US00RE44819E

(19) **United States**

(12) **Reissued Patent**

Braun et al.

(10) **Patent Number: US RE44,819 E**

(45) **Date of Reissued Patent: Apr. 1, 2014**

(54) **TOOTHBRUSH**

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(21) Appl. No.: **10/820,562**

(22) Filed: **Apr. 8, 2004**

Related U.S. Patent Documents

Reissue of:

(64) Patent No.: **6,553,604**
Issued: **Apr. 29, 2003**
Appl. No.: **09/526,679**
Filed: **Mar. 16, 2000**

(51) **Int. Cl.**
A46B 9/04 (2006.01)
A46B 7/06 (2006.01)

(52) **U.S. Cl.**
USPC **15/167.1**; 15/201

(58) **Field of Classification Search**
USPC 15/167.1, 186, 201, 202
See application file for complete search history.

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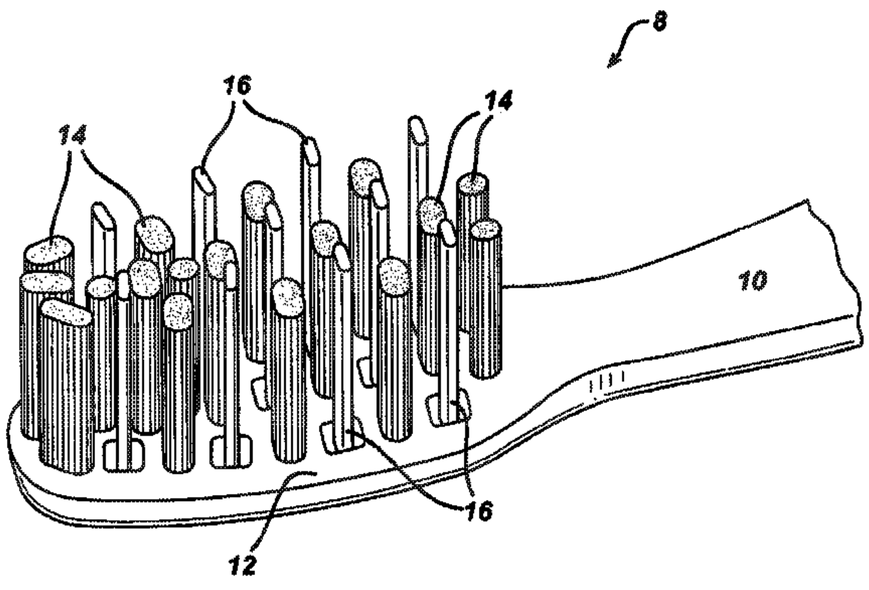
(57) **ABSTRACT**

A toothbrush includes a handle, a head extending from the handle, and a plurality of tooth cleaning elements, such as tufts of bristles, extending from the head. Each tooth cleaning element is supported for rotation about primarily only one axis. Each tooth cleaning element is rotatable independent of the other tooth cleaning element(s).

41 Claims, 4 Drawing Sheets



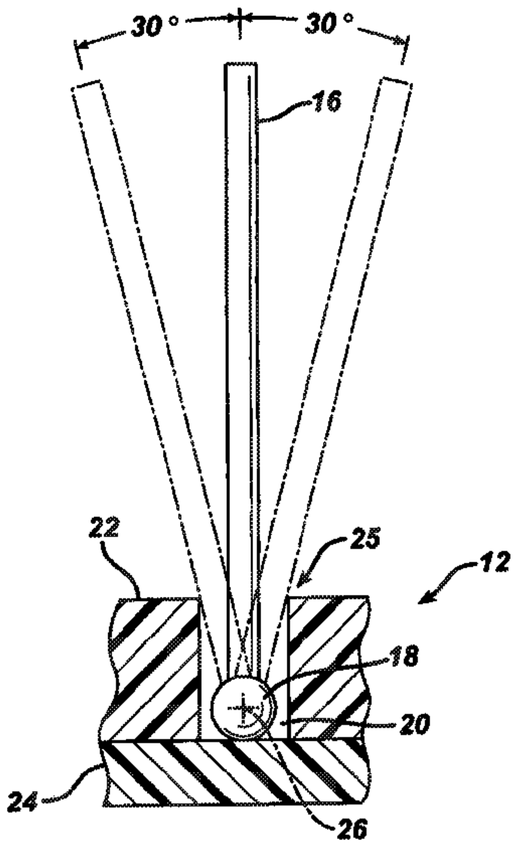


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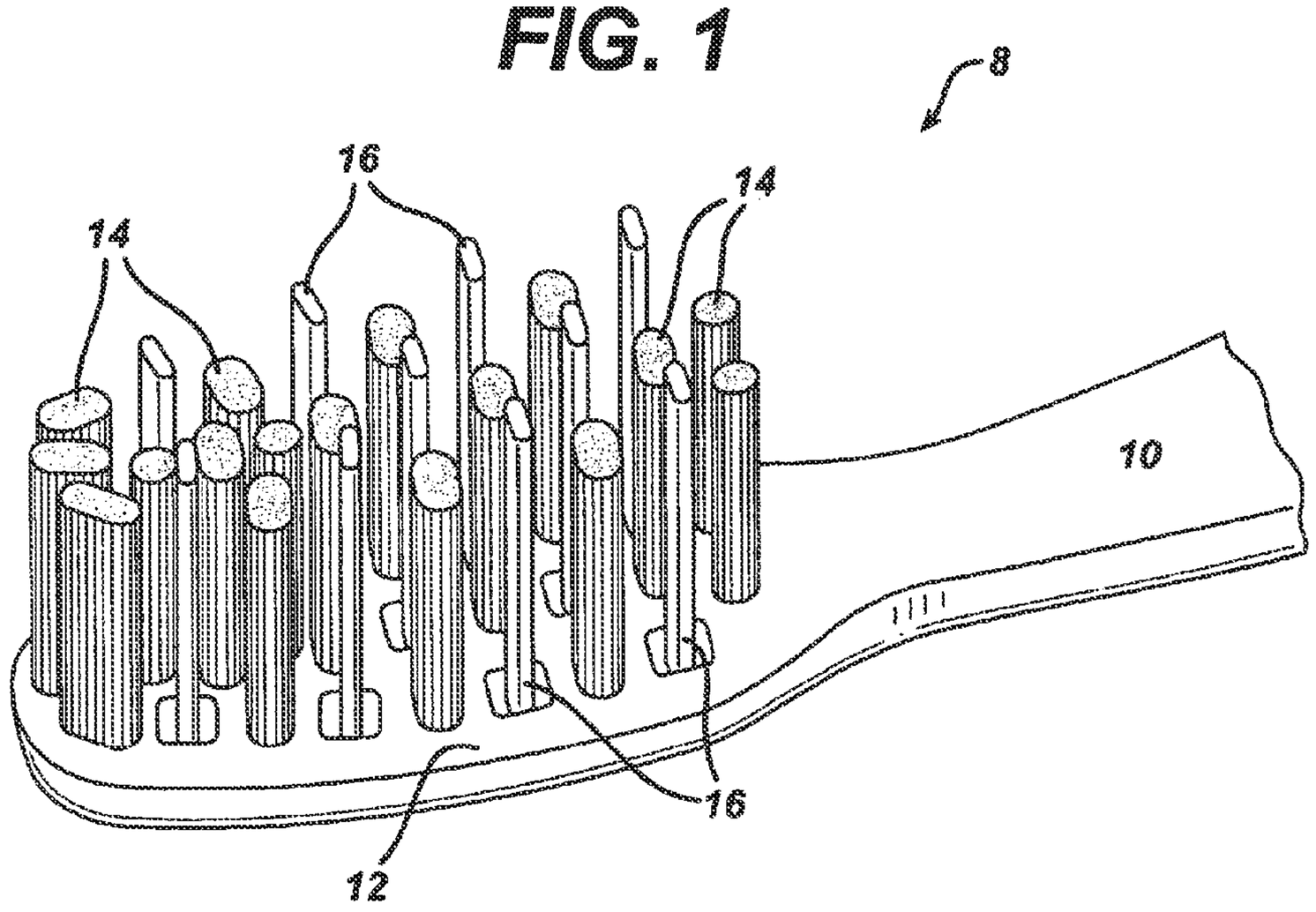
FIG. 1



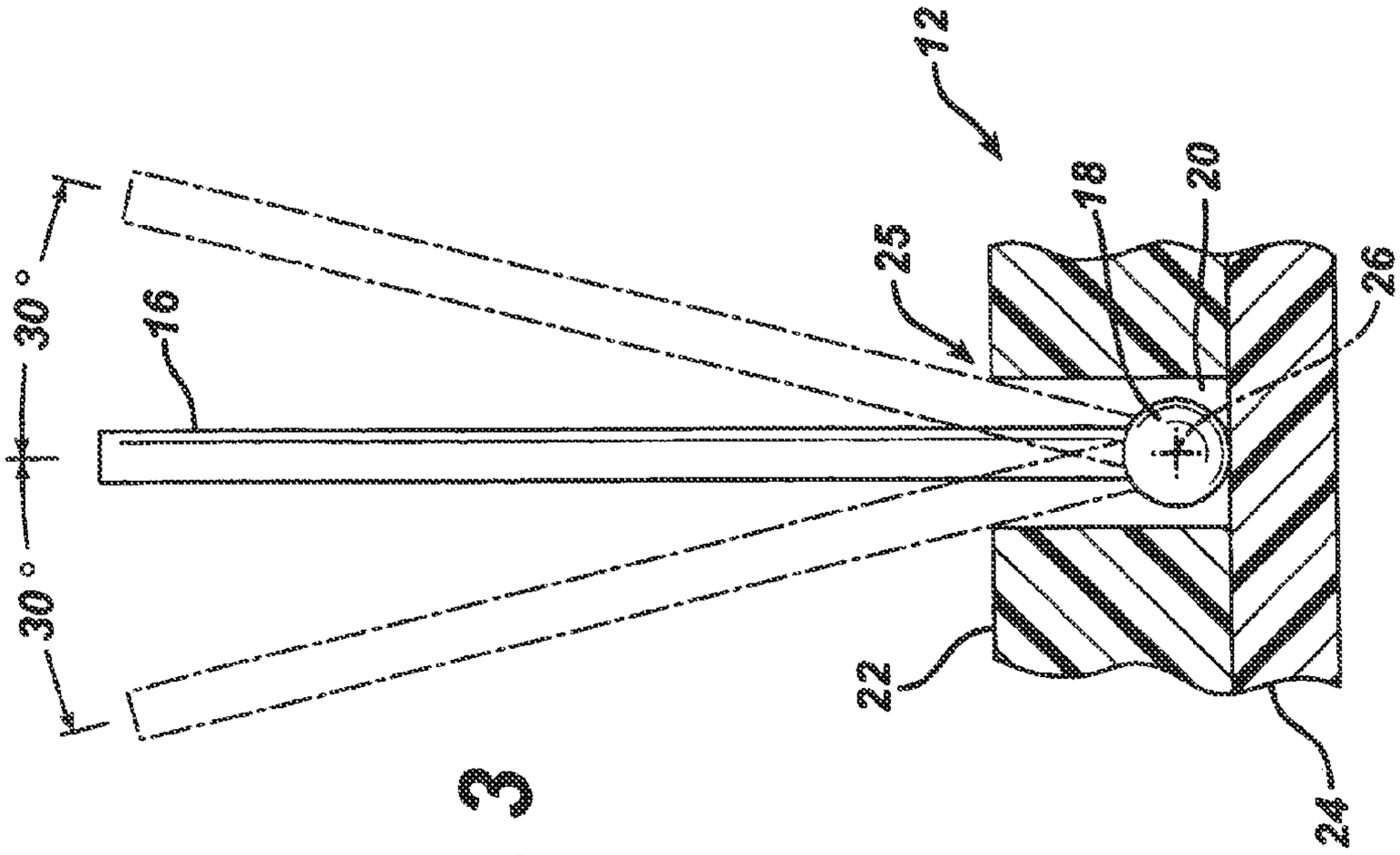


FIG. 3

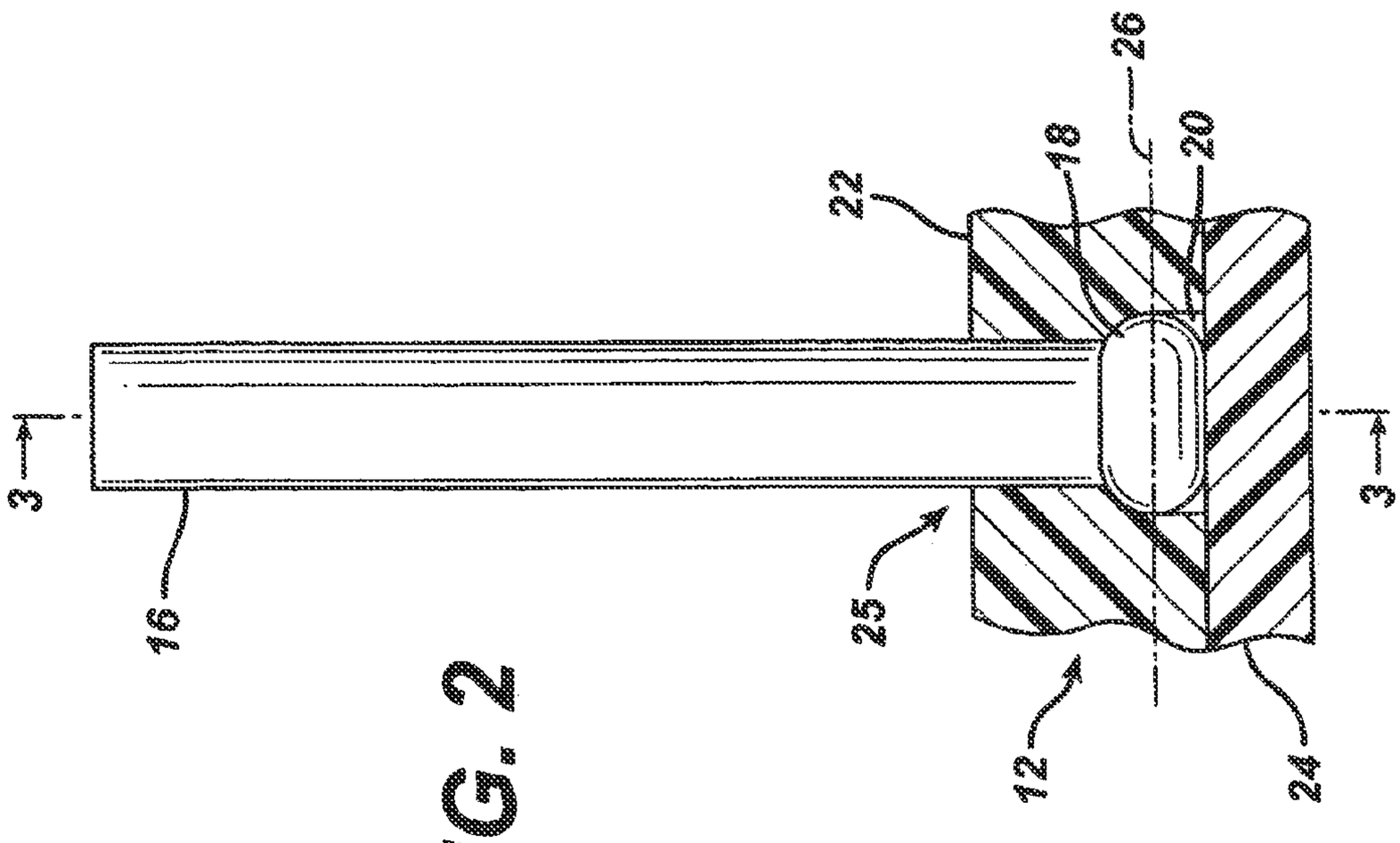


FIG. 2

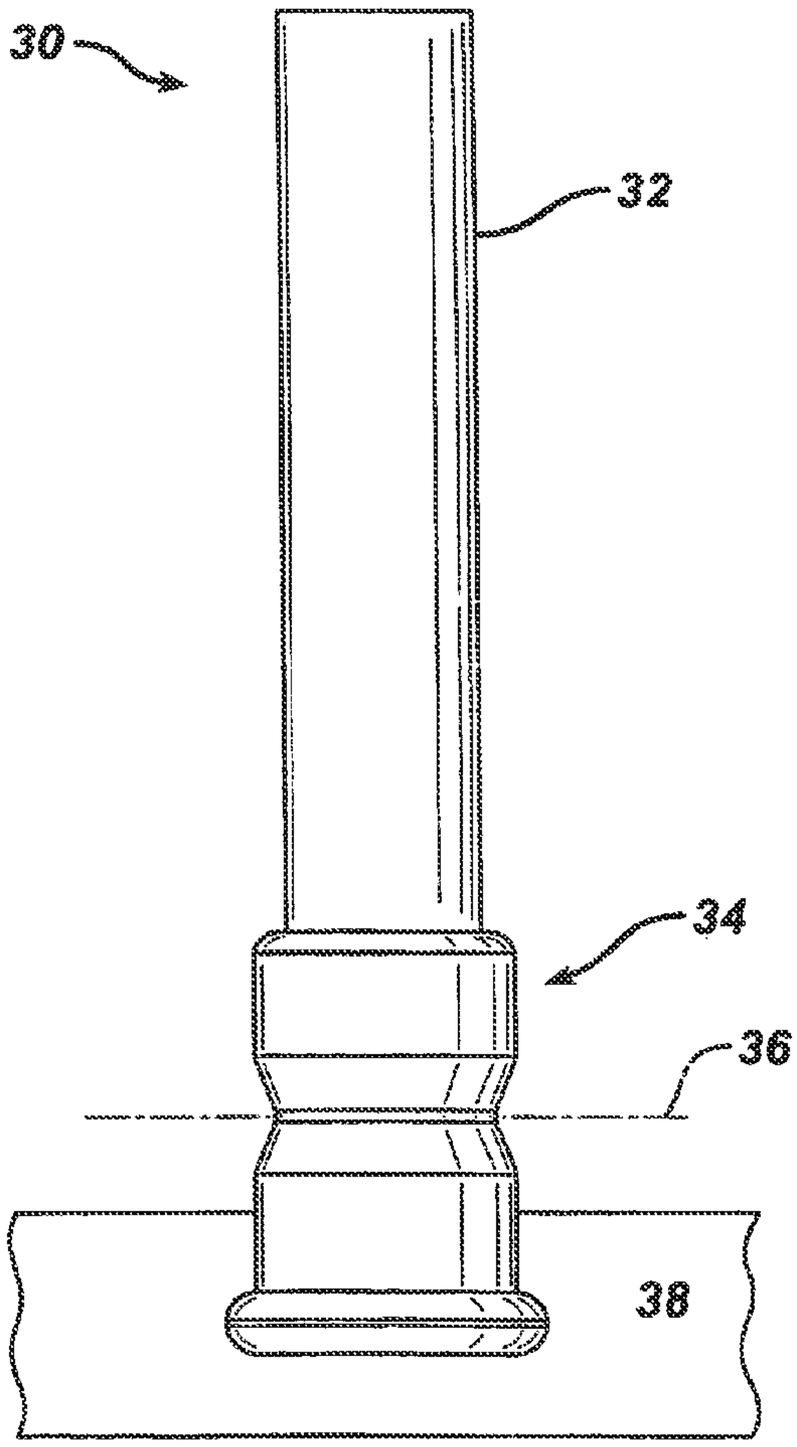


FIG. 4

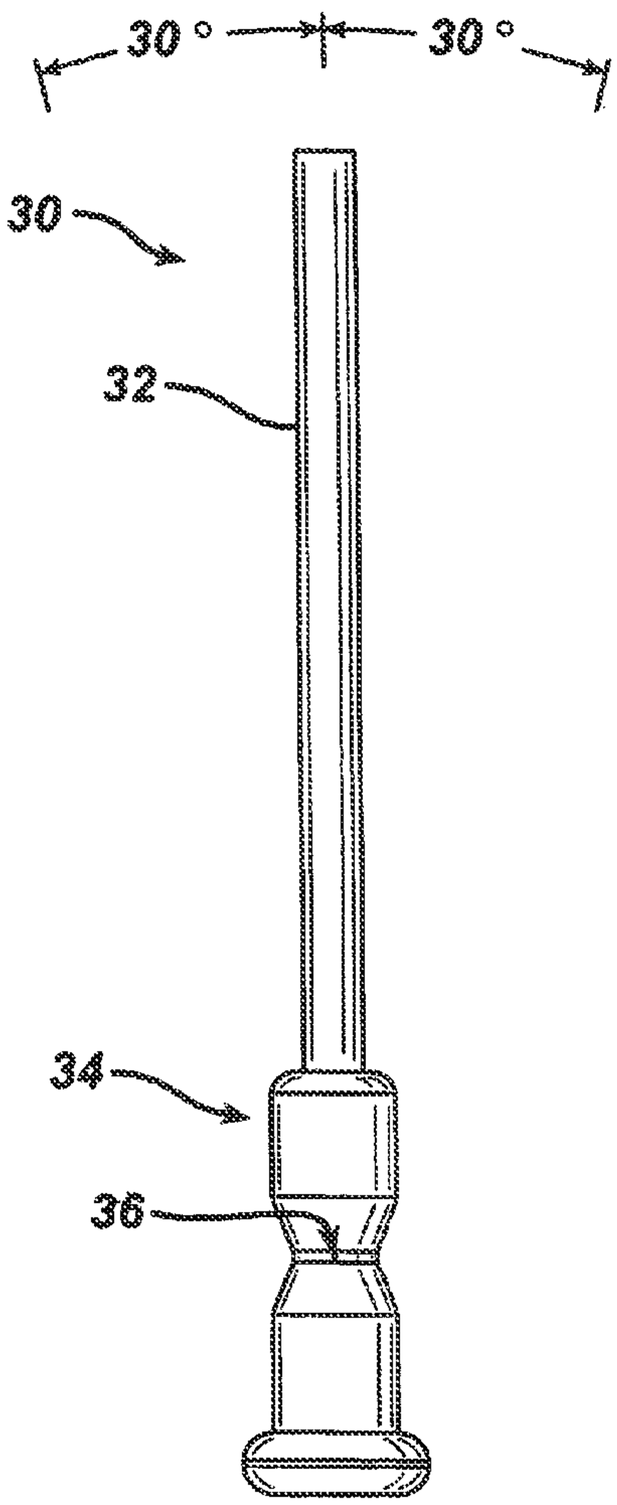
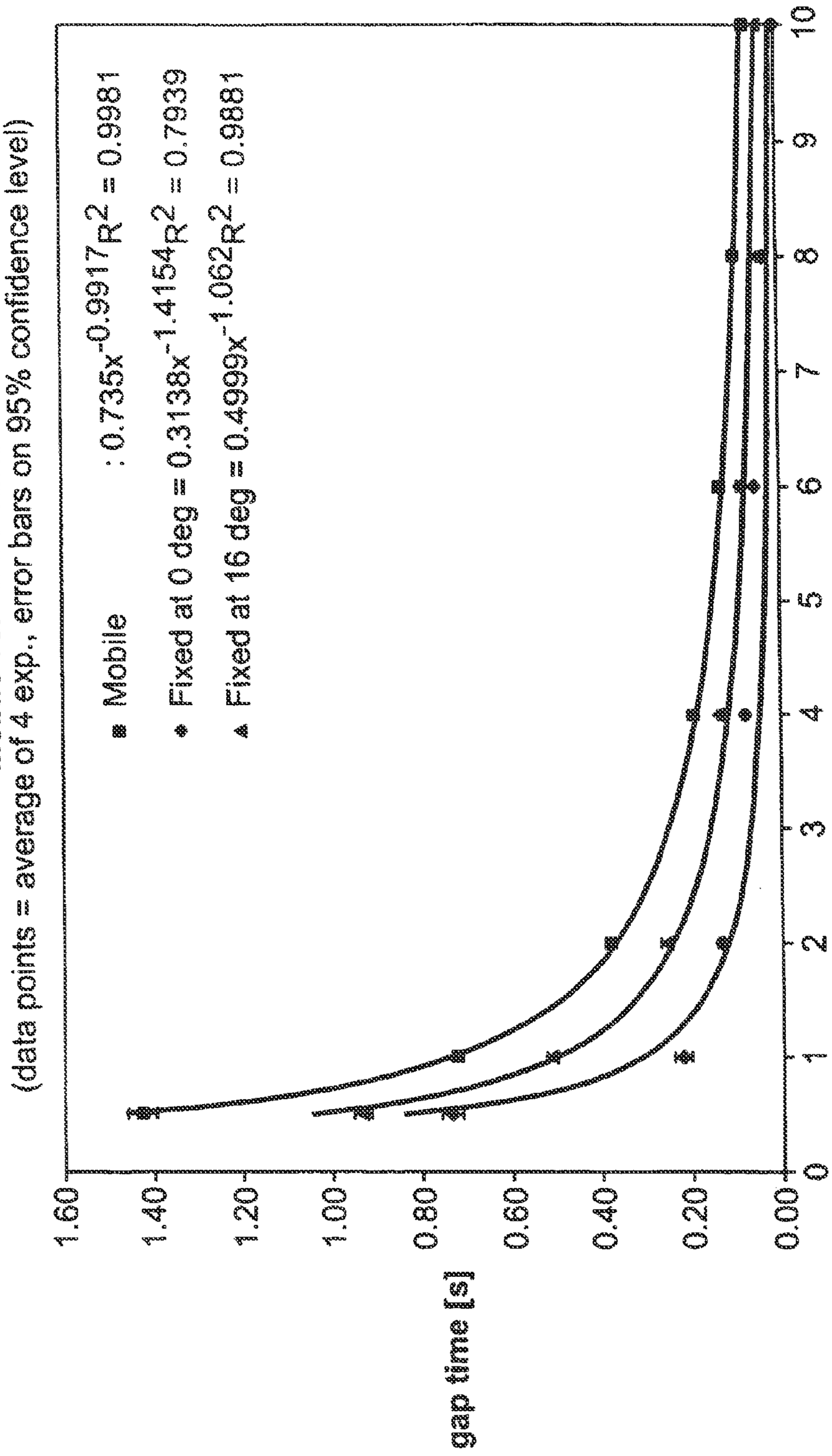


FIG. 5

FIG. 6


Mobile vs. Fixed Tufts
(data points = average of 4 exp., error bars on 95% confidence level)
■ Mobile : $0.735x^{-0.9917}$ $R^2 = 0.9981$
◆ Fixed at 0 deg = $0.3138x^{-1.4154}$ $R^2 = 0.7939$
▲ Fixed at 16 deg = $0.4999x^{-1.062}$ $R^2 = 0.9881$
gap time [s]
1.60
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
velocity [m/s]
0
1
2
3
4
5
6
7
8
9
10

TOOTHBRUSH

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

More than one reissue application has been filed for the reissue of U.S. Pat. No. 6,553,604.

This application (U.S. application Ser. No. 10/820,562) is a reissue application based on U.S. application Ser. No. 09/526,679, filed Mar. 16, 2000, which previously issued as U.S. Pat. No. 6,553,604. U.S. application Ser. No. 12/828,653 and U.S. application Ser. No. 12/828,667 (now abandoned) were filed on Jul. 1, 2010 as divisional applications of and claim priority to U.S. application Ser. No. 10/820,562, filed on Apr. 8, 2004. Thus, U.S. application Ser. No. 10/820,562, U.S. application Ser. No. 12/828,653, and U.S. application Ser. No. 12/828,667 (now abandoned) are all reissue applications of U.S. Pat. No. 6,553,604.

FIELD OF THE INVENTION

The invention relates generally to the field of oral care, and in particular to toothbrushes.

BACKGROUND OF THE INVENTION

A Japanese patent document having an application number of 3-312978 discloses a toothbrush having a multiplicity of tufts of nylon bristles. In a first embodiment shown in FIGS. **1**, **2** and **3**, a plurality of cylindrical recessed sections in the head are set orthogonally to the longitudinal axial direction of a shank and are formed at equal intervals. Column-shaped rotary bodies **5** are respectively contained in the recessed sections. On the peripheral surfaces of the rotary bodies **5**, along the axial direction, projected strip sections **5**a are formed, and they are set in a state that they are positioned at the opening sections of the recessed sections. At the opening sections of the recessed sections, contact surfaces to be positioned on both the sides are formed. At both the ends of the upper surfaces of the projected strip sections **5**a, nylon bristles **6** are arranged to be vertically erected.

As shown in FIG. **3**, the arrangement described above allows bristles **6** to rotate during use of the brush. A problem with this brush is that two tufts of bristles are secured to each strip section **5**a and thus must rotate in unison. As a result, an individual tuft of bristles cannot rotate independently of its "partner" tuft. The individual tuft may thus be prevented from achieving optimal penetration between two teeth during brushing because the partner tuft might contact the teeth in a different manner and interfere with rotation of the individual tuft.

FIGS. **4**, **5** and **6** disclose a second embodiment in which each tuft of bristles is secured to the head by a ball and socket type arrangement. While this embodiment allows each tuft of bristles to swivel independent of the other tufts, it does have disadvantages. If a tuft of bristles is tilted out towards the side of the head and that tuft is positioned near the interface between the side and top surfaces of the teeth, chances are increased that the bristle tips will not even be in contact with the teeth during brushing. Further, random orientation in which the tufts can end up after brushing detracts from the attractiveness of the brush.

SUMMARY OF THE INVENTION

The present invention is directed to overcoming one or more of the problems set forth above. Briefly summarized,

according to one aspect of the present invention, a toothbrush includes a handle, a head extending from the handle, and a plurality of tooth cleaning elements, such as tufts of bristles, extending from the head. Each tooth cleaning element is supported for rotation about primarily only one axis. Each tooth cleaning element is rotatable independent of the other tooth cleaning element(s).

By having each tooth cleaning element supported for rotation about only one axis, the problems mentioned above for the ball and socket tuft support are avoided. That is, the chances are increased that the tooth cleaning element will remain in contact with teeth during brushing and the brush will be more attractive in appearance.

Further, as each tooth cleaning element is rotatable independent of the other tooth cleaning element(s), the problem discussed above with the first Japanese embodiment is avoided. Each tooth cleaning element can achieve optimal interdental penetration without interference from rotation by another tooth cleaning element.

These and other aspects, objects, features and advantages of the present invention will be more clearly understood and appreciated from a review of the following detailed description of the preferred embodiments and appended claims, and by reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of a toothbrush according to a first embodiment of the invention;

FIG. **2** is a partial sectional view of the head of the toothbrush of FIG. **1** and one of the tooth cleaning elements;

FIG. **3** is a sectional view taken along the lines **3**-**3** of FIG. **2**;

FIG. **4** is a front view of an alternative tooth cleaning element; and

FIG. **5** is a side view of the tooth cleaning element of FIG. **4**.

FIG. **6** is a graph showing interproximal residence time of mobile tufts and fixed tufts in the interdental gap(s).

DETAILED DESCRIPTION OF THE INVENTION

Beginning with FIG. **1**, a toothbrush **8** includes a handle **10** from which extends a head **12**. Head **12** includes a first group of tooth cleaning elements **14**, such as tufts of bristles, which are secured to the head in a conventional manner (e.g. by stapling or hot-tufting). Elements **14** are designed to clean the exposed surfaces of teeth.

A second group of tooth cleaning elements **16** are secured to head **12** such that each element can independently rotate about a single axis during use of the brush. Each elements **16** can be a tuft of bristles or, alternatively, a single unitary fin made of plastic or rubber. Elements **16** are designed to penetrate in between teeth to clean the interdental spaces.

The interproximal residence time of elements **16** is significantly increased as compared to elements **14** which are rigidly fixed to head **12**. An experiment was conducted in which the interproximal residence time was determined for fixed tufts at both a 0 degree (like element **14**) and 16 degree forward angle, and for rotating tufts such as element **16**. The tufts had an average of 40 bristles each with each bristle having a 7-mil diameter. Residence times were measured on a Single Filament Tester (SFT) with a load of 4 g/tuft at velocities between 0.5 and 10 in/s.

The graph of FIG. **6** shows interproximal residence time of mobile tufts and fixed tufts in the interdental gap(s). The data are averages over 4 experiments. The error bars represent the

error of the mean at the 95% confidence level. This experimental data shows that rotating tufts experience 1.6 times more interproximal residence time compared to angled fixed bristle tufts, and 2.7 times more interproximal residence time compared to vertical fixed bristle tufts. More interproximal residence time translates into better cleaning between teeth .

With reference to FIGS. **2** and **3**, the structure for enabling element **16** to rotate and its methods of manufacture will be described. Element **16** includes at its lower end a unitary bearing **18** which is cylindrical in shape and rounded at its ends. Bearing **18** can be formed by either melting some of the material from which element **16** is made, or by molding the bearing in a separate molding operation.

Such a molding operation would use a high flow material such as Exxon Escorene Polypropylene PP-1105, or FINA Polypropylene 3824. It is important to gate from both sides and to have very low pack pressure during the molding operation. An undercut on element **16** is preferable in order to secure bearing **18** to element **16**. If bearing **18** is molded separately and then secured to element **16**, an adhesive can be used in place of the undercut to secure element **16** and bearing **18** together.

An example of a specific molding operation would be to use a 90 Ton Toshiba Injection Molding Machine to mold Exxon Escorene Polypropylene PP-1105. The temperature profile is a 350 F. barrel temperature, a 350 F. rear temperature, a 405 F. front temperature and a 390 F. nozzle temperature. The mold temperature is preferably about 90 F., and a 1/16 inch nozzle should be used. Fill time is 0.25 seconds, screw forward time is 3.75 seconds, injection time is 4.00 seconds and cool time is 15 seconds. Peak hydraulic pressure is 250 psi.

Head **12** is actually made up of a top piece **22** and a bottom piece **24**. Both of these pieces are created in separate molding steps with piece **22** being integrally molded with the brush handle. Element **16** is inserted through an aperture **25** in top piece **22** bearing end last to the position shown in the figures. Aperture **25** includes a bearing socket **20** which captures bearing **18**. It is preferable to insert a viscous substance, such as some food-grade grease, into socket **20** to provide some resistance to rotation of element **16** to prevent the element from loosely flopping back and forth. Finally, piece **24** is fixed to piece **22** to secure bearing **18** in socket **20**. Piece **24** can be secured to piece **22** by, for example, snap features (not shown) or heat welding. Alternatively, piece **24** can be injection molded into place.

An alternative manufacturing method to using two pieces **22**, **24** for the head is to injection mold the entire head (and handle) about bearing **18**. A higher melting temperature material would need to be used for element **16** and bearing **18** so that they are not softened/melted during injection molding of the head/handle. Element **16** can be exercised after completion of the brush by rotating the element back and forth to free it in the event some plastic from the head is interfering with rotation.

The arrangement described above allows element **16** to rotate back and forth about only one axis **26** which is preferably substantially perpendicular to a long axis of element i**6**. Preferably, element **16** can rotate about 30 degrees either side of vertical. The top of aperture **25** limits the amount of rotation that can be experienced by element **16**. It should be noted that there is no spring force or other force which returns element **16** to a home position, so the element can end up at any one of an infinite number of positions along its 60 degree freedom of movement at the end of the brushing process.

Alternatively, bearing **18** could be made in a spherical shape. Use of such a spherical bearing would still only allow element **16** to rotate about only one axis because, as shown in FIG. **2**, head **12** fits up against opposite sides of element **16**, thereby restricting rotation to occurring about one axis only.

Turning to FIGS. **4** and **5**, an alternative tooth cleaning element will be described. Element **30** includes a tooth cleaning portion **32** which can be a tuft of bristles or a unitary plastic or rubber fin. A hinge **34** (e.g. a living hinge) made of a soft plastic or elastomer is injection molded onto cleaning portion **32**. The material from which hinge **34** is made must be carefully selected, because if it is too soft, retention of element **16** will be poor, and if the material is too hard, the hinge will not be flexible enough. The hinge is preferably made of GLS Corp.'s DYNAFLEX thermoplastic rubber compound G2780 or G2711 and can be injection molded under the conditions outlined above. The living hinge allows cleaning portion **32** to rotate primarily only about an axis **36** which, as described above, is preferably substantially perpendicular to a long axis of portion **32**. Resistance to rotation increases as portion **32** is moved away from a position vertical to the top surface of the brush head. A toothbrush head **38** with integral handle (not shown) is injection molded about a base portion of living hinge **34** to capture the living hinge in the head (see FIG. **4**).

The invention has been described with reference to a preferred embodiment. However, it will be appreciated that variations and modifications can be effected by a person of ordinary skill in the art without departing from the scope of the invention.

What is claimed is:

1. **[**A toothbrush**]** *An apparatus*, comprising**[**;**]**:

a *toothbrush* handle;

a *toothbrush* head extending from the *toothbrush* handle; and

a plurality of tufts of bristles extending from the head, *the tufts of bristles sized such that multiple tufts of bristles are placed beside each other in a direction generally orthogonal to the handle,* each tuft of bristles being supported for rotation about only one axis, each tuft of bristles being rotatable independent of **[**the other tuft(s) of bristles**]** *one another*.

2. The **[**toothbrush**]** *apparatus* of claim **1**, wherein each tuft has a range of rotation of about 60 degrees.

3. The **[**toothbrush**]** *apparatus* of claim **1**, wherein each tuft can rotate about 30 degrees to either side of a vertical position in which the tuft is perpendicular to a top surface of the head.

4. The **[**toothbrush**]** *apparatus* of claim **1**, further including at least one tooth cleaning element which cannot be rotated.

5. The **[**toothbrush**]** *apparatus* of claim **1**, wherein each tuft includes at its non-brushing end a bearing which is substantially cylindrical in shape in its major portion, each bearing being secured in its own hollow space within the head, each bearing allowing rotation of its respective tuft.

6. The **[**toothbrush**]** *apparatus* of claim **5**, wherein the head is made of at least two pieces which are joined together to secure the bearing within the head.

7. The **[**toothbrush**]** *apparatus* of claim **5**, wherein a viscous substance is provided in each hollow space in the head to provide some resistance to rotation of the tufts.

8. The **[**toothbrush**]** *apparatus* of claim **1**, wherein a portion of the head limits rotation of each tuft.

9. The **[**toothbrush**]** *apparatus* of claim **1**, wherein the tufts are rotated by contact with a portion of an oral cavity.

10. The **[**toothbrush**]** *apparatus* of claim **1**, wherein each tuft includes at its non-brushing end a living hinge, each living hinge being secured partially within the head, each living hinge allowing rotation of its respective tuft.

11. The **[**toothbrush**]** *apparatus* of claim **1**, wherein the axis about which each tuft is rotatable is substantially perpendicular to a long axis of the **[**element**]** *tuft*.

12. The apparatus of claim 1, wherein two or more of the tufts of bristles are disposed in a row extending generally laterally across a long axis of the toothbrush handle.

13. An apparatus comprising:

a toothbrush head having a longitudinal axis; and

a first group of tooth cleaning elements extending from the head and a second group of a plurality of tooth cleaning elements extending from the head,

the elements within each of the groups being of a common type and the type of elements in the first group being different from the type of elements in the second group, and

wherein each of the elements of the first group is nonrotatable, and

wherein each of the elements in the second group is supported for rotation about only one axis and independently rotatable with respect to any other rotatable tooth cleaning element on the toothbrush head, the elements of the second group sized such that multiple elements of the second group are placed beside each other in a direction generally orthogonal to the longitudinal axis of the toothbrush head

wherein the axis about which each element in the second group is rotatable is substantially perpendicular to the longitudinal axis of the toothbrush head.

14. The apparatus of claim 13 wherein all of the tooth cleaning elements of the toothbrush are in the first and second group.

15. The apparatus of claim 13 wherein the first group includes a plurality of tooth cleaning elements.

16. The apparatus of claim 13 wherein each of the elements in the second group is adjacent to at least one of the elements in the first group.

17. The apparatus of claim 13 wherein the interproximal residence time of elements in the second group is about 1.6 times or greater than the interproximal residence time of the elements in the first group.

18. The apparatus of claim 13 wherein the elements in the second group are longer than the elements in the first group.

19. The apparatus of claim 13 wherein the elements in the second group are made of polymer.

20. The apparatus of claim 13 wherein each of the elements in the second group is a fin or tuft of bristles.

21. The apparatus of claim 13 wherein each of the elements in the second group is a fin.

22. The apparatus of claim 21 wherein each of the elements in the first group is a tuft of bristles.

23. The apparatus of claim 13, further comprising a handle, and wherein the head extends from the handle.

24. The apparatus of claim 13 wherein the elements in the first group are free of spring bias tending to rotate the elements after deflection.

25. The apparatus of claim 13, wherein the type of elements in the first group is structurally different from the type of elements in the second group.

26. The apparatus of claim 13, wherein the type of elements in the first group is compositionally different from the type of elements in the second group.

27. The apparatus of claim 13, wherein the type of elements in the first group is structurally and compositionally different from the type of elements in the second group.

28. The apparatus of claim 13, wherein the elements in the first group are rigidly secured to the toothbrush head.

29. The apparatus of claim 13, wherein two or more of elements of the second group are disposed in a row extending generally laterally across a long axis of the toothbrush head.

30. An apparatus comprising:

a toothbrush head having a longitudinal axis; and

a plurality of tufts of bristles extending from the head, each tuft of bristles being supported for rotation about only one axis, each tuft of bristles being rotatable independent of all other rotatable tuft(s) of bristles on the toothbrush head, the tufts of bristles sized such that multiple tufts of bristles are placed beside each other in a direction generally orthogonal to the longitudinal axis of the toothbrush head,

further including at least one tooth cleaning element which cannot be rotated.

31. The apparatus of claim 30, wherein each tuft has a range of rotation of about 60 degrees.

32. The apparatus of claim 30, wherein each tuft can rotate about 30 degrees to either side of a vertical position in which the tuft is perpendicular to a top surface of the head.

33. The apparatus of claim 30, wherein each tuft includes at its non-brushing end a bearing which is substantially cylindrical in shape in its major portion, each bearing being secured in its own hollow space within the head, each bearing allowing rotation of its respective tuft.

34. The apparatus of claim 33, wherein the head is made of at least two pieces which are joined together to secure the bearing within the head.

35. The apparatus of claim 33, wherein a viscous substance is provided in each hollow space in the head to provide some resistance to rotation of the tufts.

36. The apparatus of claim 30, wherein a portion of the head limits rotation of each tuft.

37. The apparatus of claim 30, wherein the tufts are rotated by contact with a portion of an oral cavity.

38. The apparatus of claim 30, wherein each tuft includes at its non-brushing end a living hinge, each living hinge being secured partially within the head, each living hinge allowing rotation of its respective tuft.

39. The apparatus of claim 30, wherein the axis about which each tuft is rotatable is substantially perpendicular to a long axis of the element.

40. The apparatus of claim 30, further comprising a handle.

41. The apparatus of claim 30, wherein two or more of the tufts of bristles are disposed in a row extending generally laterally across a long axis of the toothbrush head.

* * * * *