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(54) **POWERED TOOTHBRUSH WITH FLEXIBLE HEAD**

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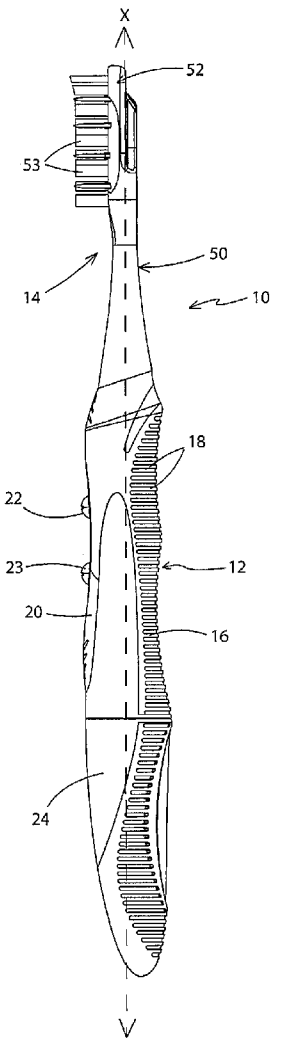
(57) **ABSTRACT**

A toothbrush having a head with at least two movable members. The members flex inwardly and outwardly away from each other in a direction that is substantially at right angles to the longitudinal axis of the brush handle. Force is transferred from one movable member to another to aid in this relative movement. Bristles extending from both movable members are brought into contact with the surface of teeth so that the tips are disposed at right angles thereto. In a first embodiment, two movable members are connected by an oscillating rod that flexes the members away from each other. In a second embodiment, a center section on the head nests within a perimeter section and a rotatable cam extends between the sections and flexes them inwardly and outwardly away from each other.



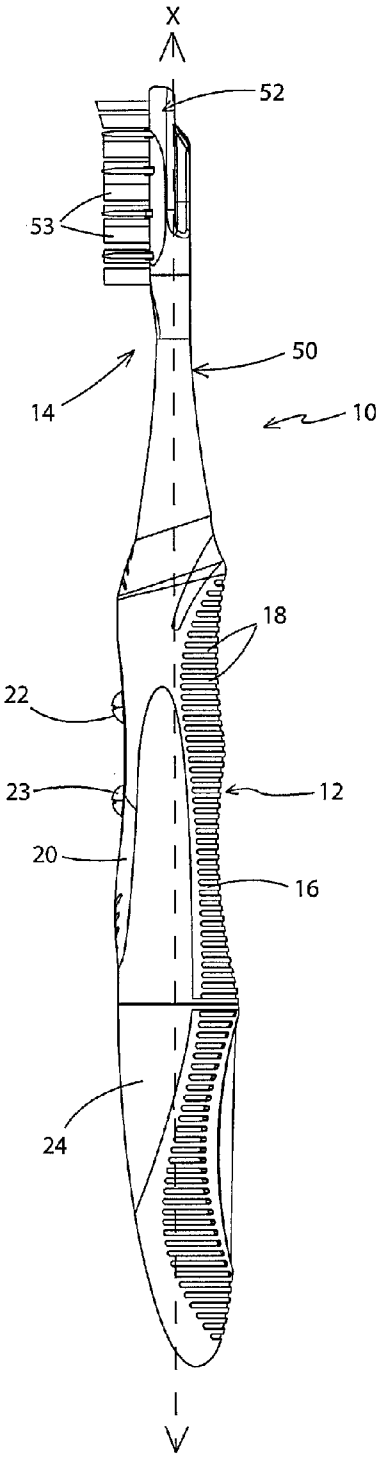

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FIG. 1

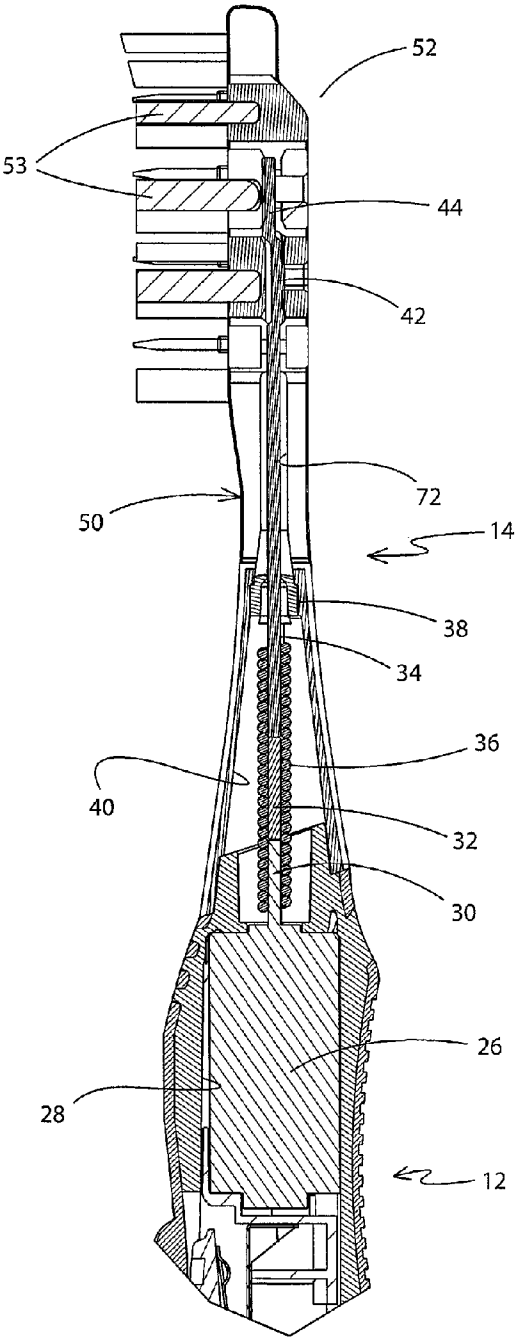
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FIG. 2

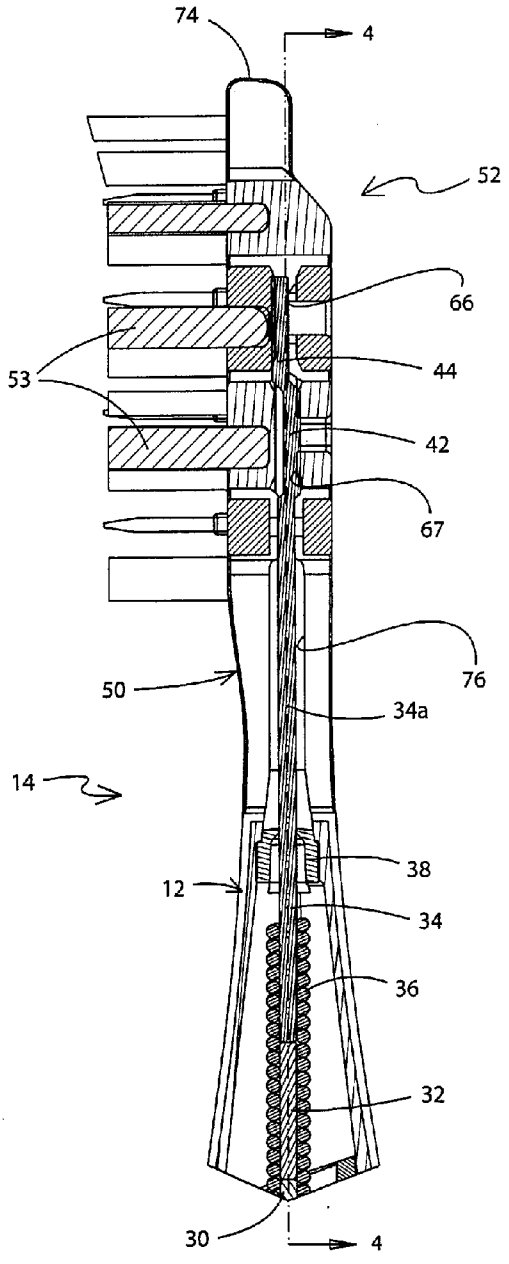
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FIG. 3

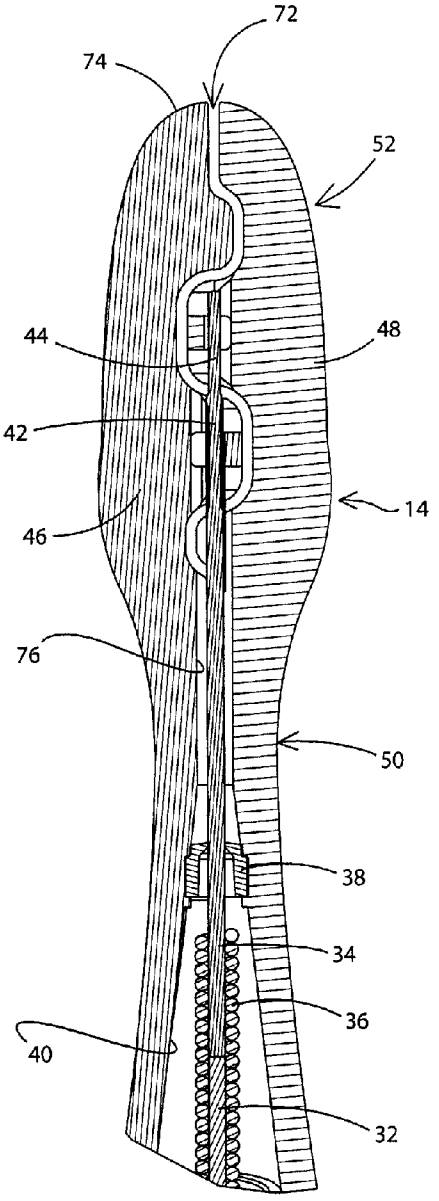
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FIG. 4

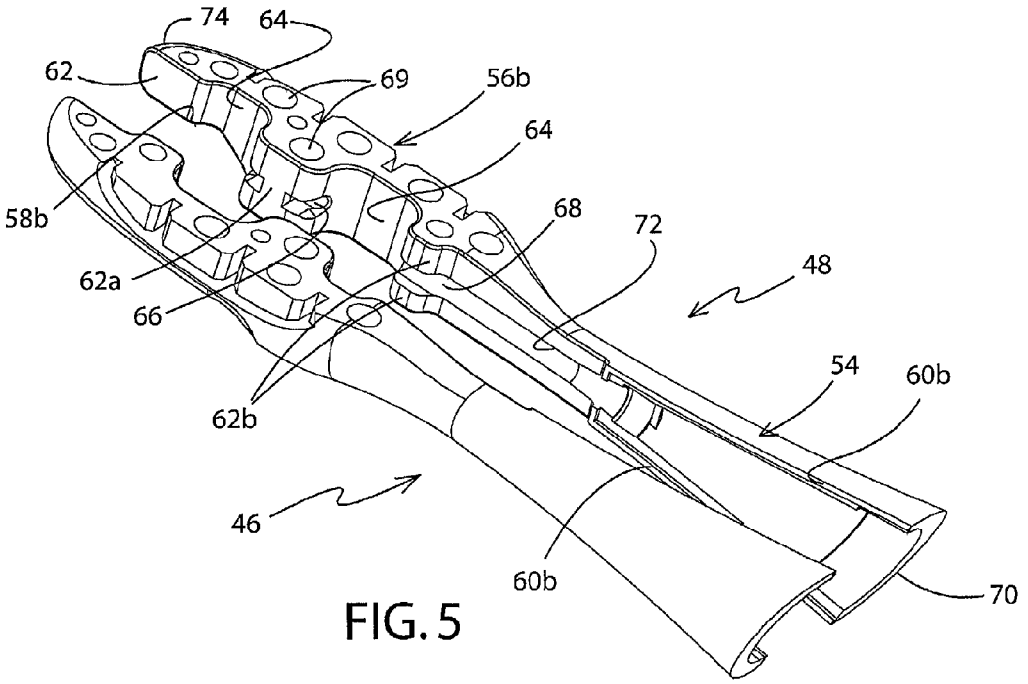
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FIG. 5

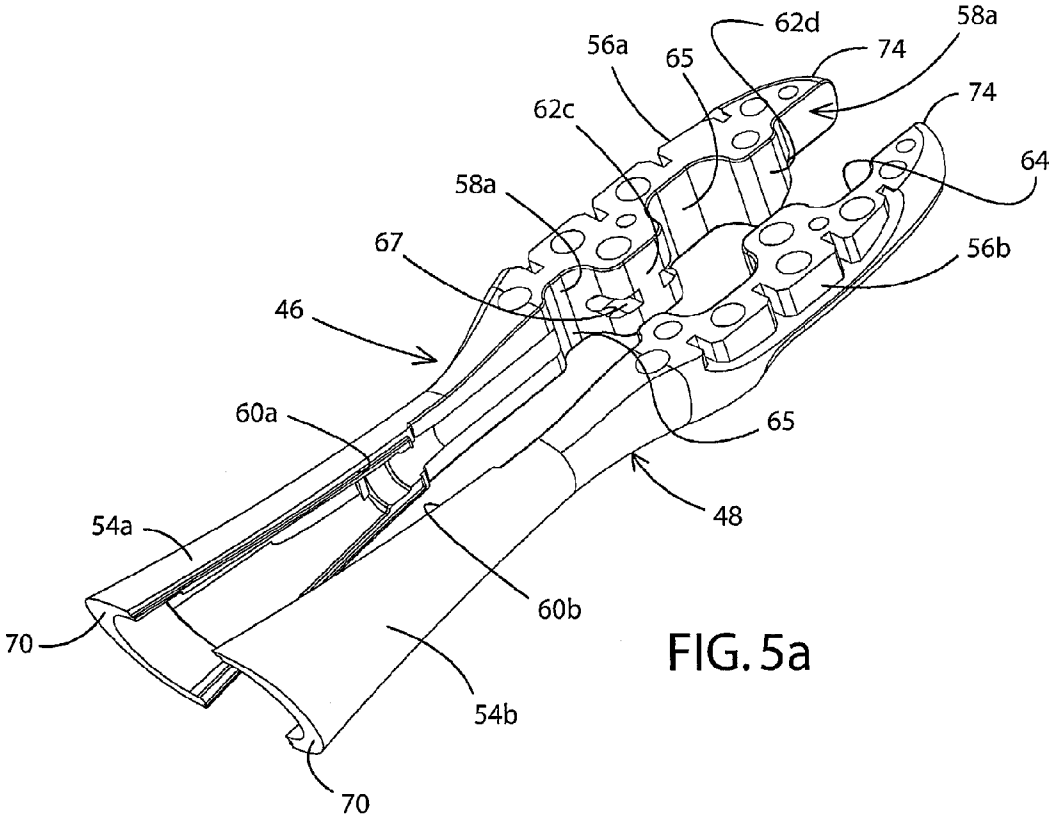
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FIG. 5a

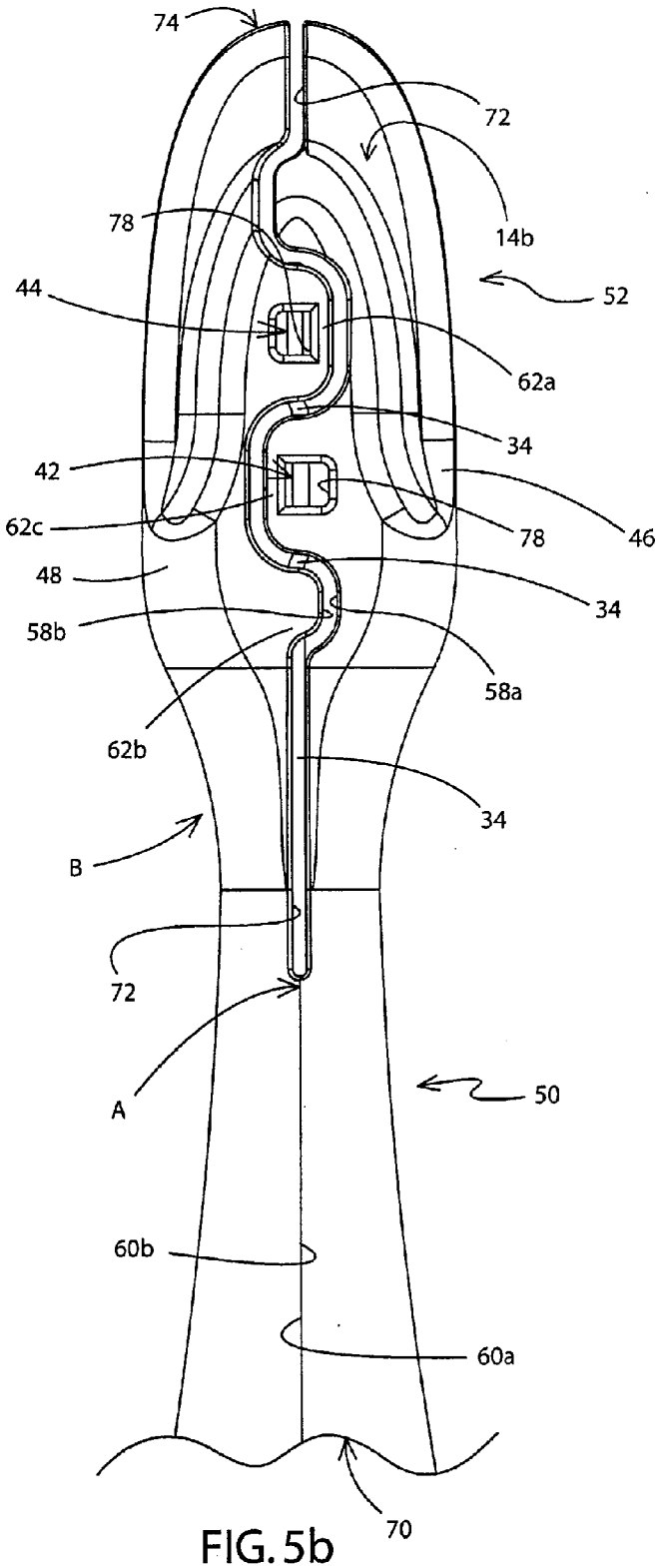
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FIG. 5b

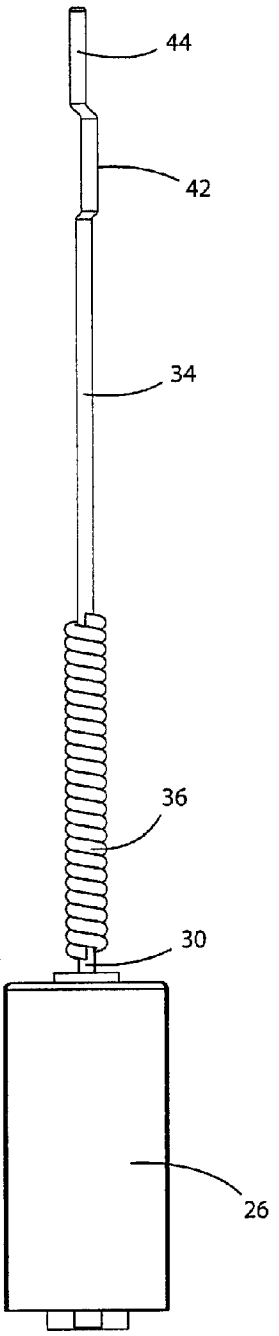
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FIG. 6

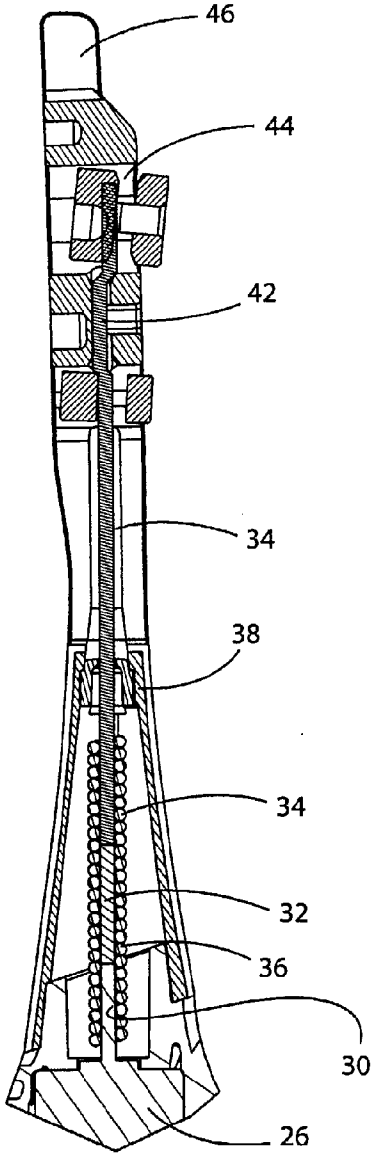


FIG. 7

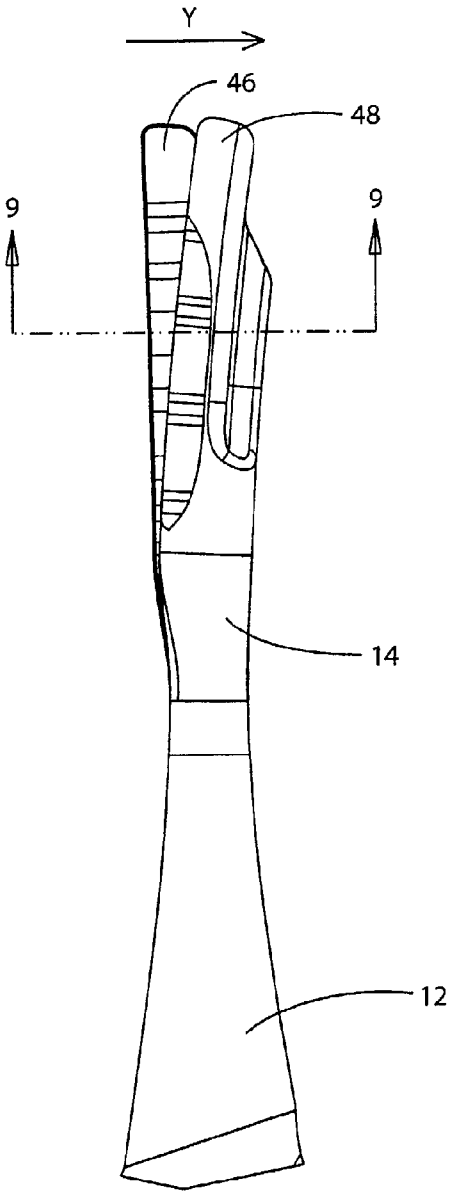


FIG. 8

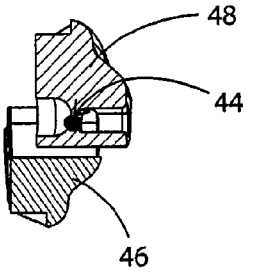
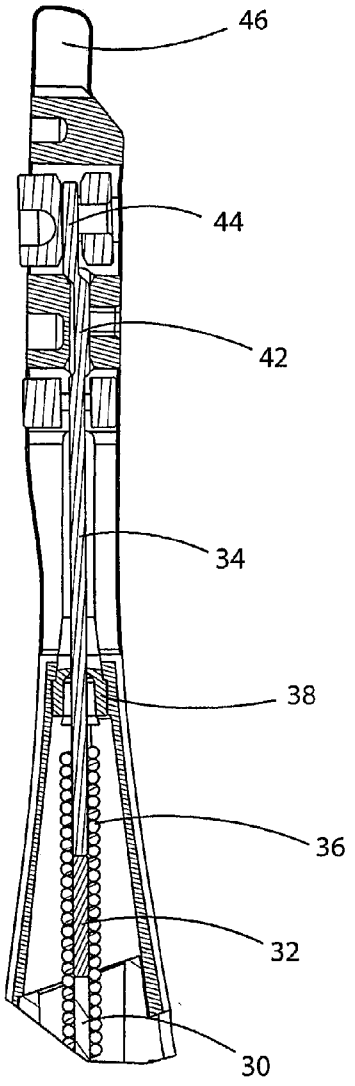


FIG. 9



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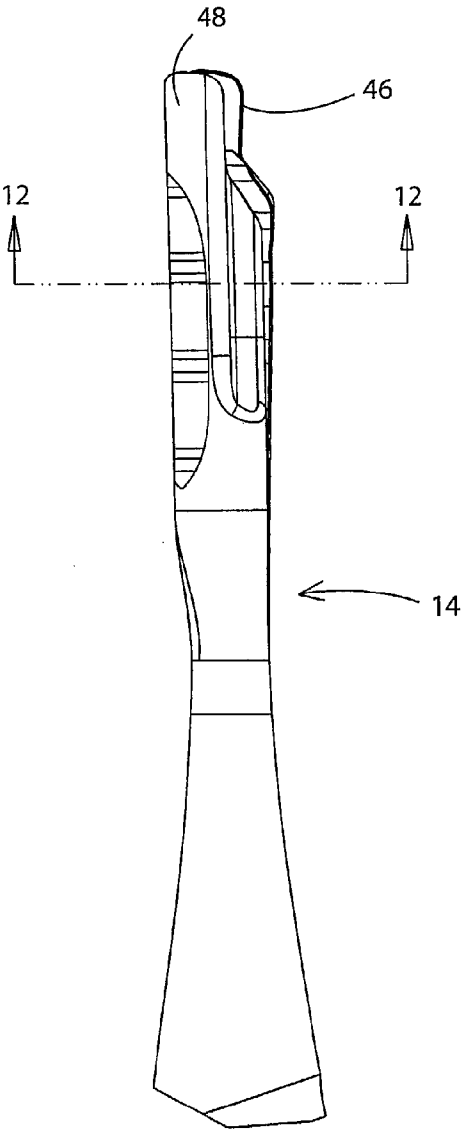

FIG. 11

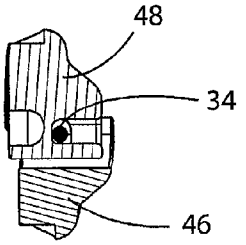

FIG. 12

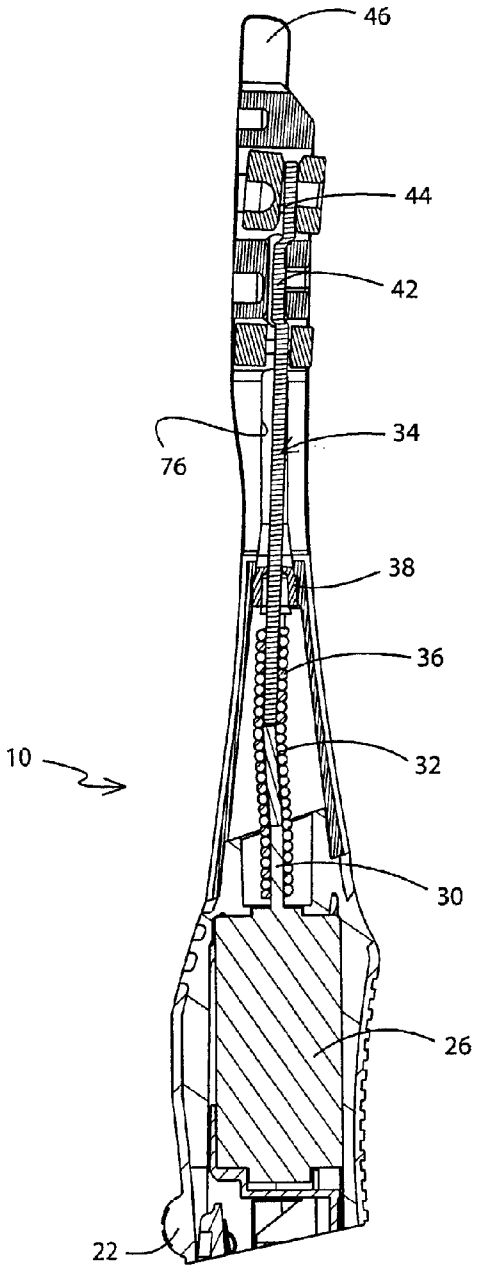

FIG. 13

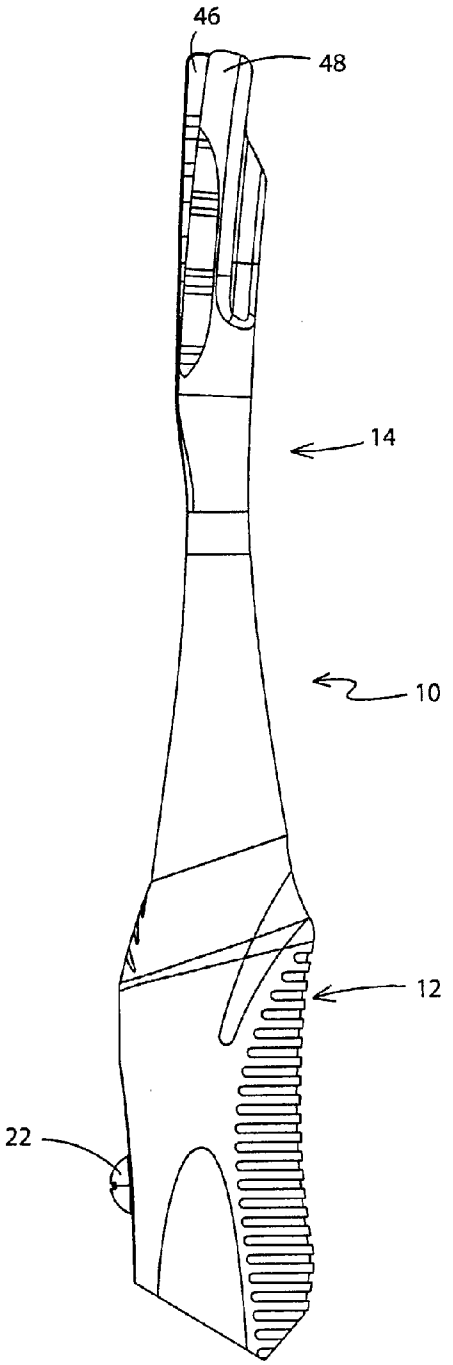

FIG. 14

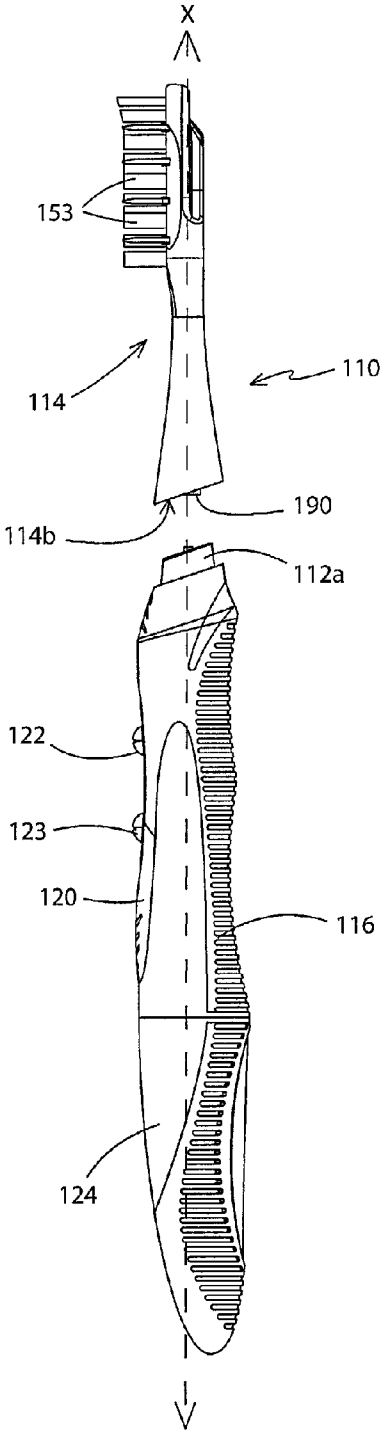
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FIG. 15

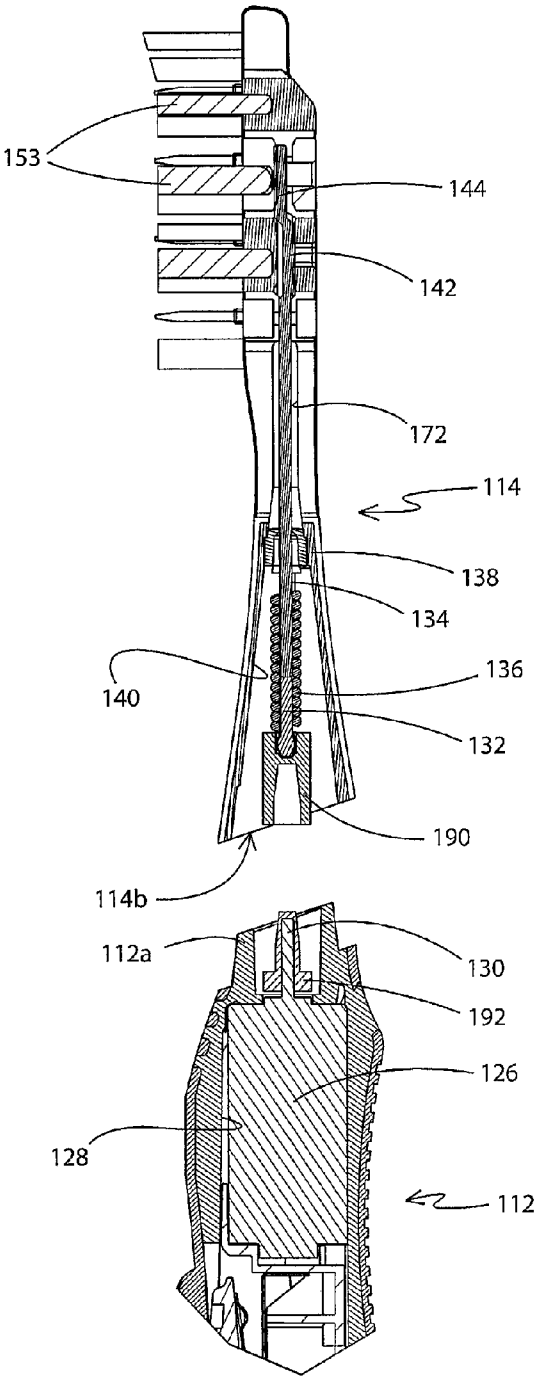
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FIG. 16

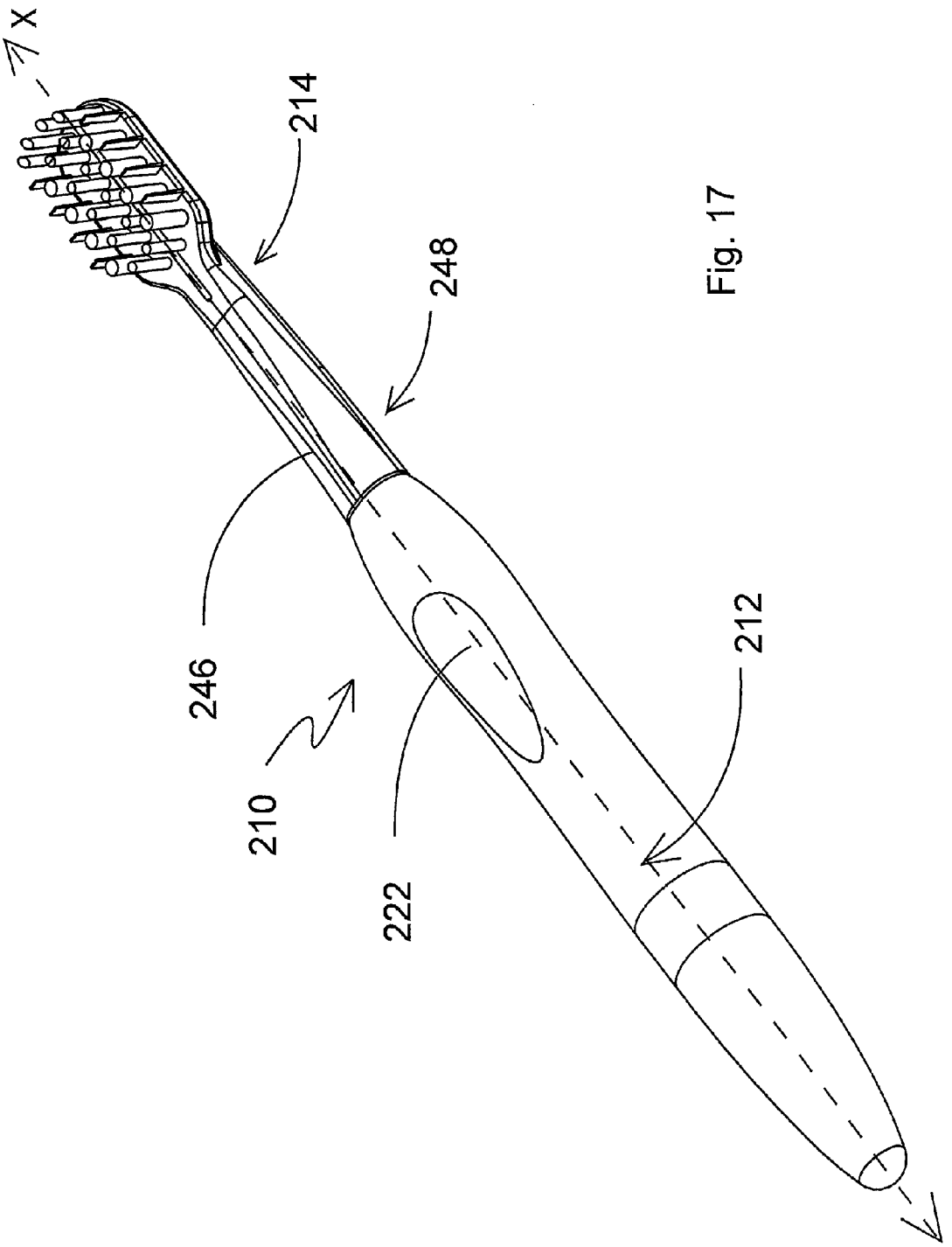

Fig. 17

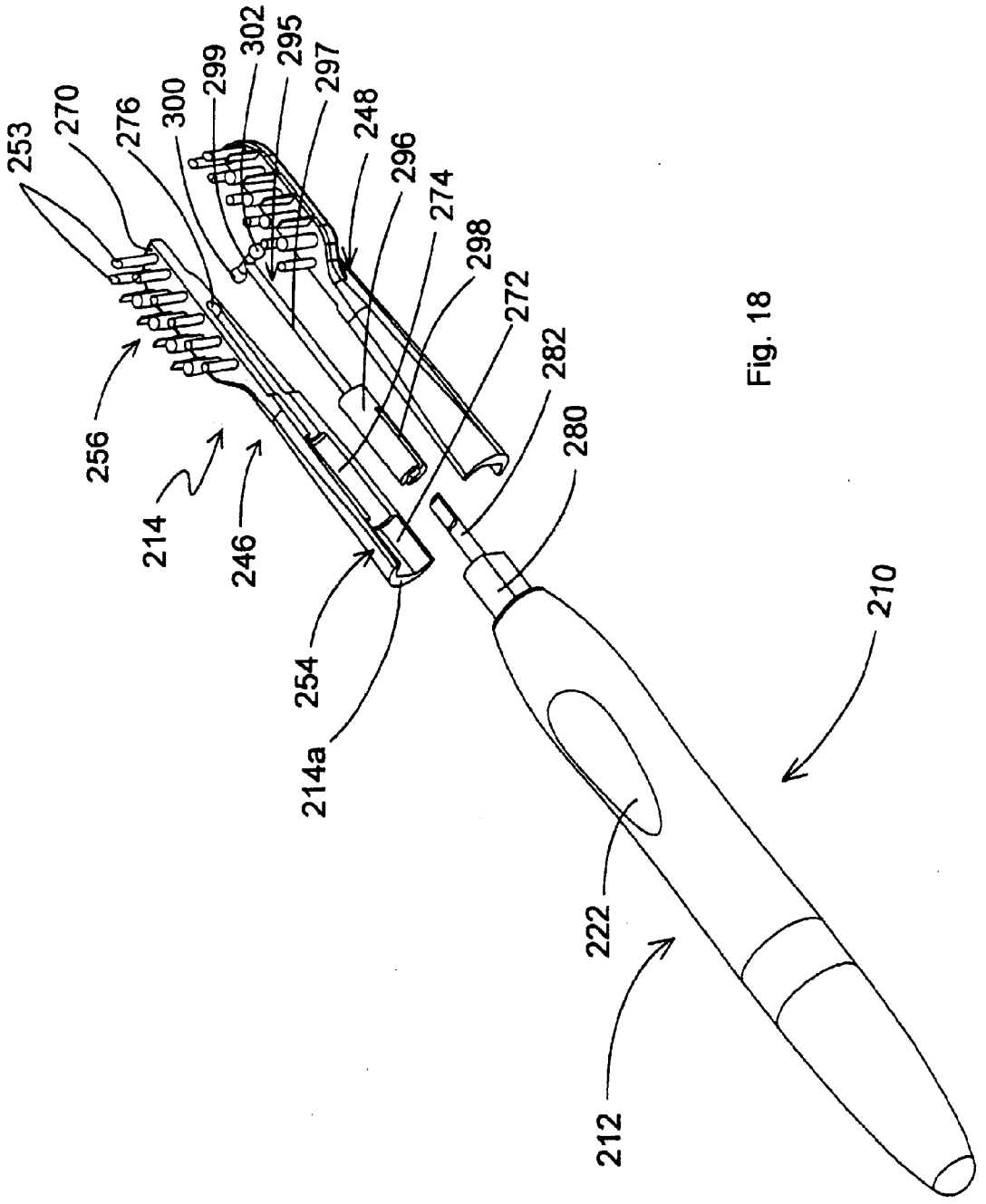
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Fig. 18

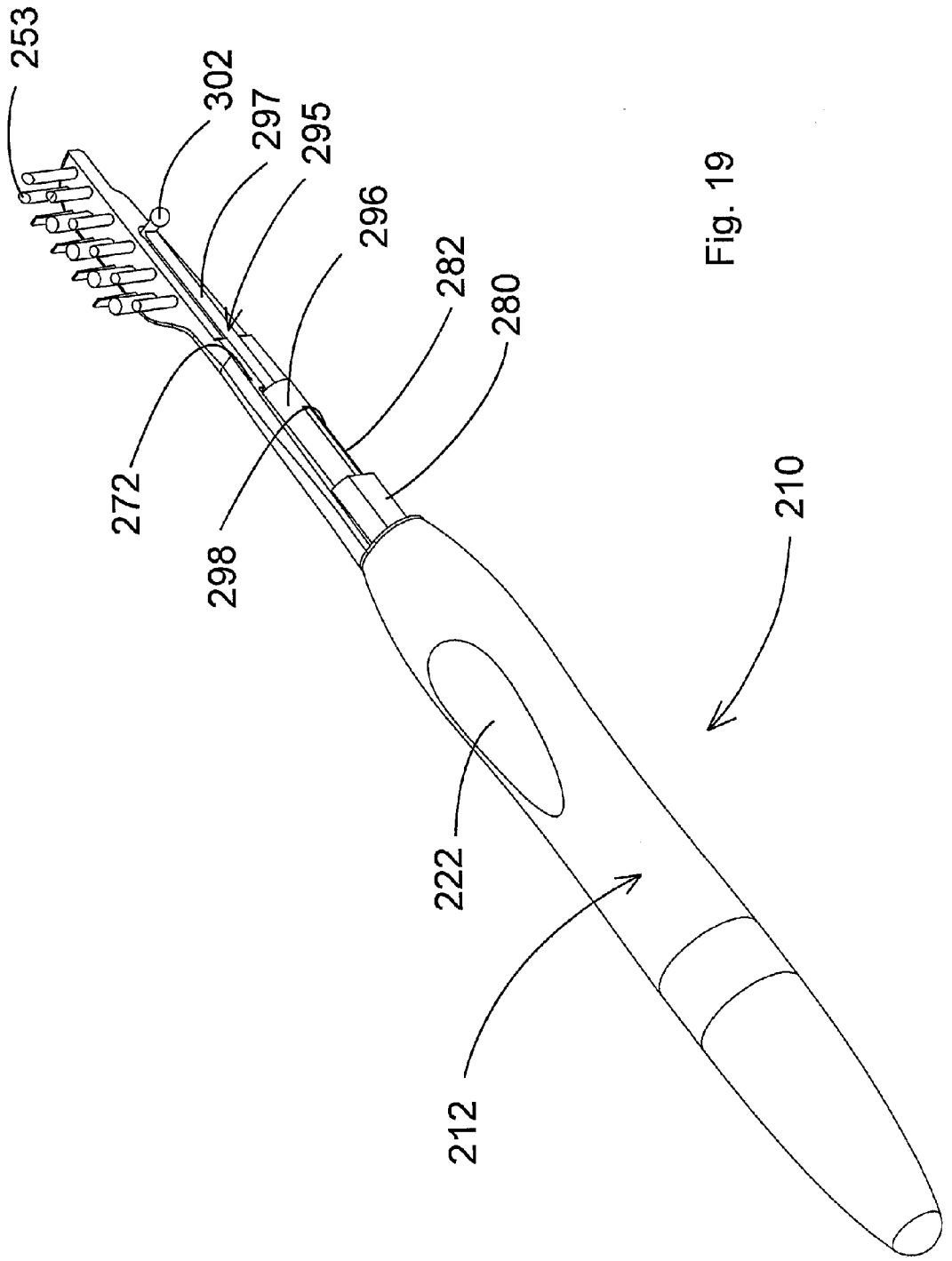

Fig. 19

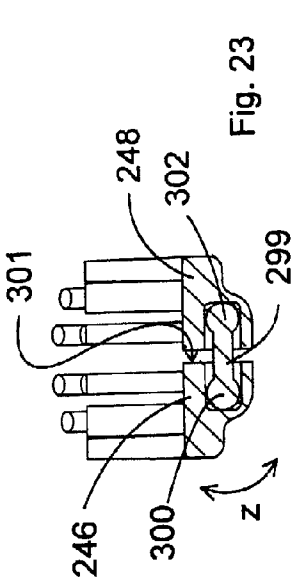

Fig. 23

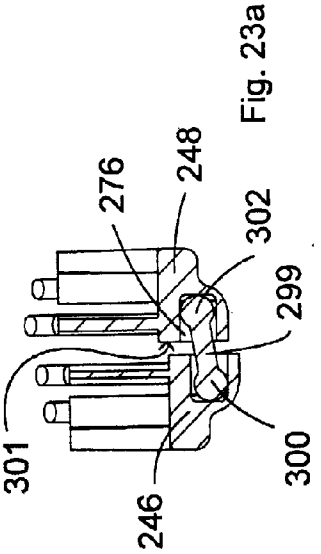

Fig. 23a

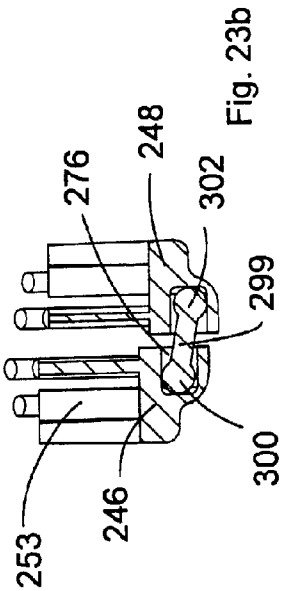

Fig. 23b

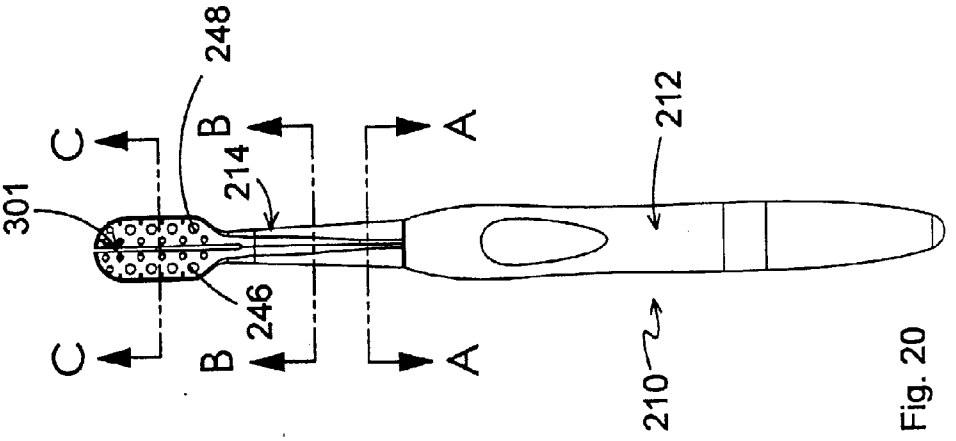

Fig. 20

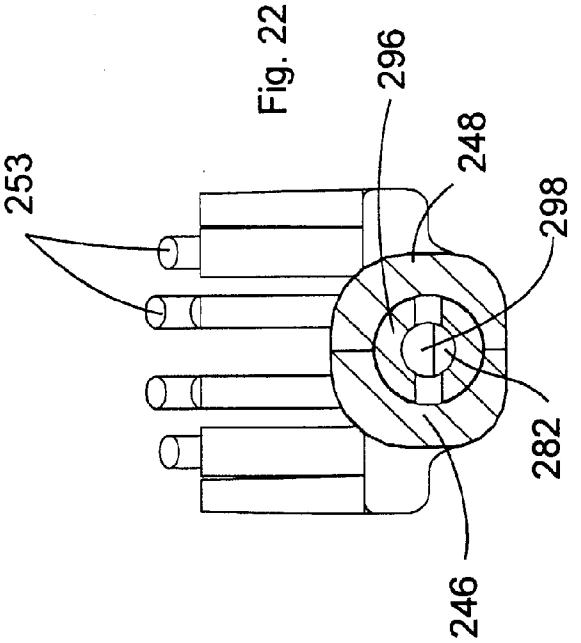

Fig. 22

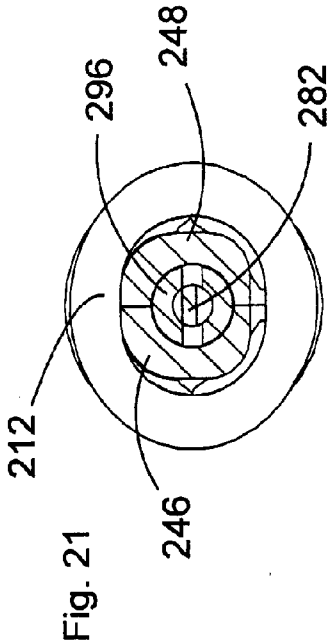

Fig. 21

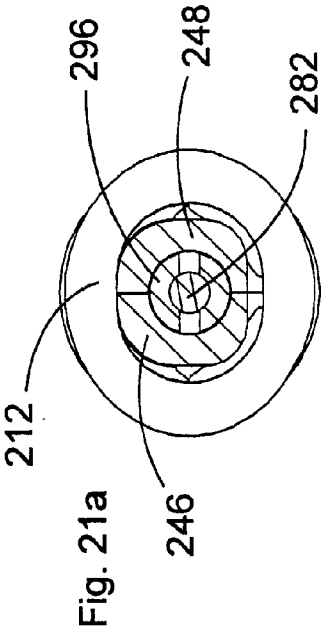

Fig. 21a

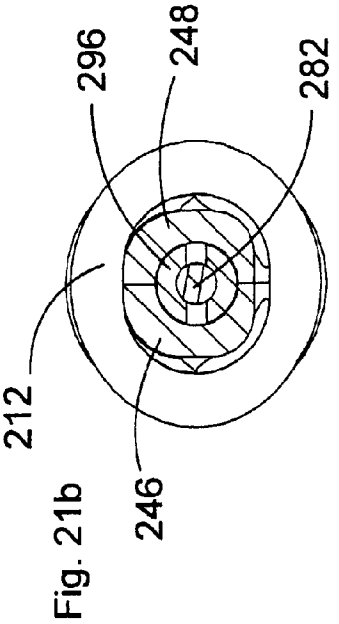

Fig. 21b

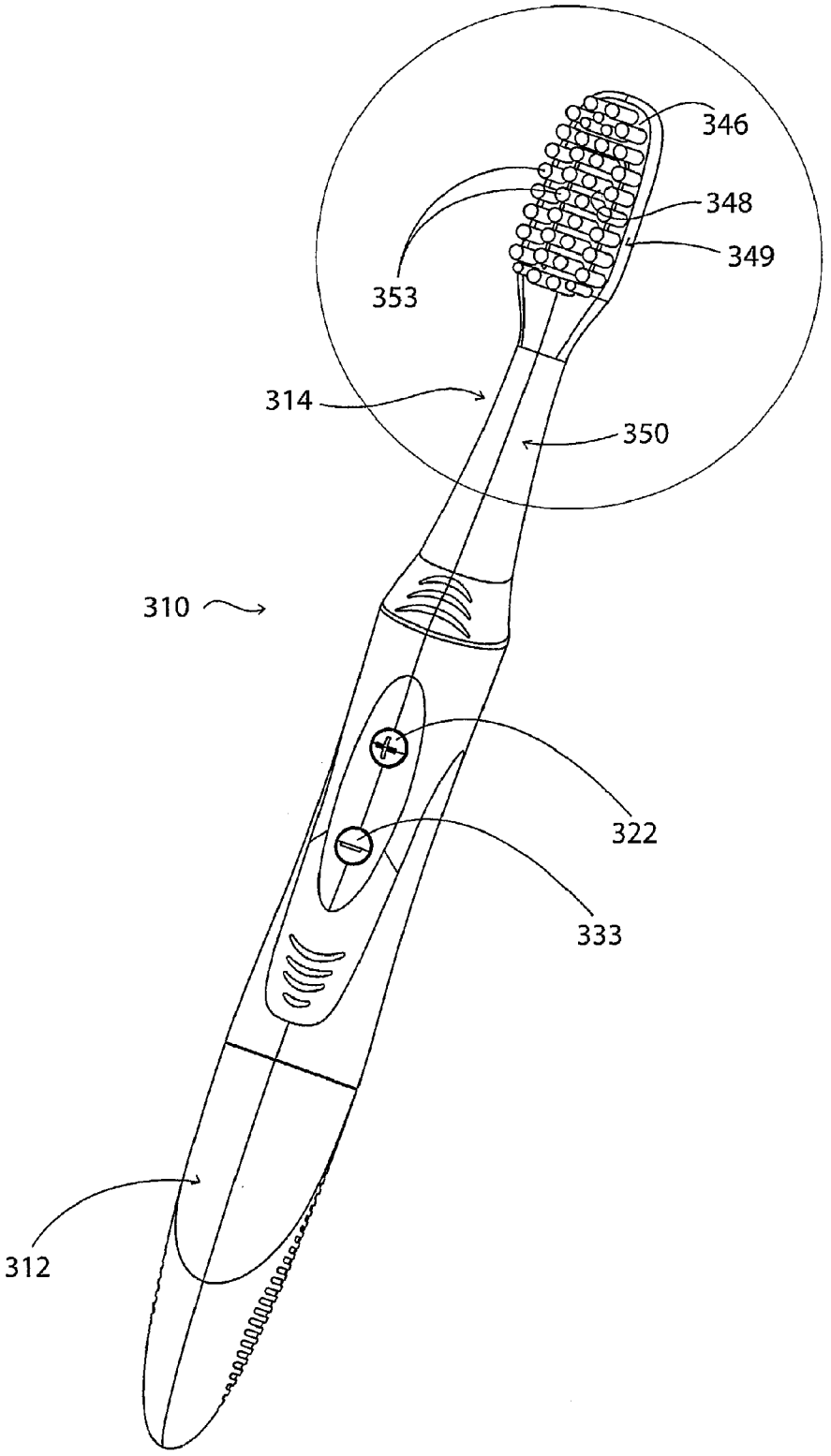

Fig. 24

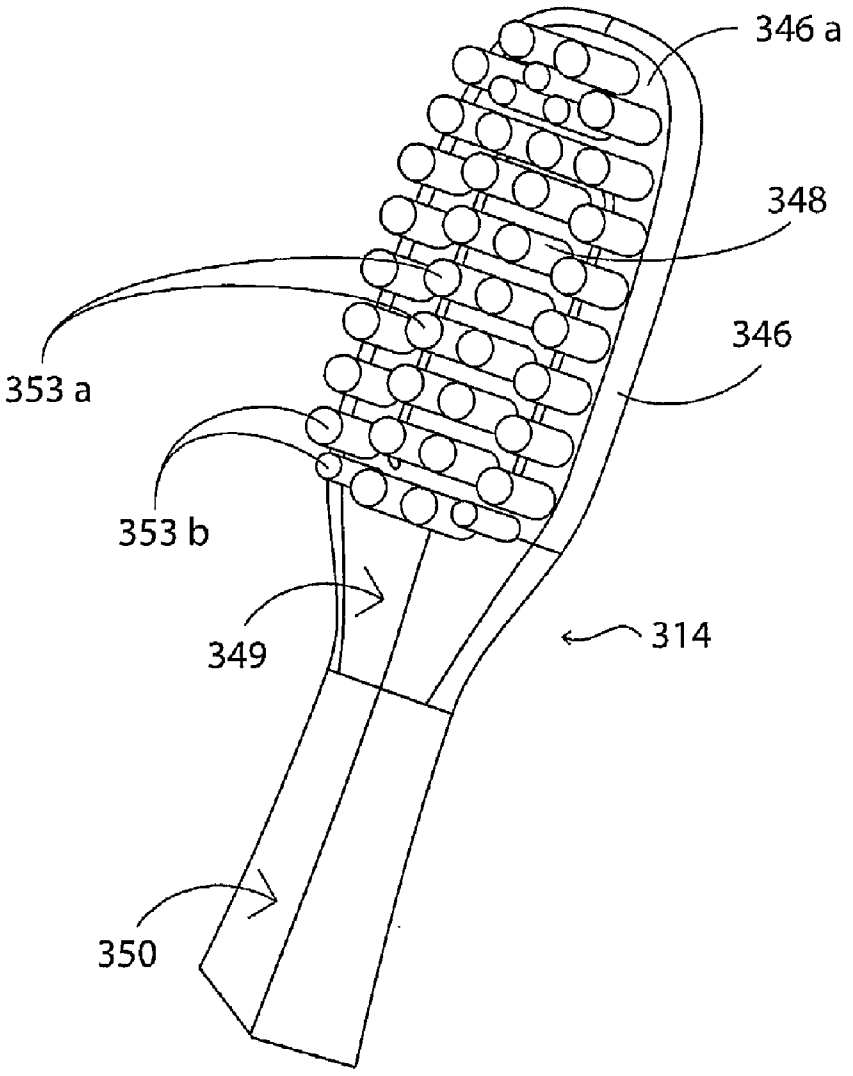

Fig. 25

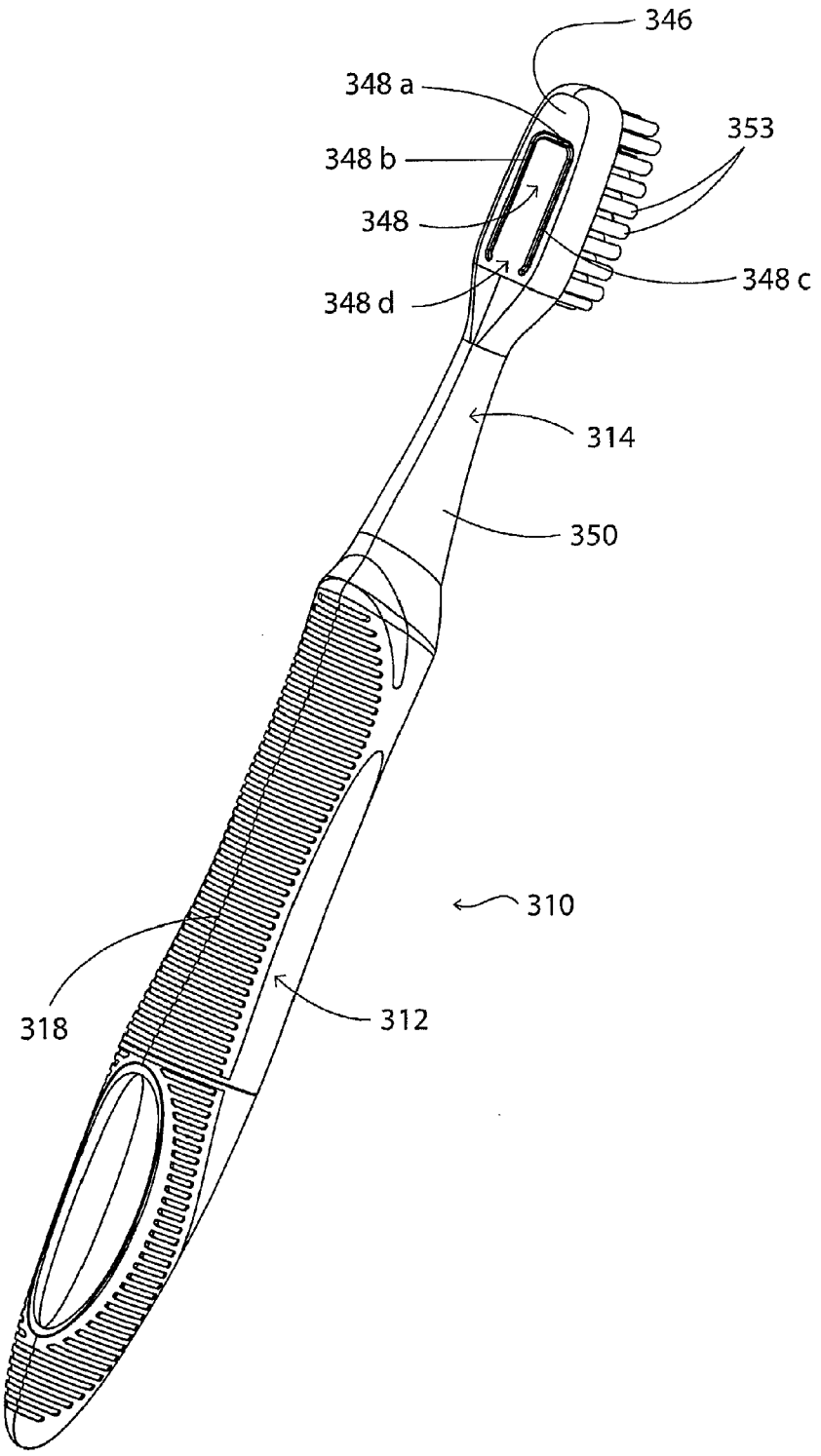

Fig. 26

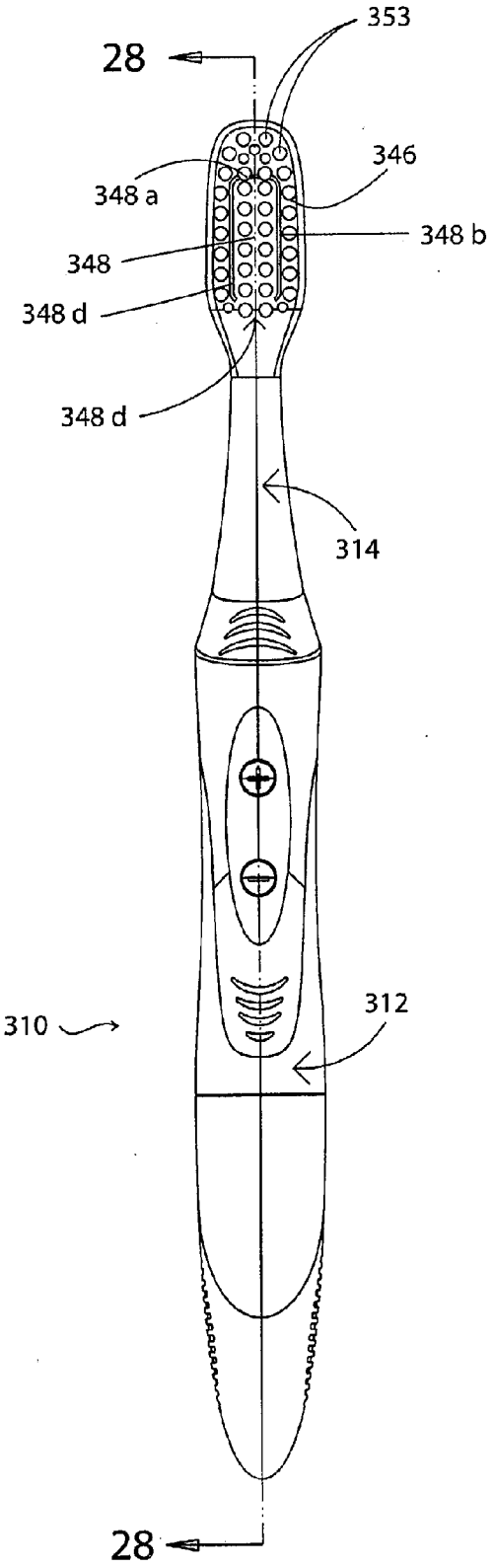

Fig. 27

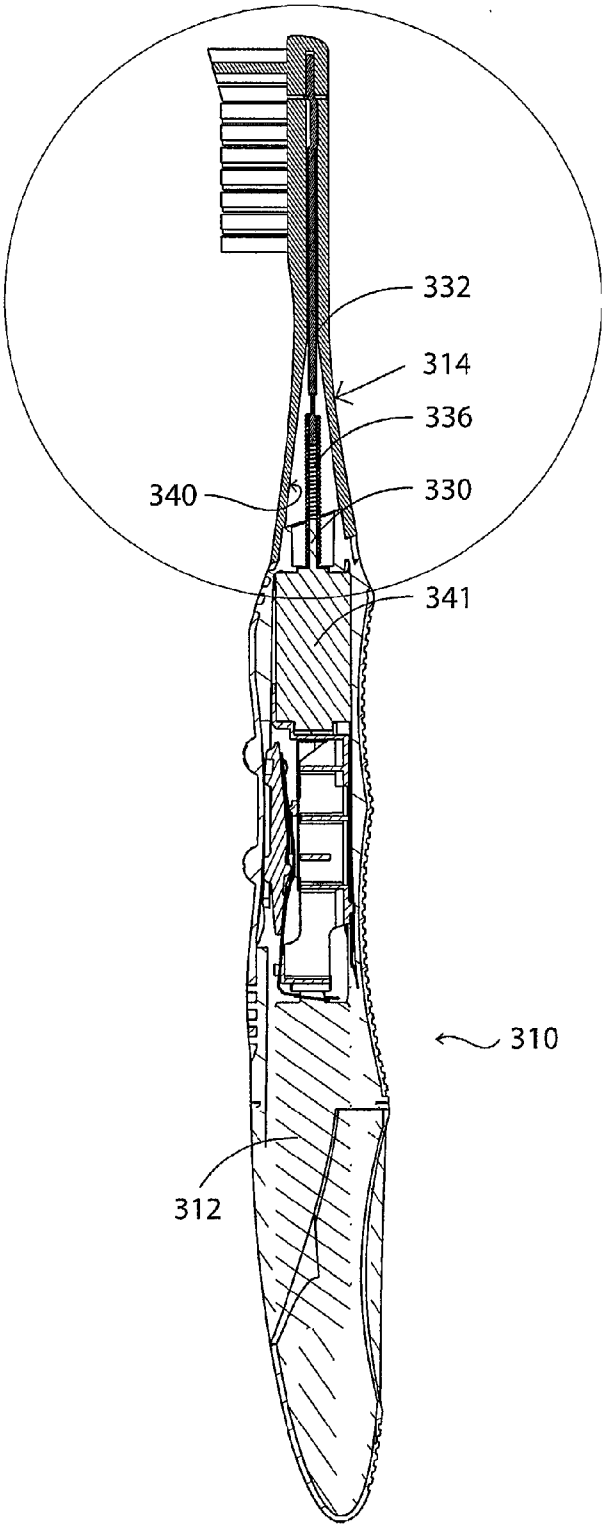

Fig. 28

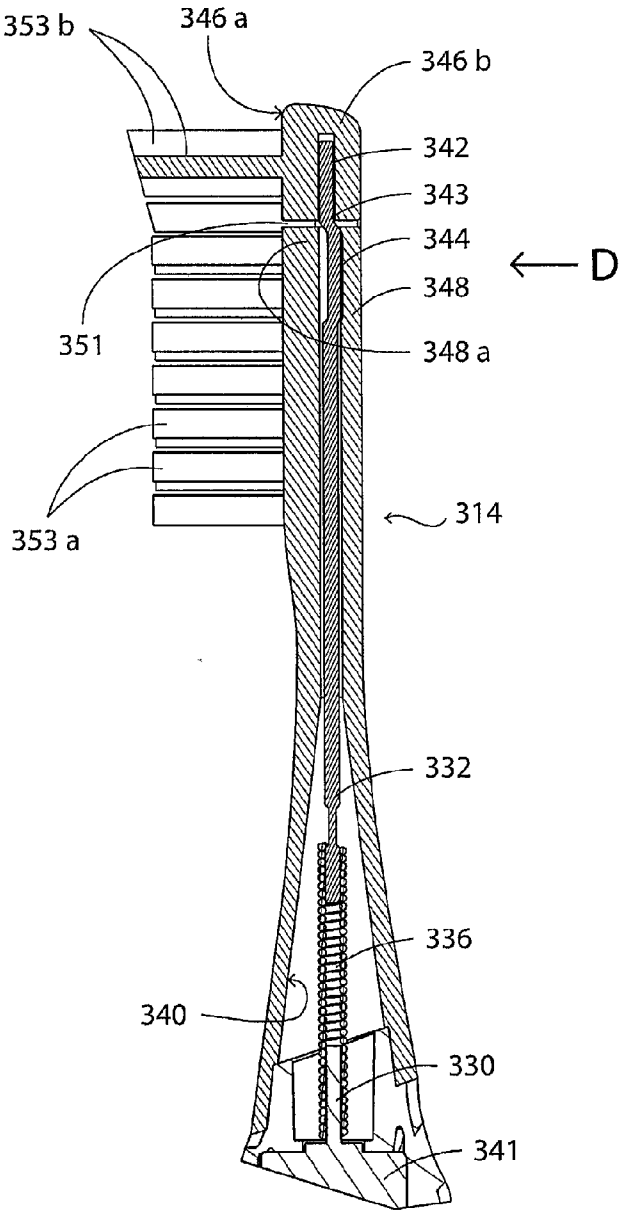
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Fig. 29

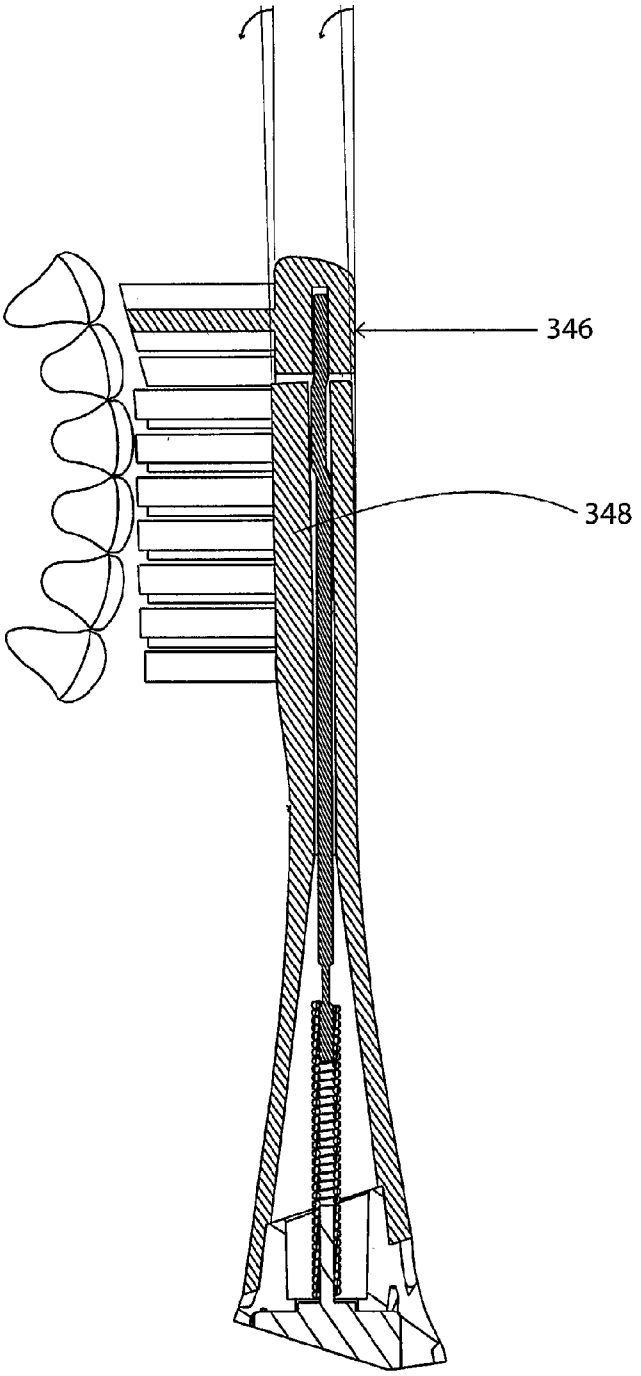

Fig. 30

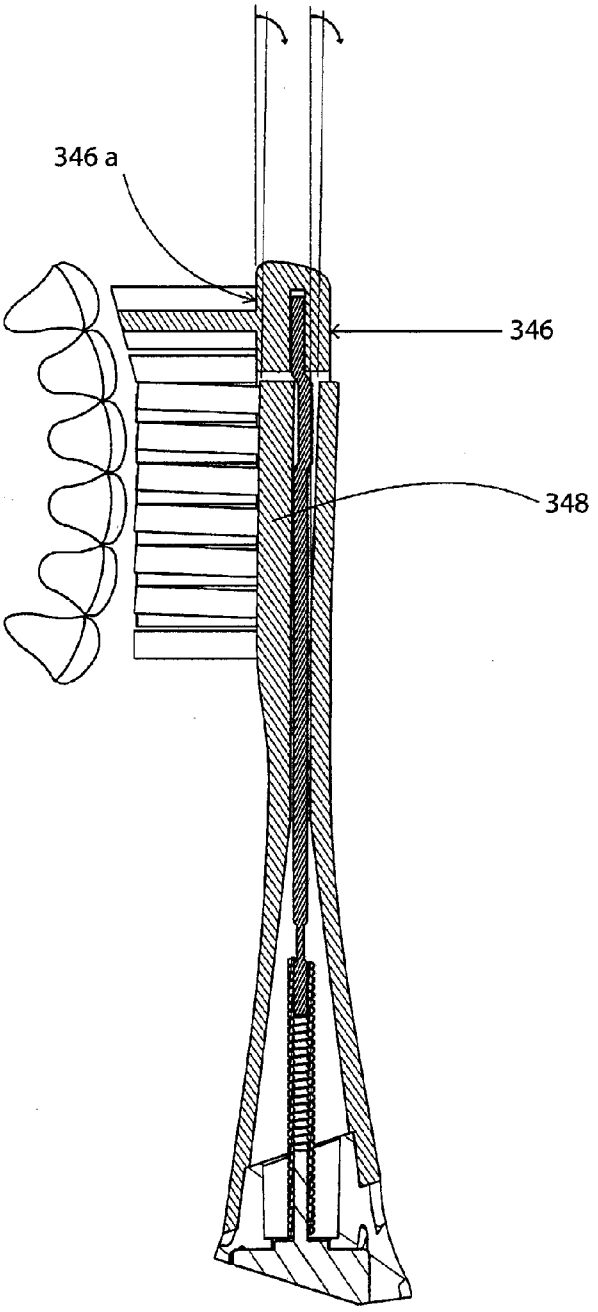

Fig. 31

POWERED TOOTHBRUSH WITH FLEXIBLE HEAD

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This is a Continuation-in-Part of U.S. patent application Ser. No. 11/879,561, filed Jul. 18, 2007, the entire disclosure of which is incorporated herein by reference.

BACKGROUND OF THE INVENTION

[0002] 1. Technical Field

[0003] This invention generally relates to dental hygiene. More particularly, the invention relates to a cleaning implement for teeth. Specifically, the invention relates to an electric toothbrush in which the head includes two members that are actively moved relative to each other, preferably in a direction that is substantially at right angles to the longitudinal axis of the brush.

[0004] 2. Background Information

[0005] The goal of every electric powered toothbrush designer is to make a fully active powered-head toothbrush with the same size, look and feel as that of a small manual toothbrush. Some toothbrushes have been designed and manufactured to achieve this end, such as the Pulsar™ made by Procter & Gamble. These toothbrushes have a split head with a plurality of movable bristles mounted thereon. When pressure is applied to the bristles during brushing, the split portions of the head are able to be deflected independently of each other. Furthermore, these toothbrushes have a tiny, vibratory motor installed in the handle, as close to the brush head as space and styling will allow. A camshaft extends from the motor into the neck of the brush and a small, and D-shaped weight hangs off the end of the camshaft. The camshaft terminates a distance away from the head upon which the bristles are mounted. As the camshaft rotates, the weight produces a vibration that is transmitted through the neck and into head and bristles. This vibration causes the bristles to move back and forth and gives the toothbrush the appearance of having a very active head. Most of the vibration is felt in the user's hand and the vibration is not transmitted as much to the brush head itself. As soon as any pressure is applied to the ends of the bristles, such as during brushing, the vibration caused by the weight is dampened and substantially ceases.

[0006] U.S. Publication No. 2006/0272112 in the name of Braun et al and assigned to The Gillette Company, discloses a toothbrush that operates in the manner described above. The toothbrush disclosed in this publication has a split head with two portions that can move independently. The toothbrush also includes a powered mechanism for setting up a vibration in the head of the brush. The handle of the brush includes a battery and a motor and a drive shaft projects outwardly from the motor and rotates to drive an eccentrically mounted weight at the end thereof. The rotating weight sets up a vibration that is transmitted to all parts of the brush. While the head of this brush is split into two portions and the portions are able to move independently, the portions are only moved in this manner through direct pressure when the bristles contact the teeth. The vibrations produced by the weight may cause very small independent movements in the two portions, but any such movement is essentially dampened as soon as the bristles contact the teeth and pressure is applied thereto during brushing.

[0007] U.S. Pat. No. 6,564,416, issued to Claire et al and also assigned to Gillette Canada Company, discloses a manual toothbrush that has a head which is split longitudinally into two portions. The portions are angled transversely to one another and define an opening between them. The opening permits water to flow through the head to facilitate flushing away of particulate materials that have been removed from the teeth by the bristles. The two portions may be movable independently of each other, but this movement is passive in that it is only caused by pressure applied on the regions during brushing

[0008] U.S. Publication No. 2004/0177462 in the name of Brown, Jr. et al, which again is assigned to The Gillette Company, discloses a manual toothbrush that has a head which is split into two portions. The split in the head permits the two portions to flex or move independently of each other but, once again that movement is passive in that it is only caused by pressure applied to the bristles by the teeth during brushing. An opening is defined between the two movable portions and the opening permits water and debris removed from the teeth to flow through this opening.

[0009] U.S. Pat. No. 5,987,681 issued to Hahn et al discloses an electric toothbrush that includes a mechanism for vibrating the head and therefore the tooth cleaning elements or bristles mounted thereon. The toothbrush includes a handle which houses a rotary motor. An unbalanced weight is provided on one or both sides of a shank close to the head of the brush. A drive shaft extends outwardly from the motor and drives the shank. When the motor is activated then the head of the toothbrush is vibrated.

[0010] There is therefore a need in the art for a toothbrush that includes a mechanism for actively moving the two portions of a split head type toothbrush to improve the cleaning power of the brush.

SUMMARY OF THE INVENTION

[0011] The device of the present invention comprises a toothbrush having head with at least two movable members. The members flex inwardly and outwardly away from each other in a direction that is substantially at right angles to the longitudinal axis of the brush handle. Force is transferred from one movable member to another to aid in this relative movement. Bristles extending from both movable members are brought into contact with the surface of teeth so that the tips are disposed at right angles thereto. In a first embodiment, two movable members are connected by an oscillating rod that flexes the members away from each other. In a second embodiment, a center section on the head nests within a perimeter section and a rotatable cam extends between the sections and flexes them inwardly and outwardly away from each other.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] The preferred embodiments of the invention, illustrative of the best mode in which applicant has contemplated applying the principles, are set forth in the following description and are shown in the drawings and are particularly and distinctly pointed out and set forth in the appended claims.

[0013] FIG. **1** is side view of the electric toothbrush in accordance with the present invention;

[0014] FIG. **2** is an enlarged cross-sectional side view of the toothbrush FIG. **3** is an enlarged cross-sectional side view of the toothbrush shown from the end of the first camshaft section to the tip of the head;

[0015] FIG. **4** is a top view of the toothbrush head taken through line **4-4** of FIG. **3**;

[0016] FIG. **5** is an exploded left perspective view of the first and second head sections shown with the bristles removed therefrom for clarity;

[0017] FIG. **5***a* is an exploded right perspective view of first and second head sections with the bristles removed;

[0018] FIG. **5***b* is a rear view of the first and second head sections attached to each other and showing the camshaft extending through the neck portion and into the body portion of the head;

[0019] FIG. **6** is a front view of the motor and the camshaft removed from the toothbrush;

[0020] FIG. **7** is a cross-sectional side view of a portion of the toothbrush with the bristles removed and showing the camshaft in position to flex the first and second sections away from each other;

[0021] FIG. **8** is a side view of the portion of the toothbrush shown in FIG. **7** and showing the second head section being moved toward the right by the camshaft and the first head section being moved toward the left;

[0022] FIG. **9** is a bottom view of the first and second head sections in a flexed position and taken through line **9-9** of FIG. **8**;

[0023] FIG. **10** is a cross-sectional side view of a portion of the toothbrush head where the camshaft is causing the second head section being moved toward the left and the first head section being moved to the right;

[0024] FIG. **11** is a side view of the portion of the toothbrush shown in FIG. **10** and showing the first head section being moved toward the right by the camshaft and the second head section being moved toward the left;

[0025] FIG. **12** is a bottom view of the first and second head sections in a flexed position and taken through line **12-12** of FIG. **11**;

[0026] FIG. **13** is cross-sectional side view of a portion of the toothbrush and showing the connection between the camshaft and the drive shaft upon pressure being applied to the bristles and therefore the head in response to pressure being applied to the bristles during brushing;

[0027] FIG. **14** is a side view of the portion of the toothbrush shown in FIG. **13**;

[0028] FIG. **15** is an exploded side view of a second embodiment of the toothbrush showing that the head thereof is detachably connectable to the handle;

[0029] FIG. **16** is an exploded cross-sectional side view of the toothbrush of FIG. **15** shown from the motor to the tip of the head;

[0030] FIG. **17** is a perspective view of a third embodiment of a toothbrush in accordance with the present invention;

[0031] FIG. **18** is a partially exploded perspective view of the toothbrush of FIG. **17**;

[0032] FIG. **19** is a perspective view of the toothbrush of FIG. **17** with the right-hand side of the head removed to show the shaft engaged with the left-hand side of the head;

[0033] FIG. **20** is a front elevational view of the toothbrush;

[0034] FIG. **21** is a cross-sectional top view of the toothbrush handle taken through line A-A of FIG. **20** and showing the drive shaft extending from the handle in a neutral position;

[0035] FIG. **21***a* is a cross-sectional top view of the toothbrush handle taken through line A-A of FIG. **20** and showing the drive shaft in a first position;

[0036] FIG. **21***b* is a cross-sectional top view of the toothbrush handle taken through line A-A of FIG. **20** and showing the drive shaft in a second position;

[0037] FIG. **22** is a cross-sectional bottom view of the head of the shaft taken through line B-B of FIG. **20**;

[0038] FIG. **23** is a cross-sectional bottom view of the head taken through line C-C of FIG. **20** and showing the leg portion of the drive shaft and the two head sections in a neutral position;

[0039] FIG. **23***a* is a cross-sectional bottom view of the head taken through line C-C of FIG. **20** and showing the leg portion of the drive shaft and the two head sections in a first position;

[0040] FIG. **23***b* is a cross-sectional bottom view of the head taken through line C-C of FIG. **20** and showing the leg portion of the drive shaft and the two head sections in a second position;

[0041] FIG. **24** is a perspective front view of a fourth embodiment of a powered toothbrush in accordance with the present invention;

[0042] FIG. **25** is an enlarged perspective view of the highlighted portion of FIG. **24**;

[0043] FIG. **26** is a perspective rear view of the toothbrush of FIG. **24**;

[0044] FIG. **27** is a front view of the toothbrush of FIG. **24**;

[0045] FIG. **28** is a cross-sectional side view taken through line **28-28** of FIG. **27**;

[0046] FIG. **29** is an enlargement of the highlighted area of FIG. **28** showing the toothbrush head in the neutral position;

[0047] FIG. **30** is a cross-sectional side view of the head of the toothbrush showing the center section in a first flexed position; and

[0048] FIG. **31** is a cross-sectional side view of the head of the toothbrush showing the center section in a second flexed position.

DETAILED DESCRIPTION OF THE INVENTION

[0049] Referring to FIGS. **1-14** there is shown a first embodiment of an electric toothbrush in accordance with the present invention and generally indicated at **10**. Toothbrush **10** includes a handle **12** and a head **14** and has a longitudinal axis "X" (FIG. **1**). In the first embodiment, handle **12** and head **14** are integrally formed with each other. Handle **12** is ergonomically designed so that it is easily gripped in that a first surface **16** thereof is contoured and textured with ribs **18**. A second surface **20** of handle **12** houses the control button **22** for activating brush **10** and control button **23** for deactivating brush **10**. The bottom end **24** of handle **12** may be unscrewed or otherwise detached to allow access to a battery compartment within handle **12**.

[0050] Referring to FIG. **2**, a motor **26** is housed within an interior cavity **28** of handle **12**. Motor **26** is driven by one or more batteries, but preferably by a single AAA battery. A drive shaft **30** extends outwardly from motor **26** and into a lower portion of the neck **50** of brush **10**. One end of a camshaft abuts an end of drive shaft **30**. The camshaft comprises a shorter first camshaft section **32** and a longer second camshaft section **34** which are in end to end contact with each other. First camshaft section **32** abuts the end of drive shaft **30**. A second end of first camshaft section **32** abuts second camshaft section **34**. A coiled flexible spring **36** tightly surrounds

a portion of drive shaft **30**, the entire length of first camshaft section **32** and a portion of second camshaft section **34**. Spring **36** maintains a flexible contact between drive shaft **30**, first camshaft section **32** and second camshaft section **34** and ensures that any motion of drive shaft **30** is imparted to second camshaft section **34**. Spring **36** also ensures that if head **14** is bent backwardly during brushing, first camshaft section **32** does not become misaligned with motor **26**. This flexible operational contact is illustrated in FIGS. **13** and **14**.

[0051] Second camshaft section **34** is a thin rod manufactured from stainless steel. Second camshaft section **34** passes through a soft rubber seal **38** and into head **14**, terminating at a point underneath the region of the head where bristles **53** are mounted. Seal **38** is provided to prevent water and debris removed from the teeth during brush from entering cavity **40**. Second camshaft section **34** terminates in a first and a second cam lobe **42**, **44** (FIGS. **3** and **6**). First and second cam lobes **42**, **44** are offset relative to each other and to the main shaft **34**a of second camshaft section **34**.

[0052] Referring to FIGS. **5**-**5***b* and in accordance with a specific feature of the present invention, head **14** of toothbrush **10** is manufactured from two separate molded head sections **46**, **48**. Each head section **46**, **48** includes a neck portion **54** and a body portion **56**. When head sections **46**, **48** are joined together, the two neck portions **54***a*, **54***b* (FIG. **5***a*) form the elongated, thinner neck **50** of brush **10**, and the two body portions **56***a*, **56***b* form the wider body **52**. A plurality of bristles or bristle tufts **53** extend outwardly from one of the surfaces of body **52**. Preferably, bristles or bristle tufts **53** are fixedly mounted to body **52** and only flex relative thereto as opposed to the bristles being pivotally or rotatably mounted within body **52**.

[0053] Each body portion **56***a*, **56***b* of head sections **46**, **48** is provided with an arcuately contoured inner wall **58***a*, **58***b*. Neck portions **54***a*, **54***b* are each provided with an angular or planar inner wall **60***a*, **60***b*. The contours of the inner wall **58***a* are complementary to the contours of inner wall **58***b* and are designed to substantially mesh with each other. Inner walls **60***a*, **60***b* are also complementary and designed to mate with each other when brush **10** is assembled during manufacture.

[0054] FIG. **5** shows head section **48** in greater detail. Inner wall **58***b* of head section **48** is shaped to form a plurality of arcuate protrusions **62** and recesses **64**. A first protrusion **62***a* defines an aperture **66** therein that is aligned with longitudinal axis "X" of brush **10**. Aperture **66** is four-sided in cross-sectional shape, being substantially rectangular or square in cross-sectional shape. A second protrusion **62***b* of inner wall **58***b* defines an axially aligned slot **68** therethrough. Slot **68** is substantially U-shaped in cross-section. The shape of aperture **66** and slot **68** substantially resists the tendency of head portions **46**, **48** to split apart in response to rotation of camshaft lobes **42**, **44**. Neck portion **54***b* of head section **48** is substantially C-shaped in cross-section and tapers in size from end **70** toward body portion **56***b*. An elongated narrow channel **72** is defined in that part of neck portion **54***b* proximate body portion **56***b*. Channel **72** is longitudinally aligned and substantially continuous with slot **68**. Head section **48** includes a plurality of holes **69** in an upper surface thereof. These holes are provided for mounting bristles **53** therein.

[0055] FIG. **5***a* shows inner wall **58***a* of head section **46** in greater detail. Inner wall **58***a* is similarly configured to inner wall **58***b* in that it includes a plurality of arcuate protrusions **62***c*, **62***d* and recesses **65**. Protrusions **62***c*, **62***d* on inner wall **58***a* are designed to mesh with the protrusions **62***a*, **62***b* on inner wall **58***b*. So, for example, protrusion **62***c* on inner wall **58***a* meshes with protrusions **62***a* and **62***b* on inner wall **58***b*. Furthermore, protrusion **62***c* defines an aperture **67** therein that is alignable with aperture **66** in protrusion **62***a* and with slot **68** in protrusion **62***b*. Aperture **67** is four sided in cross-sectional shape. Furthermore second protrusion **62***b* has planar interior walls that define slot **68**. When apertures **66**, **67**, slot **68** and channel **72** are aligned, an elongated bore **76** is formed which extends through head **14** and terminates only a short distance away from tip **74** of brush **10**. Second camshaft section **34** is received through this bore **76**. When second camshaft section **34** is engaged in bore **76**, and specifically when the first and second lobes **42**, **44** are retained in the four-sided apertures **66**, **67** respectively, first and second head sections **46**, **48** are substantially prevented from separating laterally from each other.

[0056] FIG. **5***b* shows that when head sections **46**, **48** are secured together by gluing or heat welding, the inner walls **60***a*, **60***b* of the two neck portions **54***a*, **54***b* are attached together from end **70** to a point "A". Point "A" is disposed a spaced distance away from a point "B" where body **52** of head **14** originates. The remaining length of inner walls **60***a*, **60***b* and all of inner walls **58***a*, **58***b* from point "B" to tip **74** are not secured together in any way. A narrow channel **72** is formed between inner walls **58***a*, **58***b* and extends for a distance between inner walls **60***a*, **60***b*. Channel **72** originates at point "A" and terminates at tip **74** of head **14**. Channel **72** permits water and debris removed from the teeth to be flushed away from bristles **53**. The presence of channel **72** also enables the body portions and the unattached parts of the neck of head sections **46**, **48** to flex relatively easily upwardly and downwardly out of alignment with each other as shown in FIG. **8**.

[0057] This possible relative movement between head sections **46**, **48** is not, however only a passive movement caused by the bristles **53** engaging the teeth during brushing. The transverse movement of head sections **46**, **48** relative to each other and to the longitudinal axis "X" of brush **10** is also a movement powered by the camming action of second camshaft section **34**. Second camshaft section **34** extends through bore **76** and engages both of head sections **46**, **48**. The shaft **34***a* of second camshaft section **34** extends through channel **72** of head sections **46**, **48**. The first cam lobe **42** of second camshaft section **34** extends through the aperture or groove **67** (FIG. **3**) in protrusion **62***c* of head section **46**. The second cam lobe **44** is seated in aperture **66** in first protrusion **62***a* of head section **48**. FIG. **5***b* shows that parts of second camshaft section **34** are visible through channel **72** and holes **78** in back surface **14***b* of head **14**. Rotational movement generated by motor **26** causes second camshaft section **34** to rotate in bore **76**. Because second camshaft section **34** extends into body portion **52** of head **14** and terminates in a region beneath bristles **53**, the rotational motion of second camshaft section **34** is transmitted directly to first and second head sections **46**, **48** through the action of cam lobes **42**, **44**. The motion of head sections **46**, **48** relative to each other in response to the action of cam lobes **42**, **44** is shown in FIGS. **7**-**12**.

[0058] FIGS. **7**-**9** show second camshaft section **34** in a first position with cam lobe **44** forcing head section **48** to move out of alignment with head section **46** in the direction of arrow "Y". The relative displacement is shown in FIG. **9**. FIGS. **10**-**12** show second camshaft section **34** rotated through 180°. In this position, cam lobe **44** is oriented in such a manner that head section **48** has moved back into a rest position and is substantially aligned with head section **46** once again. As

second camshaft section **34** continues to rotate through another 180°, cam lobe **44** moves once again into the position shown in FIG. **7** and head section **48** moves again in the direction of arrow "Y" and into the position shown in FIG. **8**. Thus, head section **48** is caused to move alternatively into and out of alignment with head section **46** and longitudinal axis "X" of brush **10**. These movements are very small and very rapid.

[0059] The entire head **14** of brush **10** is also able to flex somewhat in response to pressure applied on head **14** during brushing. As shown in FIGS. **13** & **14** this flexing motion may cause second camshaft section **34** to become misaligned with first cam section **32** and drive shaft **30**. However, the flexible spring **36** maintains contact between second camshaft section **34**, first cam section **32** and drive shaft **30**, so that even in this flexed head position, head sections **46**, **48** continue to be able to move independently of each other in response to rotation of second camshaft section **34**.

[0060] Because bristles **53** are mounted onto head sections **46**, **48**, the movement of head sections **46**, **48** in response to rotation of the second camshaft section **34** causes a corresponding motion in bristles **53**. These movements in the transverse directions are very rapid and small in amplitude. This reduces the drag on bristles **53** as they engage the teeth and also reduces the amount of power the brush **10** uses. Consequently, toothbrush head continues to move when bristles contact the teeth, unlike the toothbrushes known in the prior art. Toothbrush **10** therefore has an active head **14** that is more efficient at removing particulate matter from the teeth.

[0061] FIGS. **15** and **16** show a second embodiment of a toothbrush in accordance with the present invention and generally indicated at **110**. In this second embodiment, the head **114** of brush **110** is removable from the handle **112**. The detachable head **114** may be removed from handle **112** if bristles **153** become damaged through use, for example. A replacement head (not shown) may then be snap-fitted or otherwise secured to handle **112**. As with the previous embodiment, handle **112** is contoured and includes ribs for gripping and control buttons **122**, **123** on front surface **120**. The other various components and operation of toothbrush **110** are substantially identical to those of toothbrush **10** except that flexible spring **136** surrounds the first camshaft section **132** and a portion of longer camshaft section **134**. First camshaft section **132** is secured to in a female connector **190** that projects slightly from the bottom end **114***b* of head **114**. Drive shaft **130** is secured to a male connector **192** that is complementary to female connector **190**. Male and female mating connectors **190**, **192** are designed to mechanically and electrically connect drive shaft **130** to camshaft **134**. It will be understood that female connector **190** may be secured to drive shaft **130** and male connector **192** may be secured to shorter camshaft section **132** without departing from the spirit of the present invention. Additionally, the male upper end **112***a* of handle **112** is complementary shaped to interlock with the female bottom end **114***b* of head **114**. Head **114** is snap-fitted onto handle **112** and the two parts may be secured together by any other suitable means that will prevent the head **114** from separating accidentally from the handle **112** during brushing. It will be understood that the interlocking male and female ends of handle **112** and head **114** may alternatively be provided on the opposite components without departing from the spirit of the present invention.

[0062] It will be understood that while the camshaft is shown as comprising first camshaft section **32** and second camshaft section **34**, a single continuous camshaft may be used in toothbrush **10**.

[0063] Referring to FIGS. **17-23**, there is shown a third embodiment of a powered toothbrush in accordance with the present invention and generally indicated at **210**. Toothbrush **210** includes a handle **212** and a head **214**. Handle **212** is not shown in any detail in these figures but could be of any suitable shape and include components such as on/off buttons, gripping ribs etc. A drive shaft **280** extends outwardly from handle **212** and is operationally connected to a motor (not shown) housed within handle **212**. A connector **282** extends outwardly from drive shaft **280**.

[0064] Head **214** is comprised of two complementary head sections **246**, **248** that are laterally disposed relative to each other. Head sections **246**, **248** are substantially mirror images of the other. Each head section includes an elongated neck portion **254** and a body portion **256** that extends outwardly away therefrom. A plurality of bristles **253** or bristle tufts are provided on body portion **256**. As with the first and second embodiments of the toothbrush, the neck portions **254** of the two head sections **246**, **248** are substantially connected together while the body portions **256** thereof are substantially independent of each other and are separated from each other by a gap **301** (FIG. **23**). Body portions **256** of the first and second head sections **246**, **248** are movable relative to each other in flexure.

[0065] In accordance with a specific feature of the present invention a substantially T-shaped coupler rod **295** is provided to aid the movement of head sections **246**, **248**. Coupler rod **295** is a substantially T-shaped member comprising a coupler shaft **297** that is substantially longitudinally aligned with the longitudinal axis "X" of handle **212**. A leg **299** is provided at one end of shaft **297** and is disposed substantially at right angles to shaft **297**. A connector **296** is provided at an end of coupler shaft **297** remote from let **297**. Connector **296** includes a longitudinally aligned slot **298** that extends for a distance into connector **296**. Slot **298** interlockingly engages a connector **282** on a drive shaft **280** that extends outwardly from handle **212**. Connector **296** and slot **298** are complementary in size and shape so that connectors **296**, **282** are tightly secured together. It will be understood that connector **296** may be different configured to be connectable to any shape or size of connector **282** extending from a drive shaft **280**. Coupler rod **295** preferably is manufactured from a plastic such as nylon.

[0066] Leg **299** includes a bulbous member at either end, namely bulbous members **300**, **302**. Bulbous member **300** is configured to engage head section **246** and bulbous member **302** is configured to engage head section **248**. Bulbous members **300**, **302** effectively act as camming surfaces on coupler rod **295** during operation of toothbrush **210**.

[0067] In accordance with another feature of the present invention, each head section **246**, **248** defines a portion of a longitudinally aligned channel **272** configured to receive the T-shaped coupler rod **295** therein. In each head section **246**, **248**, the portion of channel **272** is generally C-shaped in cross-section and extends from bottom end **214***a* of head **214** to a position spaced inwardly from tip **270**. As shown in FIG. **18**, channel **272** extends for a distance beneath the surface of body portion **256** into which bristles **253** are secured. Each portion of channel **272** defines a first chamber **274** that is complementary sized and shaped to receive a part of connec-

tor **296** therein. When first and second head sections **246**, **248** are joined together, connector **296** is retained in the combined first chambers **274** of the two portions of channel **272**. The portion of channel **272** in each head section **246**, **248** further defines a second chamber **276** which is spaced from first chamber **274**. Second chamber **276** is complementary shaped and sized to receive part of leg **299** and one of bulbous members **300**, **302** therein. Coupler shaft **297** is retained in the region of channel **272** that extends between first and second chambers **274**, **276**. FIG. **19** shows toothbrush **210** with head section **248** removed so that the coupler rod **295** may be seen engaged in channel **272**, first chamber **274** and second chamber (not numbered) of head section **246**.

[0068] Toothbrush **210** operates in the following manner. Initially, when toothbrush **210** is not powered, drive shaft **280** is in a neutral position (FIG. **21**) and, consequently, coupler rod **295** is also in a neutral position (FIG. **23**). The user activates brush **210** by depressing control button **222**. This activates a motor (not shown) which oscillates drive shaft **280** back and forth between a first and a second position as shown in FIGS. **21***a* and **21***b*. The oscillatory movement of drive shaft **280** is transferred to coupler rod **295** by interlocked connectors **282**, **296**. Coupler rod **295** is therefore caused to oscillate back and forth between a first and second position as shown in FIGS. **23***a* and **23***b*. This motion causes the coupler rod **295** to move through an arcuate path "Z" that is oriented substantially at right angles to the longitudinal axis of the toothbrush as shown in FIG. **23**. The range of motion of coupler rod **295** is such that bulbous members **300**, **302** on leg **299** are moved through an angle of between ten degrees and sixty-five degrees between the first and second positions. Preferably, the range of motion is about fifty degrees between the first and second positions, i.e., about twenty-five degrees above and below the neutral position. The coupler rod **295** is oscillated rapidly between the first and second positions.

[0069] The movement of leg **299** from a neutral position to a first position (FIG. **23***a*) causes bulbous member **300** to push the body portion **256** of head section **246** downwardly and causes bulbous member **302** to push the body portion **256** of head section **248** upwardly. As coupler rod **295** continues to oscillate, leg **299** moves through the neutral position (FIG. **23**) and on to the second position (FIG. **23***b*). The movement of leg **299** from the neutral position to the second position causes bulbous member **302** to push head section **248** downwardly and bulbous member **300** to push head section **246** upwardly.

[0070] Leg **299** effectively acts as a lever, transferring energy back and forth between the two head sections **246**, **248**. When head section **246** moves downwardly relative to head section **248**, the engagement of leg **299** with head section **246** levers head section **248** upwardly. This levering action causes the plastic material of body portion **256** of head section **248** to be flexed relative to neck portion **254** thereof, thereby storing potential energy in flexed head section **248**. Similarly, the material of body portion **256** of head section **246** is also flexed relative to neck portion **254** thereof. Thus, potential energy is also stored in flexed head section **246**. The potential energy is released from both head sections **246**, **248** as the coupler rod **295** oscillates toward the neutral position. This release and transfer of energy drives leg **299** to rotate in the opposite direction resulting in both head sections **246**, **248** being flexed in the opposite direction. The potential energy released by the flexed body portions **256** thus aids in moving head sections **246**, **248** relative to each. The system therefore requires less energy to run than would be the case if there was no flexure of the two head sections **246**, **248**. Toothbrush **210** therefore comprises two head sections **246**, **248** that are movable relative to each other and the force from head section **246** causes movement in head section **248**, and force from head section **248** causes movement in head section **246**. First and second head sections **246**, **248** are movable relative to each other free of a frame.

[0071] It should be noted that if the relative movement between head section **246** and **248** is dampened or stopped by the user biting down on the brush or the bristles, for example, then coupler shaft **297** would torsionally twist as the head sections **246**, **248** flex to allow the motor to continue running until the force on the head **214** is released.

[0072] While toothbrush **210** is illustrated as a unit having a handle **212** and head **214** that are permanently connected together, it will be understood that toothbrush **210** may instead comprise a separate handle portion and head portion that are snap-fitted together in the same way as the toothbrush **110** disclosed in FIGS. **15** and **16**.

[0073] Referring to FIGS. **24-30**, there is shown a fourth embodiment of a powered toothbrush in accordance with the present invention and generally indicated at **310**. Toothbrush **310** includes a handle **312** and a head **314**. As with previous embodiments, handle **312** is ergonomically contoured for easy gripping and includes a plurality of ribs **318** and control buttons **322**, **323**. Head **314** comprises a neck **350** and a body **349**. Body **349** includes two movable sections, namely a perimeter section **346** and a center section **348**. Center section **348** nests inside perimeter section **346** (FIG. **26**). Center section **348** is free of connection to perimeter section **346** along its sides, **348***a*, **348***b*, **348***c*. Center section **348** is connected to perimeter section **346** along a single face **348***d* which is situated proximate an edge area of body **349** proximate neck **350**. Interior end **348***a* is situated proximate an interior region of body **349**.

[0074] A plurality of bristles **353** extend outwardly away from a front surface of each of perimeter and center sections **346**, **348**, with the bristles on center section **346** being identified as **353***a* and the bristles on perimeter section being identified as **353***b*. It will be understood that while perimeter section **346** is shown to be generally U-shaped and disposed around a substantially smaller and generally rectangular center section **348**, perimeter and center sections **346**, **348** may be of any desired shape. Center section **348** forms a central, inwardly extending tongue that is separated from perimeter section **346** by a gap **351** (FIG. **29**) Center section **348** is able to flex inwardly and outwardly relative to front face **346***a* of perimeter section **346** as will be hereinafter described. Perimeter and center sections **346**, **348** move relative to each other without a frame supporting this movement.

[0075] As shown in FIGS. **28-31**, a drive shaft **330** extends outwardly from a motor **341** housed in handle **312**. Drive shaft **330** extends into an interior cavity **340** of neck **350**. A camshaft **332** is operationally connected to drive shaft **330** and extends forwardly therefrom and into engagement with perimeter and center sections **346**, **348**. A flexible spring **336** is secured around a portion of each of the drive and cam shafts **330**, **332**. Cam shaft **332** includes a first cam lobe **342** and a second cam lobe **344**. First cam lobe **342** engages perimeter section **346**, most specifically region **346***b* (FIG. **29**) that is adjacent inner region **348***a* of center section **348**. Second cam lobe **344** engages center section **348**. First and second cam lobes **342**, **344** are longitudinally offset relative to each other

as previously described with respect to the camshaft provided in toothbrush **10**. The offset **343** between first and second cam lobes **342**, **344** occurs in the vicinity of the gap **351** between inner region **348***a* of center section **348** and region **346***a* of perimeter section **346**. When toothbrush **310** is activated via control button **322**, cam shaft **332** is rotated through 360°. As cam shaft **332** rotates through 180 ° from a first position shown in FIG. **29** to a second position shown in FIG. **30**, second cam lobe **344** pushes inner region **348***a* of center section **348** outwardly away from perimeter section **346** in the direction indicated by arrow "D". This causes center section **348** to flex, with the region of least flexure being proximate face **348***d* and the region of greatest flexure being proximate inner region **348***a*. When this occurs, center section **348** flexes about face **348***d* until it is disposed at an angle "S" relative to front face **346***a* of perimeter section **346** (FIG. **30**). At the same time, first cam lobe **342** pushes the region **346***b* of perimeter section **346** outwardly away from inner region **348***a* in the opposite direction to "D". Thus, region **346***b* of perimeter section **346** is flexed outwardly away from center section **348**, but to a much lesser extent because perimeter section **346** is larger than center section **348** and is more rigidly secured to neck **350**. The flexure of both center section **348** and perimeter section **346** stores potential energy in head **314**.

[0076] As cam shaft **332** continues to rotate through another 180° and back into the first position (FIG. **29**), second cam lobe **344** ceases to push inner region **348***a* of center section **348** in the direction "D". The potential energy stored in the flexed center section **348** is released and transmitted via cam shaft **332** to first cam lobe **342** and therefore to perimeter section **346**. The transferred force causes center section **348** and perimeter section **346** to be flexed slightly away from each other in the opposite direction. Continued rotation of cam shaft **332** causes the outward pressure on the oppositely flexed center section **348** to be relieved and the potential energy stored in the flexed center section **348** to be transferred back through the cam shaft **322** to perimeter section **346** The transferred force again aids in flexing the center section **348** away from the perimeter section **346** and back in the direction of arrow "D". The continued rotation of cam shaft **332** at high speed causes a reciprocating in-and-out motion of center section **348** relative to front face **346***a* of perimeter section **346**. The continued cycle of storing and releasing energy from the flexure of perimeter and center sections **346**, **348** reduces the energy required to rotate cam shaft **332** to move sections **346**, **348**.

[0077] When center section **348** is in the first neutral position (FIG. **29**), the bristles **353***a* on center section **348** are substantially aligned with bristles **353***b* on perimeter section **346**. This configuration will exist when toothbrush **310** is in a deactivated condition. When toothbrush is activated, center section **348** is flexed into the second position (FIG. **30**), the bristles **353***a* on center section **348** are disposed outwardly relative to bristles **353***b* on perimeter section **346**. Furthermore, bristles **353***a* are disposed at an angle relative to bristles **353***b* because they extend outwardly from flexed center section **348**. The bristles proximate inner region **348***a* are disposed farther outwardly away from front face **346***a* of perimeter section **346** than all of the other bristles on head **314**. Continued rotation of cam shaft **332** will cause center section **348** to move into a third position (FIG. **31**) where center section is flexed in the opposite direction. When in this position, bristles **353***a* may be slightly recessed relative to bristles **353***b*. Consequently, as cam shaft **332** is rotated, bristles **353***a* move more forcefully into and out of contact with the teeth. This rapid impacting motion in the central region of the brush head, combined with the angle of attack of bristles **353***a* permits improved removal of particulate material from the teeth.

[0078] Thus, an improved method of cleaning teeth using the toothbrushes of the present invention comprises activating the powered toothbrush to cause relative movement between two members on the head of the toothbrush. This relative movement is in a direction that is substantially at right angles to the longitudinal axis of the handle of the brush and substantially aligned with the longitudinal axes of the bristles prior to engagement with the teeth. The inward and outward movement of the bristles, toward and away from the teeth, causes an impact motion on the surface of the teeth. Furthermore, the inward and outward motion causes the bristles themselves to flex as they are pushed inwardly toward the teeth by the movable members on the toothbrush head.

[0079] When the inward movement is released by the movable member moving outwardly away from the surface of the teeth, the energy stored in the flexed bristles causes particulate matter to be forcefully swept off the surface of the teeth. Furthermore, the inward and outward movement of the bristles caused by the movable members on the head, also aids the bristles in reaching lower contoured surfaces of the teeth.

[0080] It will be understood that while the toothbrush of the present invention has been disclosed as having two movable members, it will be understood that more than two movable members can be provided to form the head of the toothbrush.

[0081] In the various embodiments of a powered toothbrush disclosed herein, substantially all of the energy required to move the movable parts relative to each other is released within the head of the brush, thereby substantially reducing vibration in the handle to a negligible amount. Substantially the entire head of the brush is pulsed with a first part of the head moving upwardly and a second part moving downwardly, and then the second part of the head moving upwardly with the first part moving downwardly. The system for moving the first and second parts of the head is designed so that energy is stored on each stroke and is released in the next stroke. The system utilizes the characteristics of the plastic material of the head of the brush to flex or bend thereby storing the energy for the next stroke. This results in the drive system being between 250% and 300% more energy efficient than if the system was simply set up to accelerate the brush head in one direction, then decelerate the head to a neutral position and then accelerate the head in the opposite direction. Consequently, the toothbrush can be powered with a single standard AAA battery or can be rechargeable. This reduced power requirement also enables the toothbrush to be made in a much more lightweight format than previously known powered toothbrushes.

[0082] In the foregoing description, certain terms have been used for brevity, clearness, and understanding. No unnecessary limitations are to be implied therefrom beyond the requirement of the prior art because such terms are used for descriptive purposes and are intended to be broadly construed.

[0083] Moreover, the description and illustration of the invention are an example and the invention is not limited to the exact details shown or described.

1. A head for a powered toothbrush, said head comprising:
a neck having a first end adapted to detachably engage a handle of the powered toothbrush;
a body extending outwardly from a second end of the neck, said body comprising:
a first and a second head member that are movable relative to each other; wherein force from the first head member causes movement in the second head member and movement in the second head member causes movement in the first head member.

2. The head for a powered toothbrush as defined in claim 1, further comprising a coupler rod operatively communicating with the first and second head members, and wherein force is transferred between the first and second head members via the coupler rod.

3. The head for a powered toothbrush as defined in claim 1, in which energy stored in one of the first and second head members is transferred to the other of the first and second head members to assist in the movement thereof.

4. The head for a powered toothbrush as defined in claim 1, wherein the first head member is a perimeter section and the second head member is a center section; and the center section is positioned within the perimeter section.

5. A powered toothbrush comprising:
a handle;
a head extending outwardly from the handle and comprising a first and a second head member that are movable relative to each other; and wherein force from the first head member causes movement in the second head member and movement in the second head member causes movement in the first head member.

6. The toothbrush as defined in claim 5, further comprising a coupler rod operatively communicating with the first and second head members, and wherein force is transferred between the first and second head members via the coupler rod.

7. The toothbrush as defined in claim 5, in which energy stored in one of the first and second head members is transferred to the other of the first and second head members to assist in the movement thereof.

8. The toothbrush as defined in claim 6, further comprising a motor and said coupler rod is operationally connected to said motor; and wherein said motor causes the coupler rod to rotate through at least a partial arc.

9. The toothbrush as defined in claim 8, wherein the motor causes the coupler rod to oscillate back and forth between a first and a second position.

10. The toothbrush as defined in claim 9, wherein the oscillatory movement causes the coupler rod to move through an arcuate path oriented at right angles to a longitudinal axis of the handle.

11. The toothbrush as defined in claim 9, wherein the coupler rod passes through a neutral position between said first and second positions; and when said coupler rod is in the neutral position, the first and second head members are coplanar with each other.

12. The toothbrush as defined in claim 9, wherein the first and second head members are flexed in opposite directions relative to each other in response to movement of the coupler rod; and when the coupler rod is in the first position the first and second head members are oppositely flexed in a first orientation relative to each other; and when the coupler rod is in the second position the first and second head members are oppositely flexed in a second orientation relative to each other.

13. The toothbrush as defined in claim 9, wherein the coupler rod oscillates through a range of motion of between 10° and 65°.

14. The toothbrush as defined in claim 6, wherein the coupler rod is substantially T-shaped and includes a shaft that is longitudinally aligned with the handle of the toothbrush, and a leg disposed substantially at right angles to the shaft, and the leg engages the first head member at a first end and the second head member at a second end.

15. The toothbrush as defined in claim 5, wherein the first and second head member are movable relative to each other free of a frame.

16. The toothbrush as defined in claim 1, wherein the first head section is a perimeter section and the second head member is a center section positioned within the perimeter section; and wherein said perimeter section and center section are movable relative to each other.

17. The toothbrush as defined in claim 16, wherein the perimeter section and center section move relative to each other perpendicular to a longitudinal axis of the toothbrush.

18. The toothbrush as defined in claim 17, further comprising a coupler rod extending between the perimeter section and the center section, and wherein force is transferred between the perimeter and center sections via the coupler rod.

19. The toothbrush as defined in claim 18, wherein the coupler rod includes a first and a second camming lobe, said first camming lobe engaging the perimeter section and said second camming lobe engaging the center section; and wherein the first and second camming lobes are offset relative to each other.

20. The toothbrush as defined in claim 19, further comprising a motor operationally connected to the coupler rod to drive the same; and when the coupler rod is driven through a first range of motion the center section is flexed in a first direction relative to the perimeter section; and when the coupler rod is driven through a second range of motion, the center section is flexed in a second direction relative to the perimeter section.

21. The toothbrush as defined in claim 20, wherein the center section is connected to the perimeter section along a single face disposed proximate an outer edge of the head of the toothbrush, and the center section further includes an interior end spaced a distance inwardly from the face and proximate a center region of the head of the toothbrush, and wherein the interior end of the center section is the component on the head that is flexed outwardly to the greatest degree.

22. The toothbrush as defined in claim 16, wherein the perimeter and center sections are movable relative to each other free of a frame.

23. A method of cleaning teeth comprising the steps of:
activating a powered toothbrush to cause relative movement between at least two movable members on the head of the toothbrush, wherein the relative movement between the movable members is in a direction substantially at right angles to a longitudinal axis of a handle of the brush; and a plurality of bristles extending outwardly from the movable members are thereby caused to move in the direction substantially at right angles to the longitudinal axis of the brush handle,
positioning the brush so that the tips of the bristles move into and out of contact with the surface of the teeth as the movable members are moved;
manipulating the brush until all particulate material is swept from the surface of the teeth by the bristles.

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