(54) Title: TOOTHBRUSH WITH AUTOMATIC DETECTION OF BRUSHING ANGLE
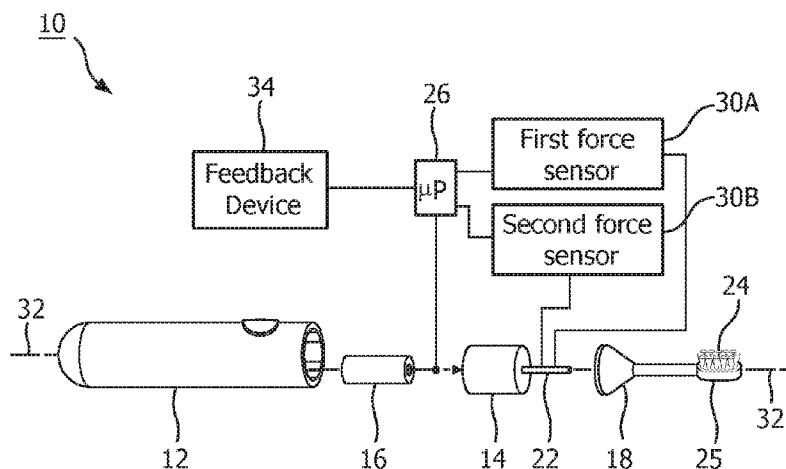
FIG. 1

(57) Abstract: A toothbrush (10) includes a brushhead (18), a first force sensor (3 OA) for measuring a first force exerted by the
brushhead at a first angle relative to a tooth and a second force sensor (3 OB) for measuring a second force exerted by the brushhead
at a second angle relative to the tooth, the second angle being different than the first angle, and a processing unit (26). The pro -
cessing unit is structured to: (i) receive first information indicative of the first force as measured by the first force sensor, (ii) receive
second information indicative of the second force as measured by the second force sensor, and (iii) determine information regarding
a current brushing angle of the brushhead based on the first information and the second information.

TOOTHBRUSH WITH AUTOMATIC DETECTION OF BRUSHING ANGLE

BACKGROUND OF THE INVENTION

1. Field of the Invention

[01]   The present invention pertains to toothbrushes, and, in particular, to a toothbrush, such as a power toothbrush, structured to detect brushing angle and provide feedback to the user based on brushing force detected at a plurality of angles.

2. Description of the Related Art

[02]   In general, power toothbrushes for cleaning teeth, including removal of plaque, are well known. Typically, power toothbrushes rely on a set of bristles which are attached to a bristle mounting plate, which in turn is moved by a driver mechanism to scrub the surfaces of teeth. Such toothbrushes, which rely on scrubbing action of the bristles for actual cleaning, typically require some amount of force to be exerted by the user against the teeth to accommodate differences in the various shapes and spacing of the teeth and to effectively clean the teeth.

[03]   Correct positioning of the bristles of a toothbrush relative to the teeth is essential for efficient plaque removal. To best remove plaque from the teeth, it is often advantageous to brush with the bristles positioned at an angle fairly perpendicular to the tooth. Trials have revealed that users regularly brush their teeth at angle far from the perpendicular. Angles of up to 70 degrees from the perpendicular are common, especially when brushing the inside of the teeth. At such extreme angles, many of the bristles are no longer in contact with the teeth (or are at an inefficient angle) and brushing is extremely inefficient.

SUMMARY OF THE INVENTION

[04]   In one embodiment, a toothbrush is provided that includes a brushhead, a first force sensor for measuring a first force exerted by the brushhead at a first angle relative to a tooth and a second force sensor for measuring a second force exerted by the brushhead at a second angle relative to the tooth, the second angle being different than the first angle, and a processing unit. The processing unit is structured to: (i) receive first information

indicative of the first force as measured by the first force sensor, (ii) receive second information indicative of the second force as measured by the second force sensor, and (iii) determine information regarding a current brushing angle of the brushhead based on the first information and the second information.

[05]   In another embodiment, a method of operating a toothbrush having a brushhead is provided. The method includes generating first information indicative of a first force exerted by the brushhead at a first angle relative to a tooth and second information indicative of a second force exerted by the brushhead at a second angle relative to the tooth, the second angle being different than the first angle, determining information regarding a current brushing angle of the brushhead based on the first information and the second information, and providing user perceptible feedback based on the determined information regarding the current brushing angle.

[06]   These and other objects, features, and characteristics of the present invention, as well as the methods of operation and functions of the related elements of structure and the combination of parts and economies of manufacture, will become more apparent upon consideration of the following description and the appended claims with reference to the accompanying drawings, all of which form a part of this specification, wherein like reference numerals designate corresponding parts in the various figures. It is to be expressly understood, however, that the drawings are for the purpose of illustration and description only and are not intended as a definition of the limits of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[07]   FIG. 1 is an exploded schematic view of a toothbrush according to an exemplary embodiment of the present invention;

[08]   FIG. 2 is a schematic diagram of the toothbrush of FIG. 1;

[09]   FIGS. 3 and 4 are schematic diagrams illustrating two alternative particular implementations of the toothbrush head of FIGS. 1 and 2; and

[10]   FIG. 5 is a flowchart illustrating operation of the toothbrush of FIGS. 1 and 2 according to one exemplary embodiment.

DETAILED DESCRIPTION OF EXEMPLARY EMBODIMENTS

[11]   As used herein, the singular form of "a", "an", and "the" include plural references unless the context clearly dictates otherwise. As used herein, the statement that two or more parts or components are "coupled" shall mean that the parts are joined or operate together either directly or indirectly, i.e., through one or more intermediate parts or components, so long as a link occurs. As used herein, "directly coupled" means that two elements are directly in contact with each other. As used herein, "fixedly coupled" or "fixed" means that two components are coupled so as to move as one while maintaining a constant orientation relative to each other.

[12]   As used herein, the word "unitary" means a component is created as a single piece or unit. That is, a component that includes pieces that are created separately and then coupled together as a unit is not a "unitary" component or body. As employed herein, the statement that two or more parts or components "engage" one another shall mean that the parts exert a force against one another either directly or through one or more intermediate parts or components. As employed herein, the term "number" shall mean one or an integer greater than one (i.e., a plurality).

[13]   As used herein, "substantially perpendicular" shall mean at an angle of 90 degrees ± 5 degrees.

[14]   As used herein, "substantially parallel" shall mean at an angle of 0 degrees ± 5 degrees.

[15]   Directional phrases used herein, such as, for example and without limitation, top, bottom, left, right, upper, lower, front, back, and derivatives thereof, relate to the orientation of the elements shown in the drawings and are not limiting upon the claims unless expressly recited therein.

[16]   FIG. 1 is an exploded schematic view of and FIG. 2 is a schematic diagram of a power toothbrush 10 according to an exemplary embodiment of the present invention. As described in detail herein, toothbrush 10 is structured to detect brushing force at a plurality of angles which, unlike prior art toothbrushes that may have a single force sensor, allows for the brushhead angle, and thus the brushing angle, to be derived. Toothbrush 10

includes a handle portion 12 and a DC motor 14 which is powered by a battery 16. Motor 14 provides the driving action for a brushhead 18, which in turn is removably mounted on a motor driveshaft 22. It should be understood, however, that various alternative driving action arrangements may be used in a power toothbrush which incorporates the concept disclosed herein. The illustration of a DC motor in the exemplary embodiment is only one of several possible motor systems.

[17]   Brushhead 18 includes a set of bristles 24 mounted on a bristle back member 25 which together define the bristle portion of brushhead 18. Bristles 24 accomplish cleaning through an oscillatory action provided to brushhead 18 by motor 14. The operation of motor 14 is controlled by a processing unit 26, which is a common component of power toothbrushes. Processing unit 26 may be, for example and without limitation, a microprocessor, a microcontroller, or any other suitable processing device and may include a suitable memory for storing routines executed by processing unit 26.

[18]   As seen in FIGS. 1 and 2, in the exemplary embodiment, handle portion 12 includes a first force sensor 30A for measuring the brushing force exerted by brushhead 18 against the teeth during use of toothbrush 10 at a first angle relative to a longitudinal axis 32 of toothbrush 10 and a longitudinal axis 36 of bristles 24 (as indicated by arrow in FIG. 2), and a second force sensor 30B for measuring the brushing force exerted by brushhead 18 against the teeth during use of toothbrush 10 at a second angle relative to the longitudinal axis 32 of toothbrush 10 and longitudinal axis 36 of bristles 24(different than the first axis). In the exemplary embodiment, first force sensor 30A and second source sensor 30B are located adjacent to motor 14 and are structured to measure the force on driveshaft 22. Thus, first force sensor 30A and second source sensor 30B are structured and positioned to measure brushing forces at two different angles. For example, first force sensor 30A may be structured and positioned to measure brushing force at an angle that is substantially perpendicular to the longitudinal axis 32 of toothbrush 10 and substantially parallel to the longitudinal axis 36 of bristles 24 and second force sensor 30B may be structured and positioned to measure brushing force at an angle that is substantially parallel to the longitudinal axis 32 and substantially perpendicular to the longitudinal axis

36 of bristles 24. It will be appreciated, however, that this configuration is meant to be exemplary only, and that alternative angles for each force sensor 30A and 30B are also possible within the scope of the concept disclosed herein. A number of exemplary alternative configurations for force sensors 30A and 30B are described in detail elsewhere herein. In addition, as seen in FIGS. 1 and 2, first force sensor 30A and second force sensor 30B are each operatively coupled to processing unit 26 and provide a signal to processing unit 26 indicative of the force measured thereby. In an alternative embodiment, force sensors 30A and 30B may be located in brushhead 18. However, as will be appreciated, the former configuration wherein force sensors 30A and 30B are located within handle portion 12 will help to keep the cost of brushhead 18 down and will avoid interconnection issues across the pluggable interface between brushhead 18 and handle portion 12.

[19]   First force sensor 30A and second force sensor 30B may be any of a number of known or hereafter developed suitable sensing devices for sensing the force exerted by brushhead 18. For example, and without limitation, first force sensor 30A and second force sensor 30B may each be a strain gauge structured to directly measure the brushing force or a sensor, such as a magnetic (Hall) sensor, which indirectly measures the brushing force by measuring the displacement of brushhead 18 and/or motor driveshaft 22.

[20]   The measured force values generated by first force sensor 30A and second force sensor 30B are provided to processing unit 26. Furthermore, as seen in FIGS. 1 and 2, handle portion 12 also includes a feedback device 34 that is coupled to processing unit 26. As described in greater detail herein, during use of toothbrush 10, feedback device 34 is structured to provide user perceptible feedback regarding the brushing angle with respect to the tooth surfaces (i.e., the brushing angle at which bristles 24 are positioned) that the user is employing at any particular time. The user perceptible feedback generated by feedback device 34 is designed to encourage the user to brush at a favorable brushing angle. A number of manners in which the brushing angle and or feedback may be determined and/or provided are described in detail herein. Feedback device 34 may be an audible feedback device, such as a speaker, that is structured to generate an audible

feedback signal under the control of processing unit 26. Alternatively, feedback device 34 may be a visual feedback device, such as one or more LEDs, that is/are structured to generate a visual feedback signal under the control of processing unit 26. In still another alternative embodiment, the feedback may be implemented by processing unit 26 modifying the motor drive mode of motor 14 to give a different sensation in the user's mouth, such as a lowered amplitude, a pulsing of the motor 14, or some other alternation of the motor vibration. Such a feedback mechanism may be more easily perceived by the user.

[21]   FIG. 5 is a flowchart illustrating a method of operation of toothbrush 10 according to an exemplary embodiment of the disclosed concept wherein a determination of current brushing angle is made/derived based upon brushing forces that are measured at two or more different angles and wherein, in response thereto, feedback is provided to the user of toothbrush 10 in order to encourage a preferred brushing angle. The method begins at step 40, wherein a first brushing force is measured at a first angle by first force sensor 30A (referred to herein as F_1). Then, at step 42, a second brushing force is measured at a second angle different than the first angle by second force sensor 30B (referred to herein as F_2). The first and second brushing forces measured at step 40 and 42 are provided to processing unit 26. Next, at step 44, processing unit 26 makes a determination regarding the current brushing angle based on the first and second brushing forces that were measured at step 40 and 42. In the exemplary embodiment, the determination made at step 44 is a determination as to the degree to which the brushing angle is something other than substantially perpendicular to the surface of the teeth (i.e., the degree of rotation of brushhead 18 and in particular bristles 24 and bristle back member 25 about longitudinal axis 32 during brushing). For example, and without limitation, step 44 may involve determining whether, based on the first and second brushing forces, the brushing angle is within an ideal range, a non-ideal yet still acceptable range, or an unacceptable range. As another, simpler example, step 44 may involve determining whether the brushing angle is above or below a suitable predetermined threshold for acceptable angle. Still other examples are within the scope of the disclosed

concept. Finally, at step 46, processing unit 26 causes a user perceptible feedback to be generated through feedback device 34 based on the determination made in step 44. For example, and without limitation, the user perceptible feedback may be causing a particularly colored LED or LEDs forming part of feedback device 34 to be lit and/or may be causing an audible signal of a particular nature to be generated feedback device 34 (for instance, a buzzing sound may be generated in the case where the brushing angle is determined to be in an unacceptable range and/or below a suitable predetermined threshold).

[22]   A number of non-limiting, exemplary implementations of the method of FIG. 5 will now be described in detail. It will be understood, however, that the implementations described below are meant to be exemplary only and thus are not to be considered limiting.

[23]   In a first exemplary implementation, first force sensor 30A is structured to measure a force F_1 at a first angle that is substantially perpendicular to the longitudinal axis 32 and substantially parallel to the longitudinal axis 36 of bristles 24 and second force sensor 30B is structured to measure a force F_2 at a second angle that is substantially parallel to longitudinal axis 32 and substantially perpendicular to the longitudinal axis 36 of bristles 24. In this exemplary implementation, the determination regarding current brushing angle can be made using the case analysis shown in TABLE 1 below, wherein F_T is a typical brushing force of the user of, for example and without limitation, 1-3N

Use Case	F_1 value	F_2 value	Determination regarding current brushing angle
Case 1	F_T	0	Brushing is perpendicular to the tooth surface – Ideal brushing
Case 2	$\sim F_T$	> 0	Brushing is not perpendicular to the tooth surface – Non ideal but still acceptable brushing
Case 3	$< F_T$	$\gg 0$	Brushing is not perpendicular to the

			tooth surface – Less than acceptable (i.e., inefficient) brushing
Case 4	$<< F_T$	F2 >>>0	Brushing is at a very high angle to the tooth surface – Very inefficient brushing

TABLE 1

[24]   Based on the case analysis described above, if processing unit 26 determines that the current brushing of the user falls within Case 3 or Case 4, and thus that the brushing angle is unfavorable and/or unacceptable, then processing unit 26 will, in the exemplary embodiment, cause feedback device 34 to provide a corrective signal to the user, such as an alarm sound or a light of a particular color, in order to encourage the user to brush at a better angle.

[25]   In the case analysis described above, the proposed figure of merit is the ratio of the measured forces $F_1/(F_1 + F_2)$. Thus, the case analysis described above may, in one particular embodiment, be implemented based on the information/formulas provided in TABLE 2 below.

$F_1/(F_1+F_2)$ Ratio	Determination regarding current brushing angle
$F_1/(F_1+F_2) > \text{Threshold}_1$	ideal brushing (green LED lit)
$\text{Threshold}_2 \leq F_1/(F_1+F_2) \leq \text{Threshold}_1$	non-ideal brushing (orange LED lit)
$F_1/(F_1+F_2) < \text{Threshold}_2$	bad brushing (red LED lit)

TABLE 2

[26]   In one particular, non-limiting embodiment, $\text{Threshold}_1 = 0.8$ and $\text{Threshold}_2 = 0.5$. In a simplified example, the case analysis described above may be implemented based upon and using a single feedback formula as follows: if $F_1/(F_1+F_2) < \text{Threshold}_3$: bad brushing (red LED lit and/or buzzer sound activated); otherwise brushing angle acceptable. In one particular, non-limiting embodiment, $\text{Threshold}_3 = 0.65$.

[27]   In a second exemplary implementation of toothbrush 10, shown schematically in FIG. 3, first force sensor 30A is structured to measure a force F_1 at a first angle that is substantially perpendicular to the longitudinal axis 32 and substantially parallel to the longitudinal axis 36 of bristles 24 and second force sensor 30B is structured to measure a force F_2 at a second angle that is substantially perpendicular to the longitudinal axis 36 of bristles 24 and that is at an angle α_1 that is not substantially perpendicular to longitudinal axis 32 (as demonstrated in FIG. 3). In this second alternative exemplary implementation, a reduction factor of about the cosine of α_1 is applied and the case analysis described herein may be implemented based on the information/formulas provided in TABLE 3 below.

$F_1/(F_1+F_2/\cos \alpha_1)$ Ratio	Determination regarding current brushing angle
$F_1/(F_1+F_2/\cos \alpha_1) > \text{Threshold}_1$	ideal brushing (green LED lit)
$\text{Threshold}_2 \leq F_1/(F_1+F_2/\cos \alpha_1) \leq \text{Threshold}_1$	non-ideal brushing (orange LED lit)
$F_1/(F_1+F_2/\cos \alpha_1) < \text{Threshold}_2$	bad brushing (red LED lit)

TABLE 3

[28]   In a simplified example, the case analysis in this alternative may be implemented based upon and using the single feedback formula as follows: if $F_1/(F_1+F_2/\cos \alpha_1) < \text{Threshold}_3$: bad brushing (red LED lit and/or buzzer sound activated); otherwise brushing angle acceptable.

[29]   In a third exemplary implementation of toothbrush 10, shown schematically in FIG. 4, first force sensor 30A is structured to measure a force F_1 at a first angle that is substantially perpendicular to the longitudinal axis 32 and substantially parallel to the longitudinal 36 axis of bristles 24 and second force sensor 30B is structured to measure a force F_2 at a second angle that is at an angle α_2 that is not substantially perpendicular to the longitudinal axis 36 of bristles 24 and that is substantially perpendicular to longitudinal axis 32 (as demonstrated in FIG. 4). In this third alternative exemplary implementation, a

reduction factor of about the sine of α_2 is applied and the case analysis described herein may be implemented based on the information/formulas provided in TABLE 4 below.

$F_1/(F_1+F_2/\sin\alpha_1)$ Ratio	Determination regarding current brushing angle
$F_1/(F_1+F_2/\sin\alpha_2) >$ Threshold$_1$	ideal brushing (green LED lit)
Threshold$_2 \leq F_1/(F_1+F_2/\sin\alpha_2) \leq$ Threshold$_1$	non-ideal brushing (orange LED lit)
$F_1/(F_1+F_2/\sin\alpha_2) <$ Threshold$_2$	bad brushing (red LED lit)

TABLE 4

[30]   In a simplified example, the case analysis in this alternative may be implemented based upon and using the single feedback formula as follows:

$F_1/(F_1+F_2/\sin\alpha_2) <$ Threshold$_3$: bad brushing (red LED lit and/or buzzer sound activated); otherwise brushing angle acceptable.

[31]   In a fourth exemplary implementation, first force sensor 30A and second force sensor 30B are both positioned at angles that are not substantially perpendicular to longitudinal axis 36 of bristles 24. In this case, it may be advantageous if both first and second force sensors 30A and 30B have the same angle relative to longitudinal axis 36 of bristles 24. The force measured by each of the first and second force sensors 30A and 30B will be substantially equal (i.e., the normalized signal $(F_1-F_2)/(F_1+F_2) \sim 0$) if the user is brushing substantially perpendicular to the tooth (ideal case),   whilst the brushing angle will increase (i.e. become less ideal) as the absolute value of the normalize force difference $(F_1-F_2)/(F_1+F_2)$ between the sensors increases. Thus, in this embodiment, feedback may be generated which indicates a poor brushing angle (e.g., red LED lit and/or buzzer sound activated) when the absolute value of the force difference (F_1-F_2) exceeds some predetermined threshold value. In an alternate embodiment, a different feedback signal (e.g., green LED lit and/or alternative, positive buzzer sound activated) indicating a good brushing angle may be provided when the absolute value of the force difference $(F_1-F_2)/(F_1+F_2)$ is less than or equal to the predetermined threshold value. It is mentioned that in this case also multiple threshold values can be used, such that e.g. green, orange or red feedback can be given.

[32]   Furthermore, in the first, second, third and fourth implementations just described, it may be advantageous for the relevant figure of merit to only be judged at absolute force levels above a certain threshold value of, for example and without limitation, 0.25N. Otherwise, feedback may be given when the brushhead 18 is not really in contact with the teeth.

[33]   Moreover, when the brushing action of toothbrush 10 is primarily on the teeth, the readings of first force sensor 30A and second force sensor 30B will, as described herein, provide a good indication of the current brushing angle. However, when the brushing action of toothbrush 10 is on the gum line, readings from first force sensor 30A and second force sensor 30B may nonetheless falsely indicate ideal brushing angles (e.g., $F_1/F_2 > 0.8$) because the position of toothbrush 10 on the gums may yield a dominant signal from the first force sensor 30A (F_1) due to the gum orientation. According to one exemplary, non-limiting particular implementation, this issue may be overcome by employing the concept disclosed herein in combination with the concept described in WO 2014/097242, entitled "Plaque Detection Using A Stream Probe," owned by the assignee of the present invention, the disclosure of which is incorporated herein by reference. In particular, WO 2014/097242 describes a system wherein signals from a stream probe may be used to obtain information indicating that a brushhead is on the gums. Using this information, more optimized feedback of brushhead orientation according to the concept disclosed herein may be provided. In particular, an indication that brushhead 18 is positioned on the gums obtained in the manner described in WO 2014/097242 may be used as a check for situations wherein readings from first force sensor 30A and second force sensor 30B indicate ideal brushing angles, such that if such readings indicate ideal brushing angles yet it is determined that brushhead 18 is on the gums, feedback indicating ideal brushing angles will not be provided.

[34]   Thus, toothbrush 10 shown in FIGS. 1 and 2 and the method of operation shown in FIG. 3 provide a system wherein users may be automatically encouraged to employ preferred brushing angles to increase brushing effectiveness and efficiency.

[35]   In the claims, any reference signs placed between parentheses shall not be construed as limiting the claim. The word "comprising" or "including" does not exclude the presence of elements or steps other than those listed in a claim. In a device claim enumerating several means, several of these means may be embodied by one and the same item of hardware. The word "a" or "an" preceding an element does not exclude the presence of a plurality of such elements. In any device claim enumerating several means, several of these means may be embodied by one and the same item of hardware. The mere fact that certain elements are recited in mutually different dependent claims does not indicate that these elements cannot be used in combination.

[36]   Although the invention has been described in detail for the purpose of illustration based on what is currently considered to be the most practical and preferred embodiments, it is to be understood that such detail is solely for that purpose and that the invention is not limited to the disclosed embodiments, but, on the contrary, is intended to cover modifications and equivalent arrangements that are within the spirit and scope of the appended claims. For example, it is to be understood that the present invention contemplates that, to the extent possible, one or more features of any embodiment can be combined with one or more features of any other embodiment.

What is Claimed is:

1.   A toothbrush (10), comprising:

a brushhead (18);

a first force sensor (30A) for measuring a first force exerted by the brushhead at a first angle relative to a tooth and a second force sensor (30B) for measuring a second force exerted by the brushhead at a second angle relative to the tooth, the second angle being different than the first angle; and

a processing unit (26), the processing unit being structured to: (i) receive first information indicative of the first force as measured by the first force sensor, (ii) receive second information indicative of the second force as measured by the second force sensor, and (iii) determine information regarding a current brushing angle of the brushhead based on the first information and the second information.

2.   A toothbrush according to claim 1, wherein the processing unit is structured to cause user perceptible feedback to be provided to a feedback device (34) based on the determined information regarding the current brushing angle.

3.   A toothbrush according to claim 2, wherein the feedback device is structured to provide at least one of an audible output, a tactile output and a visual output.

4.   A toothbrush according to claim 1, wherein the toothbrush has a first longitudinal axis (32), wherein the brushhead has a plurality of bristles (24) each extending in a direction parallel to a second longitudinal axis (36) substantially perpendicular to the first longitudinal axis, wherein the first angle is substantially perpendicular to the first longitudinal axis and substantially parallel to the second longitudinal axis and the second angle is substantially parallel to first longitudinal axis and substantially perpendicular to the second longitudinal axis, and wherein the processing unit is structured to determine the

information regarding the current brushing angle by comparing a ratio based on the first information and the second information to one or more predetermined threshold values.

5.   A toothbrush according to claim 1, wherein the toothbrush has a first longitudinal axis (32), wherein the brushhead has a plurality of bristles (24) each extending in a direction parallel to a second longitudinal axis (36) substantially perpendicular to the first longitudinal axis, wherein the first angle is substantially perpendicular to the first longitudinal axis and substantially parallel to the second longitudinal axis and the second angle that is substantially perpendicular to the second longitudinal axis and is at an angle α_1 that is not substantially perpendicular to first longitudinal axis, wherein the first information is F_1 and the second information is F_2, and wherein the processing unit is structured to determine the information regarding the current brushing angle by comparing a ratio equal to $F_1/(F_1+F_2/\cos \alpha_1)$ to one or more predetermined values.

6.   A toothbrush according to claim 1, wherein the toothbrush has a first longitudinal axis (32), wherein the brushhead has a plurality of bristles (24) each extending in a direction parallel to a second longitudinal axis (36) substantially perpendicular to the first longitudinal axis, wherein the first angle is substantially perpendicular to the first longitudinal axis and substantially parallel to the second longitudinal axis and the second angle is substantially perpendicular to first longitudinal axis and is at an angle α_2 that is not substantially parallel to the second longitudinal axis, wherein the first information is F_1 and the second information is F_2, and wherein the processing unit is structured to determine the information regarding the current brushing angle by comparing a ratio equal to $F_1/(F_1+F_2/\sin \alpha_2)$ to one or more predetermined values.

7. A toothbrush according to claim 1, wherein the toothbrush has a first longitudinal axis (32), wherein the brushhead has a plurality of bristles (24) each extending in a direction parallel to a second longitudinal axis (36) substantially perpendicular to the first longitudinal axis, wherein the first angle and the second angle are both not

substantially perpendicular to the second longitudinal axis, wherein the first information is F_1 and the second information is F_2, and wherein the processing unit is structured to cause user perceptible feedback to be provided based on at least one of (i) an absolute value of a force difference (F_1-F_2), and (ii) an absolute value of a force difference $(F_1-F_2)/(F_1+F_2)$.

8.   A toothbrush according to claim 1, wherein the processing unit is structured to determine the information regarding the current brushing angle based on a ratio including the first information and the second information, wherein the processing unit is structured to determine the information regarding the current brushing angle based on the ratio by comparing the ratio to one or more predetermined threshold values only when at least one of the first information and the second information exceeds a second predetermined threshold value.

9.   A method of operating a toothbrush (10) having a brushhead (18), comprising:
            generating first information indicative of a first force exerted by the brushhead at a first angle relative to a tooth and second information indicative of a second force exerted by the brushhead at a second angle relative to the tooth, the second angle being different than the first angle;
            determining information regarding a current brushing angle of the brushhead based on the first information and the second information; and
            providing user perceptible feedback based on the determined information regarding the current brushing angle.

10.   A method according to claim 9, wherein the toothbrush has a first longitudinal axis (32), wherein the brushhead has a plurality of bristles (24) each extending in a direction parallel to a second longitudinal axis (36) substantially perpendicular to the first longitudinal axis, wherein the first angle is substantially perpendicular to the first longitudinal axis and substantially parallel to the second longitudinal axis and the second

angle is substantially perpendicular to first longitudinal axis and substantially perpendicular to the second longitudinal axis, and wherein the method includes determining the information regarding the current brushing angle by comparing a ratio of the first information to the second information to one or more predetermined threshold values.

11.   A method according to claim 9, wherein the toothbrush has a first longitudinal axis (32), wherein the brushhead has a plurality of bristles (24) each extending in a direction parallel to a second longitudinal axis (36) substantially perpendicular to the first longitudinal axis, wherein the first angle is substantially perpendicular to the first longitudinal axis and substantially parallel to the second longitudinal axis and the second angle that is substantially perpendicular to the second longitudinal axis and is at an angle α_1 that is not substantially perpendicular to first longitudinal axis, wherein the first information is F_1 and the second information is F_2, and wherein the method includes determining the information regarding the current brushing angle by comparing a ratio equal to $F_1/(F_1+F_2/\cos \alpha_1)$ to one or more predetermined threshold values.

12.   A method according to claim 9, wherein the toothbrush has a first longitudinal axis (32), wherein the brushhead has a plurality of bristles (24) each extending in a direction parallel to a second longitudinal axis (36) substantially perpendicular to the first longitudinal axis, wherein the first angle is substantially perpendicular to the first longitudinal axis and substantially parallel to the second longitudinal axis and the second angle is substantially perpendicular to second longitudinal axis and is at an angle α_2 that is not substantially perpendicular to the first longitudinal axis, wherein the first information is F_1 and the second information is F_2, and wherein the method includes determining the information regarding the current brushing angle by comparing a ratio equal to $F_1/(F_1+F_2/\sin \alpha_2)$ to one or more predetermined threshold values.

13.   A method according to claim 9, wherein the toothbrush has a first longitudinal axis (32), wherein the brushhead has a plurality of bristles (24) each extending

in a direction parallel to a second longitudinal axis (36) substantially perpendicular to the first longitudinal axis, wherein the first angle and the second angle are both not substantially perpendicular to the second longitudinal axis, wherein the first information is F_1 and the second information is F_2, and wherein the providing user perceptible feedback is based on at least one of (i) an absolute value of a force difference (F_1-F_2), and (ii) an absolute value of a force difference $(F_1-F_2)/(F_1+F_2)$..

14. A method according to claim 9, further comprising detecting that the brushhead is positioned on the gums of a user, wherein the providing the user perceptible feedback is also based on the detecting that the brushhead is positioned on the gums of the user.

1/3

FIG. 1

FIG. 2

2/3

FIG. 3

FIG. 4

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┌─────────────────────────────┐
│      Measure first brushing  │── 40
│      force at first angle    │
└─────────────────────────────┘
              │
              ▼
┌─────────────────────────────┐
│     Measure second brushing  │── 42
│      force at second angle   │
└─────────────────────────────┘
              │
              ▼
┌──────────────────────────────────────┐
│  Make determination regarding current │
│   brushing angle based on the         │── 44
│   brushing forces at the              │
│       first and second angles         │
└──────────────────────────────────────┘
              │
              ▼
┌──────────────────────────────────────┐
│  Generate user perceptible feedback   │
│   based on the determination          │── 46
│   regarding current                   │
│       brushing angle                  │
└──────────────────────────────────────┘
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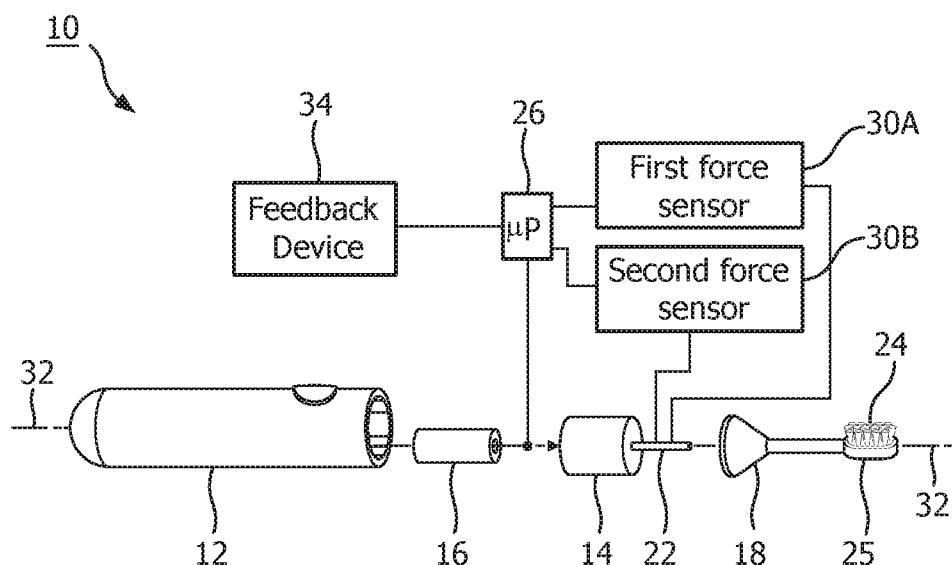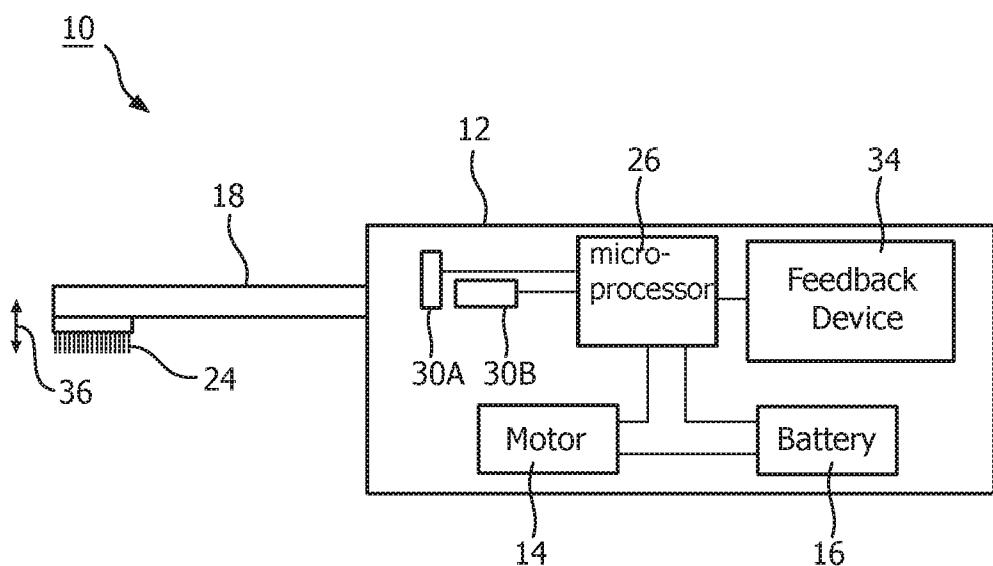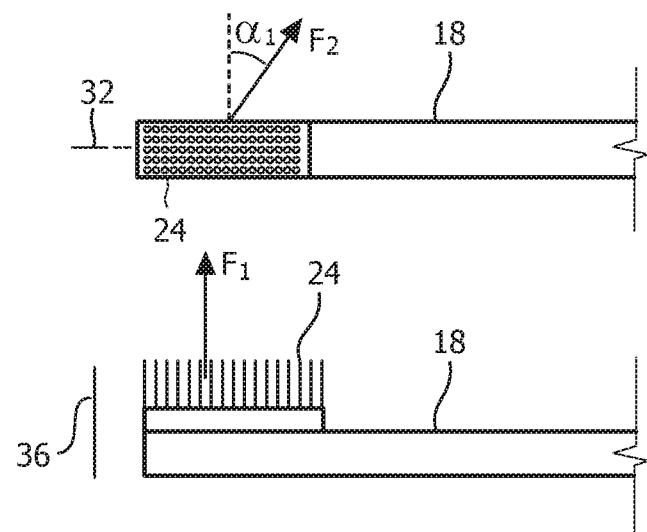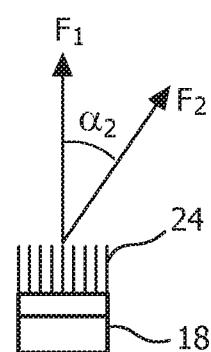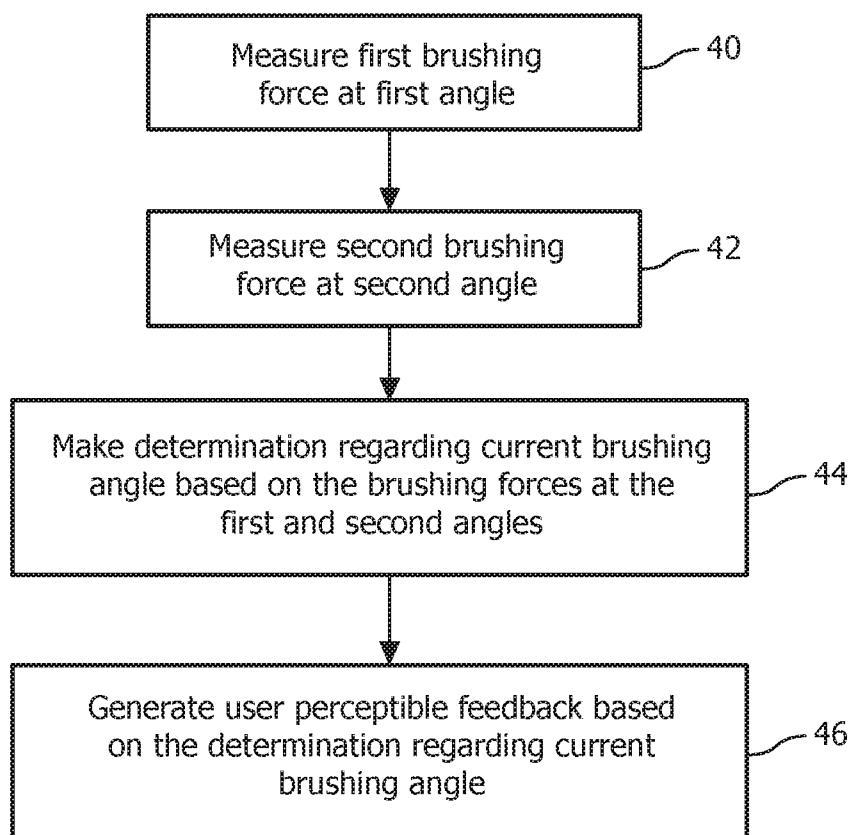
FIG. 5

INTERNATIONAL SEARCH REPORT

	International application No
	PCT/IB2015/057613

A. CLASSIFICATION OF SUBJECT MATTER

INV. A61C17/16   A61C17/22
ADD.

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)

A61C

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

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

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 02/15742 A2 (KONINKL PHILIPS ELECTRONICS NV [NL]) 28 February 2002 (2002-02-28) figures 4-6 page 7, line 16 - page 8, line 2 page 8, line 14 - line 31 -----	1-3
X	US 6 536 068 B1 (YANG ANDY [US] ET AL) 25 March 2003 (2003-03-25) column 5, line 53 - column 7, line 5; figures 1, 7c -----	1-3
A	US 5 493 747 A (INAKAGATA SATORU [JP] ET AL) 27 February 1996 (1996-02-27) the whole document -----	1-8
A	DE 195 06 129 A1 (GIMELLI & CO AG [CH]) 29 August 1996 (1996-08-29) the whole document -----	1-8

☐ 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	Date of mailing of the international search report
12 January 2016	20/01/2016

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Schmidt, Karsten

Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

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. [X] Claims Nos.: **9-14**
because they relate to subject matter not required to be searched by this Authority, namely:

> Rule 39.1(iv) PCT - Method for treatment of the human or animal body by therapy

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:

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 an 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

Information on patent family members

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