Sonic toothbrushes are very comfortable for the user and are also considered efficient because the electrically powered brush makes the movements much faster than can be done by hand.

In the case of sonic toothbrushes, it has been based on the fact that the higher the frequency of the motor and the greater the cleaning movement of the bristles, the better the cleaning.

WO 2017/050612 A1 (Curaden) describes a sonic toothbrush with an angled brush head. The fact that the sonic toothbrush is angled forwards makes the various areas of the dentition more accessible. In addition, the bend allows the filaments of the brushes to vibrate with greater amplitude transversely to the longitudinal axis of the brush. The preferred operating frequency is at 2000 to 8000 Hertz. However, the frequencies can also be higher for example at 10 kHz, 50 kHz or even lower, for example at 200 Hz or 500 Hz.

From US 2012/02912 A1 an ultrasonic toothbrush is known which has two parallel channels running transversely to the longitudinal axis of the brush to increase the resonant frequency. The frequency is increased in the forward-backward direction when the two channels are placed at the front. If the channels are provided on the left and right of the brush neck, the frequency is increased in the lateral direction.

Disadvantages:

There is still a lack of sufficient understanding of the cleaning behavior of sonic toothbrushes. The knowledge we have today regarding the cleaning effect of manual toothbrushes cannot be transferred to the highly dynamic situation of a sonic toothbrush.

Disclosure of the invention

Embodiments of the invention disclose a toothbrush for sonic toothbrushes which belongs to the technical field mentioned at the beginning and which has a better cleaning effect, in particular one which is gentle on the gums. In particular, a defined and controlled two-dimensional movement of the bristles is to be produced.

According to an aspect of the present invention, there is provided a brush for a sonic toothbrush with longitudinal axis vibration including an elongated base body that includes: a frustoconical base portion having a drive adapter for rotation-fixed coupling to a sonic tooth brush drive with longitudinal axis vibration, the drive adapter defining a geometric base portion longitudinal axis (x) of the brush, a head portion with a head portion alignment axis and a bristle support in which a plurality of bristles are anchored, and having a neck portion with a tapered cross-section compared to the base portion, connecting the base portion and the head portion, wherein the base body has a kink angle such that a geometric base portion longitudinal axis and a geometric head portion alignment axis include an angle γ in the range of 5° to 12°, and a geometric kink position in the base body has a distance from an end face of the base portion of at least 50% of a total length of the base body.

The sonic toothbrush according to embodiments of the invention basically generates an oscillation of the brush about the longitudinal axis, i.e. the base portion longitudinal axis (which is defined here as the x-axis). The bristles thereby primarily perform a wiping motion transverse to said longitudinal axis. A particular advantage of the brush according to embodiments of the invention is that it has a kink angle position which results in a sufficiently large deflection (also called eccentricity) of the head portion so that it also performs a certain oscillation in the direction of the longitudinal axis. The result is a two-dimensional movement, which can be called an "8" movement. Such a movement is particularly advantageous in several respects.

The combination of the special kink angle, which according to embodiments of the invention is not too small and not too large, and the kink angle position according to embodiments of the invention, which is not too close to the base portion, results in a deflection (or eccentricity with respect to the base portion longitudinal axis) and a leverage effect that results in a slight nodding movement of the brush head during operation of the toothbrush. This results in the above-mentioned two-dimensional "8" movement of the bristle tips.

However, it is an advantage of the present brush design that the brush also performs a small "nodding movement" in the direction of the bristles. This forces the mixture of saliva and

toothpaste "forward" into the interdental spaces. This is particularly important for single-bristle toothbrushes, which are specially designed for better interdental cleaning.

Embodiments of the invention are also based on the following basic features:

a) The brush has a base portion on which an adapter to the hand apparatus, a so-called drive adapter, is formed. The adapter is geometrically designed to be non-rotatably (but replaceably) connected to a coupling part (e.g. pin) of the sonic tooth brush drive. The sonic toothbrush drive generates a longitudinal axis vibration to be transmitted to the brush. The drive adapter defines a geometric base portion longitudinal axis (x) of the brush. This longitudinal axis is normally the direction in which the brush can be placed on the hand apparatus.

b) Further, the brush has a head portion with a bristle support in which a plurality of bristles are anchored (bristle field). The head portion is in principle the upper end of the brush (whereas the base portion is the lower end). The head portion defines a head portion alignment axis. For example, the bristles anchored in the head portion project away at right angles to the head portion alignment axis. Typically, but not necessarily, the bristles are perpendicular to the head portion alignment axis..

c) Between the base portion and the head portion, the base body has a neck portion. The neck portion therefore connects the base portion and the head portion. It has a tapered cross-section compared to the base portion. This means that if you look at the base portion in cross-section (in relation to the longitudinal axis of the base portion), the dimensions in the x or y direction are smaller than for the cross-section of the neck portion (i.e. transverse to the longitudinal axis of the neck portion). Here, cross-sectional taper refers to the cross-sectional area. It is therefore not mandatory that the dimensions in the x-direction and y-direction are smaller.

In a first variant, the bristle support comprises a plurality of tufts, each with a plurality of bristles. In a second variant, the bristle support comprises exactly one tuft with a large number of bristles (single-tuft variant).

However, the bristles can also be indirectly anchored to the surface of the bristle support, particularly if the brush is designed as an interdental brush. In a third variant, the bristle support comprises a wound or layed wire loop on its surface, with the bristles clamped between the strands. In this case, the head portion alignment axis is preferably aligned at right angles to the wire orientation.

The geometric kink position is defined by an intersection between the geometric base portion longitudinal axis and the geometric head portion alignment axis. At the geometric kink position, therefore, there does not necessarily have to be a kink-like (or knee-like) change in direction of the base body. Preferably, the geometric kink position is located within the base body. The shape of the base body does not necessarily have to comprise a visually recognizable kink, but can be curved, for example. In variants, the geometric kink position can also be located outside the base body. Further variations are known to the skilled person.

The distance between the end face of the base portion and the kink position is measured along the longitudinal axis of the base portion. Likewise, the total length of the base portion is measured along the longitudinal axis of the base portion.

According to embodiments of the invention, the geometric kink position comprises a relatively large distance from the head portion in order to achieve a particularly optimum vibrational behavior for cleaning the teeth in connection with the angle γ (gamma) between the geometric base portion longitudinal axis and the geometric head portion alignment axis of 5° to 12°. The greater the angle selected, the greater the deflection of the head portion from the longitudinal axis of the base portion (eccentricity). Similarly, the eccentricity becomes greater as the kink position is moved further away from the head portion. However, it has been shown that the two parameters (kink position and angle) do not influence the vibrational behavior to the same extent and in the same way, so that with regard to the cleaning effect, an increase in the angle, for example, cannot be compensated directly by a smaller distance between the kink position and the head portion, since the 2-dimensional or 3-dimensional vibration pattern of the head portion reacts differently to the two parameters.

The distance between the geometric kink position and the end face of the base portion is preferably at least 60% of the total length of the base body. This defines a particularly optimal

particular the "8" movement, is particularly advantageous, which means that tooth cleaning with the brush can be performed particularly gently. The angle range has also proven to be particularly advantageous in connection with the deflection or eccentricity of the head portion in relation to the overall length of the brush between 10% and 20% and has also led to particularly good cleaning results with optimum ergonomics.

The angular range of 7° - 10° in combination with a deflection of 10% to 20% leads to good self-dynamics of the vibration of the brush head in the sense of the desired "8-movement".

In a particular embodiment, the neck portion is cross-sectionally tapered compared to the head portion. That is, the head portion is wider and/or thicker (as viewed perpendicular to the head portion alignment axis) than the neck portion. This makes the neck portion mechanically less rigid than the head portion (provided that the base body is made of one or more materials having approximately the same Young's modulus).

A sonic toothbrush with longitudinal axis vibration according to embodiments of the invention comprises a brush according to embodiments of the invention and a hand apparatus with a brush coupling for releasably attaching the brush to the hand apparatus and with a drive generating a longitudinal axis vibration at the brush coupling. The drive may comprise, for example, a piezo drive, a magnetic drive and/or an electro-rotary drive. A piezo drive is particularly preferred, especially because of its simple design, particularly compact construction and precise controllability.

Preferably, the drive is designed to generate a longitudinal axis vibration frequency in the range of 150 Hz to 400 Hz. Since a 2-dimensional or 3-dimensional motion pattern is generated with the brush, the longitudinal axis vibration frequency is set relatively low so that more time is available for carrying out several directional changes per vibration, e.g. in an "8" motion. The longitudinal axis vibration frequency is advantageously not higher than 300 Hz. If the frequency is too high, the base body can no longer transmit the longitudinal axis vibration generated by the drive to the brush head. This can lead to internal torsional movements which cause the head to perform only every second vibration, for example.

The longitudinal axis vibration frequency can also be less than 150 Hz, e.g. 120 Hz.

Preferably, the drive is designed to generate a longitudinal axis vibration with an amplitude (deflection relative to a rest position) of less than 3°, in particular in the range of 1° to 3°. That is, the base portion is periodically rotated (moved back and forth) through the angle about the base portion longitudinal axis. In variations, the amplitude may be greater than 3°.

Disclosed herein is a brush for a sonic toothbrush with longitudinal axis vibration that has an elongated base body which has a base portion having a drive adapter for rotation-fixed coupling to a sonic toothbrush drive with longitudinal axis vibration, the drive adapter defining a geometric base portion longitudinal axis (x) of the brush, a head portion with a head portion alignment axis and a bristle support in which a plurality of bristles are anchored, and a neck portion which is tapered in cross-section relative to the base portion and which connects the base portion and the head portion, wherein the base body of the brush has a kink angle in that the geometric base portion longitudinal axis and a geometric head portion alignment axis include an angle γ (gamma) in the range of 8° to 15°, and the base body comprises a load-bearing material having a Young's modulus of not more than 6000 MPa and not less than 2000 MPa (MPa = megapascale).

The sonic toothbrush according to embodiments of the invention basically generates a vibration of the brush about the longitudinal axis, i.e. about the base portion longitudinal axis (which is defined here as the x-axis). The bristles thereby primarily perform a wiping motion transverse to said longitudinal axis (which is defined here as the y-axis). A particular advantage of the brush according to embodiments of the invention is that it has a certain elasticity due to the selected material parameter and therefore also performs a vibration in the direction of the longitudinal movement (x-axis) at the intended vibration frequency. This results in a movement that can be described as an "8" movement. The bristles are moved synchronously in the x and y directions and follow a line in the shape of an "8". Such a movement is particularly advantageous for dental care in several respects.

The combination of a sufficiently large kink angle of at least 8 and a Young's modulus that provides a sufficient (but not too great) degree of flexibility results in a two-dimensional movement of the head. This movement at the anchored end of the bristles controls the movement of the bristles at their cleaning end (free end of the bristles). The upper limit of the kink angle and the lower limit of the Young's modulus ensure that the brush head is still held sufficiently stable so that the undesirable "striking" movement (in the longitudinal direction of the bristles - i.e. in the direction of the z-axis) does not occur to an excessive (damaging) extent.

However, it is definitely an advantage of the present brush design that the brush performs a small "nodding movement" in the direction of the bristles (defined here as the z-direction), because this forces the mixture of saliva and toothpaste quasi "forward" into the interdental spaces. This is particularly important in the case of single-bristle toothbrushes, which are especially suitable for improved interdental cleaning.

Furthermore, embodiments of the invention are based on the following basic features:

d) The brush has a base portion on which an adapter to the hand apparatus, a so-called drive adapter, is formed. The adapter is geometrically designed to be non-rotatably (but replaceably) connected to a coupling part (e.g. pin) of the sonic tooth brush drive. The sonic tooth brush drive generates a longitudinal axis vibration to be transmitted to the brush. The drive adapter defines a geometric base portion longitudinal axis (x) of the brush. This longitudinal axis is normally the direction in which the brush can be placed on the hand apparatus.

e) Further, the brush has a head portion with a bristle support in which a plurality of bristles are anchored (bristle field). The head portion is in principle the upper end of the brush (whereas the base portion is the lower end). The head portion defines a head portion alignment axis. For example, the bristles anchored in the head portion project away at right angles to the head portion alignment axis. Typically, but not necessarily, the bristles are perpendicular to the head portion alignment axis.

f) Between the base portion and the head portion, the base body has a neck portion. The neck portion therefore connects the base portion and the head portion. It has a tapered cross-section compared to the base portion. This means that if you look at the base portion in

The distance of the geometric kink position to the end face of the base portion is preferably at least 50% of a length of the base body. Thus, in connection with the range of the Young's modulus according to embodiments of the invention, a particularly optimal range is defined for the geometric kink position, which according to the experiments leads to particularly advantageous 2-dimensional or 3-dimensional vibration patterns. This makes it possible to achieve particularly effective and gentle tooth cleaning.

The geometric kink position is defined by an intersection between the geometric base portion longitudinal axis and the geometric head portion alignment axis. Thus, at the geometric kink position, there does not necessarily have to be a kink-like (or knee-like) change in direction of the base body. Preferably, the geometric kink position is located within the base body. The shape of the base body does not necessarily have to comprise a visually recognizable kink, but can be curved, for example. In variants, the geometric kink position can also lie outside the base body. Further variations are known to the skilled person.

The distance between the end face of the base portion and the kink position is measured along the longitudinal axis of the base portion. The total length of the base portion is also measured along the longitudinal axis of the base portion.

According to embodiments of the invention, the geometric kink position comprises a relatively large distance from the head portion in order to achieve a particularly good vibrational behavior for cleaning the teeth in connection with the angle γ (gamma) between the geometric base portion longitudinal axis and the geometric head portion alignment axis of 8° to 15°. The greater the angle selected, the greater the deflection of the head portion from the longitudinal axis of the base portion (eccentricity). Similarly, the eccentricity becomes greater as the kink position is moved further away from the head portion. However, it has been shown that the two parameters (kink position and angle) do not influence the vibrational behavior to the same extent and in the same way, so that with regard to the cleaning effect, for example, an increase in the angle cannot be compensated directly by a smaller distance between the kink position and the head portion, since the 2-dimensional or 3-dimensional vibration pattern of the head portion reacts differently to the two parameters.

In variants, the distance of the geometric kink position to the end face of the base portion can also be less than 50% of a length of the base body, e.g. at least 35%.

Preferably, a geometric base portion longitudinal axis and a geometric head portion alignment axis include an angle γ (gamma) in the range of 10° to 14°. This angular range has proved to be particularly advantageous in experiments, so that a particularly ideal vibration pattern can thus be achieved for tooth cleaning. Experiments have shown that the vibration pattern, in particular the "8" movement, is particularly advantageous, which means that tooth cleaning with the brush can be performed particularly gently. The angle range has also proven to be particularly advantageous in connection with the deflection or eccentricity of the head portion in relation to the overall length of the brush between 10% and 20% and has also led to particularly good cleaning results with optimum ergonomics.

The angle range of 10° - 14° in combination with a kink position at half the length of the brush leads to a good deflection (eccentricity) of the brush head. This results in good self-dynamics of the vibration of the brush head in the sense of the desired "8" movement.

In a particular embodiment, the neck portion is cross-sectionally tapered compared to the head portion. That is, the head portion is wider and/or thicker (as viewed perpendicular to the head portion alignment axis) than the neck portion. This makes the neck portion mechanically less rigid than the head portion (provided that the base body is made of one or more materials with approximately the same Young's modulus).

In a further embodiment of the invention, the distance (K) between the geometric kink position and the end face of the base portion is at least 60% of the total length (L) of the base body.

According to a special embodiment, the distance of the geometric kink position to the end surface of the base portion is at most 75% of the total length (L) of the base body. In this upwardly limited range, a sufficiently strong "8" movement can be achieved with the kink angle of 8° to 15° according to the invention with great design freedom with regard to the geometric dimensions of the neck portion and head portion.

A sonic toothbrush with longitudinal axis vibration according to embodiments of the invention comprises a brush according to embodiments of the invention and a hand apparatus with a brush coupling for releasably attaching