



- (51) International Patent Classification:
A61C 17/22 (2006.01)
- (21) International Application Number:
PCT/US2014/072095
- (22) International Filing Date:
23 December 2014 (23.12.2014)
- (25) Filing Language: English
- (26) Publication Language: English
- (30) Priority Data:
61/994,817 16 May 2014 (16.05.2014) US
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- (81) Designated States (unless otherwise indicated, for every kind of national protection available): AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.
- (84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

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(54) Title: SPATIALLY IMPROVED EXTENDED REACH ULTRASONIC TOOTHBRUSH

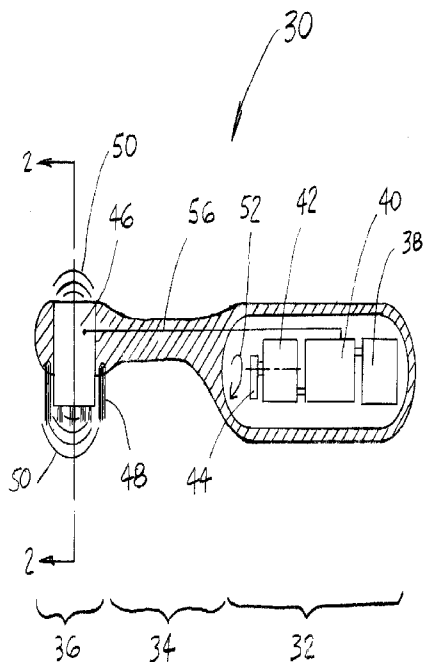


FIG. 1

(57) Abstract: An ultrasonic toothbrush having spatially extended functionality to treat various oral diseases in addition to removing plaque and treating gingivitis is disclosed. In addition to the ultrasonically activated bristles, the toothbrush incorporates a multi directional ultrasound transducer system, which spatially irradiates the oral cavity with ultrasonic pressure waves, operational to loosen plaque, to remove periodontal bacteria from teeth and gums, and to simultaneously treat and destroy disease causing bacteria and bacterial chains on the inside surfaces of cheeks and lips, providing relief from Recurring Aphthous Stomatitis, Lichen Planus, and Mucositis. Various configurations are disclosed, including user removable and replaceable brush heads and ultrasound treatment heads. A motorized version featuring sonic frequency orbital vibration brush head and bristle tufts is described.



Declarations under Rule 4.17:

- *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*
- *as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))*

Published:

- *with international search report (Art. 21(3))*

Patent Application of Robert T. Bock
Title: Spatially Improved Extended Reach Ultrasonic Toothbrush

SPECIFICATIONS

CROSS REFERENCE TO RELATED APPLICATIONS

This application claims the priority date and all other benefits of U.S. Provisional Application No. 61/994,817, filed May 16, 2014, the contents of which are hereby incorporated by reference in their entireties as if fully set forth herein.

BACKGROUND OF THE INVENTION.

1. FIELD OF THE INVENTION.

This invention relates to toothbrushes and more particularly toothbrushes utilizing sonic and ultrasonic acoustic mechanism to increase the effectiveness of the toothbrushes and to provide for enhanced oral hygiene.

2. DESCRIPTION OF PRIOR ART.

Some of the early art of powered toothbrushes attempted to increase the speed of bristle vibrations by various sonic frequency and ultrasonic frequency means. These devices are exemplified by U.S. Pat. No.3,335,443 by Parisi, 3,809,977 by Balamuth, and 4,192,035 by Kuris. These proposals did not utilize ultrasonic pressure waves to impact upon the plaque and periodontal bacteria on the teeth and gums; they were merely faster vibrating mechanical toothbrush designs. It is not known if any of these patents were utilized in commercially available toothbrushes.

The first commercially available ultrasonic toothbrush utilizing ultrasonic pressure waves to help remove plaque and destroy periodontal bacteria was based on U. S. Pat.

5,138,733 by Bock, which contained a piezoelectric transducer in the tip of the brush to generate the ultrasonic pressure waves, which were transmitted through the bristles to teeth and gums. While this was a great leap forward in toothbrush design, it was not optimal since a significant portion of the ultrasound energy generated by the piezoelectric transducer were lost due to various structural ultrasound attenuation mechanisms. Material interfaces are not 100% efficient. Each material interface that the ultrasound wave has to travel through, such as the adhesive to transducer interface and the adhesive to housing interface securing the transducer in the housing, the housing to the brush head interface, and the brush head to the bristle interface are reflecting some of the ultrasound energy back toward the transducer. In addition, the long aspect ratio thin bristles attenuated some of the ultrasonic energy generated by the piezoelectric transducer. In both U. S. Pat. No. 5,138,733 and U. S. Pat. No. 5,369,831 also by Bock, the transmission of ultrasound toward the back of the brush head was also greatly reduced due to the numerous surface interfaces and thick housing materials, which attenuated the ultrasound energy toward the back side of the brush head. Nevertheless, U. S. Pat. No. 5,138,733 and U. S. Pat. No. 5,369,831 still represented the best solution for ultrasonic toothbrushes at their time.

U. S. Pat. No. 7,269,873 B2 by Brewer et. al, entitled "Ultrasonic toothbrushes employing an acoustic waveguide" represents the next technological improvement in the art. The Brewer patent is essentially a modification of 5,138,733 by Bock, wherein Brewer provides an improvement in the efficiency of the transmission of the ultrasonic pressure waves from the transducer through the toothpaste and the fluids in the mouth to the teeth and gums by the addition of a waveguide, which is more efficient in transmission of the ultrasonic waves toward teeth and gums than the bristles in 5,138,733 by Bock. However, the waveguide suggested by Brewer while more efficient than the bristles in Bock's disclosure and practice, still attenuates the ultrasonic energy produced by the transducer, both by the waveguide to transducer interfaces and the waveguide itself. In an attempt to maximize the ultrasonic energy output from the acoustic waveguide toward teeth and gums Brewer utilizes an ultrasound-reflecting element (see FIG.1 item 28) or an alternative air-gap (see FIG. 4) on the back of the ultrasound transducer. Air-gaps are known in the art to reflect and stop propagation of

ultrasound pressure waves. Both the ultrasound reflecting element and the air-gap are isolating ultrasound wave emission from the back of the brush-head and from the lips and cheeks.

U. S. Pat. No. 7,849,548 B2 by Bock represents the next technological improvement in ultrasonic toothbrushes. In his disclosure Bock eliminates all structural attenuation of ultrasound energy emitted by the piezoelectric transducer toward teeth and gums by bringing the transducer out of the brush head and getting it in direct contact with the toothpaste and the fluids between the toothbrush and the teeth and the gums, greatly enhancing the efficiency and efficacy of the design. There are no surface interfaces or any other material to attenuate ultrasound energy between the transducer and the fluids of the oral cavity on the side of the bristles and teeth and gums. However, similarly to Brewer, Bock also proposed an ultrasound reflecting closed cell foam (see FIG. 1 item 40) on the back of the ultrasound transducer, which isolates ultrasound emission from the back of the toothbrush and the lips and cheeks.

Both U. S. Pat. No. 7,269,873 B2 by Brewer et. al, and U. S. Pat. No. 7,849,548 B2 by Bock disclose the heretofore standard construction techniques of the ultrasound transducer art throughout history, wherein the objective always has been to maximize ultrasound emission from the single “working” side of the transducer by the application of ultrasound reflecting materials and ultrasound reflecting air-gaps on the non-working “back” side of the transducer. This ultrasound emission maximization from the single working side significantly reduced and most often completely eliminated ultrasound emission from the non-working back side of the transducers.

U. S. Patent Application US 20130115571 A1 by Emecki discloses a device wherein the toothbrush bristles are directly attached to one side of the transducer to act as waveguides and transfer the mechanical oscillation energy to the teeth. While Emecki does not describe the construction details of the brush head, it is clear from Fig. 2 of the disclosure that the mechanical oscillations are limited or completely eliminated by an air-gap or reflecting material on the back side of the transducer. Emecki’s entire teaching and effort is focused on maximizing emission of mechanical oscillations into the bristles.

While progress to date was significant, the fact remains that the ultrasound toothbrush art has been focused on and only been successful to date to effectively remove plaque and periodontal bacteria from the teeth and gum surfaces.

Many people are suffering from various oral diseases, such as Recurrent Aphthous Stomatitis (RAS), commonly referred to as canker sores, Lichen Planus (LP), which is a chronic inflammatory disease with painful erosive or ulcerative areas mostly in the cheeks opposite to the teeth, and Mucositis (painful ulcerative lesions), which is caused by Anticancer Chemotherapy, which are appearing on the buccal and labial mucosa, the inside surfaces of the cheeks and the lips.

The ulcerative lesions of Mucositis are colonized by opportunistic bacterial micro organism, which create secondary infections making the already difficult to handle Chemotherapy process even less tolerable. There is evidence in the scientific community to support that RAS and LP are an aberrant immune response to the presence of oral flora. Thus a beneficial effect from the reduction in the oral bacterial load would be anticipated. Treatment with immunosuppressive agents, such as systemic or topical corticosteroids, will reduce RAS and LP activity in most patients with the disease. Unfortunately, this reduction is transient, and lesions quickly recur when treatment is discontinued. Because of the significant systemic side effects of corticosteroids, such as glaucoma, fluid retention, increased blood pressure, mood swings, osteoporosis, and more, the treatments with immunosuppressive corticosteroids cannot be tolerated for an extended period of time; the immunosuppressive corticosteroids treatments are only short-term temporary solutions. Therefore an effective therapeutic modality that is well tolerated for a long time would be of great value.

The ultrasonic toothbrush is a well-tolerated modality without any side effects. The limited amount of Ultrasound emitted from the backside of the first generation ultrasonic toothbrush based on U. S. Pat. No. 5,138,733 has been demonstrated by clinical studies to have a modest beneficial effect (46% reduction in the duration of RAS lesions as well as of decreasing the number of lesions that develop) on recurrent aphthous stomatitis. This modestly beneficial effect of the first generation ultrasonic toothbrush was limited by the structural attenuation of the ultrasonic pressure waves escaping

through the backside of the brush head, contacting the inside surfaces of the lips and cheeks.

So, even the latest state of the art ultrasonic toothbrushes are not optimally efficient to attack and destroy the various oral bacteria residing and colonizing on the inside of the lips and cheeks opposite to teeth and gums, which are causative of RAS and LP.

The art is still missing the opportunity to conveniently and concurrently with removing plaque and periodontal bacteria from teeth and gums, also to provide relief of RAS and LP and improve the health status of people suffering from RAS and LP.

In summary, RAS and LP are both an aberrant immune responses related to oral flora, still waiting for an effective relief, by a well-tolerated modality, without immunosuppressive agents and their systemic side effects.

The ultrasonic toothbrush being a well-tolerated modality is a good candidate, but the quest for a multi purpose spatially highly effective device is still not fulfilled.

SUMMARY OF THE INVENTION

Responding to the above described needs the goals of this invention is to provide methods and devices, which in addition to removing plaque and periodontal bacteria from teeth and gums also effectively treat various oral health and hygiene problems, such as RAS and LP rooted in an aberrant immune response to the presence of oral flora on the lips and cheeks, and to provide relief from Mucositis by destroying the opportunistic bacterial micro organism colonizing in the Mucositis lesions, conveniently and concurrently with the daily tooth-brushing regimen.

The invention achieves these goals by the development and disclosure of the new methods and a new spatially improved ultrasonic toothbrush employing a high efficiency non-attenuated novel piezoelectric transducer mounting system wherein the transducer is exposed on two sides of the brush head. The piezoelectric transducer is exposed and protrudes between the bristles in direct contact with the toothpaste and the oral fluids toward teeth and gums to treat the periodontal bacteria and remove plaque from teeth and gums, and equally importantly, it is also exposed on the back of the brush head in direct contact with the oral fluids and with the inside surfaces of the lips and cheeks,

delivering highly efficient non-attenuated ultrasound pressure waves to treat the oral flora and the tissues of the oral cavity opposite to teeth and gums. The intensity of these non-attenuated ultrasound pressure waves are more than double of the first generation ultrasonic toothbrush both on the bristle side and particularly on the back side of the brush head. Contrary to the temporary treatments of RAS and LP by immunosuppressive corticosteroids, the ultrasound modality is a well-tolerated long-term modality for years of daily application without limitation, providing long-term relief from RAS, LP, and Mucositis in a patient.

The new method comprises of the treatment of RAS, LP, and Mucositis lesions of the oral cavity by subjecting the oral flora colonizing in the lesions to ultrasonic pressure waves between 20 kHz and 20 MHz frequency, more typically within 750 kHz and 2 MHz frequency, at a non-attenuated intensity from 0.02 to 0.5 W/cm², more typically within 0.035 to 0.150 W/cm² either concurrently, in conjunction with, or independently of the daily tooth brushing regimen.

Accordingly, the new spatially improved ultrasonic toothbrush invention comprises a handle portion and a brush head portion. The brush head portion supports the bristle tufts and a piezoelectric ultrasound transducer, which is protruding from the head toward teeth and gums between the bristle tufts on one side and protruding through the head toward the internal surfaces of cheeks and lips on the opposite side of the bristle tufts. The handle portion contains a battery pack, an electronic motor to generate sonic frequency tactile vibrations of the brush head portion, an electronic control module to generate the ultrasonic frequency current to energize the ultrasound transducer and to provide control of the other functions in the toothbrush such as motor speed control, and battery charge control. The toothbrush system may also include a battery charging stand to provide the primary current for charging the battery in the handle, usually by conductive current means.

The ultrasound transducer being exposed directly to toothpaste and the dental fluid in the oral cavity on both sides of the brush head, in between the bristles on one side and opposite to the bristles on the other side is one of the major inventive steps of the invention. The direct exposure of the transducer to the dental fluids completely

eliminates any structural attenuation of the ultrasound energy before it is transmitted to the dental fluids, the teeth and gums, and the surrounding surfaces of the dental cavity.

It has been shown in laboratory studies that without physical contact by the bristles even the highly attenuated ultrasound pressure waves emitted by the first generation ultrasonic toothbrush from a 5 mm distance through Brain Heart Infusion broth simulating gingival fluids (a) ruptured the Streptococcus Mutans bacterial chain, (b) reduced the thickness of the biofilm on the enamel surface, and (c) damaged the cell wall of Streptococcus mutans. The results showed that ultrasound also has some influence on Streptococcus mutans cell wall and intracellular components, suggesting that ultrasound inhibits the adherence of Streptococcus mutans on enamel surfaces. This is the mechanism that makes an enhanced removal of plaque possible by the bristles of the first generation ultrasonic toothbrush.

The present invention transmits more efficient and significantly higher intensity non-attenuated ultrasound pressure waves to tissues, generating mild cavitation in the fluids of the oral cavity. In combination with the dynamic fluid motion generated by the sonic frequency bristle vibration, the invention significantly improves the ability of the toothbrush to remove substantially all plaque from teeth and gum surfaces and to destroy bacterial colonies further beyond the reach of the bristles by as much as 7 to 10 mm in between teeth and into periodontal pockets.

The invention's non-attenuated ultrasound pressure waves from the back side of the brush-head treat, damage, interrupt and disorganize the bacterial colonies residing on the inside surfaces of the cheeks and lips of the oral cavity, mitigating the effects of RAS and LP and Mucositis to the extent that was not previously possible in the art.

The invention, without any extra effort by the user, extends the daily tooth-brushing regimen into a previously unavailable complete oral hygiene regimen.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a longitudinal cross section and a schematic of the invention consisting the brush head portion incorporating the tufts of bristles and the exposed ultrasonic transducer, and the handle portion containing the driving motor, electronic controls and a battery.

FIG. 2 shows the cross section of the brush head and exposure of the non-attenuated piezoelectric ultrasound transducer.

FIG. 3A and 3B shows multi element transducer configurations to extend non-attenuated transducer contact areas with the mucosa.

FIG. 4 shows side cross sectional view of a removable brush head assembly.

Fig. 5 and FIG. 6 show two cross sectional views of another embodiment of a removable brush-head assembly.

Fig. 7 and Fig. 8 shows two cross sectional views of two embodiments of an ultrasound applicator head assembly.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

In the title and in the following discussion the term “spatially improved” refers to the multi-directional effectiveness of a toothbrush in space versus the conventional toothbrush, which is effective only on one side, which is toward the bristles.

The term “ultrasound” and “ultrasonic” and “ultrasonic pressure waves” refer to acoustic energy in either continuous wave ultrasound or repetitive burst type ultrasonic modality having an operating frequency of 20 kHz and above. References made to “sonic” and “sonic vibrations” utilized in toothbrushes are referring to physical vibrations or oscillating motions significantly below the 20 kHz ultrasonic threshold, typically in the range of 100 to 500 Hertz. The term “cavitation” in association with the toothbrush refers to the generation and/or dispersion of bubbles and the interaction between the sonic or ultrasonic energy and vibrations with the bubbles within the oral fluidic environment. The term “structural attenuation” in association with ultrasound refers to the attenuation effects of the various surface interfaces and materials commonly used for housing the

ultrasound transducers and for transmitting ultrasound from the transducer to the anatomy in ultrasonic toothbrushes and other ultrasonic applications.

The damaging effects of ultrasound on bacteria and bacterial colonies and rendering bacterial colonies ineffective are well known and documented in the scientific community. Clinical and laboratory studies of earlier generation ultrasonic toothbrushes cited herein are only a small set of examples of the effectiveness of the ultrasound emitted by the toothbrush on the bacterial colonies and plaque. It is well known that the effectiveness of ultrasound is related to the intensity of the application, so it is important to limit energy losses and maximize the available intensity from an ultrasound transducer within the limitation of the tissue-heating threshold.

The invention of the spatially improved extended reach ultrasonic toothbrush **30** in a preferred configuration is shown in **FIG. 1** and **FIG. 2**. The toothbrush **30** comprises of a handle portion **32**, a neck portion **34**, and a brush-head portion **36** constructed of a rigid or semi rigid plastic material. The handle portion **32** contains a battery pack **38**, an electronic control module **40**, and an electric motor **42** with an off-center weight **44** mounted on the shaft of the motor **42**. The brush-head portion **36** contains an ultrasound transducer **46** and one or more bristle tufts **48**.

The battery pack **38** is typically a multi-cell rechargeable battery of NiCd or NiMH chemistry system providing approximately 4.8 VDC to the electronic control module **40**. The electronic control module **40** has multiple functions. It controls the electric motor **42** to produce various speed sonic frequency orbital vibrations **52** typically between 100 Hz and 500 Hz to the preference of the user, or no vibration when the application calls for the toothbrush to emit only ultrasonic pressure waves **50** without sonic frequency bristle vibrations. The electronic control module **40** generally will boost the battery voltage by a voltage multiplier circuit to the range of 9.6 VDC to 16.0 VDC in conjunction with generating the ultrasonic frequency current between 20 kHz and 20 MHz frequency, more typically within 750 kHz and 2 MHz frequency, for energizing the ultrasound transducer **46**.

The brush-head portion **36** houses the bristle tufts **48** and the ultrasound transducer **46**. The ultrasound transducer **46** is positioned within and protrudes from the brush-

head **36** in two directions to provide spatial radiation of ultrasound pressure waves **50** without any structural attenuation of the spatially radiating ultrasound energy.

The transducer **46** protrudes from the brush-head **36** between the bristle tufts **48** toward teeth and gums on one side and protrudes through the brush-head **36** on the opposite side of the bristle tufts **48** toward the internal surfaces of the cheeks and lips.

The transducer **46** is typically constructed of one or more elements of hard piezoelectric materials, such as PZT-4 or PZT-8 Lead Zirconate Titanate composition ceramics. The PZT-4 material is a particularly good candidate for the toothbrush application since it is capable of producing large mechanical drive amplitudes while maintaining low mechanical and dielectric losses. However various other transducer materials are also available in the art, such as single crystal silicones, capacitive micro-machined materials, electrostatic polymers, and more will be available in the future to construct an ultrasonic transducer. When energized by the ultrasonic frequency current supplied by the electronic control module **40** through the interconnecting wiring **56** to the ultrasound transducer **46** the transducer **46** expands and contracts in tune with the ultrasonic frequency current, producing and transmitting ultrasound pressure waves **50** spatially into the surrounding and contacting materials, the toothpaste, the oral fluids, and the tissues of the oral cavity. To assure the best possible intimate contact with and transmission of the non-attenuated ultrasound pressure waves **50** into the lips and the cheeks, the brush head surface **54** opposite to the bristles **48** is constructed with a curved configuration and the ultrasound transducer is exposed at the peak of this surface. While FIG. 2 depicts the simplest transducer configuration constructed of a single element, other advanced multi-element configurations are possible.

FIG. 3A depicts a two-element straight "T" shape ultrasound transducer **58** while FIG. 3B depicts a curved "T" shape ultrasound transducer **60** illustrative of numerous configurations possible to increase contact areas with the mucosa of the lips and cheeks to further widen the spatial feature of the ultrasonic toothbrush, and not to miss the sometimes small but painful lesions of RAS and LP and Mucositis.

FIG. 4 depicts a removable brush-head assembly configuration of the invention. The removable brush-head assembly **70** comprises a substantially rigid elongated structural member **72** having a base portion **74** designed for secure attachment to a mating **73**

portion of the toothbrush handle, a brush-head portion **76** housing one or more bristle tufts **48** and an ultrasound transducer **46**. The ultrasonic frequency power to energize the transducer **46** is provided by an ultrasonic frequency current generator located in the toothbrush handle through a connector set **82** and connecting wiring **84**.

The ultrasound transducer **46** protrudes from the brush-head portion **76** in two directions to provide spatial radiation of ultrasound pressure waves **50** without any structural attenuation of the ultrasound energy. The transducer **46** protrudes from the brush-head **76** between the bristle tufts **48** on one side and protrudes through the brush-head **76** on the opposite side of the bristle tufts **48**.

FIG. 5 and FIG. 6 depict another embodiment of a removable brush-head assembly **90**. In this embodiment the brush-head assembly **90** comprises a substantially rigid elongated tubular stem **92**, which slides over and secures on a mating shaft **95** of the toothbrush handle, a brush-head portion **76** housing one or more bristle tufts **48** and an ultrasound transducer **46**. The ultrasonic frequency power to energize the transducer **46** is provided by an ultrasonic frequency current generator located in the toothbrush handle connecting through a spring loaded sliding connector set **96** located in a slot **98** in the tip of the mating shaft **95** and connecting wiring **84**.

The ultrasound transducer **46** protrudes from the brush-head portion **76** in two directions to provide spatial radiation of ultrasound pressure waves **50** without any structural attenuation of the ultrasound energy. The transducer **46** protrudes from the brush-head **76** between the bristle tufts **48** on one side and protrudes through the brush-head **76** on the opposite side of the bristle tufts **48**.

FIG. 7 depicts a cross section of a removable ultrasound applicator head assembly **37** configuration of the invention, having a one-element ultrasound transducer **47**. The removable ultrasound applicator head assembly **37** has an identical construction as the removable brush-head assemblies **70** and **90** shown in FIG. 4 and FIG. 5 respectively, with the exception that the removable ultrasound applicator head assembly **37** does not contain any bristles. All construction notes contained in the descriptions of FIG. 4 and FIG. 5 of the removable brush-head assemblies **70** and **90** are applicable to the removable ultrasound applicator head assembly **37** with the exception of references to the bristles.

The purpose of the removable ultrasound applicator head assembly **37** is to provide an optional accessory for the ultrasonic toothbrush to apply non-attenuated ultrasound treatment for RAS, LP, or Mucositis lesions at any time, independently from the daily tooth-brushing regimen. The ultrasound transducer **47** is exposed at the peak of the curved surface **54** of the applicator head assembly **37** and the ultrasound pressure waves **50** are conducted from the non-attenuated transducer to the bacterial flora by the oral fluids without the need for toothpaste.

FIG. 8 depicts a cross section of a removable ultrasound applicator head assembly **37** having a curved two-element ultrasound transducer **61** adopted to increase the contact surface between the transducer **61** and the lesions in the oral cavity. All other construction notes of FIG. 7 are applicable to FIG. 8 also.

All of the patents and publications cited herein and in the appended Information Disclosure Statement are hereby incorporated by reference in their entireties.

While the preceding description contains numerous specificities, these should not be construed as limitations on the scope of the invention, but rather as an exemplification of a preferred and additional embodiments thereof. Skilled artisans will readily be able to change dimensions, shapes, and construction materials of the various components described in the embodiments and adopt the invention to all types of sonic and ultrasonic energy applications. Accordingly, the scope of the invention should be determined not by the embodiments illustrated, but by the appended claims and their legal equivalents.

Patent Application of Robert T. Bock

Title: Spatially Improved Extended Reach Ultrasonic Toothbrush

CLAIMS

What is claimed:

1. An ultrasonic toothbrush comprising:
 - a) a brush head portion having at least one bristle tuft composed of a plurality of bristles and at least one ultrasound transducer protruding from said brush head portion at least on one side, said ultrasound transducer radiating and coupling ultrasound pressure waves by the dentifrice and the fluids in the oral cavity simultaneously in multiple directions to teeth and gums and the inner surfaces of cheeks and lips;
 - b) a handle portion containing means generating ultrasonic frequency electronic current and connecting means of said electronic current to energize said ultrasound transducer located in said brush head portion.
2. The ultrasonic toothbrush of claim 1, wherein the ultrasonic pressure waves radiated by said transducer are non attenuated and operating between 20 kHz and 20 MHz frequency and producing non attenuated ultrasound intensity of 0.02 to 0.5 W/cm².
3. The ultrasonic toothbrush of claim 1 or 2, wherein the said ultrasound pressure waves radiated by said transducer are operative to damage and reduce the effectiveness of disease causing bacteria and bacterial colonies in the oral cavity.
4. The ultrasonic toothbrush of claim 1 or 2, wherein said brush head portion is removable from said handle portion and includes means to securely connect said brush head portion to said handle portion and means to connect said ultrasonic frequency electronic current from said handle portion to power said ultrasound transducer within said brush head portion.

5. The ultrasonic toothbrush of claim 1 or 2, wherein the ultrasound transducer comprises of at least two transducer elements radiating ultrasonic pressure waves, one said transducer element radiating toward teeth and gums, another said transducer element radiating toward the inside surfaces of the cheeks and lips of the oral cavity.
6. The ultrasonic toothbrush of claim 1 or 2, additionally comprising a motor secured to the structure of said handle portion having means to generate orbital vibrations of said handle portion and said brush head portion.
7. The ultrasonic toothbrush of claim 6, wherein the frequency of said orbital vibrations is between 100 Hz and 500 Hz.
8. The ultrasonic toothbrush of claim 6, further comprising means to selectively generate orbital vibrations or not to generate said orbital vibrations of said handle portion and said brush head portion according to the desires of the user.
9. The ultrasonic toothbrush of claim 6, wherein said brush head portion is removable from said handle portion and includes means to securely connect said brush head portion to said handle portion having means to transmit said orbital vibrations from said handle portion to said removable brush head portion and means to connect said ultrasonic frequency electronic current from said handle portion to power said ultrasound transducer within said brush head portion.
10. An ultrasonic toothbrush comprising:
 - a) a removable brush head portion having at least one bristle tuft composed of a plurality of bristles and at least one ultrasound transducer protruding from said brush head portion at least on one side, said ultrasound transducer radiating and coupling ultrasound pressure waves by the dentifrice and the fluids in the oral cavity simultaneously in multiple directions to teeth and gums and the inner surfaces of cheeks and lips;
 - b) a removable ultrasound applicator head portion having at least one ultrasound transducer said ultrasound transducer radiating and coupling ultrasound pressure waves by the oral fluids in the oral cavity simultaneously in multiple directions to teeth and gums and the inner surfaces of cheeks and lips;

- c) a handle portion containing means generating ultrasonic frequency electronic current and connecting means of said electronic current to energize said ultrasound transducer located in said brush head portion or said ultrasound applicator head portion.
11. The ultrasonic toothbrush of claim 10, wherein the ultrasound pressure waves radiated by said transducer are operative to damage and reduce the effectiveness of disease causing bacteria and bacterial colonies in the oral cavity
12. The ultrasonic toothbrush of claim 10, additionally comprising a motor secured to the structure of said handle portion having means to generate orbital vibrations of said handle portion and means to couple said orbital vibrations from said handle portion to said removable brush head portion and to said removable ultrasound applicator head portion.
13. The ultrasonic toothbrush of claim 12, further comprising means to selectively generate said orbital vibrations or not to generate said orbital vibrations of said handle portion and said removable brush head portion and said removable ultrasound applicator head portion according to the desires of the user.
14. A method of treating lesions of the oral cavity by subjecting the oral flora colonizing in the said lesions to ultrasound pressure waves between 20 kHz and 20 MHz frequency operative to damage disease causing bacteria and to disrupt disease causing bacterial chains residing in said lesions.
15. The method of claim 14, wherein the treatment of said lesions is executed concurrently with a tooth-brushing regimen.
16. The method of claim 14, wherein the ultrasound pressure waves administered are between 750 kHz and 2 MHz at an intensity of 0.035 to 0.150 W/cm².
17. The method of claim 16, wherein the treatment of said lesions is executed concurrently with a tooth-brushing regimen.

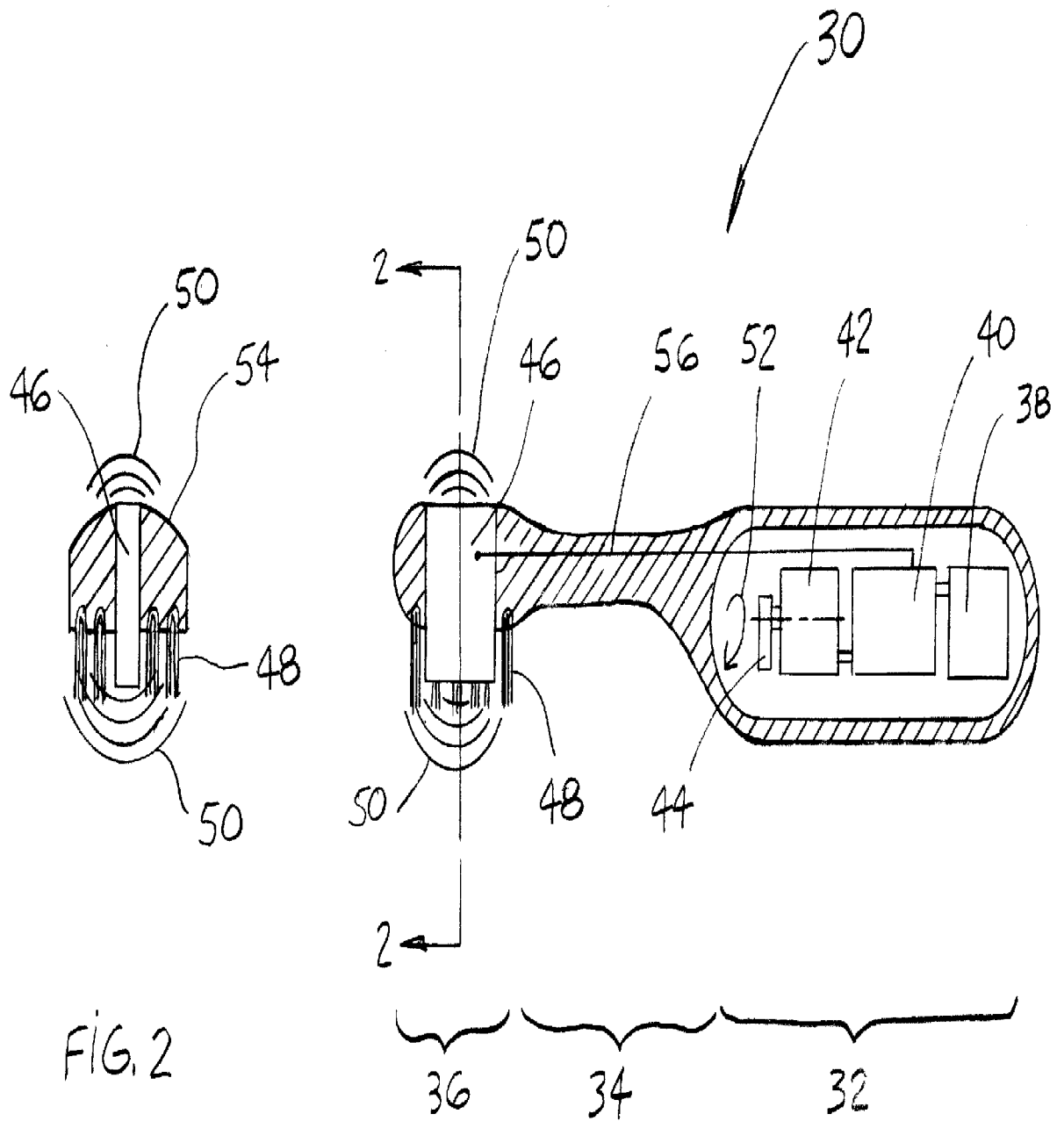


FIG. 2

FIG. 1

1/5

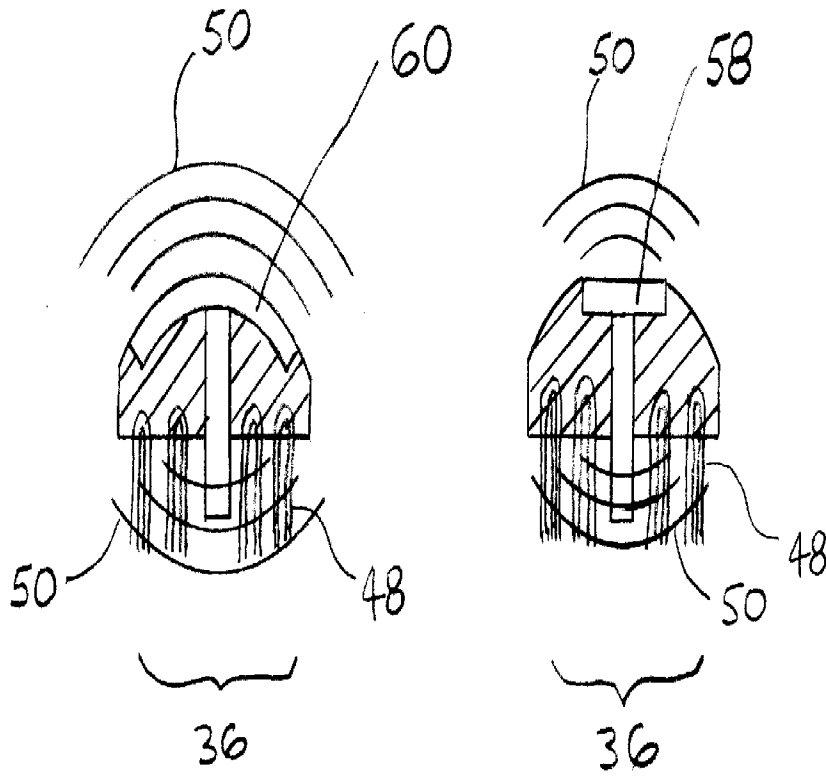


FIG. 3B

FIG. 3A

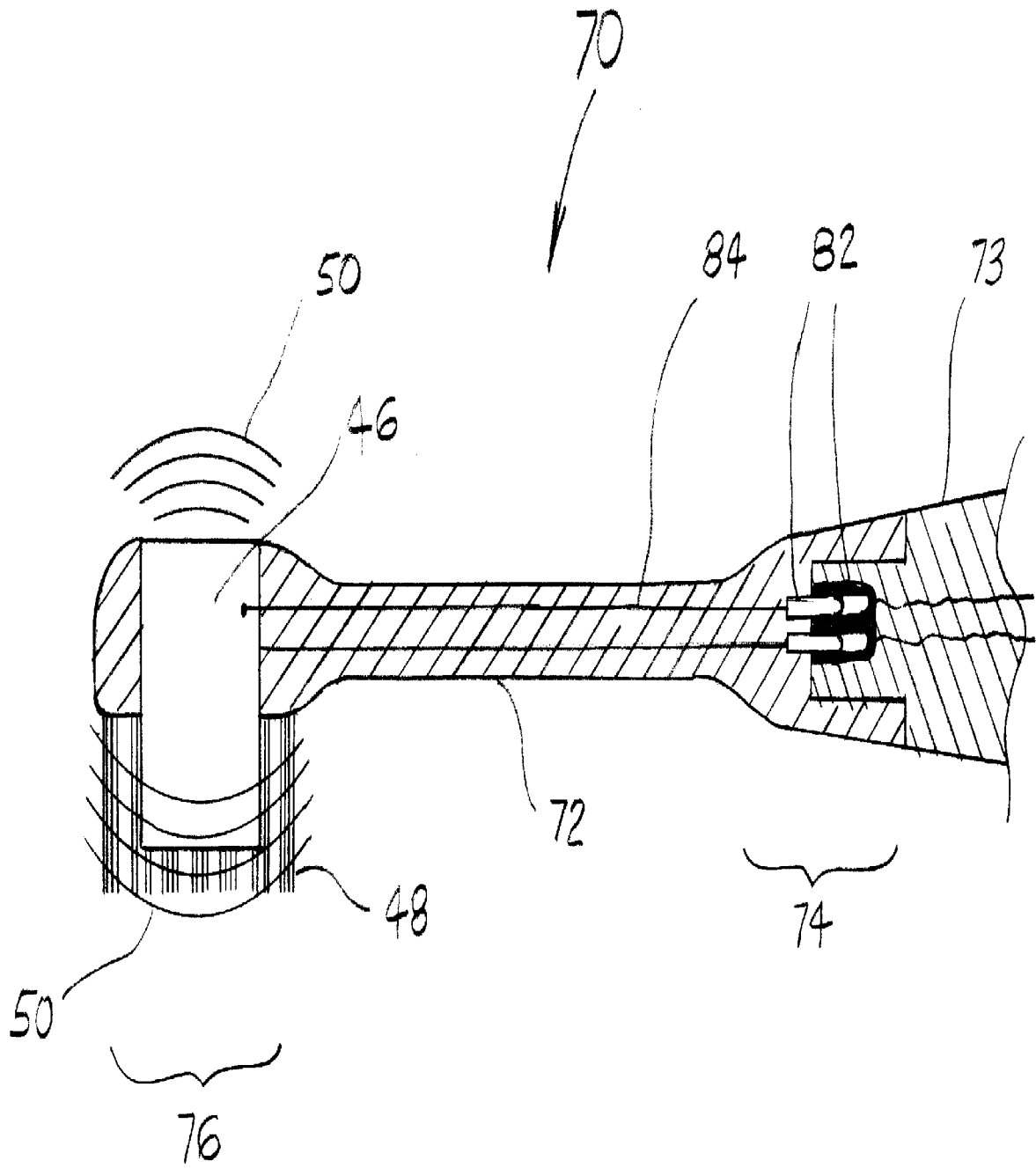


FIG. 4

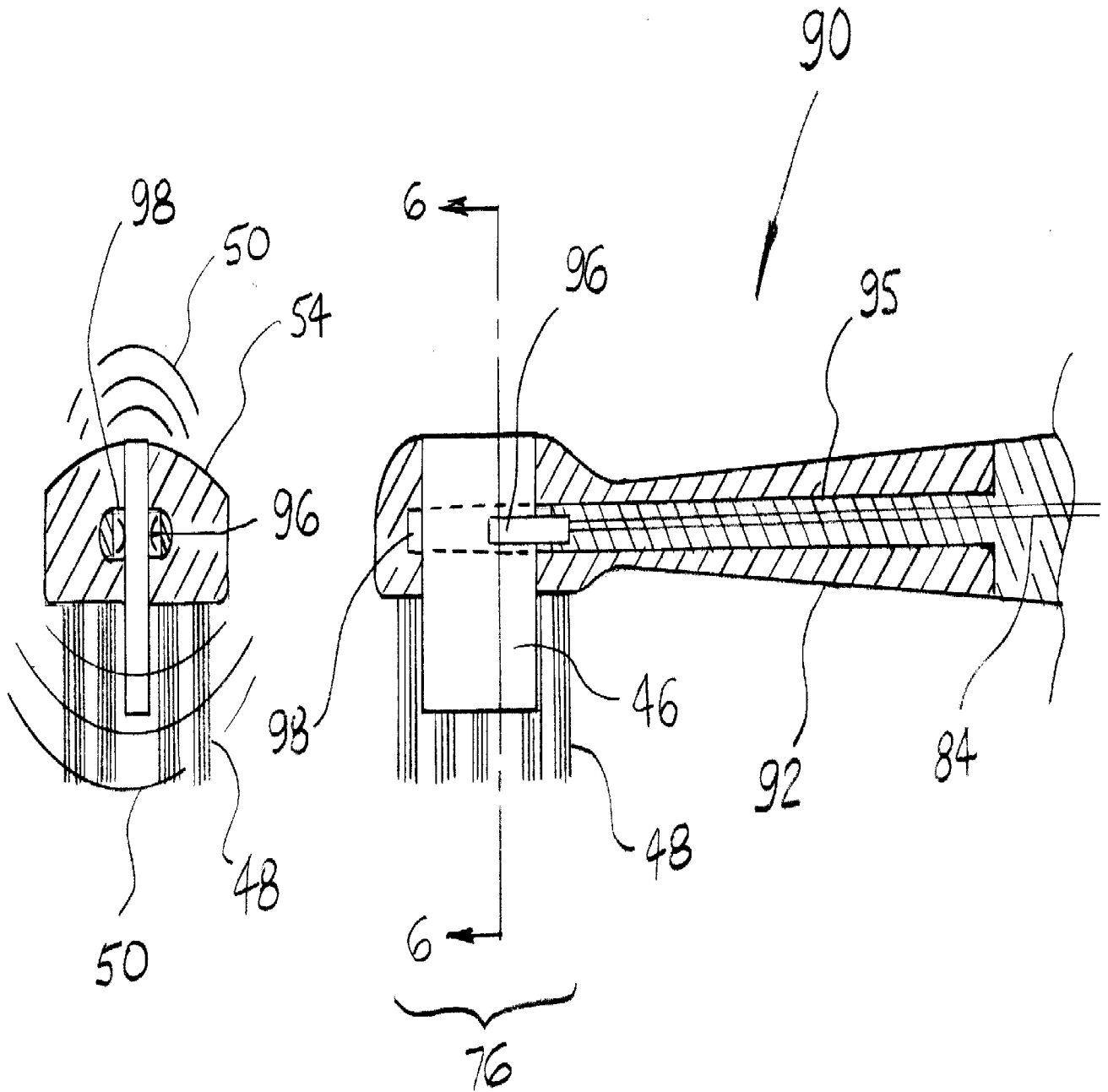


FIG. 6

FIG. 5

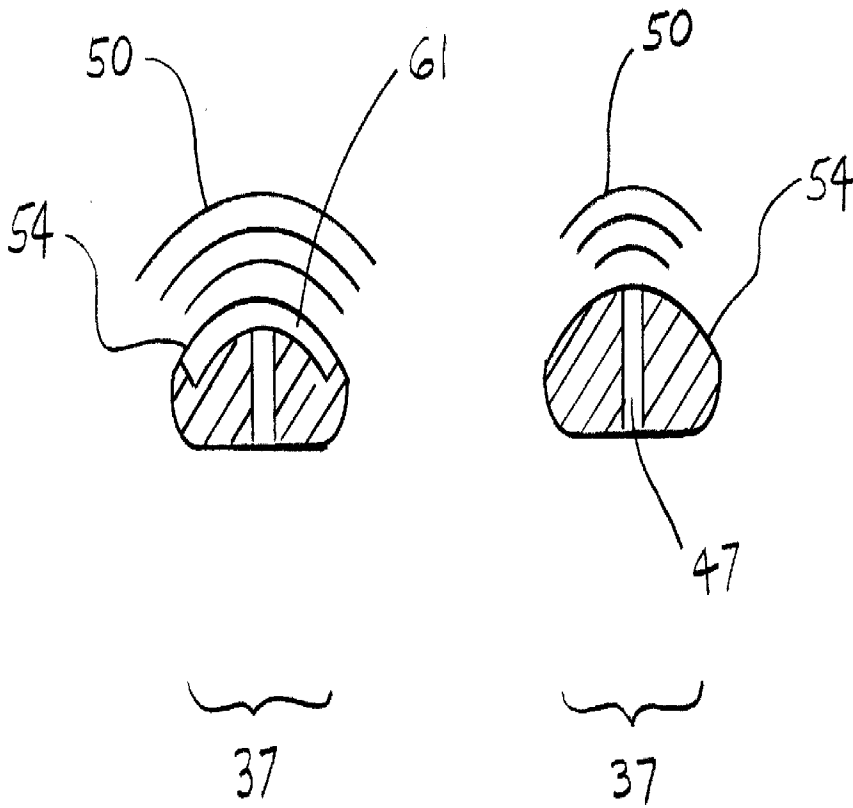


FIG. 8

FIG. 7

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2014/072095

<p>A. CLASSIFICATION OF SUBJECT MATTER IPC(8) - A61C 17/22 (2015.01) CPC - A61C 17/22 (2015.01) According to International Patent Classification (IPC) or to both national classification and IPC</p>																				
<p>B. FIELDS SEARCHED</p> <p>Minimum documentation searched (classification system followed by classification symbols) IPC(8) - A61C 17/20, 17/22, 17/24 (2015.01) CPC - A46B 7/04, 13/023, 15/0028, 2200/1066; A61C 17/20, 17/22, 17/222 (2015.01)(keyword delimited)</p> <p>Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched USPC - 15/167.1; 433/119, 216</p> <p>Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) PatBase, Google Patents, Google Scholar, Google, YouTube Search terms used: toothbrush, ultrasonic, ultrasound, removable, transducer, waves, lesion treatment, protruding</p>																				
<p>C. DOCUMENTS CONSIDERED TO BE RELEVANT</p> <table border="1"> <thead> <tr> <th>Category*</th> <th>Citation of document, with indication, where appropriate, of the relevant passages</th> <th>Relevant to claim No.</th> </tr> </thead> <tbody> <tr> <td>X — Y</td> <td>US 2009/0211041 A1 (BOCK) 27 August 2009 (27.08.2009) entire document</td> <td>1-3, 6-8, 10-13 4, 5, 9, 16, 17</td> </tr> <tr> <td>X — Y</td> <td>WO 2013/073935 A1 (KAMOSI) 23 May 2013 (23.05.2013) entire document</td> <td>14, 15 16, 17</td> </tr> <tr> <td>Y</td> <td>US 2005/0091770 A1 (MOURAD et al) 05 May 2005 (05.05.2005) entire document</td> <td>4, 5, 9</td> </tr> <tr> <td>A</td> <td>JP 2009-45345 A (SANTEC, KK et al) 05 March 2009 (05.03.2009) see machine translation</td> <td>1-17</td> </tr> <tr> <td>A</td> <td>US 2005/0050658 A1 (CHAN et al) 10 March 2005 (10.03.2005) entire document</td> <td>1-17</td> </tr> </tbody> </table> <p><input type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/></p> <p>* 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</p>			Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.	X — Y	US 2009/0211041 A1 (BOCK) 27 August 2009 (27.08.2009) entire document	1-3, 6-8, 10-13 4, 5, 9, 16, 17	X — Y	WO 2013/073935 A1 (KAMOSI) 23 May 2013 (23.05.2013) entire document	14, 15 16, 17	Y	US 2005/0091770 A1 (MOURAD et al) 05 May 2005 (05.05.2005) entire document	4, 5, 9	A	JP 2009-45345 A (SANTEC, KK et al) 05 March 2009 (05.03.2009) see machine translation	1-17	A	US 2005/0050658 A1 (CHAN et al) 10 March 2005 (10.03.2005) entire document	1-17
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<p>Date of the actual completion of the international search 02 March 2015</p>		<p>Date of mailing of the international search report 16 APR 2015</p>																		
<p>Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201</p>		<p>Authorized officer: Blaine R. Copenheaver PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774</p>																		