ELECTRICALLY DRIVEN TOOTHBRUSH

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Appl. No.: 10/504,761
PCT Filed: Feb. 7, 2003

Publication Classification

Int. Cl. 7 A63D 5/10
U.S. Cl. 15/4

ABSTRACT

The invention relates to an electrically driven toothbrush comprising an electric motor for rotationally driving a drive shaft around a drive axis, a brush shaft having a first free outer end provided with a bristle, conversion means for converting the rotational movement of the drive shaft into a reciprocal rotational movement of the brush shaft around a brush shaft axis according to conversion characteristics, and pivoting means for enabling the pivoting of at least part of the brush shaft around a pivot axis, extending perpendicularly to the longitudinal direction of the drive shaft, from a neutral pivoting position and against the action of forcing means, to a non-neutral position due to forces acting on the bristle, the pivoting of the at least part of the brush shaft around the pivot axis to the non-neutral position causing a change in the conversion characteristics.
ELECTRICALLY DRIVEN TOOTHBRUSH

[0001] The invention relates to an electrically driven toothbrush comprising an electric motor for rotationally driving a drive shaft around a drive axis, a brush shaft having a free outer end provided with a bristle, conversion means for converting the rotational movement of the drive shaft into a reciprocal rotational movement of the brush shaft around a brush shaft axis according to conversion characteristics, and pivoting means for enabling the pivoting of at least part of the brush shaft around a pivot axis, extending perpendicularly to the longitudinal direction of the drive shaft, from a neutral pivoting position and against the action of forcing means, to a non-neutral position due to forces acting on the bristle.

[0002] The brush head of an electrical toothbrush can damage the gums or be painful, especially in case the gums are irritated. This damage or pain occurs when the contact force between bristle and gum becomes too large. By applying forces which are not detrimental to the gums of a user, better mouth health can be reached. Therefore, several electrically driven toothbrushes are developed which are provided with some kind of force control.

[0003] A toothbrush according to the preamble is known from U.S. Pat. No. 5,406,664 which refers to the above-described problem and is provided with some kind of force control. In this patent document in fact several electrically driven toothbrushes are described, which have in common that of the bristle each of them is resiliently tiltable over a tilting distance with respect to an axis extending through and perpendicularly to a brush shaft extending between the bristle and a conversion mechanism for converting the rotation of an electric motor into a reciprocal rotation of the brush shaft with the bristle. In order to achieve this either the brush shaft contains a bending portion using for instance a partially cut off part of the brush shaft, a resilient strip interconnecting two longitudinal parts of the brush shaft or a coil spring within the brush shaft. Alternatively the brush shaft is split into two longitudinal brush shaft portions of which the one carrying the bristle is pivotable around a pivot axis extending perpendicularly to the longitudinal direction of the brush shaft. The two longitudinal brush portions are interconnected by a coil spring. The reciprocation stroke of the bristle is changed by a change of the magnitude of the tilting distance due to the force with which a user presses the brush against the user’s teeth. The disadvantage of electrically driven toothbrushes as described in the above-mentioned US patent is that the one part of the brush shaft carrying the bristle is provided with special means for enabling the resilient tilting. These special means make the one part carrying the bristle more expensive which is, bearing in mind that this part should be replaced regularly (for instance every two or three months), a very important drawback at least for consumers. Furthermore, a rather large tilting stroke should be made by the bristle before the user registers a difference in the reciprocating stroke.

[0004] European patent application 481 553 is another patent relating to an electrically driven toothbrush which aims to prevent the exertion of an excessive pressure by the toothbrush upon the teeth. For this purpose the toothbrush features an acoustically perceptible sound which is reproduced when a certain contact pressure is exceeded during teeth cleaning. The electric drive unit is rotatable against the operation of a spring element. The warning sound is caused by the fact that a spur wheel, mounted on a drive shaft extending on the backside of the drive unit, contacts a leaf spring. The housing of the toothbrush acts as a resonator. A disadvantage of such a toothbrush is that many users do not like to hear an acoustically perceptible sound, especially not if other people are still sleeping. Furthermore, the interaction between the spur wheel and the leaf spring causes an additional mechanical force acting upon the mechanisms.

[0005] The object of the invention is to provide a toothbrush according to the preamble which effectively prevents a user of an electrically driven toothbrush from pressing too hard and which toothbrush does not have the drawbacks of the toothbrushes of the prior art as described above. The invention also aims to provide a toothbrush having a haptic feedback, which has proven to be more effective than non-haptic feedbacks in helping a user to adapt the handling of the brush.

[0006] In order to achieve these objects the pivoting of the at least part of the brush shaft around the pivot axis to the non-neutral position causes a change in the conversion characteristics. This means that the way the rotational movement of the drive shaft is converted into the reciprocal rotational movement of the brush shaft is influenced directly by the pivoting of the brush shaft around the pivot axis as this will occur if an excessive contact pressure is applied between bristle and teeth. This influence is haptically detected by a user who can change the way of handling the electrically driven toothbrush by reducing the contact pressure such that the brush shaft returns to its neutral pivoting position.

[0007] A very effective embodiment is achieved when the conversion means comprise an arm member extending essentially radially from the brush shaft and an excenter body, being rotatable about an excenter axis which is located at a radial distance from the brush shaft axis, the excenter body and the arm member being constantly in contact with each other during rotational movement of the excenter body, the pivoting of the at least part of the brush shaft around the pivot axis causing a change in the magnitude of the radial distance. This change in the magnitude of the radial distance can influence the conversion characteristics basically in two different ways as will be explained below.

[0008] In a preferred embodiment of the invention the bristle faces away from the excenter axis. This means that if too much pressure is exerted upon the bristle, the pivoting of the brush shaft around the pivot axis will cause the radial distance to increase since the arm member will move away from the excenter body. Consequently, the stroke of the bristle will decrease; this will be registered by the user as a loss of power.

[0009] In an alternative preferred embodiment of the invention the bristle faces the excenter axis. In such a configuration, when too much pressure is exerted upon the bristle, the pivoting of the brush shaft around the pivot axis will cause the radial distance to decrease since the arm member will move towards the excenter body. Consequently, the stroke of the bristle will increase as well as the power to be delivered by the electric motor. Finally, the motor will drop its frequency. This is clearly a completely other kind of signal to the user indicating an excessive contact pressure.
It is very advantageous, at least from a constructional point of view, if the forcing means comprise spring means. However, it should be realized that within the framework of the invention other kinds of forcing means, such as magnetic actuators, could also be used.

Although a simple excenter pin as described in U.S. Pat. No. 5,406,664 may be used as the excenter body, preferably a cam having an odd number of lobes, said number being equal to or larger than three, is used as the excenter body. Such a cam enables a smooth reciprocating movement of the brush. The preferred geometry of the cam follows a so-called Reuleaux curve.

In order to have the best control over the influence the pivoting of the brush shaft has on the conversion characteristics, the brush shaft is preferably rigid.

The invention will be further explained by way of a description of some preferred embodiments of the invention, given with reference to the following figures:

FIG. 1 shows a longitudinal cross-sectional view of a first preferred embodiment of the invention;

FIG. 2 shows a longitudinal cross-sectional view of a second preferred embodiment of the invention;

FIG. 3 shows a longitudinal cross-sectional view of a third preferred embodiment of the invention;

FIG. 4 shows a longitudinal cross-sectional view of a fourth preferred embodiment of the invention;

FIG. 5 shows a longitudinal cross-sectional view of a fifth preferred embodiment of the invention;

FIG. 6 shows a longitudinal cross-sectional view of a sixth preferred embodiment of the invention;

FIGS. 7a and 7b show the cross section according to the line VII-VII in the FIGS. 1 to 3 in a neutral position and a non-neutral position, respectively;

FIGS. 8a and 8b show the cross section according to the line VIII-VIII in the FIGS. 4 to 6 in a neutral position and a non-neutral position, respectively, and

FIG. 9 shows the cross-section according to the line IX-IX in the FIGS. 1 to 6.

The FIGS. 1 to 6 show six different embodiments of electrically driven tooth brushes 1, 2, 3, 4, 5 and 6 according to the invention which have a large number of similar components. Thereinafter such similar components will be designated by the same reference number. Each toothbrush has a housing 7 within which an electric-motor 8 with an outgoing drive shaft 9, rotatable around a drive axis 18, is accommodated. On this drive shaft 9 a three-lobe cam 10 is mounted (see also the FIGS. 7a, 7b, 8a and 8b).

A brush shaft 21 extends partly within the housing. This brush shaft 21 contains three main shaft parts: a bristle shaft part 11, a connecting shaft part 12 and a fork shaft part 13. The bristle shaft part 11 carries at its outer end a bristle 15 for contacting, with a certain contact force as indicated by an arrow 14, the teeth of the user of the toothbrush. When the bristle 15 is worn out, the bristle shaft part 11 should be replaced. It is important to note already that the bristles 15 of the toothbrushes 1, 2 and 3 face in an opposite direction compared to the bristles 15 of the toothbrushes 4, 5 and 6.

At its outer end, on the fork shaft part 13, a fork 16 with two arms 17a and 17b is mounted. The fork shaft part 13 can rotate around the brush shaft axis 20 within the bearing unit 19 accommodated within housing 7. The brush shaft axis 20 and the drive axis 18 are parallel to each other at a radial distance from each other which is indicated by a with double arrow 22 in the FIGS. 1 and 4. Connecting shaft part 12 rigidly interconnects the bristle shaft part 11 and the fork shaft part 13. The cam 10 is located within the arms 17a and 17b of the fork 16. A rotation of the drive shaft 9 with the cam 10 thus causes an oscillatory rotational movement of the brush shaft 21 with the bristle 15.

In addition the brush shaft 21 is also pivotable around a pivot axis 23 extending perpendicularly to the brush shaft axis 20 through fork shaft part 13, since the bearing unit 19 is pivotable within the housing 7 as is shown in FIG. 9. To this end, the bearing unit 19 is provided with two opposed pivot shaft parts 24a and 24b.

In order to force the brush shaft 21 to position itself in a neutral pivot position, the tooth brushes 1, 2, 3, 4, 5, 6 are provided with spring means which operate between the bearing unit 19 near the free end of the fork shaft part 13 and the housing 7. The various tooth brushes 1, 2, 3, 4, 5, 6 differ as regards the kind of spring means used. The tooth brushes 1 and 4 make use of a leaf spring 25. The tooth brushes 2 and 5 are provided with a compression spring 26 which is located at the side against of the brush shaft 21 as the bristle 15. The tooth brushes 3 and 6 have a tension spring which is located at the side opposite the bristle 15. In order to limit the pivoting movement of the brush shaft 21, caused by the spring means, the tooth brushes 2, 3, 5, 6 are provided with stop units 27, 28, 29, 30, respectively, which are rigidly connected to the housing 7.

Regarding the functioning of the tooth brushes 1, 2, 3, 4, 5, 6, a distinction should be made between tooth brushes 1, 2, 3 on the one hand and the tooth brushes 4, 5, 6 on the other hand.

A tooth brushes 21, 2, 3 operate as follows. If, starting from a neutral position (FIG. 7a), an excessive contact pressure 14 exists between the bristle 15 and the teeth of a user, the brush shaft 21 will pivot around the pivot axis 23, against the action of the spring means, to a non-neutral position (FIG. 7b). This will cause a radial movement of the fork 16, thus decreasing the radial distance 22. Due to this decrease of the radial distance 22, the stroke of the oscillatory rotational movement of the brush shaft 21 with the bristle 15 will also decrease; this will be registered by the user as a loss of power.

The tooth brushes 4, 5, 6 operate as follows. If, starting from a neutral position (FIG. 8a), an excessive contact pressure exists between the bristle 15 and the teeth of a user, the brush shaft 21 will also pivot around the pivot axis 23, against the action of the spring means, to a non-neutral position (FIG. 8b), causing a radial movement of the fork 16. However, this time the radial movement of the fork 16 causes an increase of the radial distance 22 and, consequently, the stroke of the oscillatory rotational movement of the brush shaft 21 with the bristle 15 will initially also increase. This causes also an increase of the power to be delivered by the electric motor 8. If this increase of required power is too high, the motor will drop its frequency.

The stroke or frequency change as described above, applicable if an excessive contact pressure exists...
between the bristle 15 and the teeth of a user, will immediately be registered by the user, who will reduce the application load so as to regain the initial power again. Over time, the user will adapt the handling of the toothbrush such that high contact pressures will become rare or will even no longer occur at all.

1. An electrically driven toothbrush comprising an electric motor for rotationally driving a drive shaft around a drive axis, a brush shaft having a first free outer end provided with a bristle, conversion means for converting the rotational movement of the drive shaft into a reciprocal rotational movement of the brush shaft around a brush shaft axis according to conversion characteristics, and pivoting means for enabling the pivoting of at least part of the brush shaft around a pivot axis, extending perpendicularly to the longitudinal direction of the drive shaft, from a neutral pivoting position and against the action of forcing means, to a non-neutral position due to forces acting on the bristle, characterized in that the pivoting of the at least part of the brush shaft around the pivot axis to the non-neutral position causes a change in the conversion characteristics.

2. An electrically driven toothbrush according to claim 1, characterized in that the conversion means comprise an arm member extending essentially radially from the brush shaft and an excenter body, being rotatable about an excenter axis which is located at a radial distance from the brush shaft axis, the excenter body and the arm member being constantly in contact with each other during rotational movement of the excenter body, the pivoting of the at least part of the brush shaft around the pivot axis causing a change in the magnitude of the radial distance.

3. An electrically driven toothbrush according to claim 2, characterized in that the bristle faces away from the excenter axis.

4. An electrically driven toothbrush according to claim 2, characterized in that the bristle faces the excenter axis.

5. An electrically driven toothbrush according to claim 1, characterized in that the forcing means comprise spring means.

6. An electrically driven toothbrush according to claim 1, characterized in that the excenter body is a cam having an odd number of lobes, said number being equal to or larger than three.

7. An electrically driven toothbrush according to claim 1, characterized in that the brush shaft is rigid.

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