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Canadian Intellectual Property Office

CA 3237209 A1 2023/05/11

(21) 3 237 209

(12) DEMANDE DE BREVET CANADIEN
CANADIAN PATENT APPLICATION

(13) A1

(86) Date de dépôt PCT/PCT Filing Date: 2022/11/04
(87) Date publication PCT/PCT Publication Date: 2023/05/11
(85) Entrée phase nationale/National Entry: 2024/05/01
(86) N° demande PCT/PCT Application No.: EP 2022/080884
(87) N° publication PCT/PCT Publication No.: 2023/079121
(30) Priorité/Priority: 2021/11/08 (EP21207029.6)

(51) Cl.Int./Int.Cl. *A46B 15/00* (2006.01), *A46B 3/20* (2006.01), *A46B 7/02* (2006.01), *A46B 7/06* (2006.01), *A46B 9/04* (2006.01)

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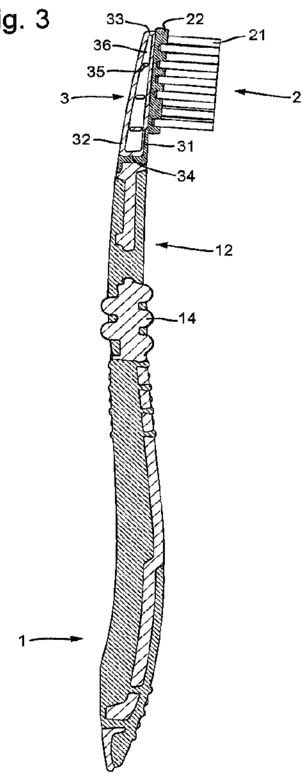
(54) Titre : BROSSE A DENTS
(54) Title: TOOTHBRUSH

Fig. 3



(57) Abrégé/Abstract:
Toothbrush with a handle, at least one cleaning zone and at least one deformable element, where the deformable element has a first flexible arm arranged relatively towards the cleaning zone and a second flexible arm arranged relatively away from the cleaning zone. The deformable element can move from a resting position in which the first arm is substantially flat and aligned to the handle, to a cleaning position in which the first arm and the cleaning zone adopt a curvature of a surface of a dentition, where the arms form a wedge being connected together at one end of the deformable element and distanced from each other at the other end of the deformable element. The first and second arms are linked by at least two bridges which are tiltable with respect to the first and second arms when pressure is applied to the cleaning zone, wherein the arms and bridges enclose a void space.

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) **World Intellectual Property Organization**
International Bureau

(43) **International Publication Date**
11 May 2023 (11.05.2023)

WIPO | PCT

(10) **International Publication Number**
WO 2023/079121 A1

(51) **International Patent Classification:**
A46B 15/00 (2006.01) ***A46B 7/06*** (2006.01)
A46B 9/04 (2006.01) ***A46B 3/20*** (2006.01)
A46B 7/02 (2006.01)

(21) **International Application Number:**
PCT/EP2022/080884

(22) **International Filing Date:**
04 November 2022 (04.11.2022)

(25) **Filing Language:** English

(26) **Publication Language:** English

(30) **Priority Data:**
21207029.6 08 November 2021 (08.11.2021) EP

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(81) **Designated States** *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CV, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IQ, IR, IS, IT, JM, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

(84) **Designated States** *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, CV, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, ME, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report (Art. 21(3))*
— *in black and white; the international application as filed contained color or greyscale and is available for download from PATENTSCOPE*

WO 2023/079121 A1

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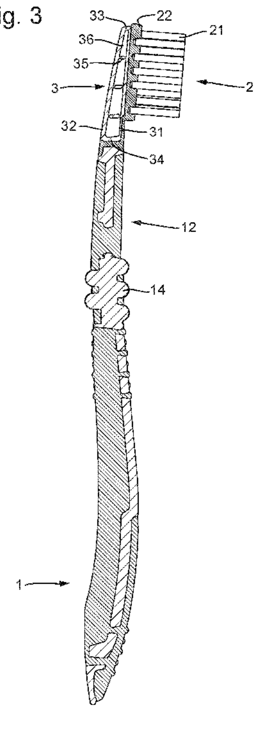
Fig. 3



(57) **Abstract:** Toothbrush with a handle, at least one cleaning zone and at least one deformable element, where the deformable element has a first flexible arm arranged relatively towards the cleaning zone and a second flexible arm arranged relatively away from the cleaning zone. The deformable element can move from a resting position in which the first arm is substantially flat and aligned to the handle, to a cleaning position in which the first arm and the cleaning zone adopt a curvature of a surface of a dentition, where the arms form a wedge being connected together at one end of the deformable element and distanced from each other at the other end of the deformable element. The first and second arms are linked by at least two bridges which are tiltable with respect to the first and second arms when pressure is applied to the cleaning zone, wherein the arms and bridges enclose a void space.

TOOTHBRUSH

FIELD OF THE INVENTION

This invention relates to toothbrushes. In particular, the present invention relates to a toothbrush with a cleaning zone which can be adapted to the shape of the tooth surface.

BACKGROUND TO THE INVENTION

Toothbrushes are well known devices generally comprising a handle by which the toothbrush is held, and a cleaning zone (commonly known as a "head") on which tooth-cleaning elements are arranged, and which are pressed with a cleaning force against the teeth during cleaning. The head and handle define a toothbrush longitudinal handle-head direction, with a neck longitudinally between the head and handle. Tooth cleaning elements normally project from the cleaning zone in a direction transverse to the longitudinal direction.

The toothbrush disclosed by WO2006/089784 comprises a cleaning zone and a deformable element by which the cleaning zone can be adapted to the shape of the tooth surface upon application of a cleaning force by the user. The deformable element of the toothbrush has at least a first and second flexible wing arranged relatively towards and away from the cleaning zone, respectively, and also at least one guide element which is integrally formed with the wings, whereby the first and second wings hold a wedge space at least partially filled with an elastic material, a gel or a fluid. This solution does not have a satisfying deformation capability, due to the materials used and due to the filling in the wedge spaces.

Currently, there remains a need for an improved toothbrush which adapts to the shape of the tooth surface and therefore cleans teeth effectively whilst reducing risk of breakage and difficulty of manufacturing.

SUMMARY OF THE INVENTION

The present disclosure provides a toothbrush with a handle, at least one cleaning zone and at least one deformable element, where the deformable element has a first flexible arm arranged relatively towards the cleaning zone and a second flexible arm arranged relatively away from the cleaning zone. According to the invention, the deformable element can move from a resting position in which the first arm is substantially flat and aligned to the handle, to a cleaning position in which the first arm and the cleaning zone adopt a curvature of a surface of a dentition. According to the invention, the arms form a wedge being connected together at one end and distanced from each other at the other end, where the first and second arms are linked by at least two bridges which are tiltable with respect to the first and second arms when pressure is applied to the cleaning zone, wherein the arms and bridges enclose a void space. Since the bridges are tiltable with respect to the arms, the deformable element is able to adopt the curvature of the surface of a dentition when pressure is applied to the cleaning zone. The arrangement of arms and bridges within the deformable element is reminiscent of the structure of fish fins, which have two bones arranged in a wedge shape linked by connective tissue. Inspired by their analysis of fish fins, biologist Leif Kniese discovered the FIN RAY® effect, whereby application of a force to the fin-like structure causes the base and tip to deform towards the applied force. This technology has been used namely for robot grippers, but not in the domain of oral health in general or for toothbrushes in general. Inclusion of a void space between the arms and bridges allows the deformable element of the invention to easily bend towards the applied load in the cleaning position. Provision of a void space in the deformable element also reduces complexity of manufacturing of the toothbrush, because this feature removes the need for additional manufacturing steps such as filling the void with elastic material, gel or fluid.

In one embodiment, the arms and the bridges are formed integrally by injection moulding. This makes manufacturing particularly efficient, and reduces the risk of dissociation of arms and bridges during use.

In one embodiment, the arms and the bridges are made of a thermoplastic elastomer (TPE) material. TPE are a class of polymeric materials with both thermoplastic and elastomeric properties which will provide the desired flexibility and solidity.

According to a preferred embodiment, the TPE material has a Shore D hardness of about 50 to 66, preferably about 54 to 62, more preferably about 56 to 60, most preferably about 58. The use of such TPE material gives the deformable element sufficient flexibility to move to the cleaning position when force is applied to the cleaning zone, whilst also providing ease of manufacturing at scale. Furthermore, reliable adhesion to the gelpad can be obtained.

In one embodiment, the bridges have hinges flexibly connecting the bridges to the arms. Such hinges will allow for the necessary tilting. Preferably, an angle between the bridges and the arms is around 90° in the resting position, and when pressure is applied to the cleaning zone and the bridges tilt with respect to the arms, the angle increases to around 95° to 110°, preferably to around 97° to 105°.

According to a preferred embodiment, the hinges are integral hinges, i.e. they are formed integrally with the arms and the bridges they are connecting during the manufacturing process, and are made out of the same material, preferably during an injection moulding process. This is particularly advantageous in terms of tilting angle and ease of manufacturing, and reduces the risk of breakage.

According to a preferred embodiment, the integral hinges have a thickness in the longitudinal direction of the toothbrush of about 0.2 to 0.4 mm. This is advantageous because the integral hinge has the required flexibility whilst also minimising risk of breakage. This is particular advantageous when using a TPE material with a Shore D hardness between 54 to 62.

In one embodiment, the distance between the arms at the proximal end of the deformable element is between about 3mm and 5mm, preferably between 3.5mm and 4.5mm. This is advantageous because it reduces the risk of breakage, increases the efficiency of cleaning and is compact enough to fit comfortably in the user's mouth during cleaning.

In one embodiment, the longitudinal distance between the bridges is between about 5 and 9 mm, preferably between 7 and 8mm. Furthermore, the longitudinal distance between the bridge being closest to the tip of the toothbrush head and the tip is preferably also between 5 to 9, preferably between 7 and 8mm. Preferably, the longitudinal distance between the bridge which is closest to the handle and the end of the deformable element, i.e. the length of the void which is closest to the toothbrush handle, is preferably smaller than the longitudinal distance between bridges, for example between 5 and 6mm. Various tests have shown that these dimensions, namely in combination with the use of 3 bridges, lead to optimal results in terms of deformability and cleaning performance.

In one embodiment, the deformable element is not longer than 150% of the length of the cleaning zone, preferably not longer than 130% of the length of the cleaning zone. Consumer testing has shown that an excessively long deformable element produces an unpleasant sensation in the mouth of the user. A deformable element which is not longer than 130% of the length of the cleaning zone also decreases the difficulty of the moulding manufacturing process and the likelihood of breakage during use.

In one embodiment, the deformable element has 2 to 7 bridges, preferably 3 to 5 bridges, most preferably 3 bridges. Less than 3 bridges have been found to not provide the desired deformation properties, i.e. the deformable element remains too rigid with only two bridges. On the other hand, consumer tests have shown that consumers prefer not to have too many bridges in the toothbrush deformable element. An excessive number of bridges, which then often requires also a longer deformable element, produces an unpleasant sensation during brushing. The larger void space associated with additional bridges may also be prone to filling with toothpaste, thus requiring additional post-brushing cleaning. A toothbrush having 3 bridges is preferred, because such a toothbrush has the optimum functionality, namely in terms of cleaning properties, whilst minimising user discomfort and the size of the void space.

In one embodiment, the handle comprises a polypropylene skeleton and is formed integrally in one piece with the deformable element by injection moulding.

In one embodiment, the deformable element consists of a material, preferably a TPE, having an elongation at break of 500 to 800%, preferably 600 to 750%, more preferably 650 to 700%. A material with this property provides the required flexibility and reduces the risk of breakage during use.

In another preferred embodiment, the deformable element consists of a material, preferably a TPE, having a tensile strength between 25 and 36 MPa, preferably between 30 and 33MPa, more preferably between 31 and 32 MPa. Tensile strength has an impact on adhesion properties and on physical properties, and values in these ranges have given best results in terms of adhesion of the deformable element to the gel pad, and in terms of risk of breakage.

The toothbrush of the present invention is formed by a cascade injection moulding process. A single cavity in the mould is injected with TPE to form the deformable element and neck region, whilst polypropylene (PP) is injected to produce a skeleton for the handle region. Different TPE materials are injected on top or around the PP skeleton to provide for the desired surface feel and grip. The TPE and PP materials of the deformable element and the handle are mixed with each other in a contact zone, and all the materials used will adhere to eachother in this bi-injection moulding process.

BRIEF DESCRIPTION OF DRAWINGS/FIGURES

FIG. 1 shows a side view of the toothbrush neck and head portion when not in use .

FIG. 2 shows a side view of the toothbrush neck and cleaning zone during brushing of a dentition. Inset shows a detailed view of the bridge and hinge of the toothbrush.

FIG. 3 shows a side cut view of the toothbrush, the cut being along the cleaning zone-handle longitudinal direction.

FIG. 4 shows a cut view through the head of the toothbrush in the resting position, along a plane perpendicular to the view of Fig. 3.

DETAILED DESCRIPTION OF INVENTION

FIG. 1 shows a side view of a head and neck portion of a toothbrush according to an embodiment of the invention. The toothbrush comprises a head 5, consisting of a cleaning zone 2 and a deformable element 3, and a toothbrush neck 12, linking the head 5 to a handle 1 (cf Fig 4, not shown in Fig. 1). The cleaning zone 2 has a gel pad 22 which holds cleaning elements 21. The cleaning elements 21 of the depicted toothbrush are bristles arranged in tufts (tufts not shown in figures), as it is conventional for toothbrushes. The gel pad 22 is approximately 12 mm wide and 27 mm long in the cleaning zone 2-handle 1 longitudinal direction, and is made out of a TPE material with a Shore A hardness 28, i.e. a flexible, gel-type material.

The deformable element 3 has a first flexible arm 31, on which the cleaning zone 2 sits, with the gel pad 22 being arranged on a surface of the flexible arm 31. Furthermore, the deformable element 3 has a second flexible arm 32, arranged relatively away from the cleaning zone 2. The first and second arms 31, 32 form a wedge (V-shape) whereby the arms are connected together at the distal end 33 and distanced from each other at the proximal end 34 of the deformable element 3 relative to the neck zone 12 and handle 1. The distance I‴ between the first and second arms 31, 32 at the proximal end 34 of the deformable element 3 is approximately around 3.5mm. As the first and second arms 31, 32 converge towards the distal end 33 of the deformable element 3, the distance between the arms reduces as indicated by I, I′ and I″ in Figure 1, respectively. The first and second arms 31, 32 are connected to each other by three bridges 35, 35′, 35″, which extend in a direction perpendicular to the longitudinal direction of the handle 1. Each bridge 35, 35′, 35″ is linked to the first and second flexible arms 31, 32 via integral hinges 38, which enable the bridges to tilt with respect to the first and second arms 31, 32, as shown in the cleaning position depicted in Figure 2. When a pressure is applied to the cleaning zone during brushing, the bridges 35, 35′, 35″ will tilt, thereby causing a curvature of the deformable element 3, with the two flexible arms 31, 32 moving closer to each other at their proximal end 34. The cleaning zone 2 of the toothbrush head 5 will thereby adopt the curvature of the dentition 40, which leads to pressure being applied in a more uniform manner across several teeth, and less risk of gum irritation. The bridges 35, 35′, 35″ have a length in the direction transverse to the longitudinal axis of the handle 1 axis, parallel to the distance I, I′, I″, and I‴ between the arms 31, 32, which increases from the distal bridge 35 to the proximal bridge 35″, with their length ranging approximately between 2mm and 3.5mm. The arms 31, 32 and bridges 35, 35′, 35″ enclose several void spaces 36, 36′, 36″, 36‴ (cf Fig. 1 and 2). The length of these void spaces 36, 36′, 36″, 36‴ in the longitudinal direction of the handle 1 varies between 5 to 8 mm and is shown in Fig. 1 as D1, D2, D3 and D4. While the three distal voids 36, 36′, 36″, closer to the tip 33 of the head 5, are of similar or equal length D1, D2, D3, and extend all below the cleaning zone 2, the proximal void 36‴ has a smaller length D4 and extends beyond the cleaning zone 2 towards the neck 12. The region between the proximal end 34 of the deformable element 3 and a S-bend zone 14 is herein referred to as the neck 12. The S-bend zone 14 serves as a design element desirable to consumers and provides no additional functionality to the toothbrush of the present disclosure, in particular no increased flexibility.

FIG. 2 shows a side view of the toothbrush neck 12 and head 5 during brushing of a surface of a dentition 40, i.e. when pressure is applied on the cleaning. The cleaning elements 21 mounted on the gel pad 22 contact the surface of the dentition 40 during brushing, which exerts a force on the cleaning zone 2, causing the deformable element 3 to adopt the curvature of the surface of the dentition 40, as already mentioned above. Inset shows a detailed view of one of the bridges 35″ of the deformable element 3. The bridge 35″ has a thickness in the longitudinal direction of the handle direction of approximately 0.9 mm as indicated in the figure by w_2. The detailed view shows that the bridge 35″ is connected to the two flexible arms 31, 32 via two hinges 38. These hinges 38 are formed integrally with the bridge 35″ shown in the inset (same for all three bridges 35, 35′, 35″), and are approximately 0.3 mm in thickness, as indicated in the figure by w_1. The integral hinges 38 flexibly connect the bridges 35, 35′, 35″ to the first and second arms 31, 32, therefore allowing the deformable element 3 to adopt the curvature of the surface of the dentition 40 when force is applied by the user, as already explained above. When the deformable element 3 deforms following application of force, the hinges 38 of the bridges 35, 35′, 35″ tilt with respect to the first and second arms 31, 32) at an angle α, which varies between 90° when no pressure is applied to up to 120°, preferably up to 110° during cleaning when pressure is applied.

FIG. 3 shows a side cut view of the toothbrush, the cut being along the longitudinal direction of the handle 1, perpendicular to the plane of the gel pad 22. The toothbrush is formed by a cascade injection moulding process, whereby a single cavity in the mould is injected with TPE material to form the deformable element 3 and parts of the neck 12. The TPE material used for the deformable element has a Shore D hardness of about 50 to 66, preferably about 54 to 62, more preferably about 56 to 60. In the present preferred ambodiment as shown in the figures, the Shore D hardness is about 58. Polypropylene PP is injected to produce the handle 1 skeleton below the S-bend zone 14, with both materials mixing in the S-bend zone 14. The TPE and PP adhere to each other in this bi-injection moulding process.

FIG. 4 shows cut of the head 5 through a plane which is perpendicular to the bridges 35, 35′, 35″ and runs through them, with the toothbrush being in the resting position, i.e. with the gel pad 22 being flat. The deformable element 3 has a width indicated by w_5 of approximately 7.2 mm towards the proximal end 34 relative to the neck 12 and handle 1 as shown in Figures 1 and 2, and it narrows slightly as it extends towards the distal end 33. The three bridges 35, 35′, 35″ of the deformable element 3 have a rectangular cross-section with rounded edges. The width of the bridges 35, 35′, 35″ in the longitudinal direction of the handle 1 is approximately 0.3 mm as shown in Figure 2, here indicated as w_2. The width of the bridges 35 in the transverse direction varies between approximately 4.4 to 5 mm, here indicated by w_4, w_4' and w_4''. The gel pad 22 is shown in the rear view sitting behind the deformable element 3. The gel pad (22) has a capsular shape with rounded ends and has a width extending beyond the width of the deformable element 3 in a direction perpendicular to the handle 1. The deformable element 3 is manufactured in one piece by injection moulding and is made of a thermoplastic elastomer (TPE) material.

The TPE material used for the deformable element has a Shore D hardness of 58 as mentioned above. Furthermore, it has a tensile strangle between 25 and 36 MPa, preferably between 30 and 33MPa, more preferably between 31 and 32 MPa. In the preferred embodiment shown in the figures, it has a tensile strength of around 31 MPa. The TPO material used for the deformable element furthermore preferably has an elongation at break of 500 to 800%, preferably 600 to 750%, more preferably 650 to 700%. In the present preferred embodiment, it has an elongation at break of 686%. The elongation at break was measured using the ISO 37 standard test, but deviating from the standard test protocol, standard test piece S2 was tested with a traverse speed of 200mm/min. The PP material used for the handle 1 skeleton is a conventional PP material as they are frequently used for toothbrush handles.

CLAIMS

1. A toothbrush with a handle (1), at least one cleaning zone (2) and at least one deformable element (3), where the deformable element (3) has a first flexible arm (31) arranged relatively towards the cleaning zone (2) and a second flexible arm (32) arranged relatively away from the cleaning zone (2), where the deformable element (3) can move from a resting position in which the first arm (31) is substantially flat and aligned to the handle (1), to a cleaning position in which the first arm (31) and the cleaning zone (2) adopt a curvature of a surface of a dentition (40), where the arms (31, 32) form a wedge being connected together at one end (33) of the deformable element and distanced from each other at the other end (34) of the deformable element, where the first and second arms (31, 32) are linked by at least two bridges (35, 35′, 35″) which are tiltable with respect to the first and second arms (31, 32) when pressure is applied to the cleaning zone (2), wherein the arms (31, 32) and bridges (35, 35′, 35″) enclose a void space (36, 36′, 36″, 36‴).

2. The toothbrush of claim 1, wherein the arms (31, 32) and the bridges (35) are formed integrally by injection moulding.
3. The toothbrush of claims 1-2, wherein the arms (31, 32) and the bridges (35, 35′, 35″) are made of a thermoplastic elastomer (TPE) material.
4. The toothbrush of claim 3, wherein the TPE material has a Shore D hardness of about 50 to 66, preferably about 54 to 62, more preferably about 56 to 60, most preferably about 58.
5. The toothbrush of any of the preceding claims, wherein the bridges (35, 35′, 35″) have hinges (38) flexibly connecting the bridges (35, 35′, 35″) to the arms (31, 32).
6. The toothbrush of claim 5, wherein the hinges (38) are integral hinges.
7. The toothbrush of claim 6, wherein the integral hinges (38) have a thickness in the longitudinal direction of the toothbrush of about 0.2 to 0.4 mm.
8. The toothbrush of any of the preceding claims, wherein the distance (I‴) between the arms (31, 32) at a proximal end (34) of the deformable element is between about 3mm to 5mm, preferably 3.5 to 4.5mm.
9. The toothbrush of any of the preceding claims, wherein a longitudinal distance (D_2, D_3) between adjacent bridges is between about 5 to 9mm, preferably between 7 to 8mm.
10. The toothbrush of any of the preceding claims, wherein the deformable element (3) is not longer than 150% of the length of the cleaning zone (2), preferably not longer than 130% of the length of the cleaning zone (2).

11. The toothbrush of any of the preceding claims, wherein the deformable element (3) has 2-7 bridges (35, 35′, 35″), preferably 3-5 bridges (35, 35′, 35″), most preferably 3 bridges (35, 35′, 35″).
12. The toothbrush of any of the preceding claims, wherein the handle (1) comprises a polypropylene skeleton and is formed integrally in one piece with the deformable element (3) by injection moulding.
13. The toothbrush of any of the preceding claims, wherein the deformable element (3) consists of a material having an elongation at break of 500 to 800%, preferably 600 to 750%, more preferably 650 to 700%.
14. The toothbrush of any of the preceding claims, wherein an angle (α) between the bridges (35, 35′, 35″) and the arms (31, 32) is around 90° in the resting position, and around 95° to 110°, preferably around 97° to 105° when pressure is applied to the cleaning zone (2).

Fig. 1

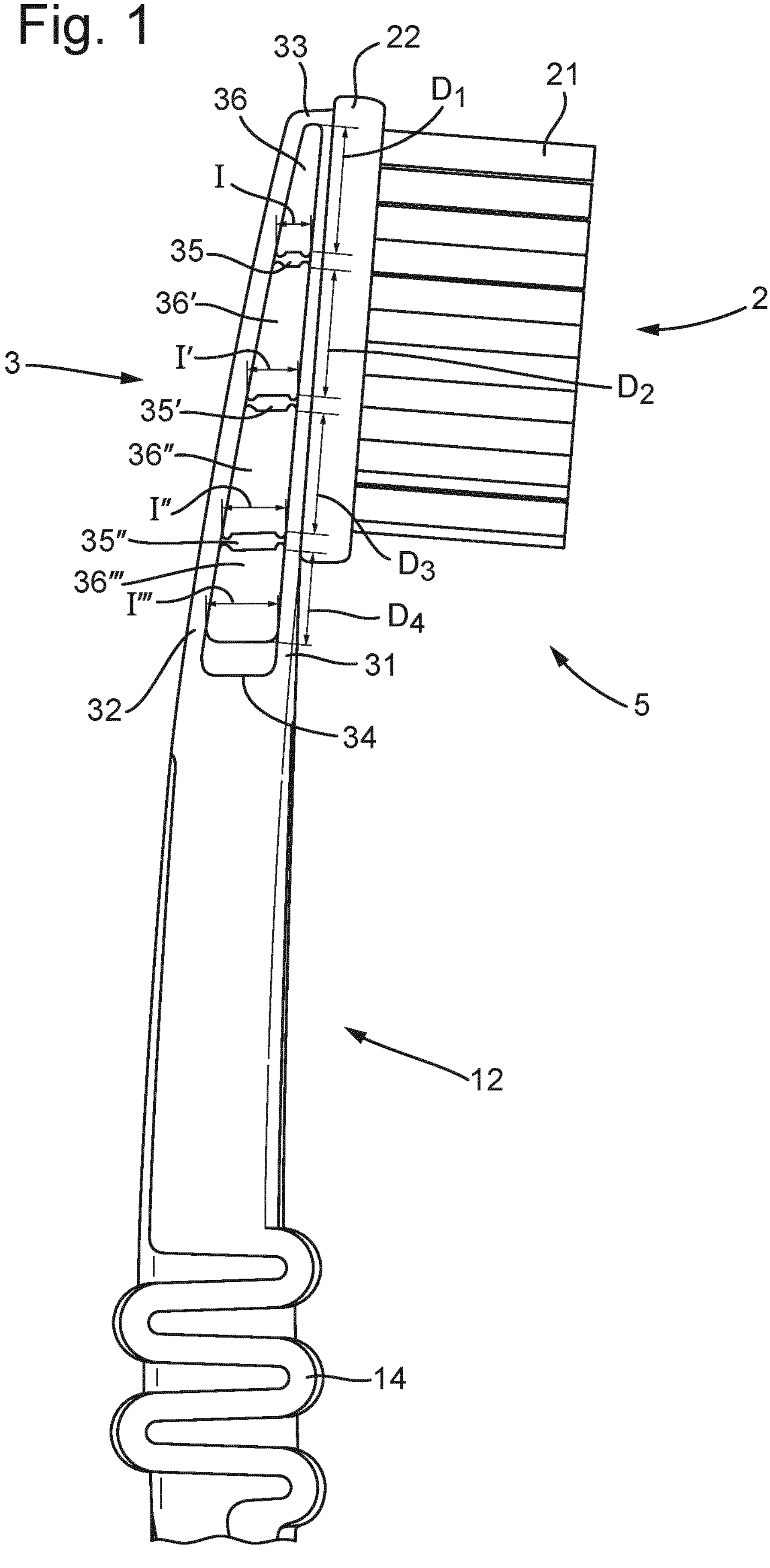
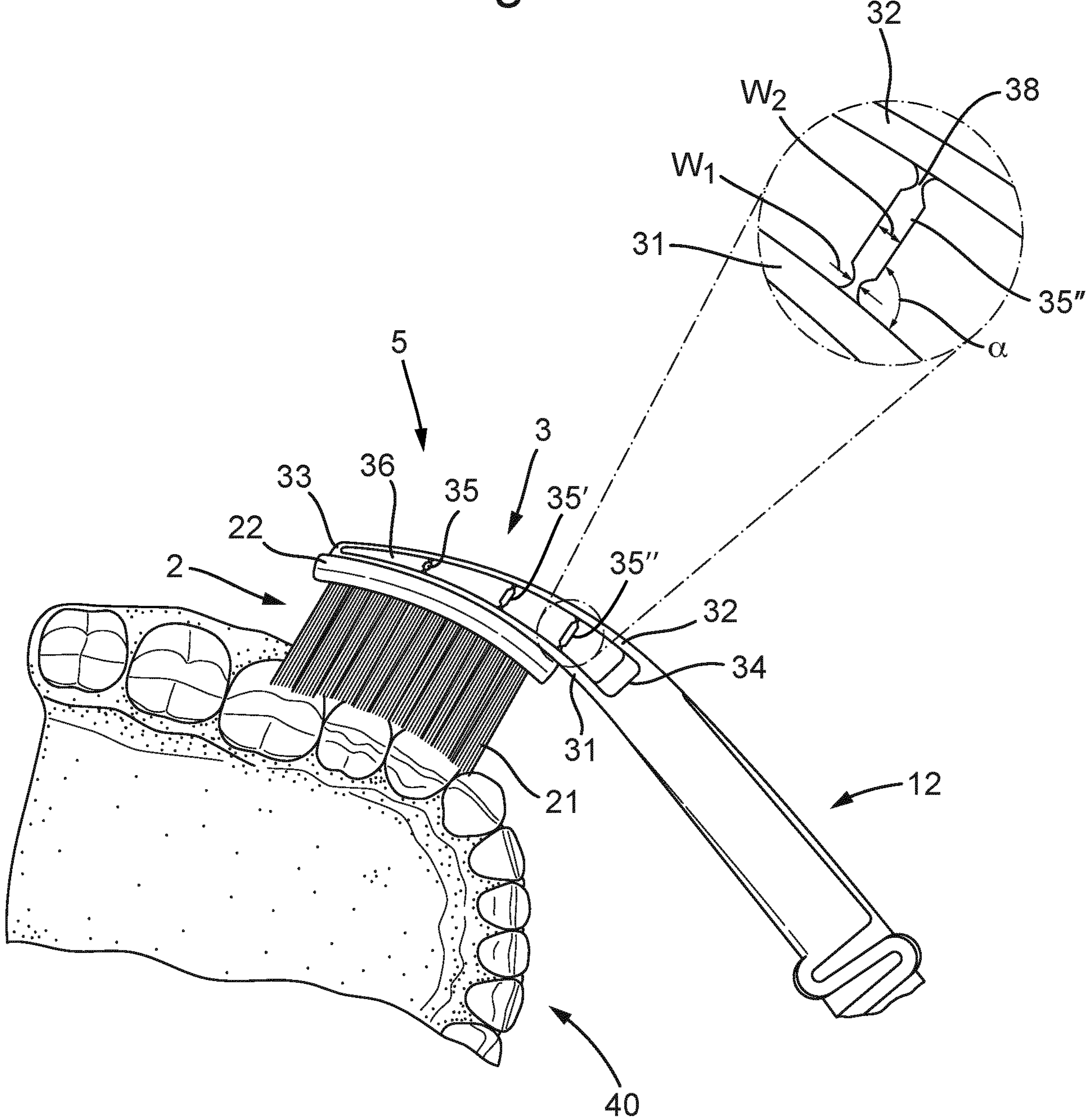


Fig. 2



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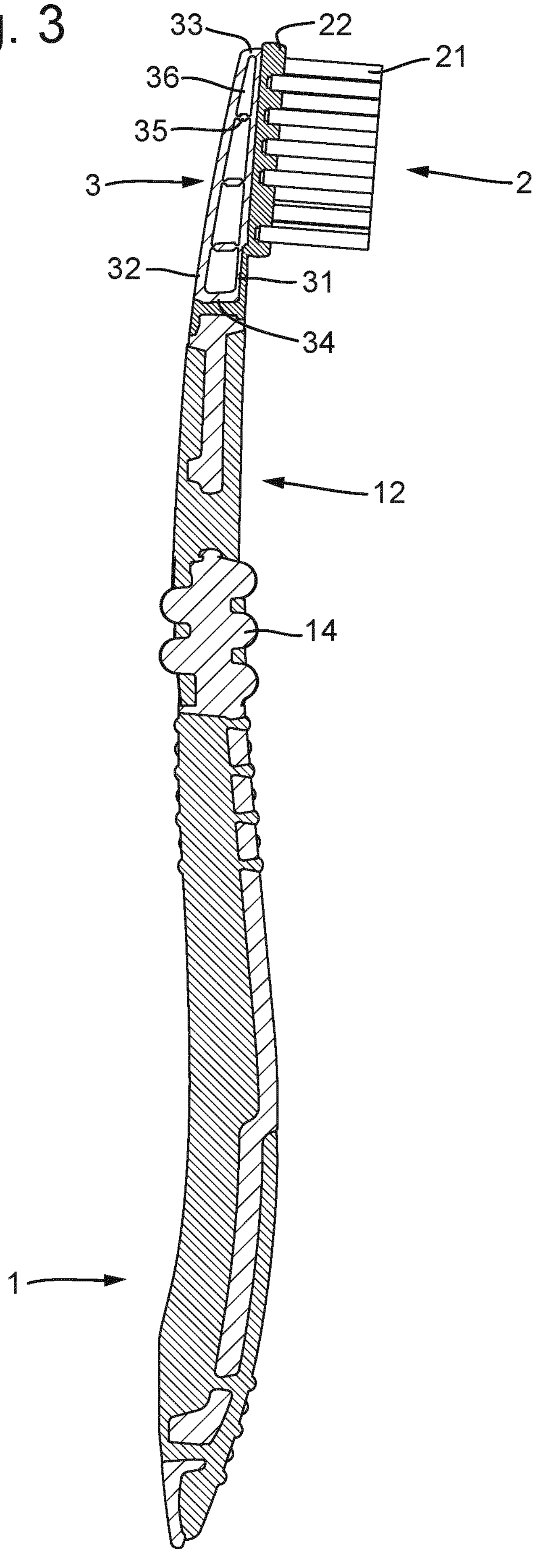

Fig. 4

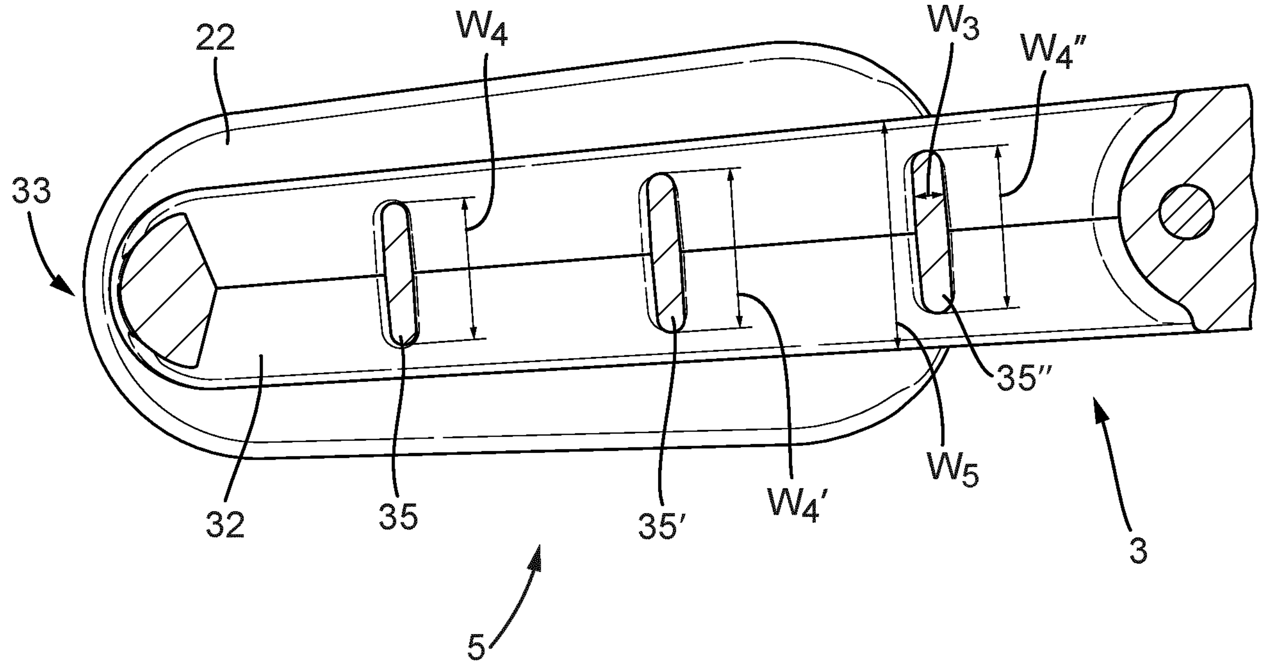

Fig. 3