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(54) **POSITION SENSING TOOTHBRUSH**

Related U.S. Application Data

(75) Inventors: **Johannes Hotze Bernhard De Vries**, Haren (NL); **Evert Alle Helfrich**, Seattle, WA (US); **Pieter Johannes Bax**, Drachten (NL); **Chad Brinckerhoff**, Issaquah, WA (US); **Sandor Gordijn**, Mierlo (NL); **Theo Anjes Maria Ruijl**, Oirschot (NL)

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(57) **ABSTRACT**

(73) Assignee: **KONINKLIJKE PHILIPS ELECTRONICS N.V.**, EINDHOVEN (NL)

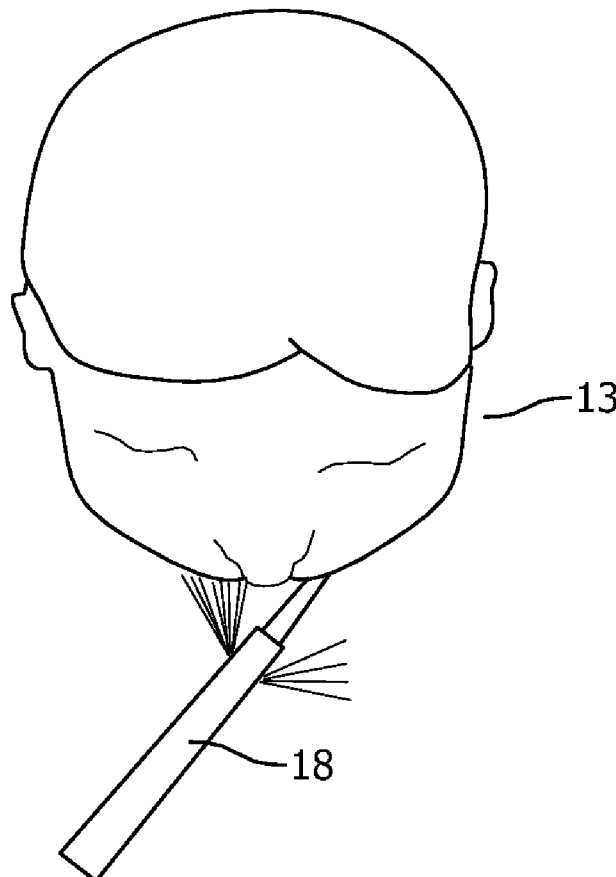
The toothbrush includes a handle portion (12 or 55) and a brushhead portion (14 or 57) with a bristle set (20 or 53) at one end of the brushhead. At least one sensor (16 or 56) is located either on the handle of the toothbrush or on the bristle set back plate (54) of the toothbrush. When the sensor is located on the handle of the toothbrush, the position of the brushhead is determined by a processor (44 or 58) relative to the inside or outside surfaces of the teeth on the basis of the temperature detected by the sensor, either the outside environmental temperature or the skin temperature of the user. When the sensor is located on the bristle set back plate, the determination is made on the basis of the position of the bristle set relative to the cheek of the user.

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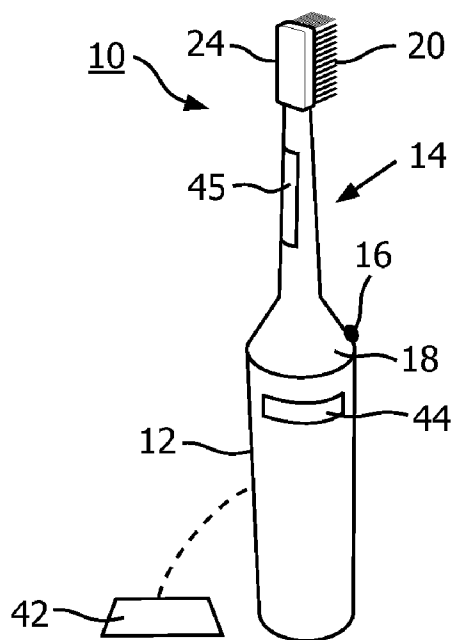


FIG. 1

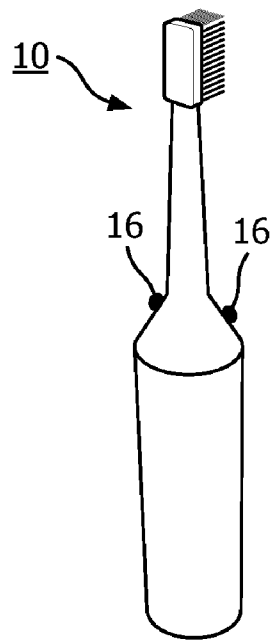


FIG. 2

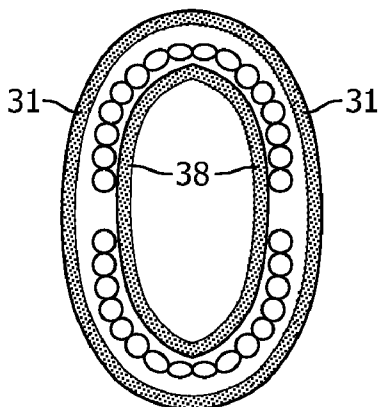


FIG. 3

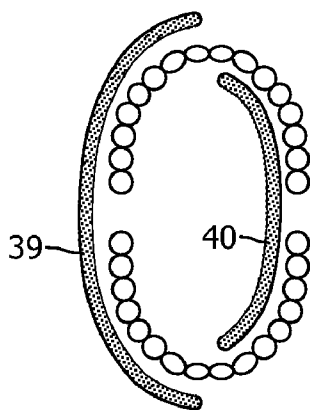


FIG. 4

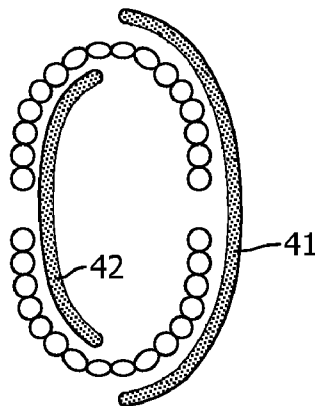


FIG. 5

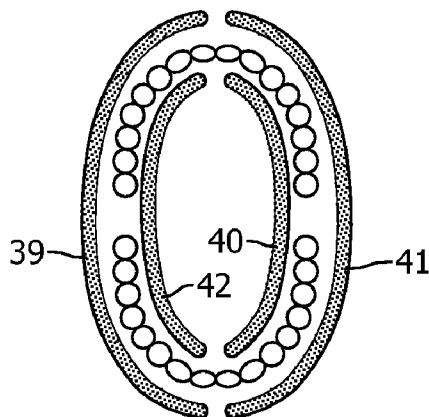


FIG. 6

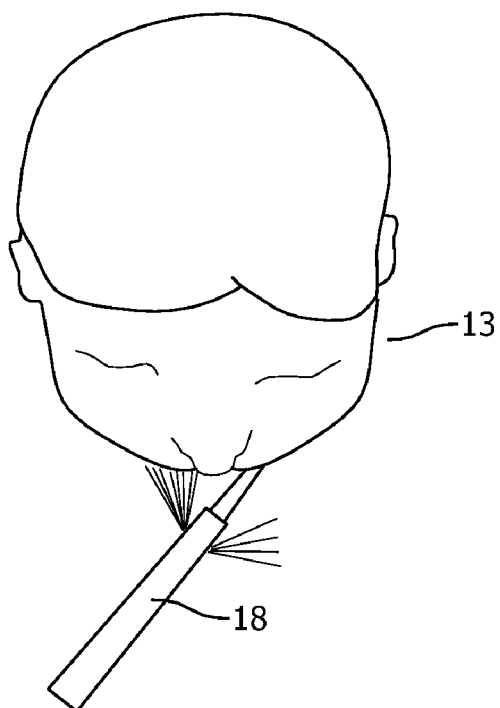


FIG. 7

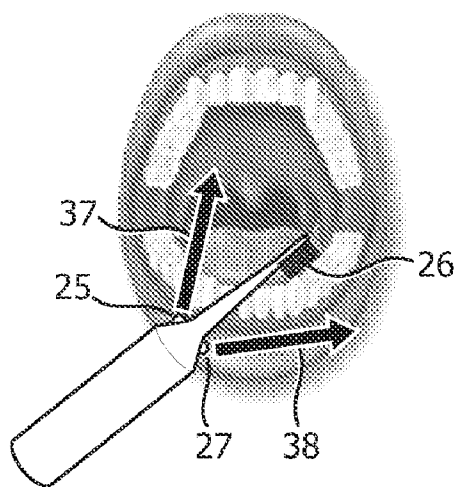


FIG. 8

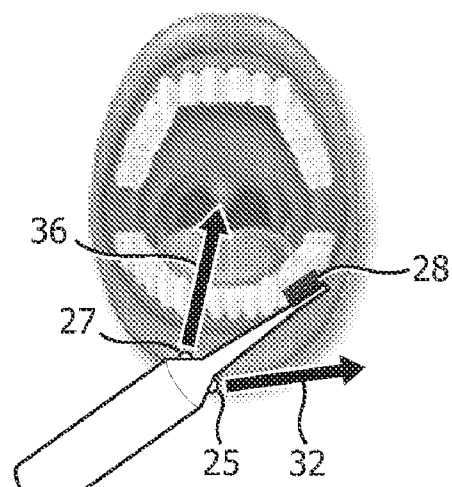


FIG. 9

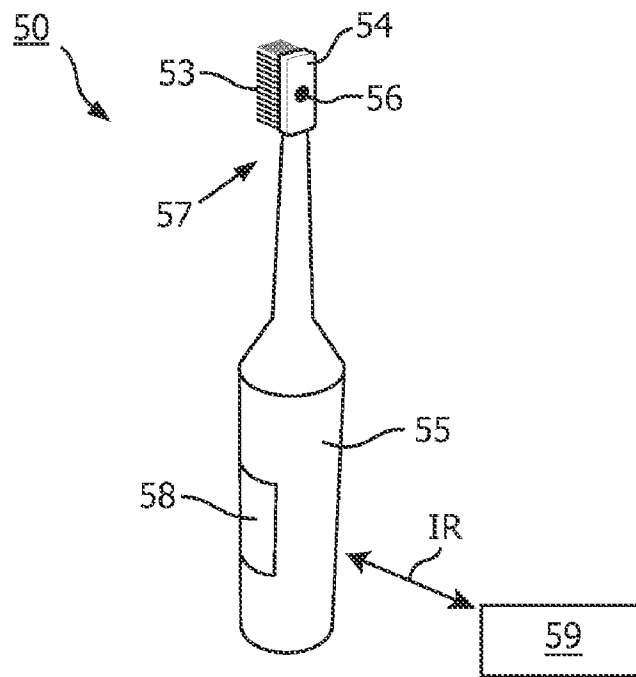


FIG. 10

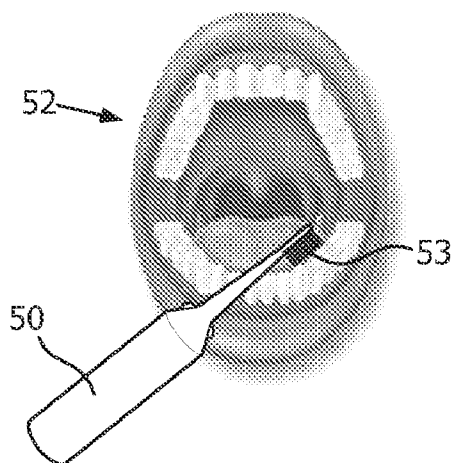


FIG. 11

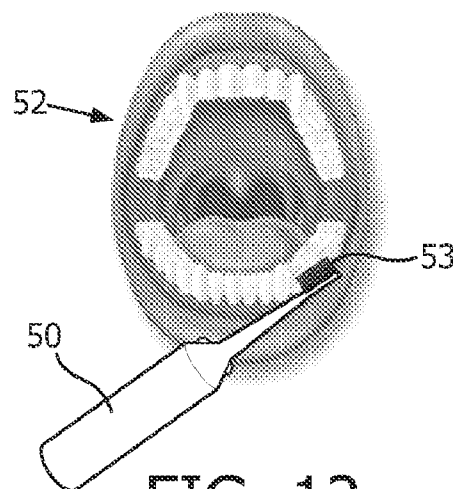


FIG. 12

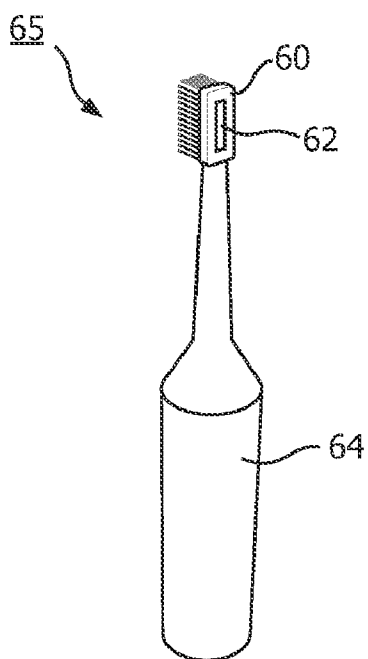


FIG. 13

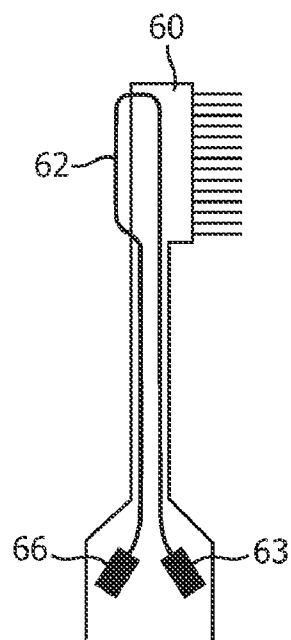


FIG. 14

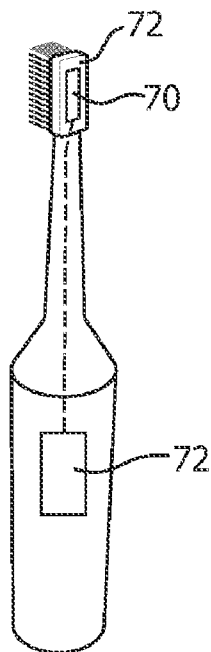


FIG. 15

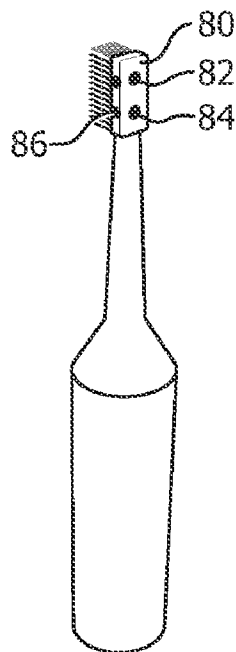


FIG. 16

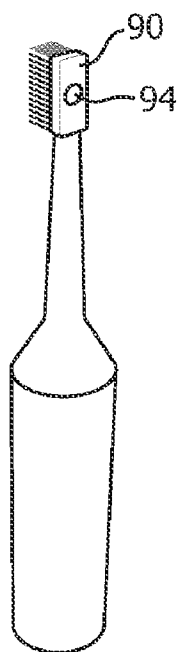


FIG. 17

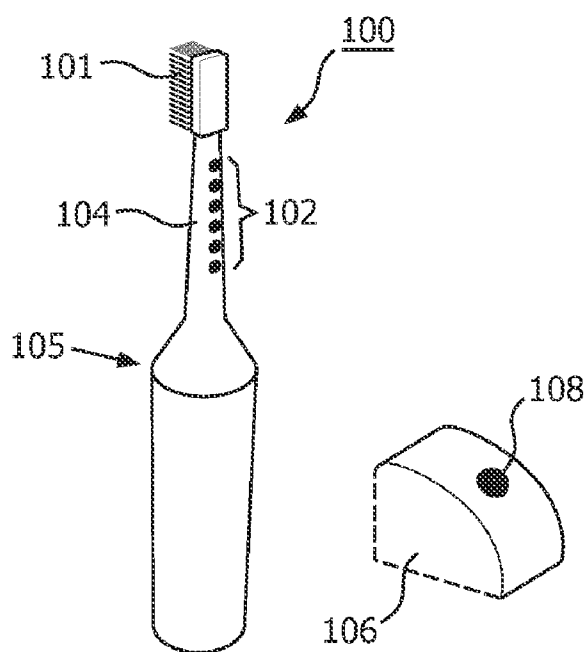


FIG. 18

POSITION SENSING TOOTHBRUSH

[0001] This invention relates generally to toothbrushes, and more specifically concerns the determination of the position of the toothbrush bristles in the mouth, including how far the toothbrush is into the mouth, and whether the user is brushing the inside or outside surfaces of the teeth.

[0002] Careful brushing of all the teeth in the mouth is important for good dental health. The teeth in each region of the mouth require careful and complete attention. In order to accomplish this, it is helpful to give feedback to users concerning how long a user brushes in each region of the mouth. This encourages the user to carefully brush all their teeth, spending sufficient time in each region. Previous arrangements for determining time spent in each region have utilized sensors to determine the position of the bristle set. However, such systems have the disadvantage of requiring a reference point or known starting position to determine the position of the bristle set in the mouth of the user, i.e. the position of the bristles relative to the teeth.

[0003] Accordingly, it is desirable to provide reliable information back to the user concerning the position of the bristle set in the mouth, preferably with an inexpensive system. This will be helpful in overcoming incomplete brushing habits.

[0004] In one embodiment, the toothbrush is capable of sensing the position of the bristle set position and a brushhead portion thereof relative to the tooth and comprises: a toothbrush which includes a handle portion and a brushhead portion with a bristle set at one end thereof for cleaning the teeth of a user; at least one sensor located on said toothbrush such that it is outside the mouth when the bristle set is in position to brush the teeth, the sensor being responsive to temperature, wherein the sensor is oriented such that it detects the temperature of the skin when the bristle set is in a position adjacent one of the outside or inside surfaces of the teeth, and detects the environmental temperature outside the mouth when the bristle set is in a position adjacent the other of the outside or inside surfaces of the teeth; a processor within the toothbrush responsive to the temperature information from the sensor for determining whether the bristle set is in position to brush the outside surfaces or inside surfaces of the teeth; and an indication system responsive to the processor for indicating to the user the position of the bristle set relative to the teeth.

[0005] In another embodiment, the toothbrush is capable of sensing the position of the bristle set portion thereof relative to the teeth, and comprises: a toothbrush which includes a handle portion and a brushhead portion, with a bristle set at one end thereof for cleaning the teeth of a user; at least one sensor located on a back member for the bristle set for providing orienting information of the sensor relative to the cheek of the user; a processor responsive to the orienting information to provide an output indicating whether the bristle set is positioned adjacent the outside surfaces of the teeth or the inside surfaces of the teeth; and an indicator system responsive to the processor for indicating to the user whether the bristle set is in position to brush the outside surfaces of the teeth or the inside surfaces of the teeth.

[0006] In another embodiment, the toothbrush is capable of sensing how far a toothbrush penetrates into the mouth, and comprises: a toothbrush which includes a handle portion, a neck portion and a bristle set portion at a distal end of the neck portion for cleaning teeth of a user; a plurality of light sources

positioned in a sequence along the neck portion of the toothbrush, the light sources oriented such that the relative number of lights within the mouth and outside of the mouth is indicative of the portion of the toothbrush which is in the mouth; and a receiver for receiving light from uncovered light sources outside the mouth, wherein the light sources are differentiated from one another by a selected characteristic, where the receiver includes a system for indicating to the user how far the toothbrush has penetrated into the mouth.

[0007] FIGS. 1 and 2 are simple elevational views for a first embodiment of a toothbrush with one and two IR sensors.

[0008] FIGS. 3-6 are simplified diagrams showing brushing coverage relative to a set of teeth.

[0009] FIGS. 7-9 are illustrations of the position of the toothbrush in a user's mouth and the direction of the IR sensor.

[0010] FIG. 10 is an elevational view of one variation of a second embodiment of the position sensor.

[0011] FIGS. 11 and 12 are brushing diagrams for the embodiment of FIG. 10.

[0012] FIGS. 13 and 14 are elevational and top views of a further variation of the second embodiment.

[0013] FIG. 15 is an elevational view of another variation of the second embodiment.

[0014] FIG. 16 is an elevational view of a still further variation of the second embodiment.

[0015] FIG. 17 is an elevational view of yet another variation of the second embodiment.

[0016] FIG. 18 is a schematic view of a system for determining how far the toothbrush extends into the mouth.

[0017] FIGS. 1-9 illustrate the structure of a first embodiment of the toothbrush described herein and the possible positions of the bristle set portion of the toothbrush in the mouth. Sensors are used on the toothbrush handle, which is outside of the mouth during brushing, to determine the orientation of the bristle set relative to the teeth when the bristle set is in the mouth in particular, whether the bristles are in position for brushing the outside surfaces of the teeth or the inside surfaces of the teeth. In the embodiment of FIGS. 1-9, a toothbrush 10, typically a power toothbrush, which includes a handle portion 12 and a brushhead portion 14, includes at least one sensor 16 near the upper end 18 of handle 12. At the distal end of brushhead 14 is a bristle set 20, fixed to a bristle plate or back member 24. Sensors 16 in the embodiment shown are IR sensors, which are responsive to temperature. FIG. 1 shows an arrangement with a single IR sensor, while FIG. 2 shows two IR sensors, approximately 180° apart. While FIGS. 1 and 2 show the sensors in the toothbrush handle, they could be on the neck of the toothbrush, as long as the sensors remain outside of the mouth.

[0018] FIG. 7 shows the toothbrush 10 in the mouth of a user 13. FIGS. 8 and 9 show a toothbrush 10 with two sensors 25 and 27 oriented so that when bristles 26 are oriented against the outside surfaces 28 of the teeth (FIG. 9), sensor 25 is pointed away from the skin of the user toward the environment (arrow 32), measuring ambient temperature (72° F.), while the other sensor 27 is pointed toward the skin of the user (arrow 36) and will measure body temperature (98.6° F.). When toothbrush 10 is positioned so that the bristles 25 are oriented against the inside surfaces of the teeth (FIG. 8), sensor 25 will be pointing in the direction of the skin (arrow 37) and sensor 27 will be pointing toward the environment (arrow 38).

[0019] It should be understood that only one sensor can be used and still provide effective results, since in one orientation of the toothbrush, the sensor will read 98.6° F., while in the other orientation, the sensor will read the environment temperature, 72° F., for example. In either case, using two sensors or one, the temperature information obtained by the sensor(s) is applied to microprocessor 44 (FIG. 1) within the toothbrush, wherein the microprocessor, having been programmed relative to the temperatures measured by the sensors and the position of the toothbrush, will make a determination of the position of the bristles. It will then send this information to a display device 42, which is typically, but not necessarily, separate from the toothbrush. The display, for instance, could be in a charger assembly for the toothbrush. It could be on a separate display or even on the toothbrush. The system could also provide an audible indication of bristle position. In any event, the system provides an indication to the user of the orientation of the bristles relative to the teeth.

[0020] FIGS. 3-6 illustrate the regions of the mouth that can be determined (inside tooth surfaces or outside tooth surfaces) by the arrangement discussed above and shown in FIG. 1 or 2. FIG. 3 shows the combined outside surfaces 37 and inside surfaces 38.

[0021] An accelerometer or inclinometer 45 can be added to the toothbrush 10, which, with the sensors, provides an ability of the toothbrush to distinguish four zones in the mouth, in particular, left and right sides of the mouth, and the inside and outside teeth surfaces. FIGS. 4 and 5 illustrate the coverage of a 180° difference in the inclination of the bristles when brushing the regions 39 and 40 (FIG. 4), and regions 41 and 42 (FIG. 5). FIG. 6 illustrates the four zones together.

[0022] Further, the chewing surfaces of the teeth can also be identified by means of two additional temperature sensors positioned at approximately 90° to the original two temperature sensors. All of the temperature and accelerometer/inclinometer information is provided to the microprocessor 44, which determines which region of the teeth the bristles are directed toward or against. While IR sensors have been disclosed, other sensors and techniques could be used to detect the presence of the face as approved to the environment. Those could include reflective or triangular IR sensing, capacitive sensing, proximity sensing, or even sonar (acoustic distance sensor) or laser sensing.

[0023] In the particular embodiment and variations thereof FIGS. 10-18, the object again is to determine whether the bristles and the toothbrush are oriented toward the outside or the inside surfaces of the teeth. These variations accomplish the bristle position determination relative to the interior surface of the cheek of the user. In each of the variations, a sensor assembly is positioned on the bristle back plate. When brushing the inside of the teeth, the sensor assembly will face the inside of the mouth away from the cheek, while when brushing the outside surfaces of the teeth, the sensor assembly will face the interior surface of the cheek. The different sensor output between these two positions is processed to provide an indication to the user of the position of the bristles. FIGS. 11 and 12 show a toothbrush 50, with a handle 35 and a brush-head 57, positioned in a user's mouth, shown generally at 52. In FIG. 11, the bristles 53 are positioned against the inside surfaces of the teeth, such that the sensor 56 on the bristle back plate 54 faces the inside of the mouth. In FIG. 12, the toothbrush 50 is oriented so that the bristles 53 are positioned against the exterior surfaces of the teeth. In this position, the sensor 56 faces the cheek of the user.

[0024] There are several embodiment variations disclosed herein relative to different sensors suitable for differentiating between the bristles facing the mouth region or facing the cheek of the user. FIG. 10 shows one embodiment variation in which a bristle back plate 54 of the toothbrush 50 is equipped with an infrared temperature sensor 56. When the outside surfaces of the teeth are being brushed, sensor 56 will measure the temperature of the cheek. When brushing the inside surfaces of the teeth, sensor 56 will measure the temperature inside the mouth. Since there is a temperature difference, the two positions of the bristles can be distinguished. The measured temperature values determined by the sensor are provided to a microprocessor illustrated generally at 58 in the toothbrush 55, which is programmed via a look-up table or the like to provide an indication of the position of the bristles to a display 59 which, like the embodiments described above, can be part of a separate unit, such as a charging unit. The information is provided typically by IR (infrared) communication. The display could also be on the toothbrush itself or another display device apart from a charger. It could be visual, audible or other type of indication.

[0025] In the variation of FIGS. 13 and 14, bristle back plate 60 is equipped with an optical fiber 62. The fiber 62 extends in a loop from the handle 64 of toothbrush 65 through the back of the bristle set and then back to the handle. At one end of the fiber 62, an LED 63 is mounted that provides light which moves through fiber 62. On the other end of the fiber is a light sensor 66 which measures the intensity of the light coming out of the fiber. When the outside surfaces of the teeth are being brushed, the optical fiber 62 will touch the cheek. Due to this cheek contact, there will be a change of the refractive index at the border of the fiber. Some light will now escape from the fiber and the light intensity sensed by light sensor 66 decreases compared to when the bristles are only adjacent the inside surfaces of the teeth. The sensor provides a different value of light intensity to the toothbrush microprocessor, depending upon whether the inside or outside surfaces of the teeth are being brushed. The microprocessor provides an indication of the position of the bristles to the user through a display or other communication means, as discussed above.

[0026] FIG. 15 shows another variation, in which a metal plate 70 is mounted at the bristle back plate 72. Plate 70 is covered with a thin layer of plastic. The capacitance of metal plate 70 changes when the metal plate touches the cheek. The capacitance of the plate can be measured by a sensor. When brushing the outside surfaces of the teeth, the capacitance of the plate will be higher due to contact with the cheek. When the inside surfaces of the teeth are being brushed, the capacitance will be lower due to lack of skin contact. The capacitance sensor 72 provides the capacitance values to a microprocessor in the toothbrush, which will then provide an indication to the user of whether the inside or outside surfaces of the teeth are being brushed on a display such as disclosed above.

[0027] Still another variation is shown in FIG. 16, wherein the bristle set back plate 80 contains an IR LED 82 and an IR detector 84. The detector 84 detects light that is emitted from the LED. When the back plate of the bristle set is in contact with the cheek, the IR LED 82 and IR detector 84 will be partly covered by the skin of the cheek. The light intensity measured by the detector 84 will be low. When the inside surface of the teeth are being brushed, the light intensity detected by the detector will be higher. The light intensity information is provided to a microprocessor in the tooth-

brush, which in turn provides an indication to the user of whether the bristles are adjacent the inside or outside surfaces of the teeth. In addition, the sides of the bristle back plate can be equipped with an IR LED and detector combination **86**, which will enable detection of additional toothbrush orientations.

[0028] Another variation is shown in FIG. 17. The bristle back plate **90** contains a contact switch **94**. When the outside surfaces of the teeth are being brushed, the bristle back plate will touch the cheek and switch **94** will be triggered, providing an indication of the position of the bristles relative to the teeth. When the inside surfaces of the teeth are being brushed, switch **94** will not be triggered. The signal (or lack thereof) from switch **94** will be processed by a microprocessor and an indication provided to the user of the position of the bristles in the mouth.

[0029] FIG. 18 shows an embodiment which determines how far a toothbrush is inserted into the mouth. The toothbrush **100** is shown with a handle **105**, a bristle set **107** and a plurality of LED light sources **102-102** positioned along the neck **104** of the toothbrush. In this embodiment, at least one but preferably two or more LEDs are provided. Each LED has a different emitting characteristic, such as a different frequency. The LEDs produce light which is transmitted to a receiver **106**. In operation, as the toothbrush is inserted into the mouth, one or more of the LEDs will be covered, eliminating that characteristic from being transmitted and received by the receiver. The receiver determines the frequencies of light which it receives. That information is provided to a microprocessor, typically in the receiver, which calculates how far the toothbrush is positioned into the mouth. That information is then provided as a display **108**, typically on the receiver. The elements on the neck of the toothbrush could also be temperature sensors. In this arrangement, no external light receiver is necessary.

[0030] As a variation of the embodiment of FIG. 18, at least four infrared temperature sensors can be provided, with a 3-D accelerometer, in addition to the LEDs (or temperature sensors) on the neck of the toothbrush. The information from the various sensors can then be processed by the microprocessor to determine a specific region of the mouth being brushed.

[0031] Hence, several embodiments have been disclosed which provide information to the user concerning the position of the bristles in the mouth relative to the teeth. This allows the user to ensure appropriate brushing of all regions of the teeth.

[0032] Although preferred embodiments of the invention have been disclosed for purposes of illustration, it should be understood that various changes, modifications and substitutions may be incorporated in the embodiments without departing from the spirit of the invention, which is defined by the claims which follow.

1. A toothbrush capable of sensing the position of a bristle set portion thereof relative to the teeth, comprising:

a toothbrush which includes a handle portion and a brush-head portion with a bristle set at one end thereof for cleaning the teeth of a user;

at least one sensor located on the toothbrush at such a location that it is outside the mouth when the bristle set is in position to brush the teeth, the sensor being responsive to temperature, or other skin characteristic, wherein the sensor is oriented such that it detects the temperature of the skin when the bristle set is in a position adjacent one of either the outside or inside surfaces of the teeth,

and detects the environmental temperature outside the mouth or the absence of said other skin characteristic when the bristle set is in a position adjacent the other of the outside or inside surfaces of the teeth;

a processor within the toothbrush responsive to the temperature information or information of the other skin characteristic from the sensor for determining whether the bristle set is in position to brush the outside surfaces or inside surfaces of the teeth; and

an indication system responsive to the processor for indicating to the user the position of the bristle set relative to the teeth.

2. The toothbrush of claim **1**, including two sensors approximately 180° apart on the handle, each responsive to temperature and oriented such that when one sensor is measuring the skin temperature, the other is measuring the temperature outside of the mouth and vice versa.

3. The toothbrush of claim **1**, including an accelerometer or inclinometer, wherein information from the accelerometer or inclinometer is provided to the processor which determines which side of the mouth the bristle set is located.

4. The toothbrush of claim **1**, wherein the sensors are IR (infrared) sensors.

5. The toothbrush of claim **1**, wherein the sensors are located on the handle of the toothbrush.

6. The toothbrush of claim **1**, including two additional sensors for detecting the toothbrush being present relative to the teeth in the upper or lower jaws.

7. The toothbrush of claim **1**, wherein the toothbrush is a power toothbrush.

8. The toothbrush of claim **1**, wherein the indicator system is a visual display separate from the toothbrush.

9. A toothbrush capable of sensing the position of a bristle set portion thereof relative to the teeth, comprising:

a toothbrush which includes a handle portion and a brush-head portion, with a bristle set at one end thereof for cleaning the teeth of a user;

at least one sensor located on a back member for the bristle set for providing orienting information of the sensor relative to the cheek of the user;

a processor responsive to the orienting information to provide an output indicating whether the bristle set is positioned adjacent the outside surfaces of the teeth or the inside surfaces of the teeth; and

an indicator system responsive to the processor for indicating to the user whether the bristle set is in position to brush the outside surfaces of the teeth or the inside surfaces of the teeth.

10. The toothbrush of claim **9**, wherein the sensor is located on a back surface of the bristle set.

11. The toothbrush of claim **9**, wherein the sensor is an IR temperature sensor to distinguish between the cheek and the interior of the mouth.

12. The toothbrush of claim **9**, wherein the sensor is an optical fiber assembly which differentiates between the interior of the mouth and the cheek by the intensity of light present at a receiver end of the optical fiber from an LED source at a transmittal end thereof.

13. The toothbrush of claim **9**, wherein the sensor includes a capacitive element and a system for sensing the capacitance thereof, wherein the capacitance of the capacitive element increases when the bristle set is close to the cheek of the user as opposed to away from the cheek.

14. The toothbrush of claim **9**, wherein the sensor is an infrared LED and an infrared detector, wherein light intensity detected by the detector will decrease as the bristle set back member comes into contact with the cheek.

15. The toothbrush of claim **14**, including additional infrared LEDs and infrared detectors positioned on the back member for determination of additional bristle set positions relative to the teeth of the user.

16. The toothbrush of claim **9**, wherein the sensor is a switch, which is activated when the bristle set back member contacts the cheek of the user.

17. A toothbrush capable of sensing how far a toothbrush penetrates into the mouth, comprising:

a toothbrush, which includes a handle portion, a neck portion and a bristle set portion at a distal end of the neck portion for cleaning teeth of a user;

a plurality of sensor members positioned in sequence along the neck portion of the toothbrush, the sensor members oriented such that the relative number of sensor members within the mouth and outside of the mouth is indicative of the portion of the toothbrush which is in the mouth; and

a receiver for receiving information from uncovered sensor members outside of the mouth, wherein the receiver includes a system for indicating to the user how far the toothbrush has penetrated into the mouth from the sensor information.

18. The toothbrush of claim **17**, wherein the sensor members are light sources, and the receiver is adapted to receive light from uncovered light sources, wherein the light sources are differentiated from one another by a selected characteristic

19. The toothbrush of claim **17**, wherein the selected characteristic is frequency, such that the light sources emit different colored light.

20. The toothbrush of claim **19**, wherein the light sources are infrared LEDs, each having a different emitting frequency.

21. The toothbrush of claim **17**, wherein the sensor members are temperature sensors.

* * * * *