discharged to the atmosphere.

 The electric power receiving module 145 and the receiving module 147 receive a
20 wireless electric power from the charger 200 by a magnetic induction manner. A barrier sheet 148 coupled to the receiving module 147 is configured to shield a magnetic field generated by the wireless high frequency signal generated in the receiving module 147.

 The insulation plate 149 is configured to be placed between the barrier sheet 148 and the electric power receiving module 145, and to transfer the heat generated in the receiving
25 module 147 and the electric power receiving module 145 to the battery casing 110. The insulation plate 149 may be formed of a metal material having high heat transfer efficiency, for example, aluminums. The insulation plate 149 is configured to have an area corresponding to an area of the barrier sheet 148, and to receive the heat generated from the receiving module 147 and the electric power receiving module 145 through the barrier sheet
30 148.

The insulation plate 149 may be placed between the barrier sheet 148 and the electric power receiving module 145 as well as between the battery 143 and the electric power receiving module 145. A plurality of insulation plates 149 may be placed at various positions as needed. Also, the insulation plate 149 may be configured to have a multi-layer structure including a two-layer structure.

One or more insulation arms 149a extending vertically are provided at an outer periphery of the insulation plate 149. The insulation arm 149a is configured to be exposed to the outside of the battery housing 141 through the arm exposing hole 141a of the battery housing 141 to contact directly with the battery casing 110 as shown in FIG. 15.

Accordingly, when a wireless charging is made with the wireless device 100 coupled to the charger 200, a heat generated in the receiving module 147 can be transferred from the insulation plate 149 to the insulation arm 149a and then to the battery casing 110 and quickly transferred to the atmosphere.

Therefore, a temperature of the battery casing 110 held by a user can be prevented from rising, and a temperature of contact with a user's body becomes lower than the electrical and electronic medical instrument standard of 41°C.

Here, the insulation plate 149 according to one embodiment of the present invention has a pair of insulation arms 149a on both sides thereof. However, this is only an example, and depending on the case, the insulation arm 149a may be formed of three, four, or the like.

The charger 200 is configured to be coupled wirelessly to the wireless device 100 to charge the wireless device 100 with an electric power. FIG. 13 is an exploded perspective view illustrating a configuration of a charging casing 210. The charger 200 includes a charging casing 210, an electric power transmitting module 220 provided in a bottom of the charging casing 210, and a base board 230 covering an open lower portion of the charging casing 210.

The charging casing 210 includes a device insertion groove 211 configured to be recessed and to correspond to a shape of the wireless device 100. An electric power transmitting module 220 is provided under the device insertion groove 211. The electric power transmitting module 220 includes an electric power transmitting coil (TX coil) 221.

Although not shown in the figures, a power line (not shown) is connected to the charging casing 210. The power line (not shown) is connected to the electric power transmitting module 220.

5 A wireless charging process of the wireless device 100 according to the present invention having such a configuration will be described with reference to FIGs. 12 to 14.

The wireless device 100 includes the battery module 140 accommodated inside of the battery casing 110 as shown FIG. 12. A lower portion of the wireless device 100 is inserted into the device insertion groove 211 of the charging casing 210 for charging the battery module 140 as shown in FIG. 11.

10 As shown in FIG. 10, when the wireless device 100 is coupled to the charging casing 210, a wireless electric power is transmitted from the electric power transmitting coil 221 to the receiving module 147 in a magnetic induction manner, and the wireless electric power received by the receiving module 147 and the electric power receiving module 145 is charged to the battery 143.

15 At this time, the receiving module 147 generates a heat by magnetic induction. In particular, because a cross-sectional area of the wireless device 100 is small, a diameter of the receiving module 147 becomes narrow accordingly. As a result, a large amount of heat is generated in a narrow area.

The insulation plate 149 in contact with the barrier sheet 148 of the receiving module 20 147 receives a heat generated from the receiving module 147, the insulation arm 149a is exposed to the outside of the battery housing 141 to contact with the battery casing 110 as shown FIG. 16. The heat transferred to the insulation plate 149 is transferred to the battery casing 110 through the insulation arm 149a, and the battery casing 110 formed of an aluminum material having a high heat transfer rate transfers the heat to the atmosphere, 25 thereby blocking a temperature of the receiving module 147 from rising and preventing a temperature of the battery casing 110 itself from rising.

In addition, the vent hole 141b formed in the battery housing 141 discharges a heat generated in the receiving module 147 to the outside to prevent a temperature from rising.

Accordingly, a surface temperature change amount of the battery casing 110 of the 30 wireless device 100 according to the present invention is low in the range of 1°C-5°C during wireless charging, and may satisfy the electrical and electronic medical instrument standard.

Since a temperature of the receiving module 147 is not raised by virtue of a heat discharging process of the insulation plate 149 and the vent hole 141b, a resistance of the receiving module 147 remains constant and the charging efficiency may remain constant.

5 **Dental Light curing System with Wireless Charging Structure**

FIGs. 15-19 provides an example of a wireless dental curing light device D100 with a charger D200. While the wireless device can be a dental curing light device, it is not limited but can be other pen-type devices which can be charged through a small area of contact between the charger and the device.

10 FIG. 15 is a perspective view of a first example of a wireless dental curing light device containing the array of emitting chips and the wireless charging structure of the present invention. FIG. 16 is an exploded perspective view of the first example of a wireless dental curing light device containing the array of emitting chips and the wireless charging structure of the present invention. FIG. 17 is an exploded perspective view of the first
15 example of a wireless dental curing light device containing the array of emitting chips and the wireless charging structure of the present invention. FIG. 18 is an exploded perspective view of a charger of the first example according to the present invention. FIG. 19 is a cross-sectional view illustrating a state of a wireless device having the wireless charging structure of the present invention in a charger.

20 FIG. 20 is a perspective view of another example of a wireless dental curing light device containing the array of emitting chips and the wireless charging structure of the present invention. While the wireless device can be any type of pen-type or other small device, the charger can have various shape to achieve the purpose.

As described above, the wireless charging structure in the wireless device according
25 to the present invention transmits the heat generated in the receiving module of the wireless device to the battery casing having a high heat transfer rate using the insulation plate and the insulation arm. And then, the battery casing quickly transfers the heat to the outside to prevent a temperature of the receiving module from rising.

Accordingly, the charging efficiency of the battery remains high, and stable wireless
30 charging may be performed all the time.

Further, since a temperature of the receiving module and a temperature of the battery casing remain low, the wireless charging structure in the wireless device according to the present invention can be employed safely to electric devices such as vibrating toothbrushes, shaver, etc. used in daily life. Also, the wireless charging structure in the wireless device according to the present invention can satisfy the electrical and electronic medical device standard so that it can be employed safely to medical devices such as a light curing device or a dental charger.

The embodiment of the wireless charging structure in the wireless device of the present invention described above is merely an exemplary, it will be apparent to those skilled in the art that various modifications and equivalent embodiments may be made without departing from the scope of the present invention. It is therefore to be understood that the invention is not limited to the form set forth in the foregoing description. Accordingly, the true scope of the present invention should be determined by the technical teaching of the appended claims. It is also to be understood that the invention includes all modifications, equivalents, and alternatives falling within the spirit and scope of the invention as defined by the appended claims.

Reference Numbers

Reference Numbers in FIGs. 8-12	Reference Numbers in FIGs. 15-19	
1 :	D1	wireless device with charger
100 :	D100	Wireless device
110 :	D110	Battery casing
111 :	D111	Button exposing hole
112 :	D112	Head exposing hole
120 :	D120	Function module
121 :	D121	Control panel
123 :	D123	Head
130 :	D130	Input button
140 :	D140	Battery module

Reference Numbers in FIGs. 8-12	Reference Numbers in FIGs. 15-19	
141 :	D141	Battery housing
141a :	D141a	Arm exposing hole
141b :	D141b	Vent hole
141c :	D141c	Holding mount
143 :	D143	Battery
145 :	D145	electric power receiving module
147 :	D147	Receiving module
148 :	D148	Barrier sheet
149 :	D149	Insulation plate
149a :	D149a	Insulation arm
200 :	D200	charger
210 :	D210	Charging casing
211 :	D211	device insertion groove
220 :	D220	Electric power transmitting module
221 :	D221	Electric power transmitting coil
230 :	D230	Base board

CLAIMS

We claim,

1. A dental light curing system comprising:
a handle;

5 a light source part comprising a light emitting surface (LES) comprising a plurality of light emitting diodes chips as a light source; and

a light guide,

wherein the plurality of light emitting diodes chips are evenly spread through LES.

10 2. The dental light curing system of claim 1, wherein the plurality of light emitting diodes chips are placed on LES using a Chip on Board LED technology.

3. The dental light curing system of claim 1, wherein diameter of the LES is 5-15 mm, 7-11 mm, or 8-9 mm.

15

4. The dental light curing system of claim 1, wherein no lens for collecting or for focusing the light is included in the dental light curing system.

5. The dental light curing system of claim 1, wherein number of the emitting chips on
20 LES are 5-15, 7-11 or 8-9.

6. The dental light curing system of claim 1, further comprising a rechargeable battery.

7. The dental light curing system of claim 6, further comprising a wireless charging
25 structure comprising:

a battery;

a wireless device having an electric power receiving module electrically coupled to the battery;

wherein the wireless device comprises,

30 a battery casing configured to accommodate functional modules therein, formed of a metal material having high heat transfer efficiency; and

a battery module configured to be accommodated inside of the battery casing, and to embed the battery;

wherein the battery module comprises,

a battery housing configured to surround the battery, the electric power receiving module placed on a bottom of the battery, and a receiving module; and

an insulation plate configured to be placed one end of the receiving module, wherein the insulation plate comprises one or more insulation arms to transmit a heat of the receiving module by extending between the battery casing and the battery housing and contacting the battery casing, on both ends of the insulation plate.

8. A wireless charging structure in a wireless device, comprising:

a battery;

a wireless device having an electric power receiving module electrically coupled to the battery;

wherein the wireless device comprises,

a battery casing configured to accommodate functional modules therein, formed of a metal material having high heat transfer efficiency; and

a battery module configured to be accommodated inside of the battery casing, and to embed the battery;

wherein the battery module comprises,

a battery housing configured to surround the battery, the electric power receiving module placed on a bottom of the battery, and a receiving module; and

an insulation plate configured to be placed one end of the receiving module, wherein the insulation plate comprises one or more insulation arms to transmit a heat of the receiving module by extending between the battery casing and the battery housing and contacting the battery casing, on both ends of the insulation plate.

9. The wireless charging structure of claim 8, further comprising a charger, wherein the charger comprises an insertion groove into which the wireless device is inserted and supported, and an electric power transmitting module for transmitting wireless electric power to the electric power receiving module.

10. The wireless charging structure of claim 8, wherein the battery housing comprises a holding mount configured to have a larger diameter than an area where the battery is accommodated, and to be contacted with and supported by the battery casing, on a bottom of the battery housing, wherein the holding mount comprises an arm exposing hole configured to expose the insulation arms to the outside to contact to the battery casing, to correspond to the number of the insulation arms, and to form a shape allowing passing through, on an upper outer periphery of the holding mount.

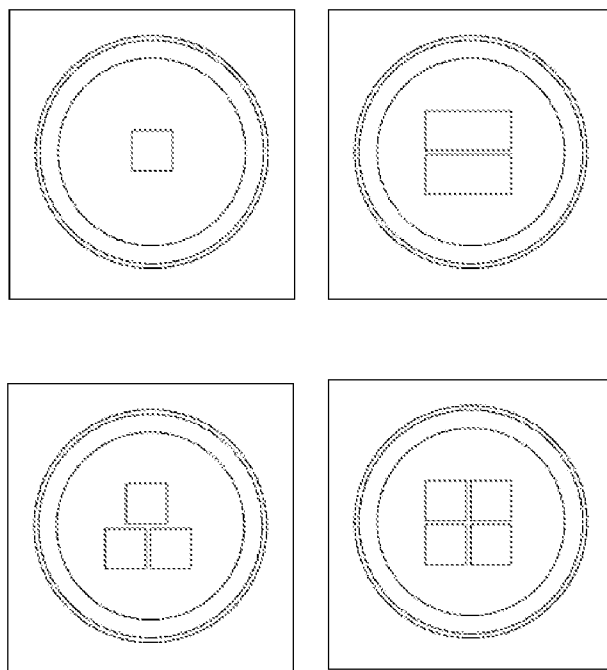
11. The wireless charging structure of claim 8, wherein the holding mount comprises vent holes configured to release the heat of the receiving module to the outside, and to form a shape allowing passing through, on a bottom outer periphery of the holding mount.

12. The wireless charging structure of claim 8, wherein the insulation plate is configured to be placed either between the electric power receiving module and the receiving module, or between the electric power receiving module and the battery, and to have a multi-layer structure.

13. The wireless charging structure of claim 8, wherein the wireless device is a dental curing light device.

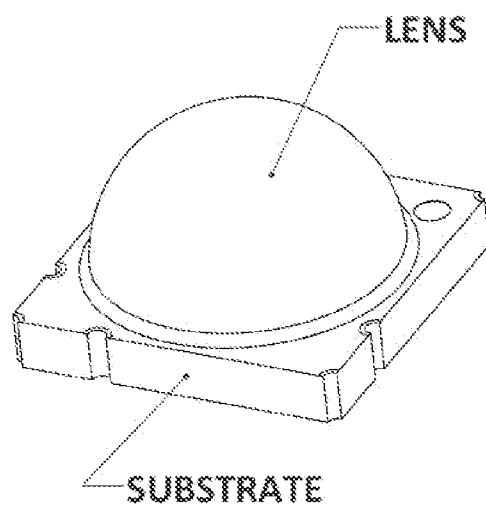
1/20

FIG. 1



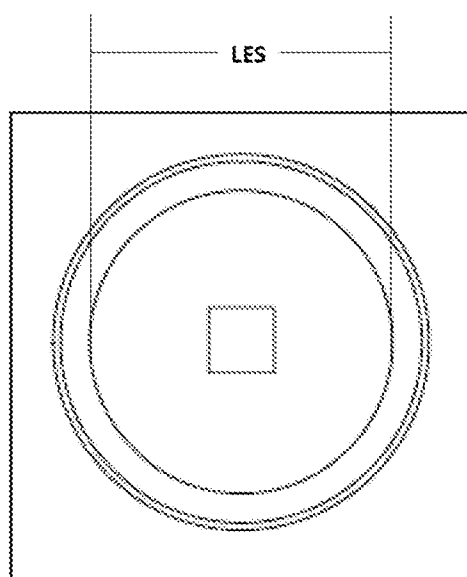
2/20

FIG. 2



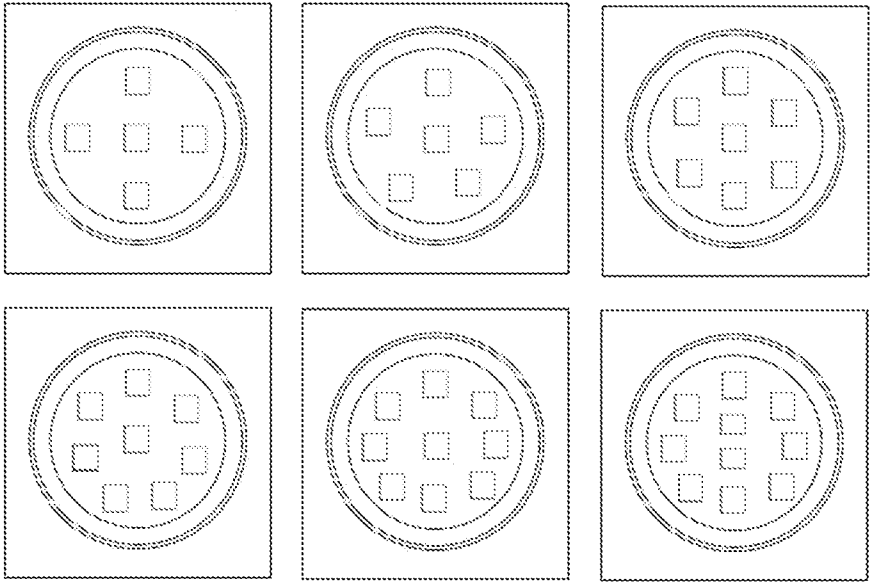
3/20

FIG. 3



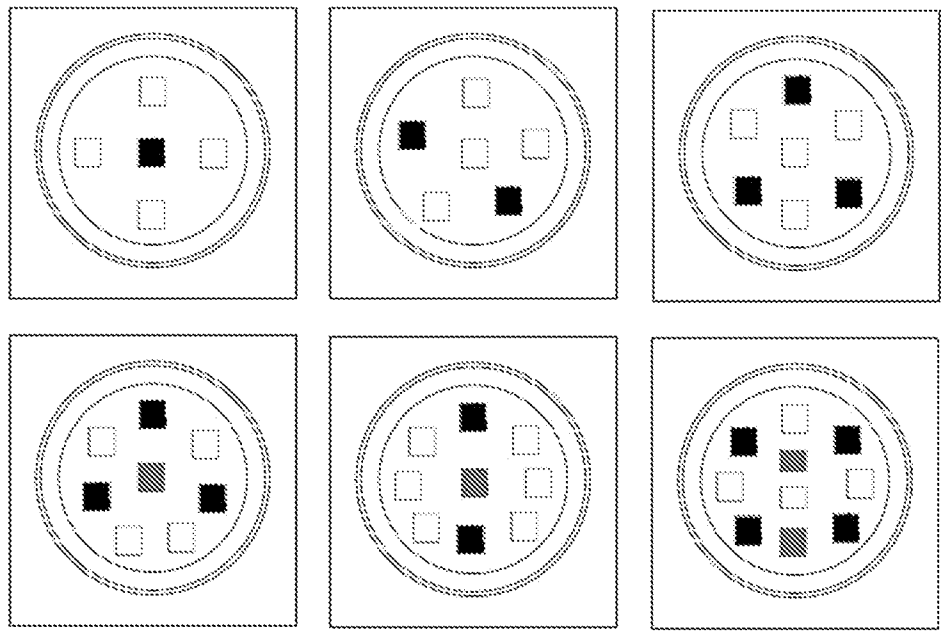
4/20

FIG. 4



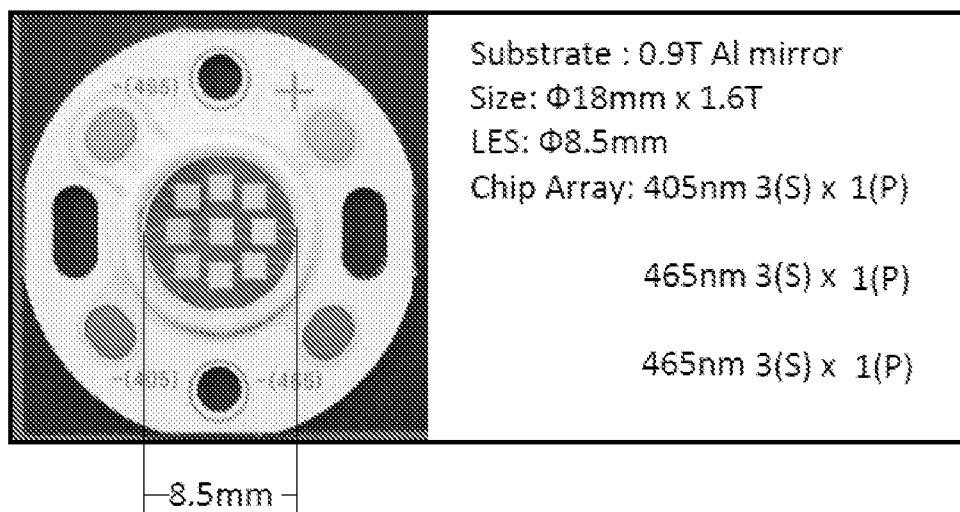
5/20

FIG. 5



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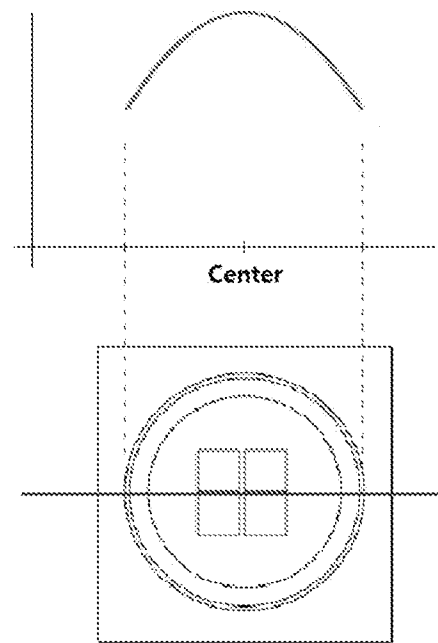
FIG. 6



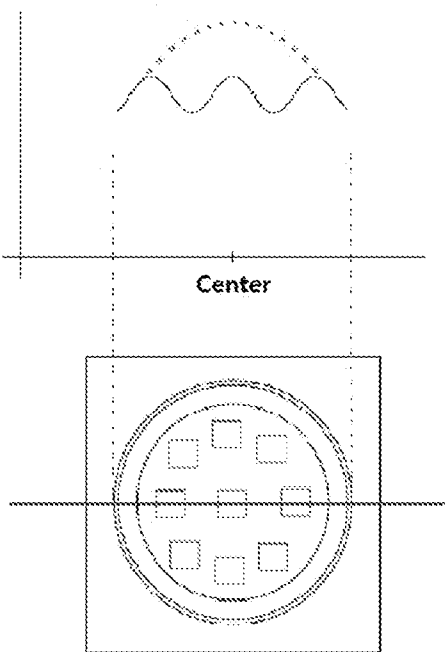
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FIG. 7

Light Intensity &
Temperature

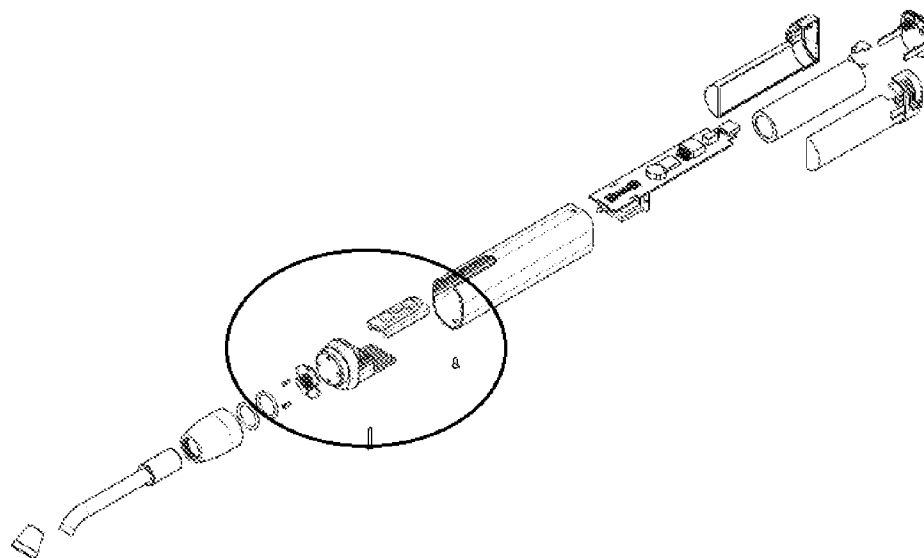


Light Intensity &
Temperature



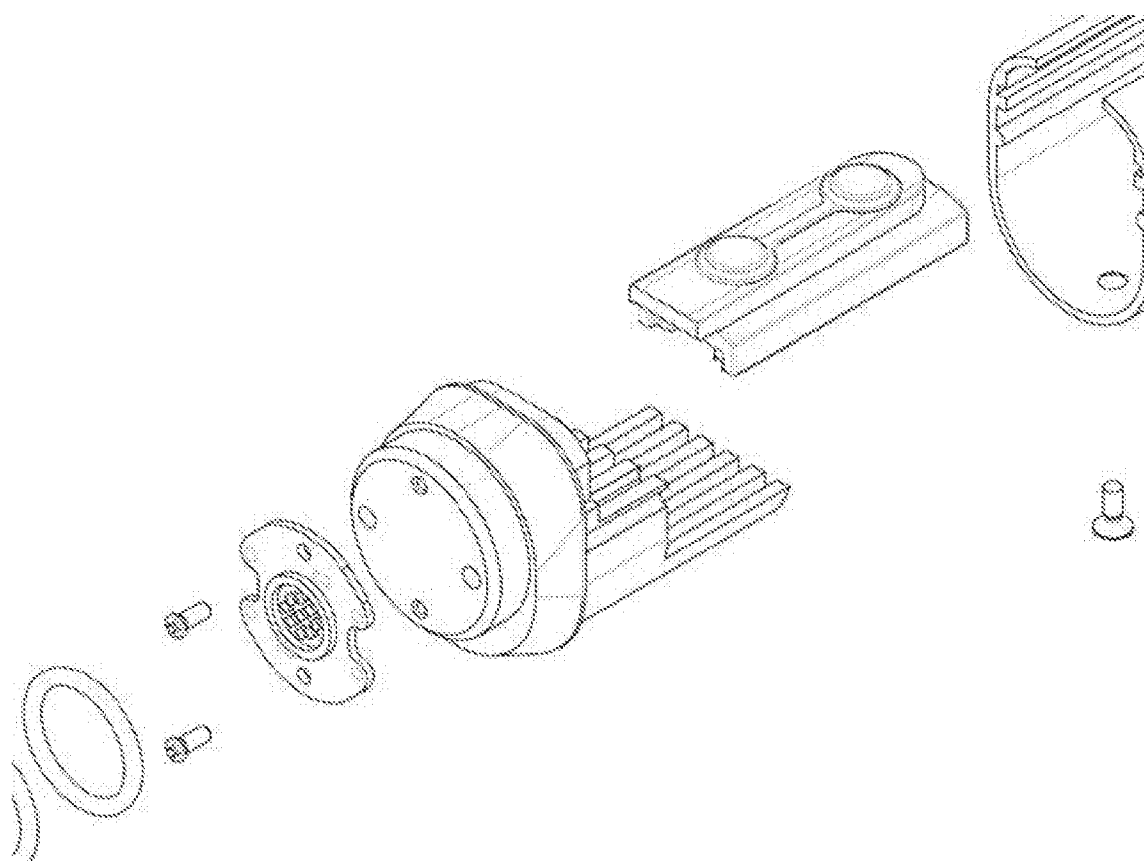
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FIG. 8



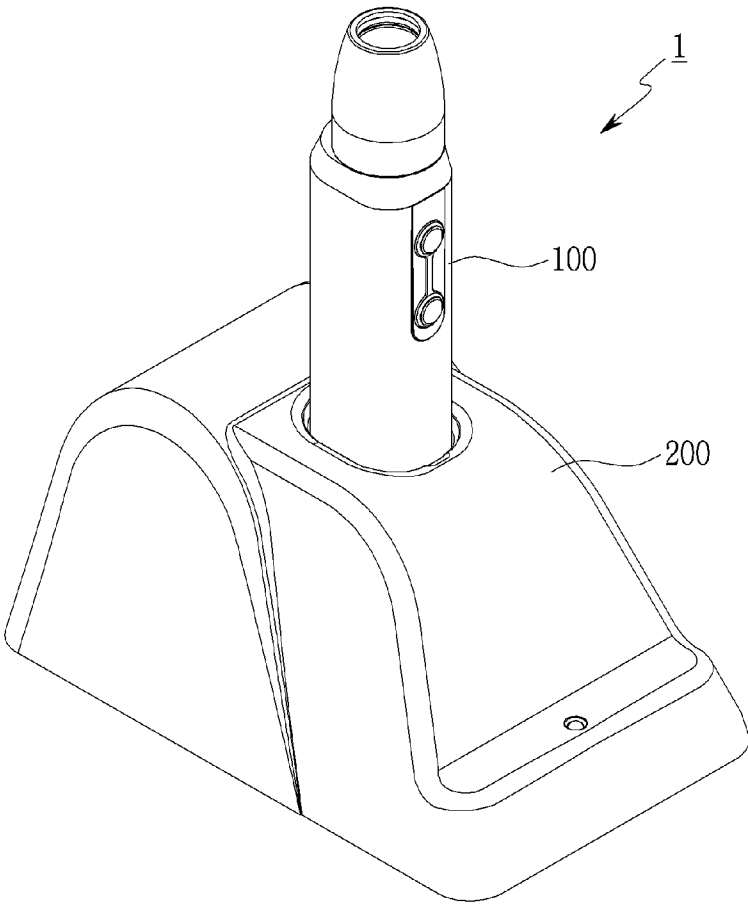
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FIG. 9



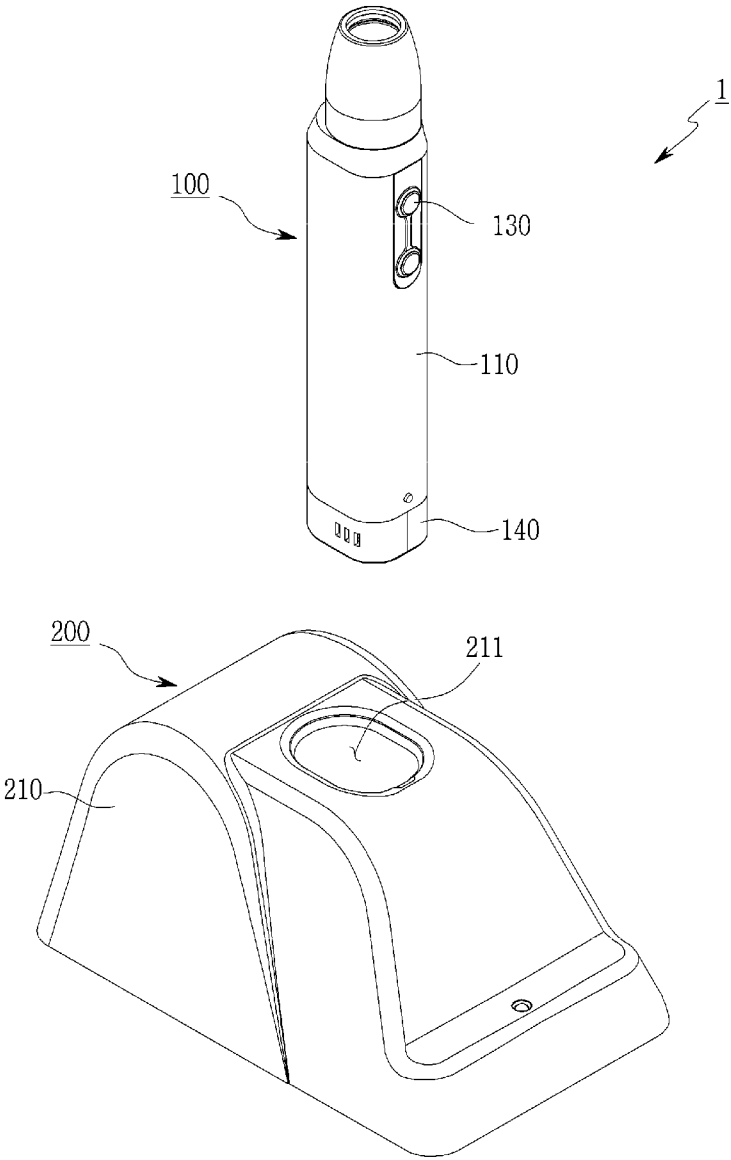
10/20

FIG. 10



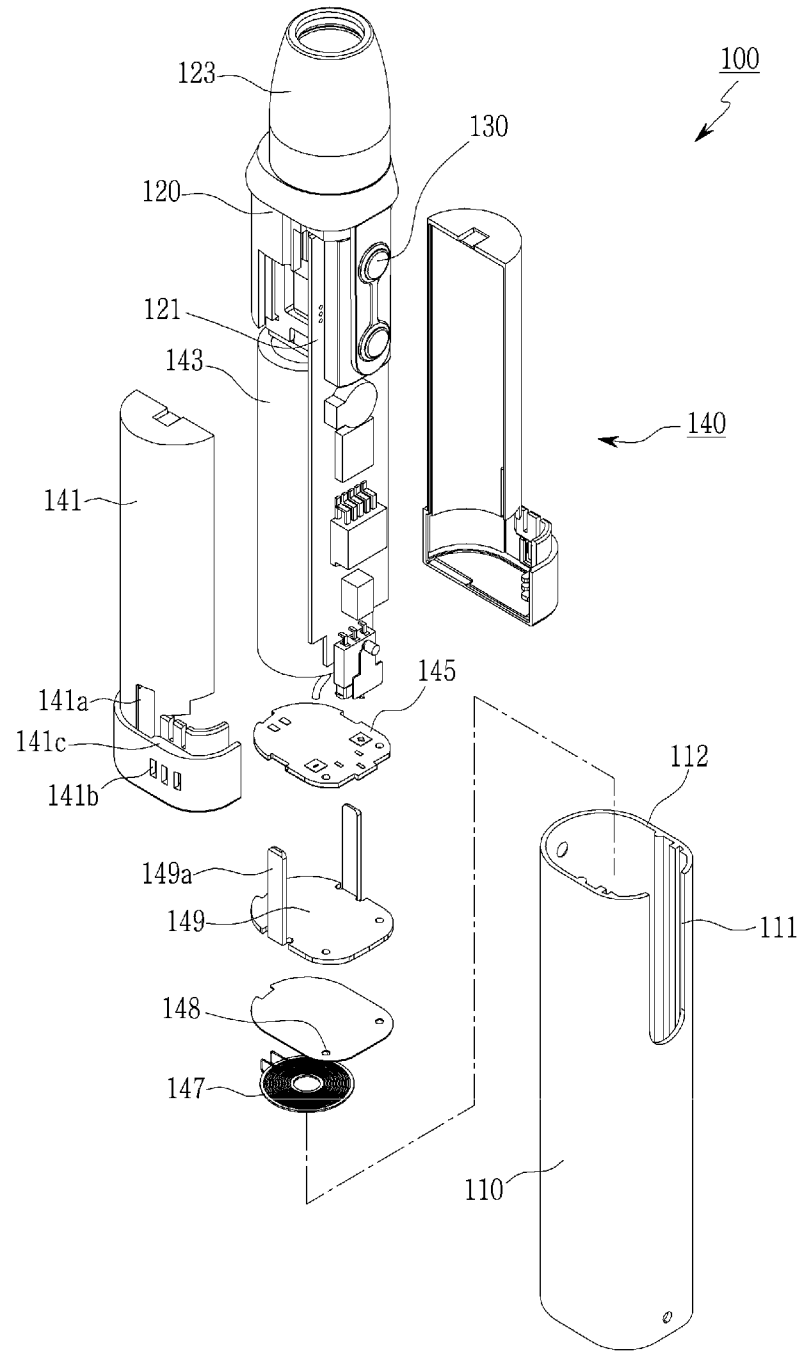
11/20

FIG. 11



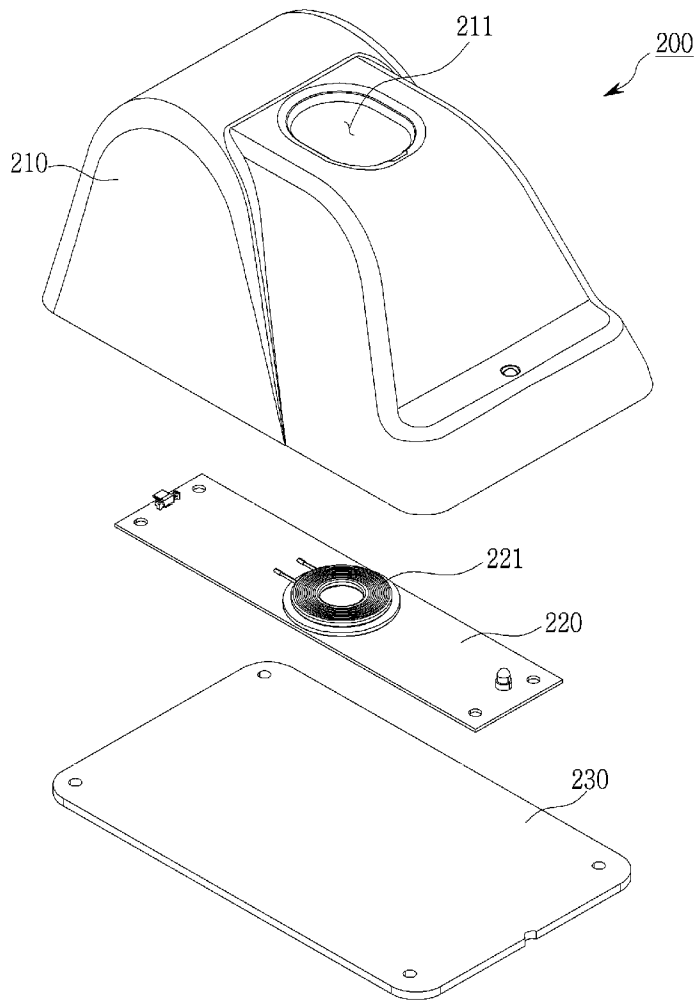
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FIG. 12



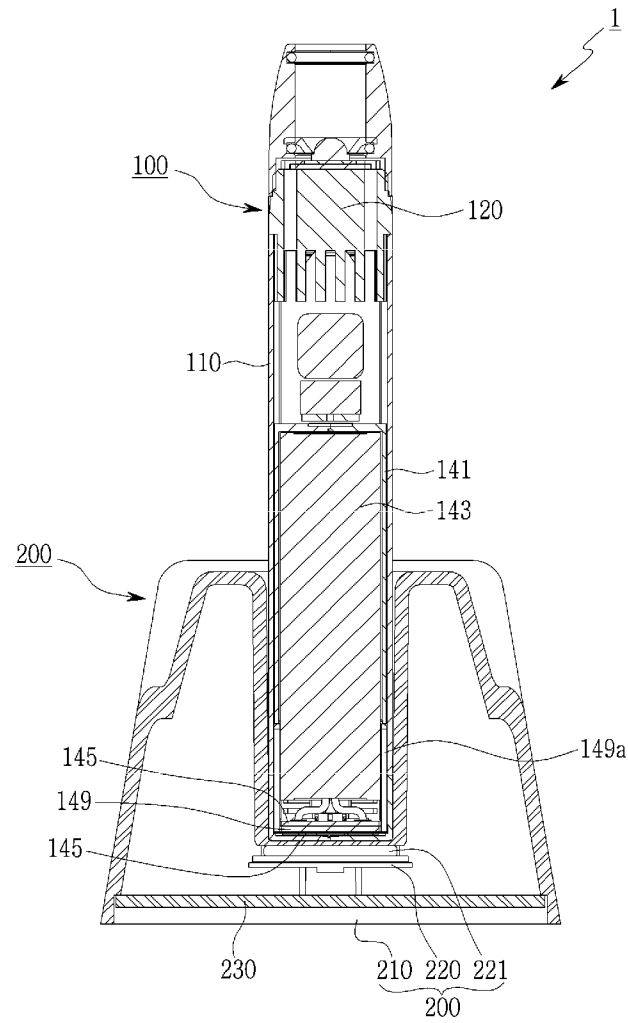
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FIG. 13



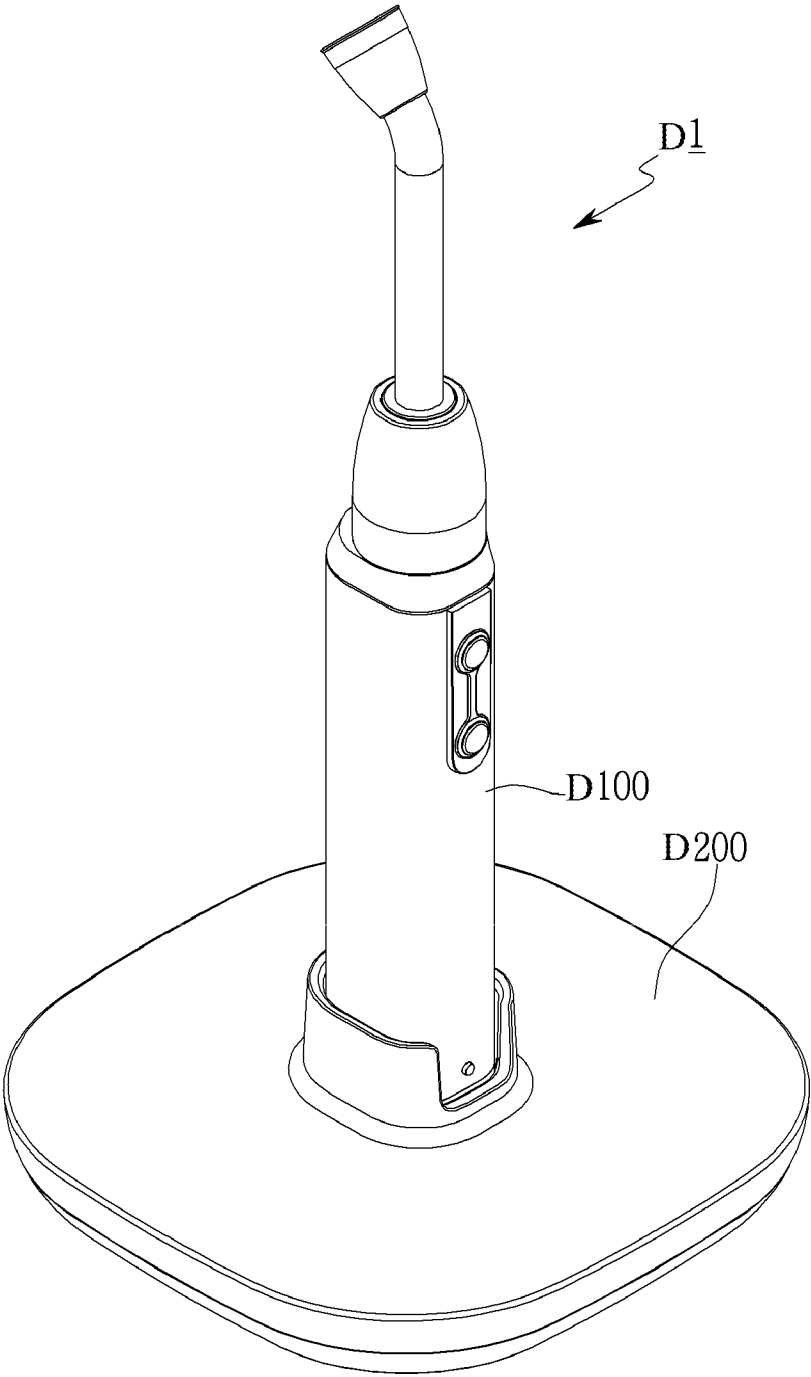
14/20

FIG. 14



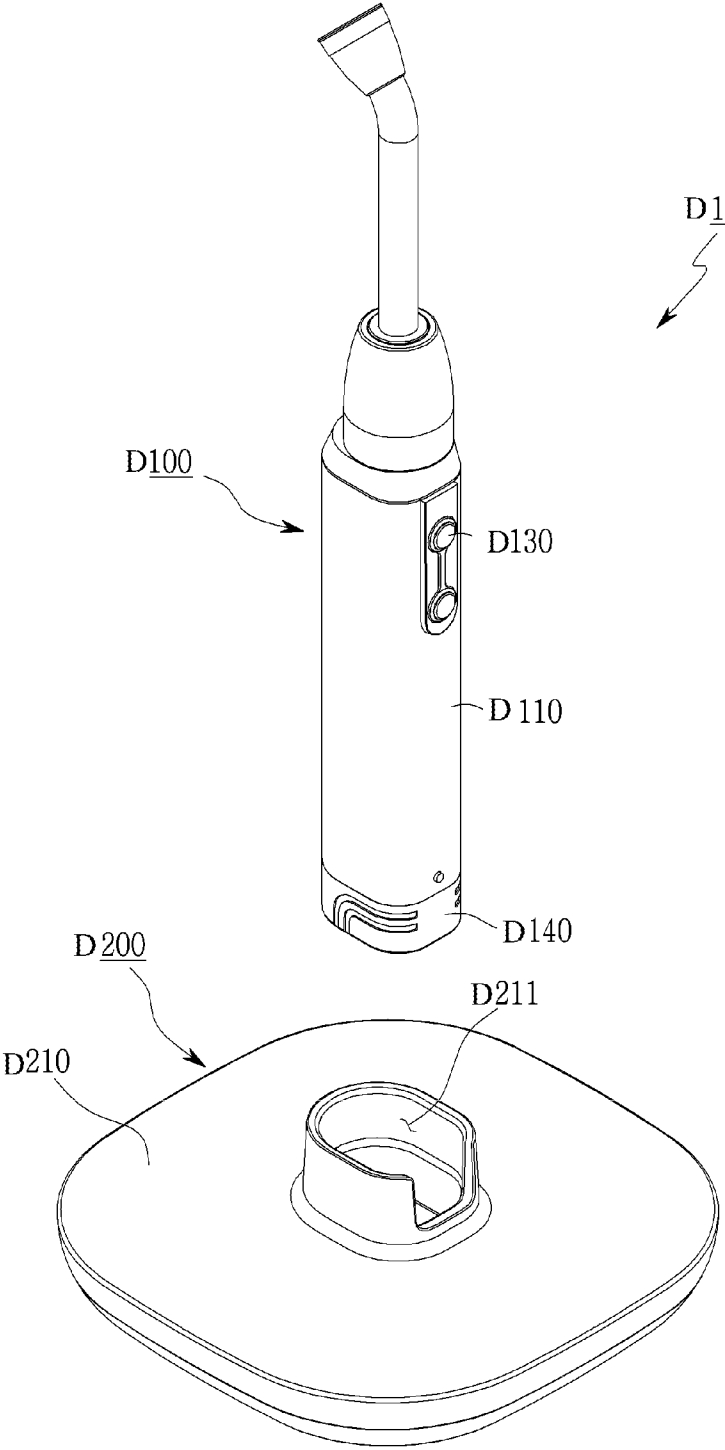
15/20

FIG. 15



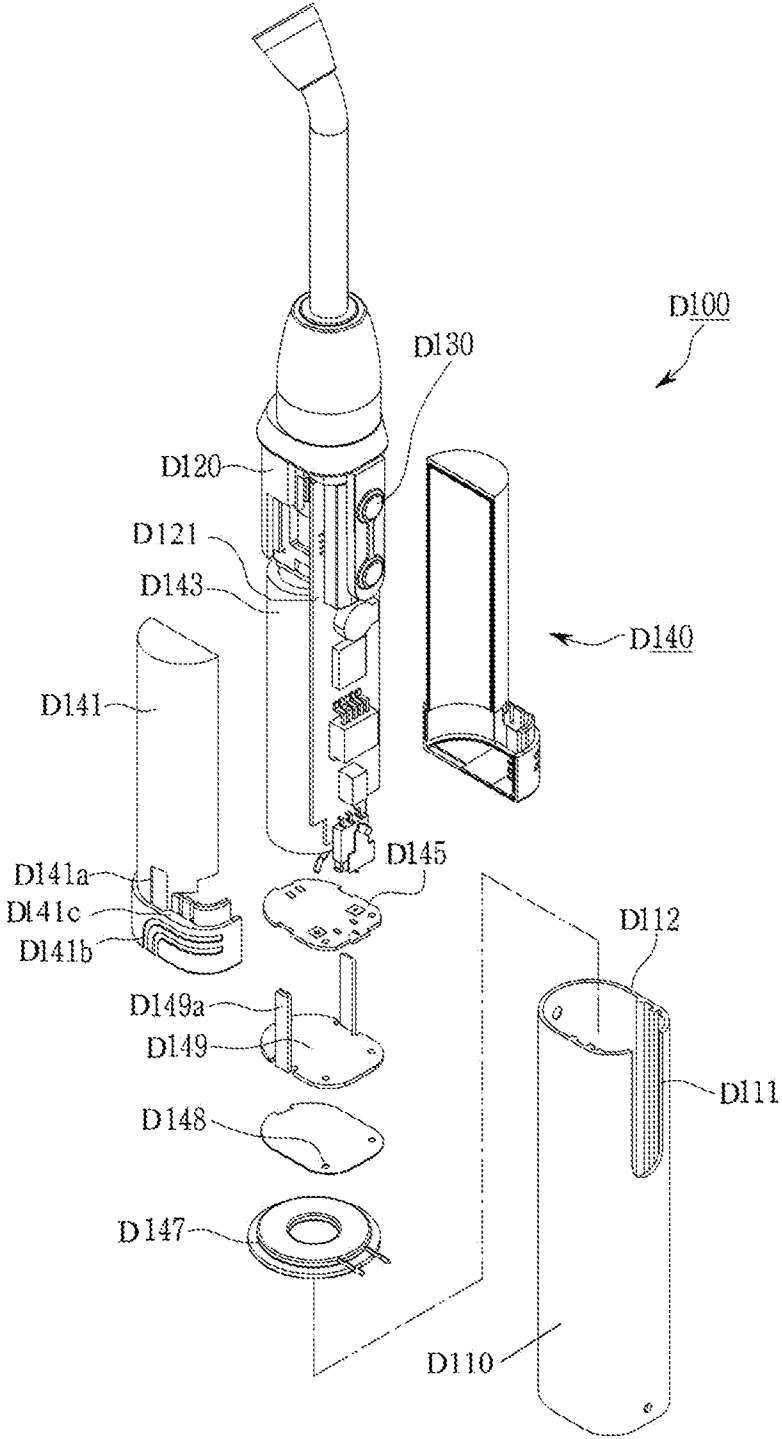
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FIG. 16



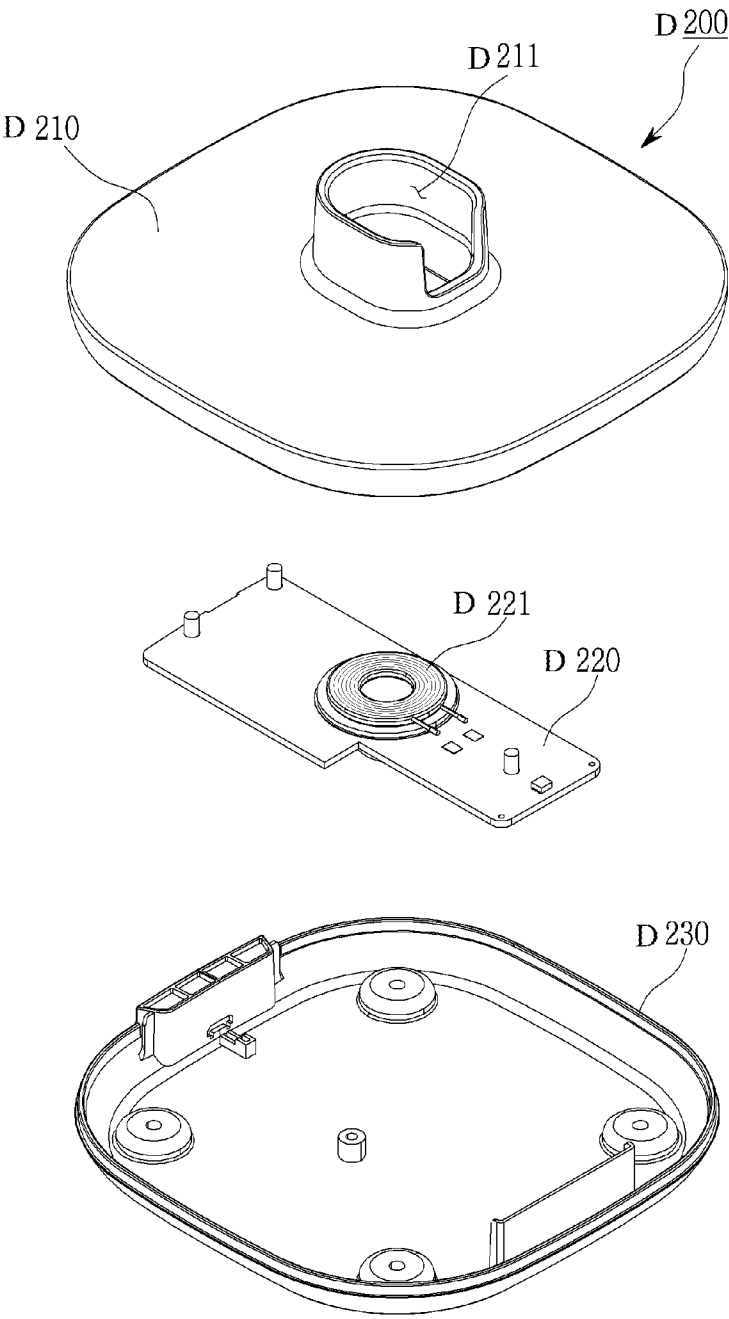
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FIG. 17



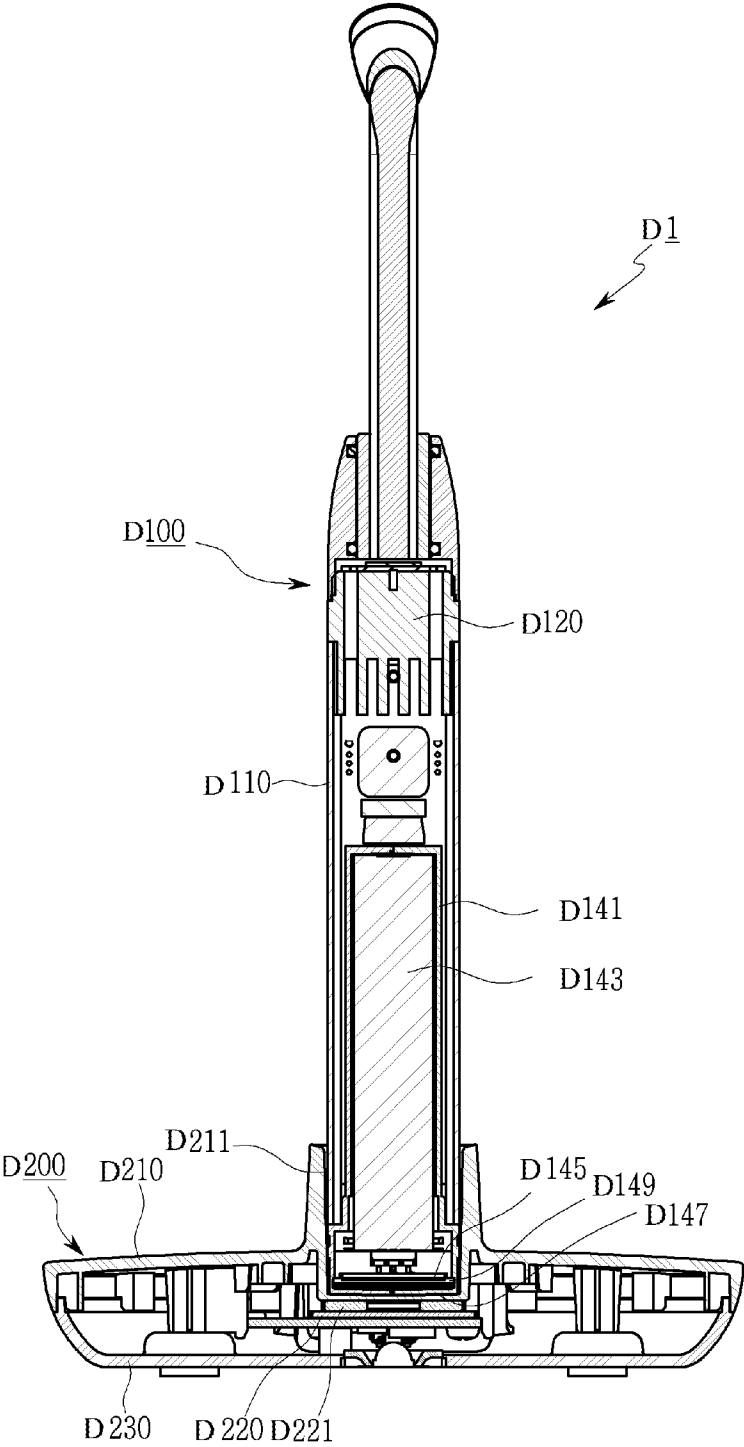
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FIG. 18



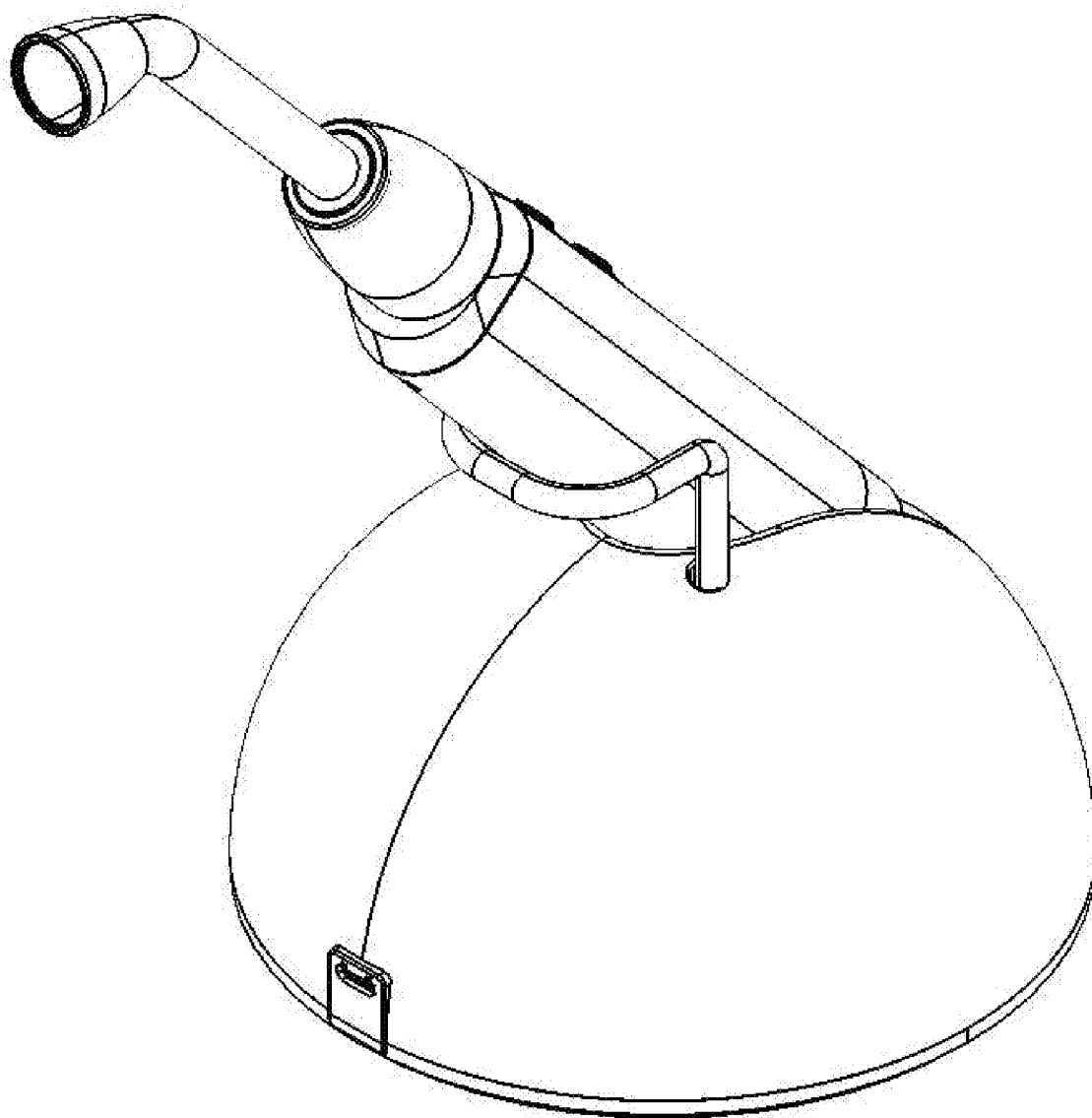
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FIG. 19



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FIG. 20



INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2017/032275

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - A61C 3/00; A61C 1/00; A61C 13/15; A61N 5/06; B23K 26/06; B23K 26/42 (2017.01)

CPC - A61C 3/00; A61C 1/00; A61N 5/06; B23K 26/06; B23K 26/42 (2017.02)

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)

See Search History document

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

USPC - 433/29; 362/800; 433/25 (keyword delimited)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

See Search History document

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 2002/0168603 A1 (CAO) 14 November 2002 (14.11.2002) entire document	1-6 --- 7, 13
X --- Y	US 2010/0289450 A1 (KOOK) 18 November 2010 (18.11.2010) entire document	8-12 --- 7, 13
A	US 8,461,801 B2 (CHEN) 11 June 2013 (11.06.2013) entire document	1-13
A	US 2015/0250572 A1 (GRAMANN et al) 10 September 2015 (10.09.2015) entire document	1-13

☐ Further documents are listed in the continuation of Box C.☐ 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

"E" earlier application or patent but published on or after the international filing date

"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)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"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

"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

"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

"&" document member of the same patent family

Date of the actual completion of the international search

01 September 2017

Date of mailing of the international search report

15 SEP 2017

Name and mailing address of the ISA/US

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P.O. Box 1450, Alexandria, VA 22313-1450

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Authorized officer

Blaine R. Copenheaver

PCT Helpdesk: 571-272-4300
PCT OSP: 571-272-7774

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2017/032275

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☐ Claims Nos.:
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

See extra sheet(s).

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☒ No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2017/032275

Continued from Box No. III Observations where unity of invention is lacking

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees must be paid.

Group I, claims 1-7, drawn to a dental light curing system.

Group II, claims 8-13, drawn to a wireless charging structure in a wireless device.

The inventions listed as Groups I-II do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons: the special technical feature of the Group I invention: a light source part comprising a light emitting surface (LES) comprising a plurality of light emitting diodes chips as a light source; and a light guide, wherein the plurality of light emitting diodes chips are evenly spread through LES as claimed therein is not present in the invention of Group II. The special technical feature of the Group II invention: a battery; a wireless device having an electric power receiving module electrically coupled to the battery; wherein the wireless device comprises, a battery casing configured to accommodate functional modules therein, formed of a metal material having high heat transfer efficiency; and a battery module configured to be accommodated inside of the battery casing, and to embed the battery; wherein the battery module comprises, a battery housing configured to surround the battery, the electric power receiving module placed on a bottom of the battery, and a receiving module; and an insulation plate configured to be placed one end of the receiving module, wherein the insulation plate comprises one or more insulation arms to transmit a heat of the receiving module by extending between the battery casing and the battery housing and contacting the battery casing, on both ends of the insulation plate as claimed therein is not present in the invention of Group I.

Since none of the special technical features of the Group I or II inventions are found in more than one of the inventions, unity of invention is lacking.