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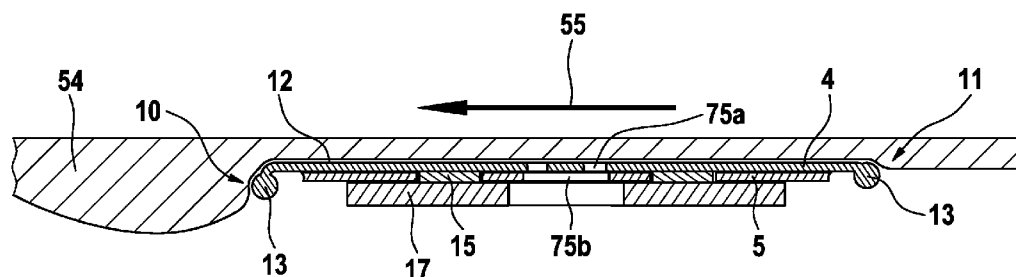


**Fig. 4a**

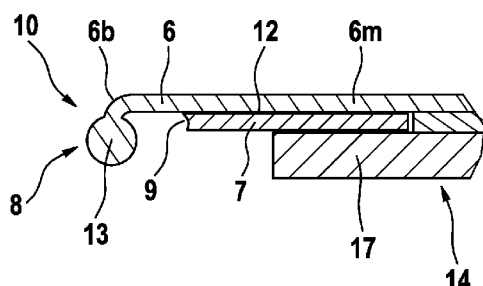


**Fig. 4b**

(57) **Abstract:** The present invention relates to a cutter system 3 for an electric shaver and/or trimmer 1, comprising a pair of comb-like cutting elements 4, 5 each with at least one row of cutting teeth 6, 7 and movable relative to each other, wherein one of said cutting elements has thickened and/or rounded tooth tips 8 overhanging the tooth tips of the other cutting element, wherein said overhanging tooth tips are provided with a two-step rounding including a spherical or drop-shaped or pearl-shaped thickening 13 and a bent or curved portion 6b connecting said thickening to a main tooth portion 6m and bent away from the skin contact surface 12 of said main tooth portion, wherein a concave depression is formed in the transitional section between said thickening and said bent or curved portion on the skin contact side of the teeth.



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## ELECTRIC BEARD TRIMMER

## FIELD OF THE INVENTION

5 The present invention relates to cutting body hair such as beard stubbles of multiday's beard. More particularly, the present invention relates to a cutter system for an electric shaver and/or trimmer, comprising a pair of comb-like cutting elements each with at least one row of cutting teeth and movable relative to each other, wherein one of said cutting elements has thickened and/or rounded tooth tips overhanging the tooth tips of the other cutting element. The present  
10 invention also relates to a method of manufacturing such cutter system and an electric shaver and/or trimmer provided with such a cutter system.

## BACKGROUND OF THE INVENTION

15 Electric shavers and trimmers utilize various mechanisms to provide hair cutting functionality. Some electric shavers include a perforated shear foil cooperating with an undercutter movable relative thereto so as to cut hairs entering the perforations in the shear foil. Such shear foil type shavers are often used on a daily basis to provide for a clean shave wherein short beard stubbles are cut immediately at the skin surface.

20 On the other hand, other cutter systems including a pair of cooperating comb-like cutting elements with a plurality of comb-like or rake-like cutting teeth reciprocating or rotating relative to each other, are often used for cutting longer beard stubbles or problem hair that is difficult to cut due to, for example, a very small angle to the skin or growing from very resilient skin. The  
25 teeth of such comb-like or rake-like cutting elements usually project substantially parallel to each other or substantially radially, depending on the type of driving motion, and may cut hairs entering into the gaps between the cutting teeth, wherein cutting or shearing is achieved in a scissor-like way when the cutting teeth of the cooperating elements close the gap between the finger-like cutting teeth and pass over each other.

30 Such cutter systems for longer hairs may be integrated into electric shavers or trimmers which at the same time may be provided with the aforementioned shear foil cutters. For example, the comb-like cutting elements may be arranged, for example, between a pair of shear foil cutters or

may be arranged at a separate, extendable long hair cutter. On the other hand, there are also electric shavers or trimmers or styling apparatus which are provided only with such comb-like cutting elements.

5 For example, EP 24 25 938 B1 shows a shaver with a pair of long hair trimmers integrated between shear foil cutters. Furthermore, EP 27 47 958 B1 discloses a hair trimmer having two rows of cooperating cutting teeth arranged at opposite sides of the shaver head, wherein the cutting teeth of the upper comb-like cutting element are provided with rounded and thickened tooth tips overhanging the tooth tips of the lower cutting element so as to prevent the projecting  
10 tooth tips from piercing into the skin and from irritating the skin. A similar cutter system is shown in US 2017/0050326 A1 wherein in such cutter system the lower comb-like cutting element is fixed and the upper comb-like cutting element is movable.

Furthermore, CN 206 287 174 U discloses a beard trimmer having a pair of cooperating comb-  
15 like cutting elements each of which is provided with two rows of projecting cutting teeth, wherein the upper cutting element defining the skin contact surface has cutting teeth provided with thickened and rounded tooth tips overhanging the teeth of the lower cutting element. Said thickened and rounded tooth tips are curved away from the skin contact surface and do not protrude towards the skin contact surface so as to have the skin indeed directly contact the main  
20 portion of the cutting teeth to cut the beard stubbles close to the skin surface.

Such beard stubble trimmers need to address quite different and diverging functional requirements and performance issues such as closeness, thoroughness, good visibility of the cutting location, efficiency and pleasant skin feel, good ergonomics and handling. Closeness  
25 means short or very short remaining stubbles, whereas thoroughness means less missed hairs particularly in problem areas like the neck. Efficiency means less and faster strokes suffice to achieve the desired trimming result. Pleasant skin feel depends on the individual user, but often includes less irritation in form of nicks, cuts or abrasion and better gliding onto the skin. Visibility of the cutting location is particularly important in case of styling or edging contours to  
30 accomplish hair removal with a local accuracy of the magnitude of, for example, 1 mm.

Fulfilling such various performance issues at the same time is quite difficult. For example, rounded tooth tips with thickened end portions as shown in EP 27 47 958 B1 may prevent skin

irritations, but do not allow for a more aggressive, closer shave. On the other hand, cutter systems with relatively sharp tooth tips at the upper driven comb as shown in US 2017/0050326 A1 may achieve closeness, but cannot be used to cut contours with the projecting teeth substantially perpendicular to the skin surface without causing skin irritations.

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## SUMMARY OF THE INVENTION

It is an objective underlying the present invention to provide for an improved cutter system avoiding at least one of the disadvantages of the prior art and/or further developing the existing solutions. A more particular objective underlying the invention is to provide for a close and thorough cutting of longer stubbles and hair including a good control of edging contours and, at the same time, avoiding skin irritations. Another objective underlying the present invention is a reliable and clean cutting action of the cooperating cutting teeth to avoid pulling and tugging of hair, without sacrificing low friction between the cutting elements, low temperatures of the cutting teeth and low energy consumption and thus long energy storage life.

According to an aspect, closeness and thoroughness of the cutting action may be combined with a pleasant skin feel avoiding skin irritations, by means of a two-step rounding of the overhanging tooth tips including a spherical or drop shaped or pearl-shaped thickening and a bent or curved tooth portion connecting said thickening to a main tooth portion and bent or curved away from the skin contact surface of said main tooth portion. A concave or flattened depression is formed in the transitional section between said thickening and said bent or curved tooth portion on the skin contact side of the teeth. Bending the teeth away from the skin contact surface in addition to the provision of a substantially spherical or drop shaped thickening at the outermost tip portion reliably prevents skin piercing and skin irritations even when using smaller sized thickening and/or rounding contours, but nevertheless allows for closeness and thoroughness of the cutting action. More particularly, the substantially spherical thickening may form the very outermost tip portion, wherein a more inwardly positioned tip portion neighboring said thickening may be bent away from the skin surface of the main tooth portion. Said more inwardly positioned tip portion is still part of the tooth tip, but is not yet part of the thickening and may have a substantially flat, plate-like configuration with a thickness comparable to or the same as the inner portions or main portion of the cutting tooth. The term “bent” in this and the following context means that the

contour of the tooth close to the tip is curved and only optionally but not necessarily may also refer to the process of bending the tip area in order to create the curved or bent shape.

According to another aspect, the rounded, overhanging tooth tips may include a composite thickening including an outer shell surrounding an inner core, said outer shell and said inner core being made from different materials. In particular, said outer shell may be made from metal, whereas the inner core may be made from a non-metallic or polymer material so as to achieve a light-weight, rigid tooth tip structure having a high resistance against wear and tear.

- 10 These and other advantages become more apparent from the following description giving reference to the drawings and possible examples.

#### BRIEF DESCRIPTION OF THE DRAWINGS

- 15 Figs. 1a-1b: perspective views of an electric beard trimmer including a cutting system with a pair of cooperating comb-like cutting elements reciprocating relative to each other, wherein partial view (a) shows a front side of the electric beard trimmer and partial view (b) shows the beard trimmer working on a chin,

- 20 Fig. 2: a cross sectional view of the beard trimmer showing the cooperating comb-like cutting elements and the drive system for driving said cutting elements,

- Fig. 3: a perspective view of the cutter system including the pair of cooperating comb-like cutting elements and the support structure for supporting the cutting elements relative to each other,
- 25

- Figs. 4a-4c: a cross sectional view of the cutter system in contact with the skin to be shaved, showing the asymmetric rows of cooperating cutting teeth on opposite sides of the cutter head and shaped differently from each other to achieve different skin contact and skin waves when moving the cutter system along the skin to be shaved, wherein partial, enlarged views a and b show the different configuration of the tooth tips of the two rows of cutting teeth,
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Figs. 5a-5b: a side view and a top view of the teeth of the upper cutting element having rounded and thickened tooth tips, wherein view (a) shows a side view of the rounding and thickening, whereas view (b) shows a top view of a pair of teeth with a gap there between,

- 5 Fig. 6: a cross sectional view of a cutter system similar to figure 4a, wherein the tooth tips of both rows of cooperating teeth on opposite sides of the cutter head are bent away from the skin contact surface and protrude only to the side opposite to the skin contact surface,

- 10 Figs. 7a – 7d: cross sectional views of the engagement of the tooth tip with the skin to be shaved according to different use options, wherein view (a) shows a smoothly configured tooth tip for close cutting in a fork mode, view (b) shows the smoothly configured tooth tip in a rake mode, view (c) shows an aggressively configured tooth tip for thorough cutting used in a fork mode and view (d) shows the aggressively configured tooth tip of view (c) in a rake mode,

- 15 Figs. 8a-8g: shows the cutter system including the cooperating cutting elements in differently assembled/exploded views, wherein view (a) shows the assembled cutting system in a perspective view, view (b) shows an exploded view of the cutter system illustrating the spacer between the support element and the upper cutting element to define a gap for receiving the sandwiched cutting element, view (c) shows a partly exploded view of the cutting system with the spacer being attached to the support element, and view (d) shows a partly exploded view showing the sandwiched cutting element assembled with the spacer, view (e) shows a partial, perspective view of the skin contact surface of the teeth with rounded and/or beveled edges, view (f) shows a top view of the skin contact surface of the teeth with the rounded and/or beveled edges, and view (g) shows two cross-sectional views of the rounding and/or beveling of the edges, and view (g) shows two cross-sectional views of the rounding and/or beveling of the edges  
25 of the skin contact surfaces of the teeth taken at different length portions of the teeth as indicated in partial view 8f to illustrate the teeth cross-section varying along the teeth longitudinal axis,

- Figs 9a-9c: shows perspective views in part of the cooperating cutting teeth to illustrate the rounded, thickened tooth tips of the upper cutting element overhanging the cutting teeth of the sandwiched cutting element and to illustrate the support element holding the sandwiched cutting element closely at the upper cutting element, said support element having a wave- or teeth-shaped edge contour,  
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Figs. 10a-10c: a cross sectional view of the support structure including a spacer for defining a gap receiving the sandwiched cutting element which gap is slightly thicker than the sandwiched cutting element,

- 5 Figs. 11a-11b: a cross sectional view of an alternative support structure including a spring device urging the sandwiched cutting element towards the upper cutting element to minimize a gap between the cooperating teeth,

- 10 Figs. 12a-12b: a top view onto the skin contact surface of a cutter system having differently configured teeth in each row of cooperating teeth, wherein partial view (a) shows an example having more aggressively configured teeth in a middle section of the rows of cooperating teeth and less aggressively configured teeth in opposite end sections of the rows to compensate for skin contact pressure increasing towards the end sections, and partial view (b) shows another example having more aggressively configured teeth in the end sections of the rows and less
- 15 aggressively configured teeth in the middle section of the rows to compensate for skin pressure increasing towards the middle section,

- Figs. 13a-13c: the relationship between tooth configuration and skin contact pressure varying along a row of teeth, wherein partial view (a) shows a front view onto the tooth tips of a row of
- 20 cooperating teeth in engagement with the skin of a user, partial view (b) shows the skin contact pressure and the pressure on the teeth in reaction thereto, for different portions of the skin contacting different sections of a row of teeth, and partial view (c) shows the skin contact pressure increasing from the center of the row of teeth towards the lateral end thereof,

- 25 Figs. 14a-14b: the skin contact pressure and teeth configuration varying along the teeth rows similar to figure 13a, wherein partial view (a) shows a cutter system with a substantially flat or planer skin contact surface with skin contact pressure increasing from the center towards the lateral end portions of the teeth rows, and partial view (b) shows a cutter system with a convex skin contact surface with skin contact pressure decreasing towards the lateral end portions of the
- 30 teeth rows,

Figs. 15a-15c: perspective views of teeth having composite tooth tips with a filler surrounded by an outer layer, and

Figs. 16a-16c: perspective views of the teeth having the composite tooth tips cooperating with teeth reciprocating relative thereto.

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## DETAILED DESCRIPTION OF THE INVENTION

So as to combine closeness and thoroughness of the cutting action with good protection against skin irritations, the overhanging tooth tips may be provided with a two-step rounding including a spherical or drop-shaped or pearl-shaped thickening and a bent or curved portion connecting said thickening to a main portion of the corresponding tooth and bent or curved away from the skin contact surface of said main tooth portion, wherein a slight depression may be formed in the transition section between the spherical or pearl-shaped thickening and said bent or curved portion. Such double-rounded configuration including the rounding of the thickening and the curved or bent configuration of the neighboring tooth portion to which the thickening is attached, may combine closeness and thoroughness of the cutting action with a pleasant skin feel avoiding skin irritations. More particularly, bending the teeth away from the skin contact surface in addition to the provision of a substantially spherical and thus round thickening at the outermost tip portion reliably prevents skin piercing and skin irritations even when the thickening is of a smaller contour which, on the other hand, helps in achieving closeness and thoroughness.

20

Said two-step rounding and/or curving may include a concave section between the two rounded portions, more particularly a concave section between the spherical or pearl-shaped thickening and the neighboring curved portion. Considering a tangential line onto the skin contact surface of the end portions of the teeth, said tangential line contacts said spherical or pearl-shaped thickening on the one hand and the convex curved portion on the other hand, wherein between said two contact points of the imaginative tangential line the aforementioned concave section forms a gap to said tangential line. In other words, the transitional section between the thickening and the bent or curved portion includes some slack and/or a dint and/or a flattening on the skin contact side of the tooth. Said thickening and the bent or curved portion form basically convex skin contact surfaces, whereas the transitional section between said thickening and curved portion form a flattened or concave skin contact surface.

30

More particularly, the substantially spherical thickening may form the very outermost tip portion, wherein the neighboring, more inwardly positioned tip portion may be curved away from the skin contact surface of the main tooth portion. Said more inwardly positioned tip portion is still part of the tooth tip, but is not yet part of the thickening and may have a substantially flat, plate-like configuration with a thickness comparable to or the same as the inner portions or main portion of the cutting tooth.

Said inner or main portion of the cutting teeth providing for the cutting action due to the other, cooperating teeth closing the gap and passing, may have a substantially elongated, plate-like configuration with at least substantially parallel cutting edges formed by longitudinal edges of the tooth body. At the tip of such parallelepiped-like tooth main portion, the substantially spherical thickening may be attached forming the tip of the teeth.

In particular, the two-step rounding provides for excellent cutting performance when the cutter system is used in the rake mode as well as in the fork mode. When used in the fork mode, i.e. the teeth, with their main tooth portion, being substantially parallel to and/or tangential to and/or touching the skin, helps in keeping the skin wave small which skin wave is created when sliding the cutter system along the skin surface. Due to the bending of the tooth tip portion neighboring the thickening away from the skin contact surface, friction between the thickening and the skin can be reduced. On the other hand, when using the cutter system in the rake mode, i.e. positioning the cutting teeth, with their longitudinal axis, substantially perpendicular to the skin, the substantially spherical thickening guides the pair of cutting elements along the skin surface and achieves a substantially soft cutting procedure.

The bent teeth portion connecting the spherical thickenings to the main portion of the teeth, may be configured to have a radius of curvature or bending radius which is smaller than 400  $\mu\text{m}$ . More particularly, the bending radius of said bend tooth portion may range from 200 to 400  $\mu\text{m}$  or 250 to 350  $\mu\text{m}$ .

The thickenings may have a diameter ranging from 300 to 550  $\mu\text{m}$  or 350 to 500  $\mu\text{m}$ .

So as to give the user the choice between a more aggressive, closer cutting action on the one hand and a less intensive, more pleasant skin feel on the other hand, the cutter system provides

for two separate rows of cooperating teeth which are different from each other in terms of shape and/or size and/or positioning of the thickened and/or rounded tooth tips of the teeth. Thus, using a first row of cooperating cutting teeth may provide for a more aggressive, closer cutting action, whereas using a second row of cutting teeth may provide for a less intensive, more pleasant skin  
5 feel. The configuration of the tooth tips, in particular the configuration of the curvature and thickening thereof may considerably influence the cutting performance and allow the user to choose between closeness, thoroughness, soft skin feel and efficiency. Due to the at least two rows of cooperating teeth having tooth tips configured differently aggressive, versatility of the cutter system is significantly increased.

10

More particularly, the rows of cooperating teeth may differ from each other in terms of the height of the tooth tips which is, at least in part, defined by the position of the thickening relative to the main portion of the teeth and the size and shape thereof. At one row, the thickening may protrude only to the side opposite to the skin contact surface what may be achieved, for example, by  
15 bending or curving the teeth portions at which the tip thickenings are attached, away from the skin contact surface and/or attaching the thickening to the main portion of the teeth in an eccentric way, in particular a bit offset away from the skin contact surface. On the other hand, at a second row of cooperating teeth, the thickenings at the tooth tips may protrude to both sides of the teeth, i.e. to the skin contact surface and to the side opposite thereto.

20

In a more general way, the asymmetric design of the cutting teeth rows may be achieved in that the overhanging tooth tips at one row of cutting teeth protrude from the skin contact surface of a main portion of the cutting teeth towards the skin to be contacted further than the overhanging tooth tips at the other row of cutting teeth. In addition or in the alternative, the overhanging tooth  
25 tips at said other row of cutting teeth may be positioned further away from the skin contact surface of the main portion of the cutting teeth than the overhanging tooth tips of said one row of cutting teeth.

30

So as to achieve a sort of protection against piercing of the tooth tips of the lower comb-like cutting element or undercutter, the upper cutting element may have tooth tips overhanging the tooth tips of the lower cutting element and protruding towards a plane in which the teeth of the lower cutting element are positioned so that the thickened tooth tips of the upper cutting element form a sort of barrier preventing the tooth tips of the lower cutting element to pierce into the skin.

More particularly, the overhanging tooth tips of the upper cutting element may be thickened and/or curved such that said overhanging tooth tips extend into and/or beyond said plane in which the tooth tips of the other cutting element are positioned. Thus, said tooth tips of the other cutting element are hidden behind the overhanging tooth tips of the other cutting element when  
5 viewing onto the tips of the teeth of the cutting elements in a direction substantially parallel to the longitudinal axis of the protruding teeth.

Said asymmetric rows of cooperating teeth may differ in the heights of the teeth having the overhanging thickened and/or curved tooth tips. The height of the teeth may be measured  
10 substantially perpendicular to the skin contact surface of the main portion of the teeth and/or perpendicular to a longitudinal axis of the teeth, and may include the contour of the thickening at the tips and the upper and/or lower contour of the main portion of the teeth. When the thickening protrudes away from the skin contact surface and/or the teeth are curved away from said skin contact surface, the height may span from the lowest point of the thickening to the upper surface  
15 of the main portion of the teeth defining the skin contact surface thereof.

Such heights may differ from row to row. More particularly, at one row the height of the cutting teeth having the overhanging tooth tips may range from 300 to 600  $\mu\text{m}$  or 350 to 550  $\mu\text{m}$ , whereas the height at the other row may range from 200 to 500  $\mu\text{m}$  or 250 to 450  $\mu\text{m}$ .

20 More generally, heights between 200 and 550  $\mu\text{m}$  may eliminate the risk of penetration when the cutting system is applied in parallel to the skin, i.e. with the skin contact surface of the main portion of the teeth touching the skin or parallel to the skin to be shaved.

25 The aforementioned thickenings may be shaped spherical or at least similar to a sphere such as drop-shape or pearl-shape, wherein a diameter – in case of a drop-shape or pearl-shape a minimum diameter – may range from 250 to 600  $\mu\text{m}$  or 300 to 550  $\mu\text{m}$  or 350 to 450  $\mu\text{m}$ .

To give the rows of cooperating teeth asymmetrical configuration, the thickenings of the  
30 overhanging tooth tips at one row may have a diameter ranging from 350 to 550  $\mu\text{m}$ , whereas the diameter of the thickenings of the tooth tips at another row may range from 250 to 450  $\mu\text{m}$ .

When the cutter system is used like a rake with the cooperating teeth extending substantially perpendicular to the skin to be shaved, it may be helpful to have a sufficiently long overhang of the thickened and/or rounded tooth tips of the standing, not reciprocating or not rotating cutting element to prevent the reciprocating or rotating teeth of the other cutting element from touching and irritating the skin. Such overhanging length defining the length of protrusion of the overhanging tooth tips beyond the tooth tips of the other cutting element, may range from 400 to 800  $\mu\text{m}$  or 400 to 600  $\mu\text{m}$ .

So as to allow for a close cut, the teeth may have a rather reduced thickness and/or the thickness of the teeth may be adjusted to the gap between pairs of neighboring cutting teeth. Usually, the skin to be shaved bulges when the cutter system is pressed against the skin to be shaved. More particularly, the skin may bulge into the gaps between the cutting teeth which depress or dent the skin in contact with the teeth bodies. Due to such bulging effect of the skin, it may be advantageous to have a teeth thickness, at a main portion of the teeth providing the cutting action, ranging from 50 to 150 or 30 to 180  $\mu\text{m}$ . In addition or in the alternative, the width of a gap between neighboring cutting teeth may have a gap width ranging from 150 to 550 or 200 to 500  $\mu\text{m}$ . In addition or in the alternative, the teeth may have a width ranging from 200 to 600  $\mu\text{m}$  or 250 to 550  $\mu\text{m}$ .

The rows of teeth having different aggressiveness may be positioned on opposite sides of a cutter head and/or may look into opposite directions, i.e. may be open towards opposite directions so as to allow hair to enter into the gaps between the teeth when moving the cutter head into opposite directions.

More particularly, the cutter system may define a skin contact surface which is inclined at an acute angle relative to the longitudinal axis of the elongated handle of the cutting device so that one side of the skin contact surface slopes down towards a front side of the handle, whereas the opposite side of the skin contact surface extends towards the back side of the handle. Said front side of the handle may include, for example, an operation button for switching on and off the drive unit and/or may include a surface contour or portion adapted to a thumb gripping the handle. Said skin contact surface of the cutter system may form a sort of monopitch roof attached to one end of the handle. However, the skin contact surface does not have to be flat or planar, wherein, when said skin contact surface is convex and/or concave, a plane tangential to the skin

contact surface may have the aforementioned inclination relative to the longitudinal axis of the handle. The row of teeth having the more aggressive configuration may be arranged at the lower side of said monopitch roof, i.e. at the side of the skin contact surface sloping down towards the front side of the handle, whereas the row of teeth configured less aggressive may be arranged at the opposite side, i.e. at the upper side of the monopitch roof or the side ascending towards the back side of the handle. Usually, when the skin contact surface is inclined to slope down towards the front side of the handle, the skin contact pressure at the sloped down side is lower than the skin contact pressure at the ascending side. Thus, the more aggressive teeth at the sloped down side having the lower skin contact pressure may achieve efficient hair cutting and catch difficult hair without skin irritations, since the low skin contact pressure is sort of compensating by the increased aggressiveness of the teeth configuration. On the other hand, the less aggressive teeth at the opposite, ascending side of the skin contact surface may compensate for the higher skin contact pressure there and to avoid skin irritations.

According to another aspect, the aggressiveness of the teeth may vary also within the same row of cooperating cutting teeth. More particularly, the cutting teeth in a middle section of a row may be different from cutting teeth in end sections of said row in terms of shape and/or size and/or position of the tooth tips so as to provide for a different level of aggressiveness. More particularly, in sections of relatively high skin contact pressure, the teeth may be configured to provide for reduced aggressiveness, whereas the teeth arranged in sections having relatively low skin contact pressure may be configured to provide for a higher level of aggressiveness.

The skin contact pressure may vary due to the contour of the skin contact surface of the cutter system. For example, when the skin contact surface of the cutter system is substantially flat and/or substantially planar and/or slightly concave, the skin contact pressure may increase towards the lateral end portions of the skin contact surface. Said lateral end portions mean the end portions in the direction of the reciprocating movement of the cutting teeth relative to each other. So as to achieve uniform cutting despite such varying skin contact pressure, the teeth positioned in the middle section having the lower skin contact pressure may be configured to have a higher aggressiveness what might be achieved by means of a smaller diameter of the rounded tooth tips and/or less curvature away from the skin contact surface. On the other hand, the teeth positioned in the end sections having higher skin contact pressure may be configured to

provide for reduced aggressiveness what might be achieved by an increased diameter of the rounded tooth tips and/or more curvature away from the skin contact surface.

- According to another aspect, the skin contact surface of the cutter system may have a convex contour when viewed in a cross-sectional plane parallel to the direction of reciprocating movement of the cooperating teeth relative to each other and perpendicular to the skin contact surface. In other words, the skin contact surface of the cutter system may slope down or may be curved away from the skin towards the lateral end portions towards which the teeth reciprocate. Due to such convex contour of the skin contact surface, the skin contact pressure may decrease from the center section of the cutter system towards the end portions thereof. So as to compensate for such varying skin contact pressure, the teeth in the lateral end sections may be configured to have an increased aggressiveness, whereas the teeth in a middle section may be configured less aggressive.
- It may be sufficient to have three or four or five groups of teeth in a row having the aforementioned different configuration and different aggressiveness. On the other hand, the configuration of the teeth of a row may change step by step or continuously from the center of the row of teeth to the end portions thereof, wherein said change of the configuration may provide for a distribution of tooth configurations substantially symmetrical with regard to the center of the row of teeth. More particularly, the tooth aggressiveness may change step by step or continuously from the center of a row towards each of the end sections thereof.

- Another sort of asymmetrical contouring may be provided at the side edges of the skin contact surface of each tooth or at least a group of teeth. More particularly, the teeth which may have a finger-like shape, have skin contact surfaces which may have rounded and/or beveled edges, wherein the degree or level of rounding and/or beveling may vary along the longitudinal axis of the teeth.

- More particularly, the rounding and/or beveling of the skin contact surface edges may be more pronounced and/or larger at a base section or root section of the teeth than the rounding and/or beveling at a middle section and/or a projecting teeth section close to the tooth tips. Usually, the skin contact pressure decreases towards the base section or root section of the teeth so the increased rounding and/or beveling of the edges of the skin contact surface of the teeth may

allow the skin to sufficiently bulge into the gap between the teeth despite the decreased skin contact pressure. Thus, an efficient hair cutting and closeness can be achieved over the entire length of the cutting teeth.

5 Said rounding and/or beveling of the edges of the skin contact surface of the teeth also may vary along the length of a row of teeth so that in a middle section of the row the rounding and/or beveling of the edges of the skin contact surface of the teeth may be different from the rounding and/or beveling of the skin contact surface of the teeth in end sections of a row of teeth. In particular, the rounding and/or beveling may be larger and/or more pronounced in sections of the  
10 row where the skin contact pressure is lower, whereas the rounding and/or beveling may be smaller in sections where the skin contact pressure is higher.

So as to achieve a light-weight, but still rigid tooth tip structure resistive against wear and tear, the tooth tips may have composite thickenings including an outer shell surrounding an inner core,  
15 said shell and core being made from different materials.

The cutter system may be provided with said overhanging rounded tooth tips which may include a composite thickening which may include an outer shell surrounding an inner core, said shell and said core being made from different materials.

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Said shell can be made from metal and said core can be made from a non-metallic material.

Said outer shell may surround said inner core at three sides thereof, wherein the inner core can be uncovered and visible from two opposite sides which are facing neighboring teeth.

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Said outer shell can be plate-shaped and curved by more than 100° or more than 150°, in particular U-shaped.

Said outer shell may have three open sides, wherein first and second open sides may be opposite  
30 to each other and face neighboring teeth and a third open side may face the tooth tip of the other cutting element.

The inner core may have a diameter or thickness ranging from 50% to 250% or 75% to 125% of the wall thickness of the outer shell.

According to another aspect, the comb-like cutting elements may be manufactured by bending  
5 the teeth about an axis parallel to the row of teeth before the thickenings are formed at the tooth tips.

The comb-like cutting elements may be manufactured by use of different processing techniques. More particularly, the toothed cutting edges including the teeth and the gaps therebetween may  
10 be formed by edging and/or electro-chemical machining and/or pulsed electro-chemical machining. In addition or in the alternative, the teeth and/or the gaps therebetween may be formed by e-polishing or electro-polishing to remove material from the cutting element body, reducing the surface roughness by leveling micro-peaks and valleys to improve the surface finish. The cutting element may be immersed in a bath of electrolyte and may be connected to a terminal  
15 of a power supply to pass a current to the cutting element where metal on the surface may be oxidized and dissolved in the electrolyte. Furthermore, in addition or in the alternative, stamping and/or grinding may be used to form the cutting element.

In addition or in the alternative, the substantially spherical thickenings at the tooth tips may be  
20 formed by laser melting. In addition or in the alternative, stamping and/or embossing and/or injection molding and/or dipping and/or coating may be used to form said thickenings.

Basically, each of the cooperating cutting elements may be driven. However, to combine an easy drive system with safe and soft cutting action, the upper or outer cutting element having the skin  
25 contact surface and/or the overhanging tooth tips may be standing and/or may be not reciprocating and not rotating, whereas the lower cutting element which may be the sandwiched cutting element, may reciprocate or rotatorily oscillate.

As can be seen from figure 1, the cutter system 3 may be part of a cutter head 2 which may be  
30 attached to a handle 100 of a shaver and/or trimmer 1. More particularly, the shaver and/or trimmer 1 may include an elongated handle 100 accommodating the electronic and/or electric components such as a control unit, an electric drive motor or a magnetic drive motor and a drive

train for transmitting the driving action of the motor to the cutter system at the cutter head 2 which cutter head 2 may be positioned at one end of the elongated handle 100, cf. figure 1.

The cutter system 3 including a pair of cooperating cutting elements 4 and 5 may be the only cutter system of the cutter head 2 as it is the case with the example shown in figure 1. On the other hand, the cutter system 3 may be incorporated into a shaver head 2 having other cutter systems such as shear foil cutters, wherein, for example, the cutter system 3 having at least one row of cooperating cutting teeth 6, 7 may be positioned between a pair of shear foil cutters, or, in the alternative, may be positioned in front of such a shear foil cutter.

As shown by figure 1, the cutter system 3 may include elongated rows of cutting teeth 6 and 7 which may reciprocate relative to each other along a linear path so as to effect the cutting action by closing the gaps between the teeth and passing over each other. On the other hand, the cutter system 3 also may include cutting teeth 6 and 7 which are aligned along a circle and/or are arranged radially. Such rotatory cutting elements 4 and 5 may have cutting teeth 6 and 7 projecting substantially radially, wherein the cutting elements 4 and 5 may be driven to rotate relative to each other and/or to rotatorily oscillate relative to each other. The cutting action is basically similar to reciprocating cutting elements as the radially extending teeth, when rotating and/or rotatorily oscillating, cyclically close and reopen the gap between neighboring teeth and pass over each other like a scissor.

As shown by figure 2, the drive system may include a motor the shaft of which may rotate an eccentric drive pin which is received between the channel-like contours of a driver 18 which is connected to one of the cutting elements 4 which is caused to reciprocate due to the engagement of the rotating eccentric drive pin with the contours of said driver 18.

As shown by figures 3, 8 and 10, the cooperating cutting elements 4 and 5 basically may have – at least roughly – a plate-shaped configuration, wherein each cutting element 4 and 5 includes two rows of cutting teeth 6 and 7 which may be arranged at opposite longitudinal sides of the plate-like cutting elements 4 and 5, cf. figure 8b and figure 10a. The cutting elements 4 and 5 are supported and positioned with their flat sides lying onto one another. More particularly, the cutting teeth 6 and 7 of the cutting elements 4 and 5 touch each other back to back like the blades of a scissor.

So as to support the cutting elements 4 and 5 in said position relative to each other, but still allowing reciprocating movement of the teeth relative to each other, the cutting element 5 is sandwiched between the other cutting element 4 and a support structure 14 which may include a frame-like or plate-like support element 17 which may be rigidly connected to the upper or outer cutting element 4 to define a gap 16 therebetween in which gap 16 the sandwiched cutting element 5 is movably received.

As can be seen from figures 8b, 8c and 8d, a spacer 15 is accommodated between the support element 17 and the upper cutting element 4 so as to precisely define the width or thickness of said gap 16. Said spacer 15 may be plate-shaped to precisely adjust the distance between the support element 17 and the cutting element 4.

More particularly, said spacer 15 may be located in the center of gap 16 so that, on the one hand, gap 16 is ring-shaped and/or surrounds said spacer 15 and, on the other hand, the distance between the cutting element 4 and the support element 17 is controlled at all sides due to the central location of said spacer 15.

The sandwiched cutting element 5 may include a recess 19 which may be formed as a throughhole going from one side to the other side of the cutting element 5 and in which said spacer 15 may be received. The contour, in particular the inner circumferential contour and/or the edges of said recess 19 may be adapted to the outer contour of the spacer 15 so that the cutting element 5 is guided along the spacer 15 when reciprocating. More particularly, the width of the spacer 15 may substantially correspond to the width of the recess 19 so that the cutting element 5 may slide along the longitudinal side edges of the spacer 15. The longitudinal axis of the elongated spacer 15 is coaxial with the reciprocating axis of the cutting element 5, cf. figure 8d.

The support element 17 which may be plate-shaped or formed as a frame extending in a plane, has a size and contour basically comparable to the cutting element 5 to be supported as can be seen from figure 8b, the support element 17 may have a substantially rectangular, plate-like shape supporting the cutting element 5 along lines or strips along the two rows 10 and 11 of cutting teeth 7, whereas the support element 17 may have a size and contour and/or configuration

to support also at least a part of the teeth 7 of cutting element 5. In the alternative, the support element 17 may extend at least to the root of the teeth 7.

As can be seen from figures 9a and 9b, the edge of the support element 17 extending along the row of teeth 7, may itself have a wave-shaped or teeth-like configuration with protrusions and gaps therebetween. The protrusions 20 extend towards the tips of the teeth 7 at positions where they can support said teeth 7. Due to the toothed configuration of the edge of the support element 17 including the gaps between the protrusions 20, hairs may properly enter into the gaps between the cooperating teeth even when the cutter system is used as a rake. Nevertheless, the protrusions 20 provide for a better support of the teeth 7 against deflection.

The support element 17 is rigidly held at a predetermined distance from the cutting element 4 so that the gap 16 therebetween has precisely the desired thickness. This is achieved by the aforementioned spacer 15 the thickness of which exactly defines the thickness of gap 16.

So as to avoid undesired friction and heat generation, but nevertheless keep the teeth 6 and 7 sufficiently close to each other to achieve reliable cutting of hairs, said spacer 15 may have a thickness which is slightly larger than the thickness of the sandwiched cutting element 5, wherein the amount by which the thickness of the spacer 15 exceeds the thickness of the cutting element 5 is smaller than the diameter of usual hair. More particularly, the thickness of the spacer 15 may be larger than the thickness of the sandwiched cutting element 5 by an amount ranging from 20 to 40  $\mu\text{m}$ .

The support element 17, the spacer 15 and the cutting element 4 may be rigidly connected to each other, for example by means of snap fitting contours to allow changing the cutting element 4. In the alternative, also unreleasable fastening is possible, such as welding or glueing.

For example, the cutting element 4 may be rigidly fixed at the support element 17 at opposite ends thereof, for example by means of end portions 21 which may form lateral protection elements having rounded and/or chamfered contours for soft skin engagement. Such fixation at end portions may be provided in addition or in the alternative to fixation via the spacer 15.

As can be seen from figure 11a and 11b, the support structure 14 also may include a spring device 22 which may urge the cutting element 5 onto the cutting element 4 so as to avoid any gap between the cooperating teeth 6 and 7. Such spring device 21 may be provided between the support structure 14 and the lower or under cutting element 5 so as to press the cutting element 5 onto the cutting element 4.

As can be seen from figures 4, 5 and 6, the teeth 6 of the outer cutting element 4 overlap the cutting teeth 7 of the cooperating cutting element 5, wherein the tooth tips 8 of such overlapping teeth 6 may be provided with substantially spherical thickenings 13, cf. also figure 9 showing such thickenings 13.

In addition to such thickening 13 forming the outermost tooth tips of the teeth 6, said teeth 6 of the cutting element 4 may be provided with a bent portion 6b connecting said thickening 13 to a main tooth portion 6m which forms the cutting portion of the teeth as such main tooth portion 6m form the blades cooperating with the teeth 7 of the other cutting element 5 in terms of opening and closing the gap between the comb-like, protruding pairs of teeth and passing over each other to achieve shearing of hairs entering into the spaces between the protruding teeth.

Such bent portion 6b curves away from the skin contact surface 12 of the cutting teeth 6 of cutting element 4, wherein the bent radius R of such bent portion 6b may range from 200 to 400  $\mu\text{m}$ , for example. The bending axis may extend parallel to the reciprocating axis and/or parallel to the longitudinal extension of the row 10, 11 at which the cooperating teeth 6, 7 are arranged.

As can be seen from figure 5a, the transition portion between the curved portion 6b and the thickening 13 may form a slight depression or a concave portion, as the thickening 13 may further protrude from the bent portion 6m and may have a different radius of curvature r (which is a sphere radius when the thickening is spherically shaped).

Said bent portion 6b may extend over a bent angle  $\alpha$  ranging from  $10^\circ$  to  $45^\circ$  or  $15^\circ$  to  $30^\circ$  or  $10^\circ$  to  $90^\circ$  or  $15^\circ$  to  $180^\circ$ , cf. figure 5a.

The substantially spherical thickenings 13 at the tooth tips 8 may have a diameter ranging from 300 to 550  $\mu\text{m}$  or 350 to 500  $\mu\text{m}$ .

5 A height  $h$  including the entire contour of the thickening 13 and the tooth main portion 6m as measured in a direction perpendicular to the skin contact surface 12, may range from 300 to 550  $\mu\text{m}$  to eliminate the risk of penetration when the cutting system is applied in parallel to the skin as it is shown in figures 4 and 6. The enlargement at the end of the tooth 6 for example in form of a sphere or a drop eliminates the risking case of a perpendicular application as it is shown in figures 7b and 7d. The additional bending of the bent portions 6b with the aforementioned  
10 bending radius  $R$  up to 400  $\mu\text{m}$  gives an optimal perception of guide with acceptable impact on hair capture.

As shown by figure 5a, the overhang  $o$  defining the length of protrusion of the overhanging teeth 6 beyond the teeth 7 of the other cutting element 5, may range from 400 to 800  $\mu\text{m}$  or 400 to 600  
15  $\mu\text{m}$ . When the cutter system is used like a rake as it is shown in figures 7b and 7d, such overhanging length  $o$  is helpful to prevent the reciprocating teeth 7 of cutting element 5 from touching and irritating the skin.

So as to allow for a close cut, the teeth may have a rather reduced thickness  $t$  and/or the thickness  
20  $t$  of the teeth 6 and 7 may be adjusted to the gap 22 between pairs of neighboring cutting teeth 6 and 7. Due to the aforementioned described bulging effect of the skin, it may be advantageous to have a teeth thickness  $t$ , at a main portion 6m of the teeth 6, ranging from 50 to 150  $\mu\text{m}$  or 30 to 180  $\mu\text{m}$ . The teeth 7 of the other cutting element 5 may have the same thickness  $t$ .

25 The gaps 22 between each pair of neighboring cutting teeth 6 and 7 may have a gap width  $g_w$  ranging from 150 to 550  $\mu\text{m}$  or 200 to 500  $\mu\text{m}$ .

The width  $t_w$  of the teeth 6 and/or of the teeth 7 may range from 200 to 600  $\mu\text{m}$  or 250 to 550  $\mu\text{m}$ . As shown by figure 5b, the width  $g_w$  of the teeth 6 and 7 may be substantially constant  
30 along the longitudinal axis of the teeth. Nevertheless, it would be possible to give the teeth 6 and 7 a slightly V-shaped configuration, wherein the width  $t_w$  may decrease towards the tips. In such case, the aforementioned width ranges applied to the width  $t_w$  measured in the middle of the longitudinal extension.

As can be seen from figures 8e, 8f and 8g, the skin contact surface of the finger-like teeth 6 have edges 6r which may be rounded and or beveled, wherein such rounding and/or beveling may be more pronounced or may increase towards the root section of the finger-like teeth 6.

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More particularly, the rounding and/or beveling of the skin contact surface edges may be more pronounced and/or larger at a base section or root section of the teeth 6 than the rounding and/or beveling at a middle section and/or a projecting teeth 6 section close to the tooth tips. Said rounding and/or beveling may continuously and/or smoothly increase towards the base section of the teeth 6. Usually, the skin contact pressure decreases towards the base section or root section of the teeth 6 so the increased rounding and/or beveling of the edges of the skin contact surface of the teeth 6 may allow the skin to sufficiently bulge into the gap between the teeth 6 despite the decreased skin contact pressure. Thus, an efficient hair cutting and closeness can be achieved over the entire length of the cutting teeth 6.

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Said rounding and/or beveling of the edges of the skin contact surface of the teeth 6 also may vary along the length of a row of teeth 6 so that in a middle section of the row the rounding and/or beveling of the edges of the skin contact surface of the teeth 6 may be different from the rounding and/or beveling of the skin contact surface of the teeth 6 in end sections of a row of teeth 6. In particular, the rounding and/or beveling may be larger and/or more pronounced in sections of the row where the skin contact pressure is lower, whereas the rounding and/or beveling may be smaller in sections where the skin contact pressure is higher.

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So as to give the user the choice between a more aggressive, closer cutting action on the one hand and a less intensive, more pleasant skin feel on the other hand, the cutter system provides for two separate rows 10, 11 of cooperating teeth 6 which are different from each other in terms of shape and/or size and/or positioning of the thickened and/or rounded tooth tips 8 of the teeth 6. Thus, using a first row 10 of cooperating cutting teeth 6 may provide for a more aggressive, closer cutting action, whereas using a second row 11 of cutting teeth 6 may provide for a less intensive, more pleasant skin feel. The configuration of the tooth tips 8, in particular the configuration of the curvature and thickening thereof may considerably influence the cutting performance and allow the user to choose between closeness, thoroughness, soft skin feel and efficiency.

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More particularly, the rows 10, 11 of cooperating teeth 6 may differ from each other in terms of the height of the tooth tips 8 which is, at least in part, defined by the position of the thickening relative to the main portion of the teeth 6 and the size and shape thereof. At one row 10, the thickening may protrude only to the side opposite to the skin contact surface what may be achieved, for example, by bending or curving the teeth portions at which the tip thickenings are attached, away from the skin contact surface and/or attaching the thickening to the main portion of the teeth 6 in an eccentric way, in particular a bit offset away from the skin contact surface. On the other hand, at a second row 11 of cooperating teeth 6, the thickenings at the tooth tips 8 may protrude to both sides of the teeth 6, i.e. to the skin contact surface and to the side opposite thereto.

Said asymmetric rows 10, 11 of cooperating teeth 6 may differ in the heights of the teeth 6 having the overhanging thickened and/or curved tooth tips 8. The height of the teeth 6 may be measured substantially perpendicular to the skin contact surface of the main portion of the teeth 6 and/or perpendicular to a longitudinal axis of the teeth 6, and may include the contour of the thickening at the tips and the upper and/or lower contour of the main portion of the teeth 6. When the thickening protrudes away from the skin contact surface and/or the teeth 6 are curved away from said skin contact surface, the height may span from the lowest point of the thickening to the upper surface of the main portion of the teeth defining the skin contact surface thereof.

Such heights may differ from row to row. More particularly, at one row 10 the height of the cutting teeth 6 having the overhanging tooth tips 8 may range from 300 to 600  $\mu\text{m}$  or 350 to 550  $\mu\text{m}$ , whereas the height at the other row 11 may range from 200 to 500  $\mu\text{m}$  or 250 to 450  $\mu\text{m}$ .

As can be seen from figure 1, the rows 10, 11 of teeth 6, 7 having different aggressiveness may be positioned on opposite sides of a cutter head 2 and/or may look into opposite directions, i.e. may be open towards opposite directions so as to allow hair to enter into the gaps between the teeth 6 when moving the cutter head 2 into opposite directions.

More particularly, the cutter system may define a skin contact surface which is inclined at an acute angle relative to the longitudinal axis of the elongated handle 100 of the cutting device so that one side of the skin contact surface slopes down towards a front side of the handle 100,

whereas the opposite side of the skin contact surface ascends or slopes up towards the back side of the handle 100. Said front side of the handle 100 may include, for example, an operation button for switching on and off the drive unit and/or may include a surface contour or portion adapted to a thumb gripping the handle 100. Said skin contact surface of the cutter system may form a sort of monopitch roof attached to one end of the handle 100, cf. figure 1. However, the skin contact surface does not have to be flat or planar, wherein, when said skin contact surface is convex and/or concave, a plane tangential to the skin contact surface may have the aforementioned inclination relative to the longitudinal axis of the handle 100.

- 10 The row 11 of teeth 6 having the more aggressive configuration may be arranged at the lower side of said monopitch roof, i.e. at the side of the skin contact surface sloping down towards the front side of the handle 100, whereas the row of teeth 6 configured less aggressive may be arranged at the opposite side, i.e. at the upper side of the monopitch roof or the side ascending towards the back side of the handle 100. Usually, when the skin contact surface is inclined to slope down towards the front side of the handle 100, the skin contact pressure at the sloped down side is lower than the skin contact pressure at the ascending side. Thus, the more aggressive teeth 6 at the sloped down side having the lower skin contact pressure may achieve efficient hair cutting and catch difficult hair without skin irritations, since the low skin contact pressure is sort of compensated by the increased aggressiveness of the teeth configuration. On the other hand, the less aggressive teeth 6 at the opposite, ascending side of the skin contact surface may compensate for the higher skin contact pressure there and avoid skin irritations.

- As can be seen from figures 12, 13 and 14, the aggressiveness of the teeth 6 may vary also within the same row of cooperating cutting teeth 6. More particularly, the cutting teeth 6 in a middle section of a row may be different from cutting teeth 6 in end sections of said row in terms of shape and/or size and/or position of the tooth tips so as to provide for a different level of aggressiveness. More particularly, in sections of relatively high skin contact pressure, the teeth 6 may be configured to provide for reduced aggressiveness, whereas the teeth 6 arranged in sections having relatively low skin contact pressure may be configured to provide for a higher level of aggressiveness.

The skin contact pressure may vary due to the contour of the skin contact surface of the cutter system. For example, when the skin contact surface of the cutter system is substantially flat

and/or substantially planar and/or slightly concave, the skin contact pressure may increase towards the lateral end portions of the skin contact surface, as can be seen from figure 14a. Said lateral end portions mean the end portions in the direction of the reciprocating movement of the cutting teeth 6 relative to each other. When considering the usual movement of the cutter head 2 or cutter system along the skin, said lateral end portions are the right and left end portions of the comb-like cutter. So as to achieve uniform cutting despite such varying skin contact pressure, the teeth 6 positioned in the middle section having the lower skin contact pressure may be configured to have a higher aggressiveness what might be achieved by means of a smaller diameter of the rounded tooth tips and/or less curvature away from the skin contact surface. On the other hand, the teeth 6 positioned in the end sections having higher skin contact pressure may be configured to provide for reduced aggressiveness what might be achieved by an increased diameter of the rounded tooth tips and/or more curvature away from the skin contact surface.

As can be seen from figure 14b, the skin contact surface of the cutter system may have a convex contour when viewed in a cross-sectional plane parallel to the direction of reciprocating movement of the cooperating teeth 6 relative to each other and perpendicular to the skin contact surface. In other words, the skin contact surface of the cutter system may slope down or may be curved away from the skin towards the lateral end portions towards which the teeth 6 reciprocate. Due to such convex contour of the skin contact surface, the skin contact pressure may decrease from the center section of the cutter system towards the end portions thereof. So as to compensate for such varying skin contact pressure, the teeth 6 in the lateral end sections may be configured to have an increased aggressiveness, whereas the teeth 6 in a middle section may be configured less aggressive, as can be seen from figure 14b.

It may be sufficient to have three or four or five groups of teeth 6 in a row having the aforementioned different configuration and different aggressiveness. On the other hand, the configuration of the teeth 6 of a row may change step by step or continuously from the center of the row of teeth 6 to the end portions thereof, wherein said change of the configuration may provide for a distribution of tooth configurations substantially symmetrical with regard to the center of the row of teeth 6. More particularly, the tooth aggressiveness may change step by step or continuously from the center of a row towards each of the end sections thereof, as can be seen from figure 14b.

As can be seen from figures 15 and 16, the teeth 6 or at least some of the teeth 6 may have composite tooth tips including different layers of material and/or different materials. More particularly, a filler or inner layer may be surrounded by an outer layer.

- 5 As can be seen from figure 15, the teeth 6 include composite thickenings 13, including an outer shell 13o surrounding an inner core 13i, wherein said outer shell 13o may surround the inner core 13i at three sides thereof. The inner core 13i may be uncovered or visible from at least two opposite sides which face neighboring teeth 6. The outer shell 13o may have three open sides two of which may face the neighboring teeth and a third one may face the tooth tips of the teeth 7 of  
10 the other cutting element 5, cf. figure 16.

- As can be seen from figure 15, the finger-like teeth 6 may be formed from a thin plate-like metal sheet and/or may include substantially plate-shaped tooth bodies, wherein the outer or projecting end portions of the finger-like teeth are bent by more than 90° or more than 100° or more than  
15 120° and/or may form substantially U-shaped end portions, which bent or curved end portions of the finger-like teeth form an outer layer of the tooth tip. Such outer layer surrounds an inner layer or filler layer which may fill-out substantially the entire space between the opposite legs of the U-shaped end portions, cf. figure 15. Such filler layer may be a polymeric material or foam material or any other suitable matrix material to fill the space surrounded by the bent end portion.

## CLAIMS

What is claimed is:

1. Cutter system for an electric shaver and/or trimmer, comprising a pair of comb-like cutting elements (4, 5) each with at least one row of cutting teeth and movable relative to each other, wherein one of said cutting elements (4) has thickened and/or rounded tooth tips (8) overhanging the tooth tips (9) of the other cutting element (5), characterized in that said overhanging tooth tips (8) are provided with a two-step rounding including a spherical or drop-shaped or pearl-shaped thickening (13) and a bent or curved portion (6b) connecting said thickening (13) to a main tooth portion (6m) and bent or curved away from the skin contact surface (12) of said main tooth portion (6m), wherein a concave depression is formed in the transitional section between said thickening (13) and said bent or curved portion (6b) on the skin contact side of the teeth (6).
2. Cutter system according to the preceding claim, wherein
  - said bent or curved tooth portion (6b) has a curve radius (R) smaller than 400  $\mu\text{m}$  or ranging from 200 – 400  $\mu\text{m}$  or 250 – 350  $\mu\text{m}$ , and/or
  - said thickening (13) has a diameter (2r) ranging from 300 – 550  $\mu\text{m}$ , and/or
  - an overhanging length (o) defining the length of the protrusion of the overhanging tooth tips (8) beyond the tooth tips of the other cutting element (5) ranging from 400 – 800  $\mu\text{m}$  or 400 – 600  $\mu\text{m}$ .
3. Cutter system according to one of the two preceding claims, wherein said bent or curved tooth portion (6b) extends over a bent angle  $\alpha$  ranging from 10° to 100° or 15° to 90°.
4. Cutter system according to anyone of the preceding claims, wherein at least some of the overhanging tooth tips (8) have
  - a height (h) measured in the direction perpendicular to the skin contact surface (12), ranging from 350 - 550  $\mu\text{m}$ , and
  - a spherical or drop-shaped or pearl-shaped thickening (11) with a diameter (2r) ranging from 350 - 550  $\mu\text{m}$ , and/orwherein some of the overhanging tooth tips (8) have
  - a height (h) measured in the direction perpendicular to the skin contact surface (12) ranging from 250 – 450  $\mu\text{m}$ , and

- spherical or drop-shaped or pearl-shaped thickenings (13) with a diameter ranging from 200 – 450  $\mu\text{m}$ .
5. Cutter system according to any of the preceding claims, wherein the cutting teeth (6) have skin contact surfaces with rounded and/or beveled edges (6R), wherein the rounding and/or beveling of said edges of the skin contact surfaces of the teeth (6) varies along a longitudinal tooth axis (6L).
  6. Cutter system according to the preceding claim, wherein said rounding and/or beveling of the edges of the skin contact surface of the teeth (6) is increasing step by step or continuously towards a root section of the teeth (6).
  7. Cutter system according to anyone of the preceding claims, wherein the cutting teeth (6, 7), at a main tooth portion (6m) providing for cutting action, have a tooth width ( $w_t$ ) ranging from 250 – 550  $\mu\text{m}$  and a thickness (t) ranging from 50 – 150  $\mu\text{m}$ , said tooth width ( $w_t$ ) and/or said thickness (t) being measured at half length of the teeth (6, 7).
  8. Cutter system according to anyone of the preceding claims, wherein the cutting teeth (6) define a gap between neighboring cutting teeth, having a gap width ( $w_g$ ) ranging from 200 - 500  $\mu\text{m}$ , said gap width measured at the middle of the length of the teeth (6).
  9. Cutter system according to the preamble of claim 1 or anyone of the preceding claims, wherein said overhanging rounded tooth tips (8) include a composite thickening (13) which includes an outer shell (13o) surrounding an inner core (13i), said shell (13o) and said core (13i) being made from different materials.
  10. Cutter system according to the preceding claim, wherein said shell (13o) is made from metal and said core (13i) is made from a non-metallic filler material.
  11. Cutter system according to one of the two preceding claims, wherein said outer shell (13o) surrounds said inner core (13i) at three sides thereof, wherein the inner core (13i) is uncovered and visible from two opposite sides which are facing neighboring teeth (6, 7).

12. Cutter system according to anyone of the preceding claims, wherein said outer shell (13o) is plate-shaped and curved by more than 100° or more than 150°, in particular U-shaped.

13. Cutter system according to anyone of the preceding claims, wherein said outer shell (13o) has three open sides, wherein first and second open sides are opposite to each other and face neighboring teeth (6, 7) and a third open side faces the tooth tip (9) of the other cutting element (5).

14. Cutter system according to anyone of the preceding claims, wherein the inner core (13i) has a diameter or thickness ranging from 50% to 250% or 75% to 125% of the wall thickness of the outer shell (13o).

15. Electric shaver and/or trimmer, comprising a cutter system which is configured in accordance with one of the preceding claims.

16. Method of manufacturing a cutter system configured according to anyone of the preceding claims, comprising the following steps:

- forming a toothed cutting edge at each cutting element (4, 5) including a plurality of cutting teeth (6, 7), and
- forming a thickening (13) at tooth tips (8) of at least some cutting teeth (6, 7),

characterized in that

the cutting teeth (6, 7), at their tooth tips (8), are bent about a bending axis parallel to the toothed cutting edge before said thickening (13) is formed at the tooth tips (8).

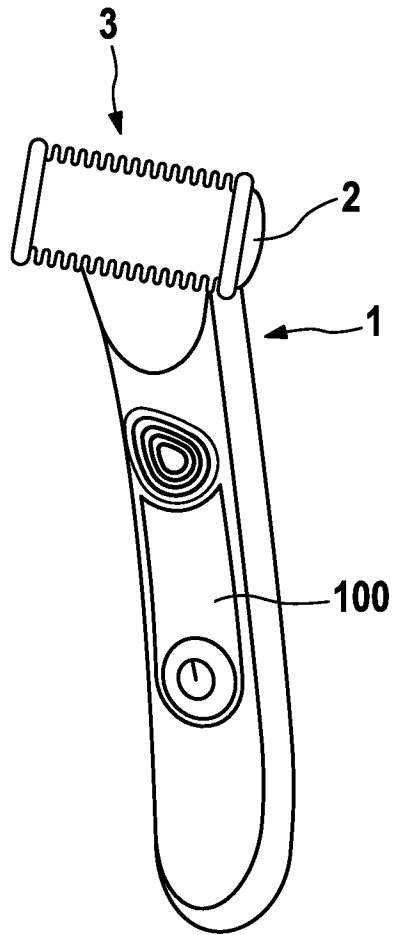


Fig. 1a

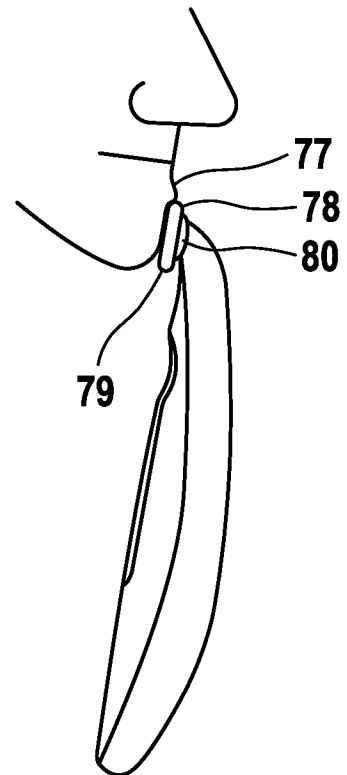


Fig. 1b

2 / 17

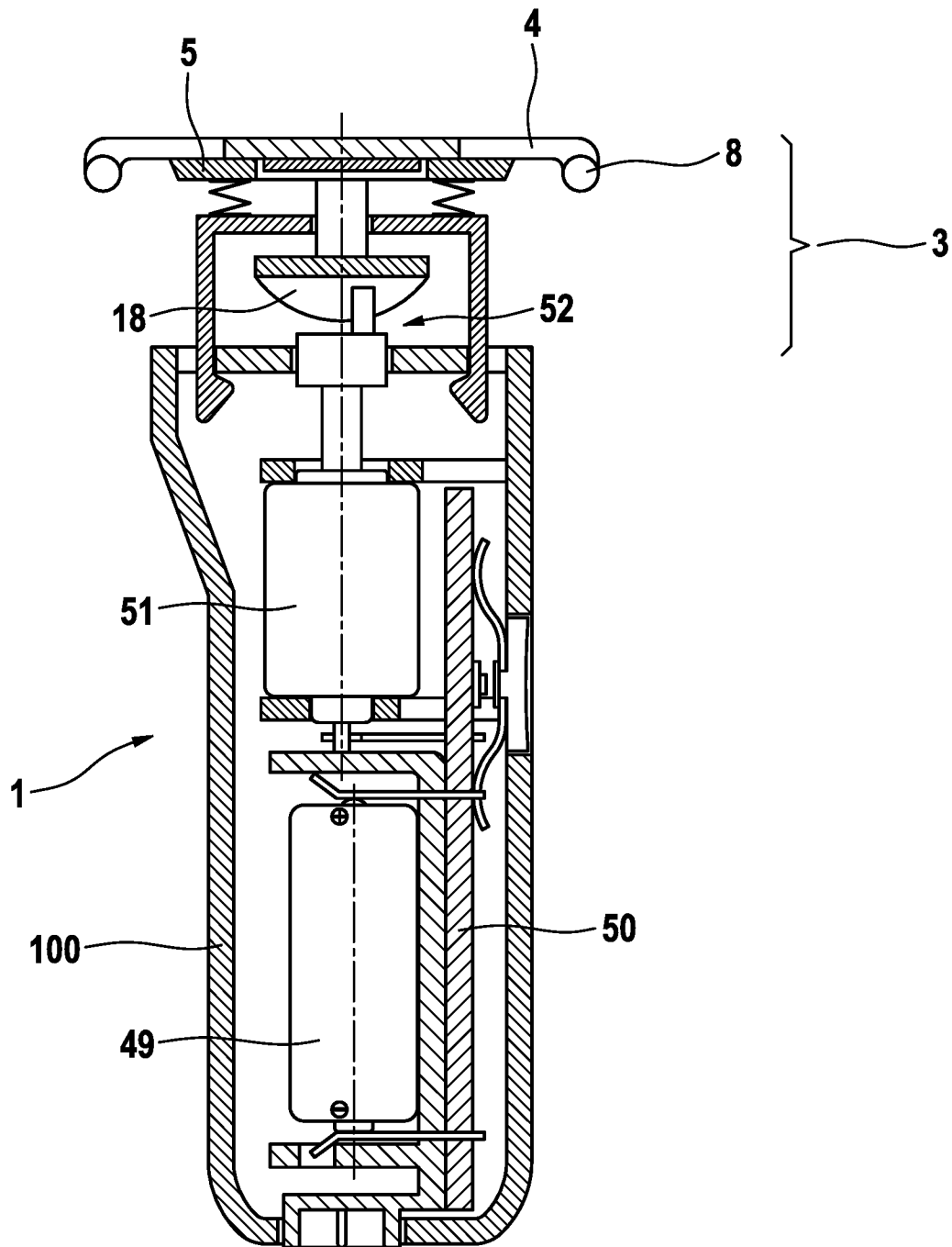


Fig. 2

3 / 17

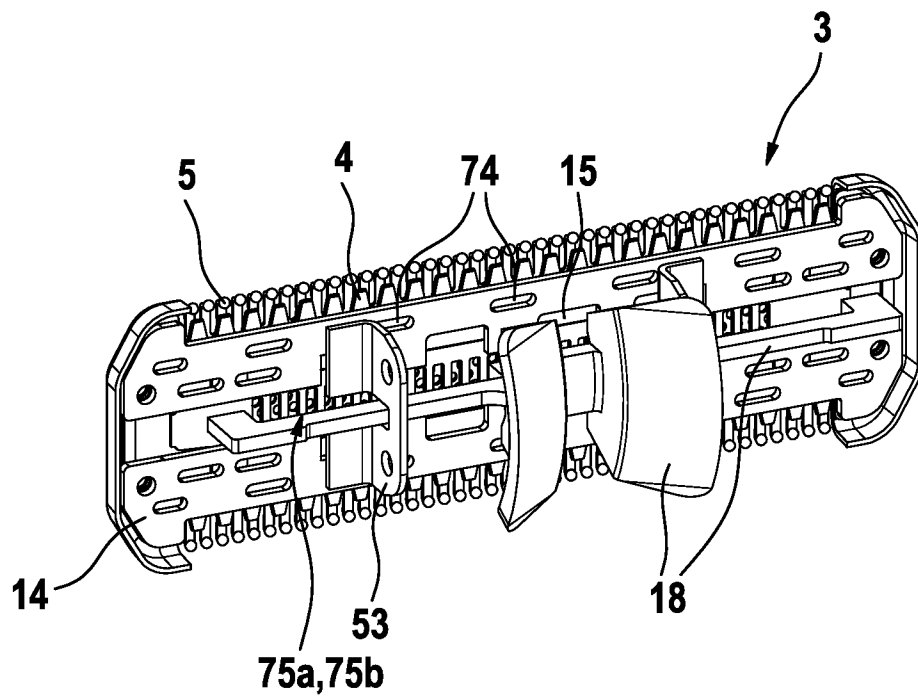


Fig. 3

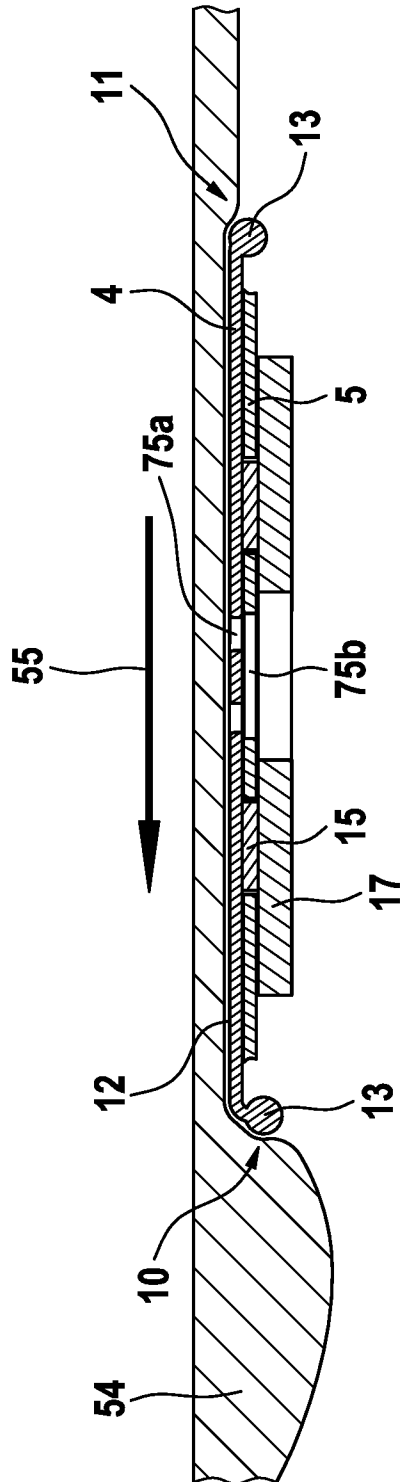


**Fig. 4a**

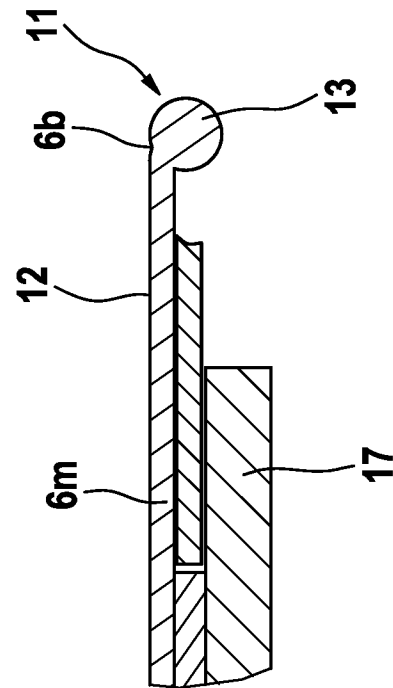


**Fig. 4c**

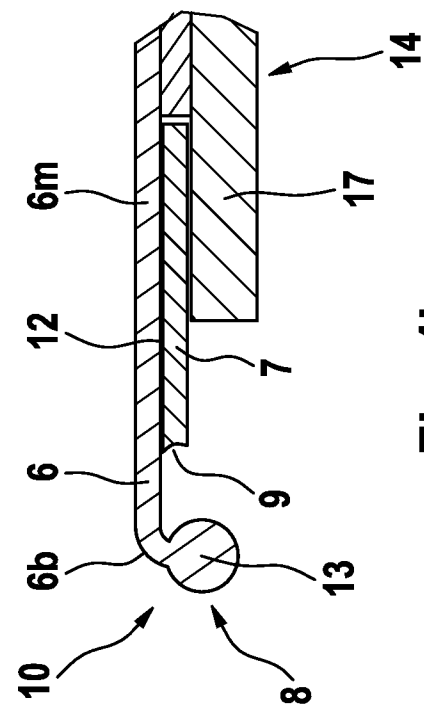


**Fig. 4b**

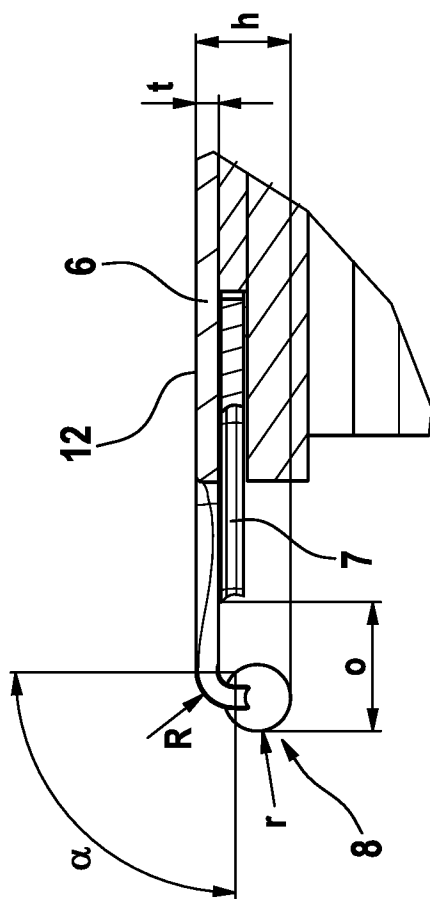


**Fig. 5a**

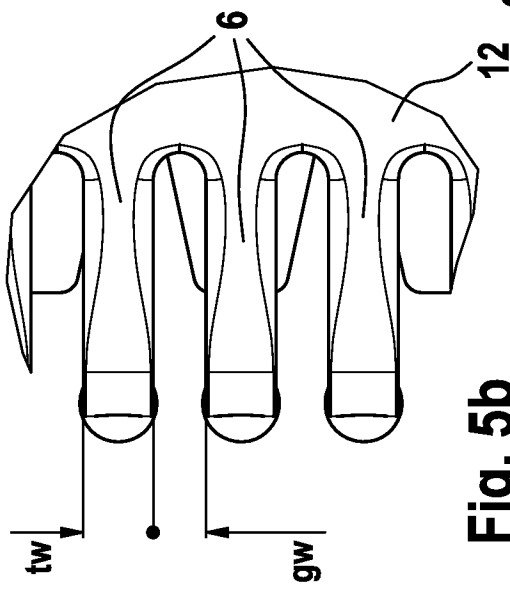


**Fig. 5b**

**5 / 17**

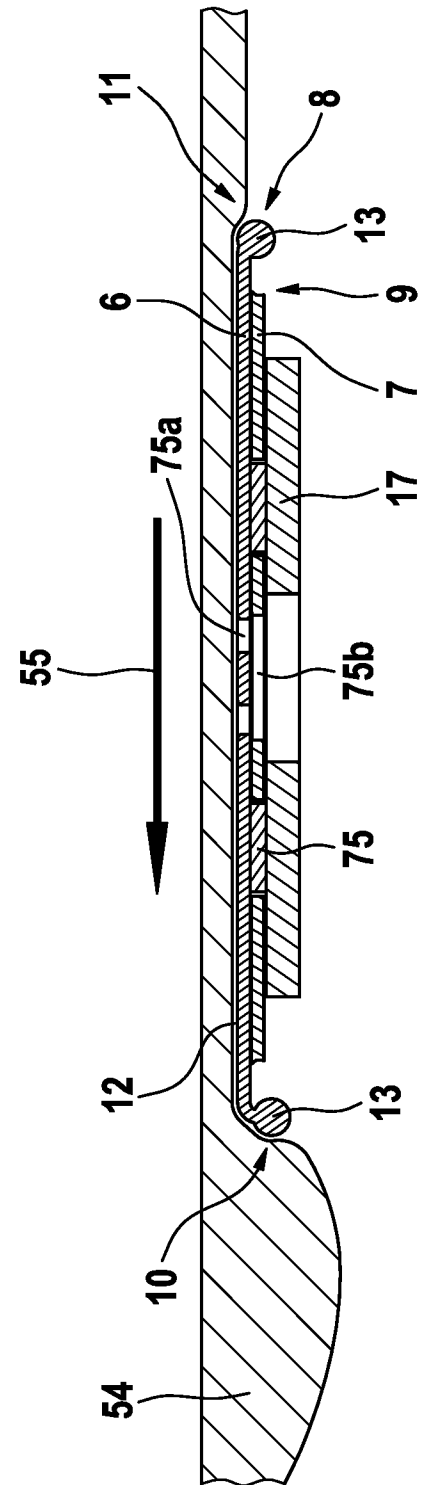


**Fig. 6**

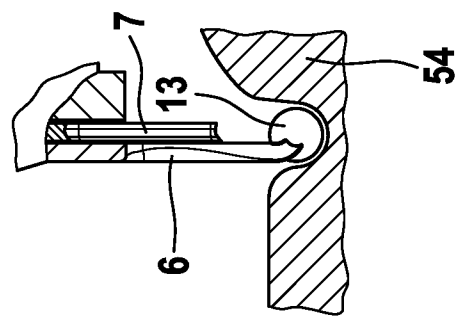


Fig. 7d

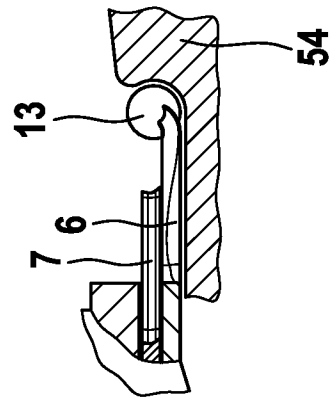


Fig. 7c

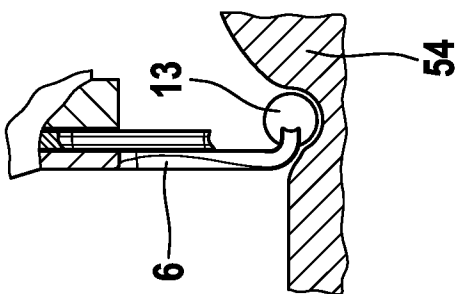


Fig. 7b

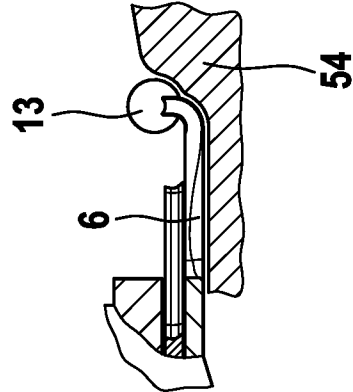


Fig. 7a

7 / 17

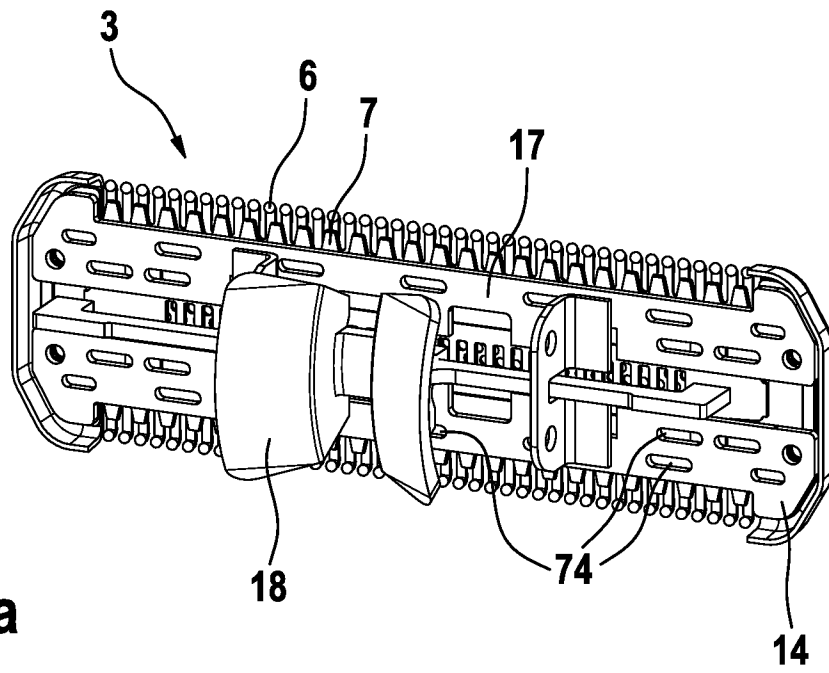


Fig. 8a

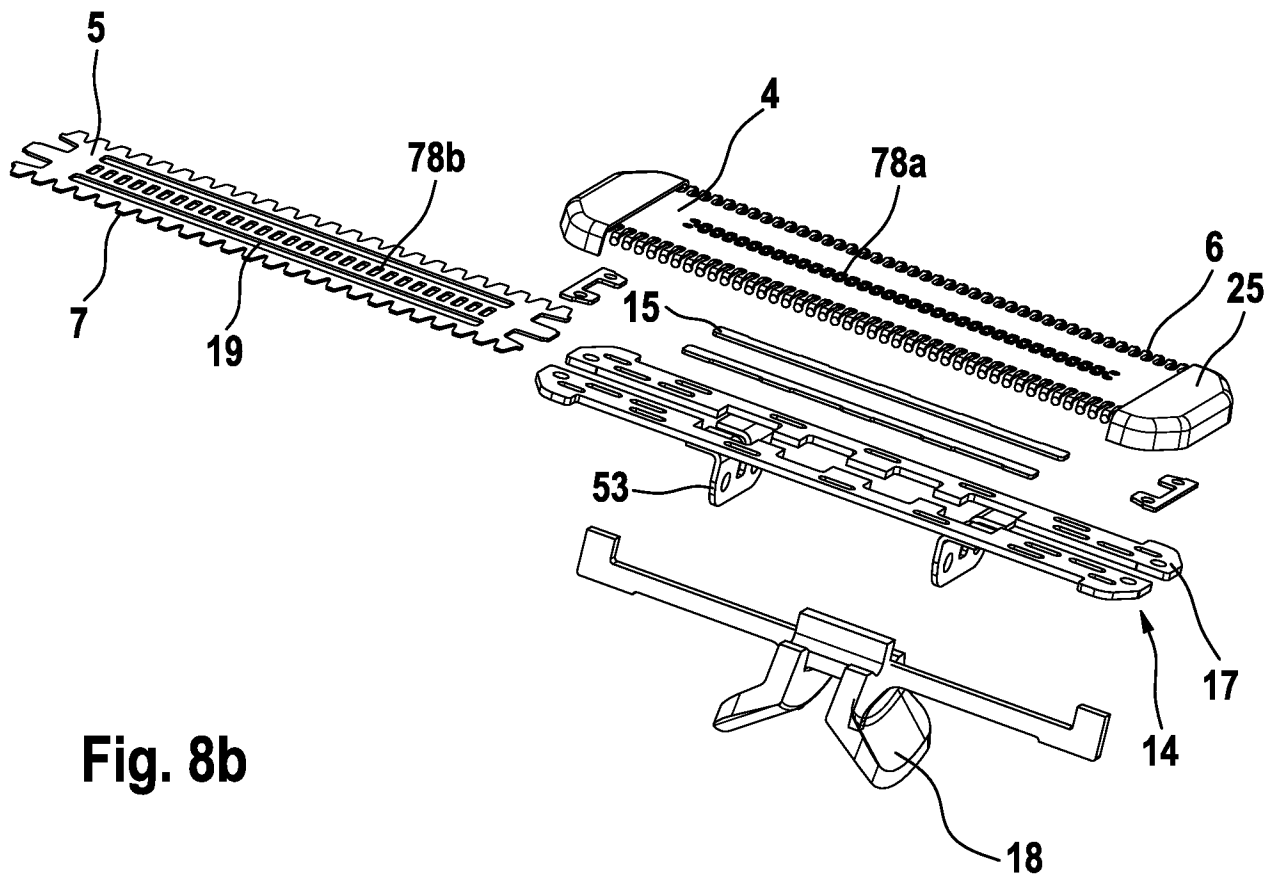


Fig. 8b

8 / 17

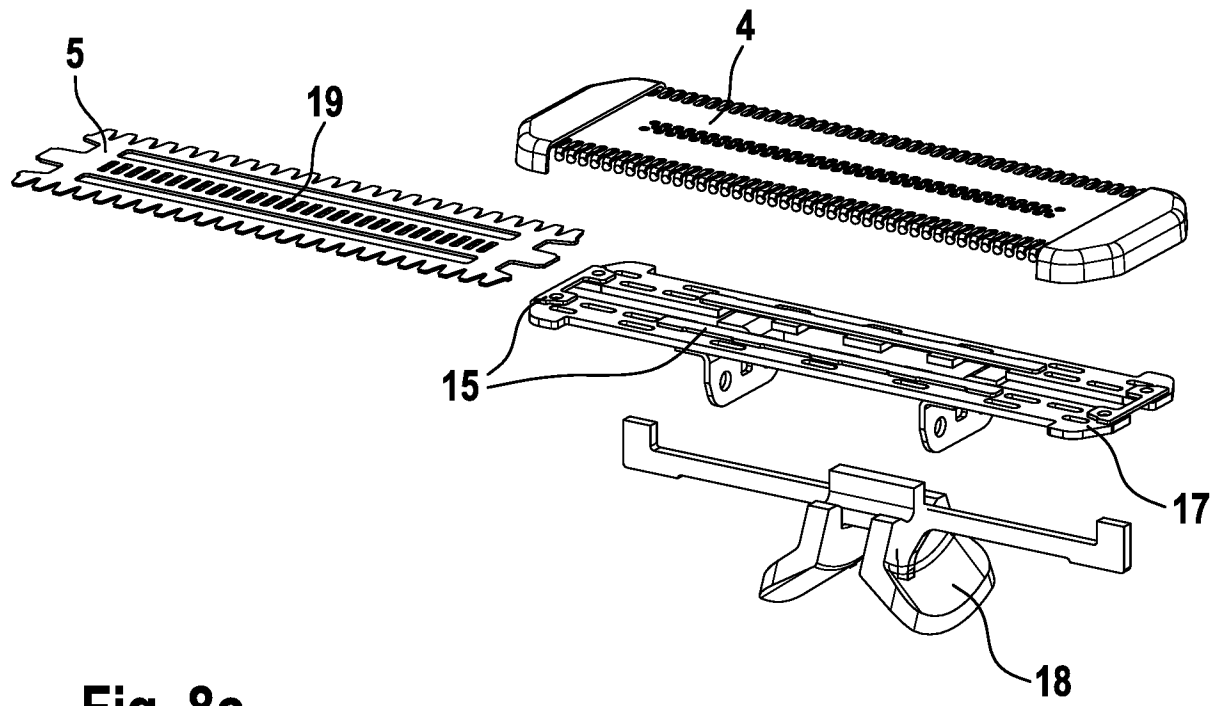


Fig. 8c

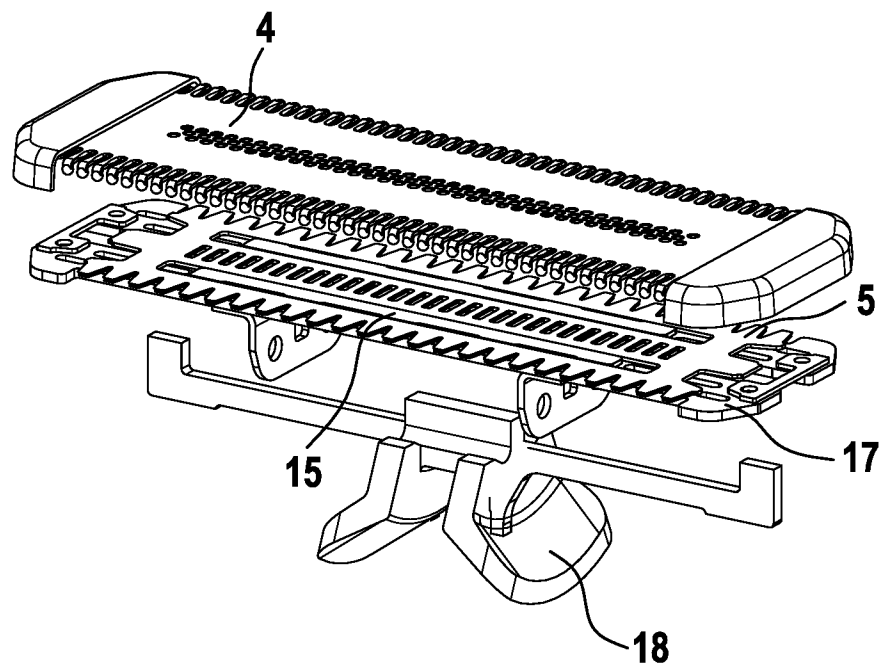


Fig. 8d

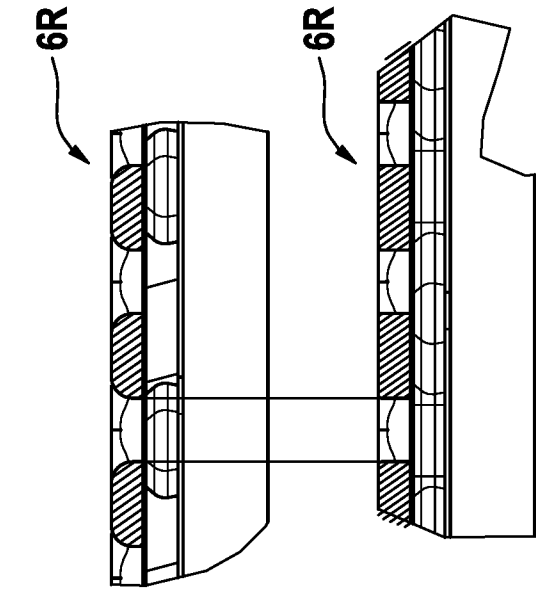


Fig. 8g

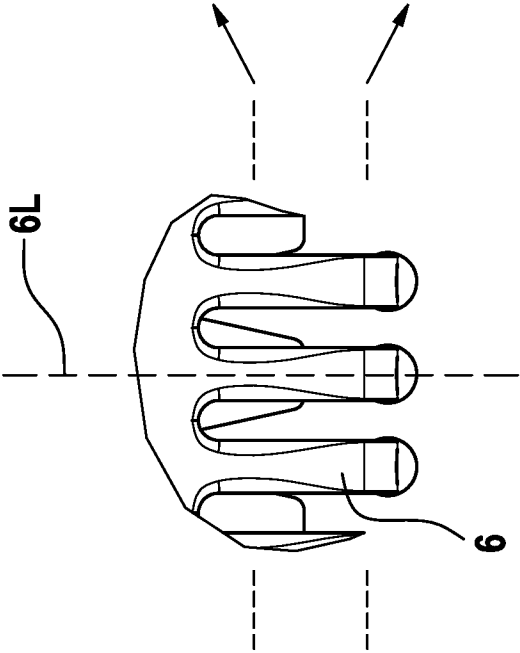


Fig. 8f

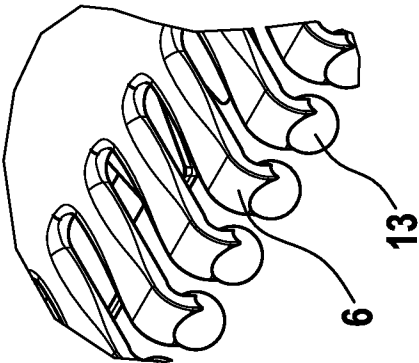
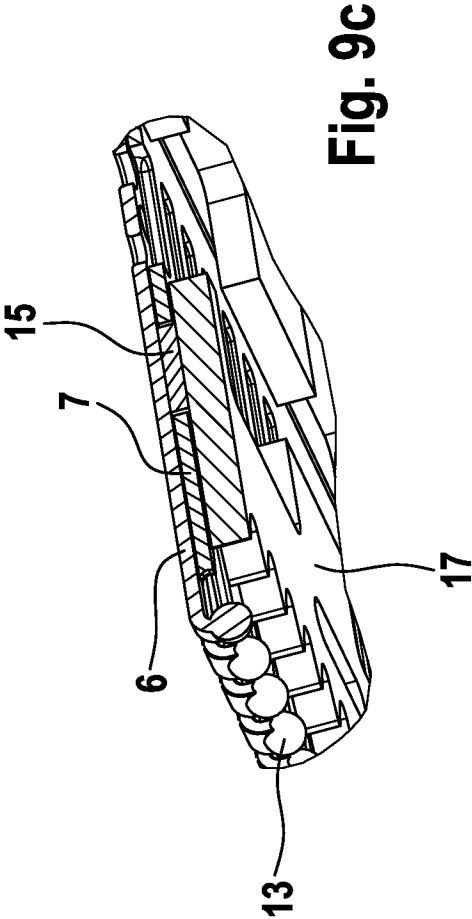
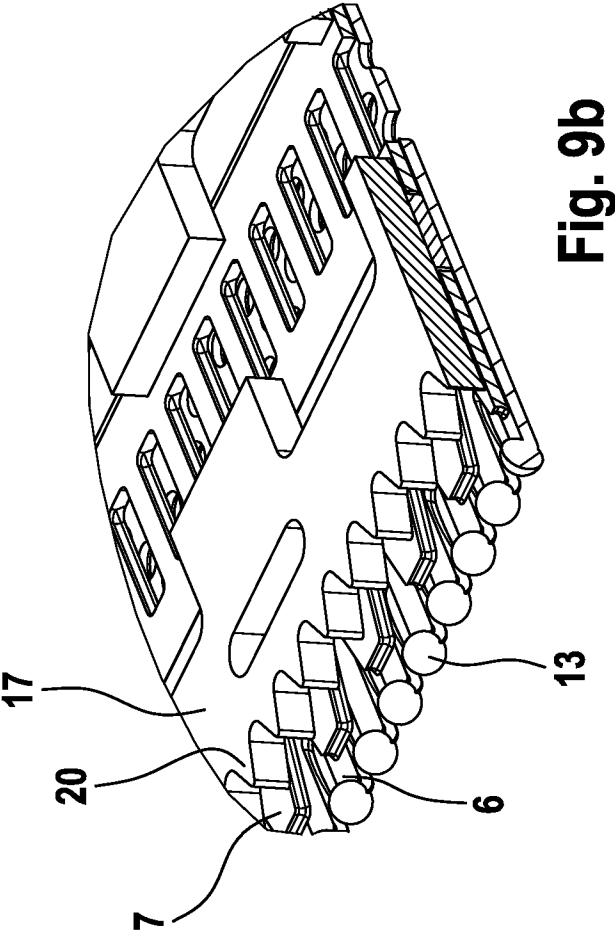
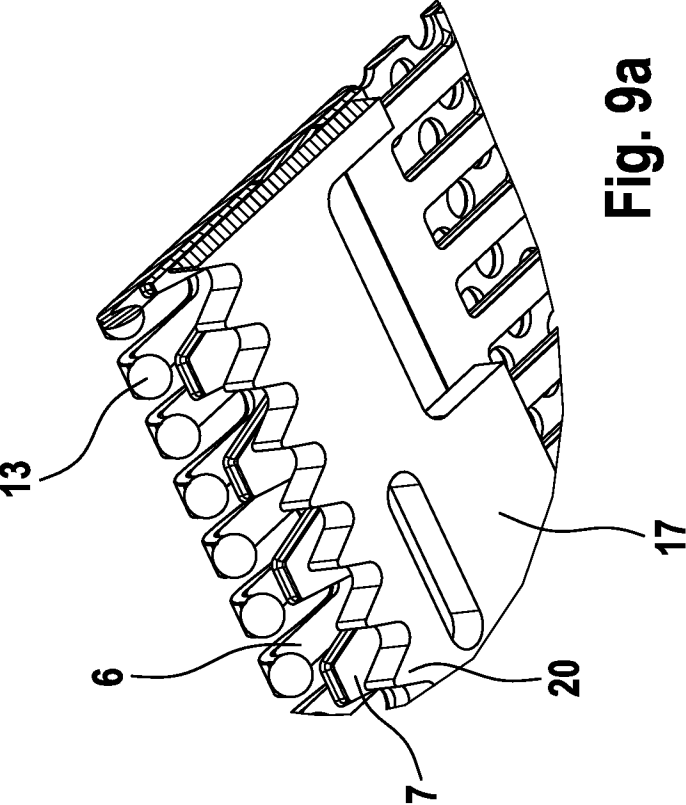
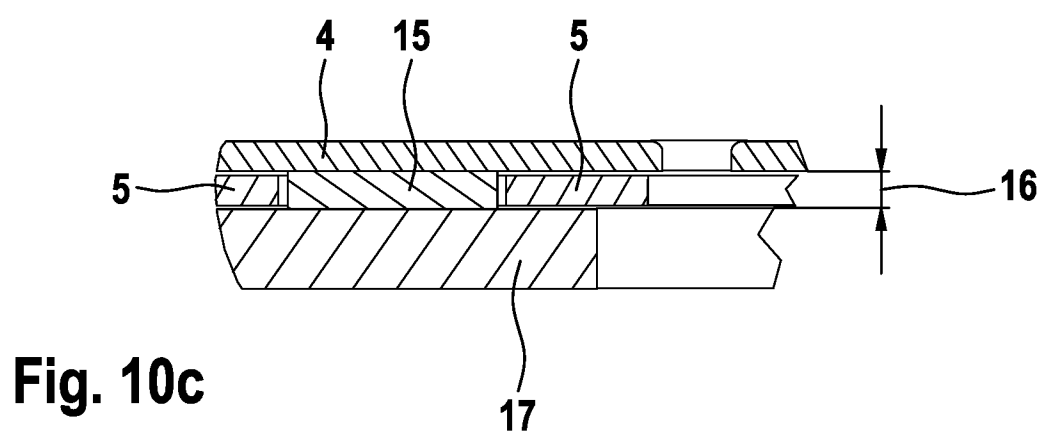
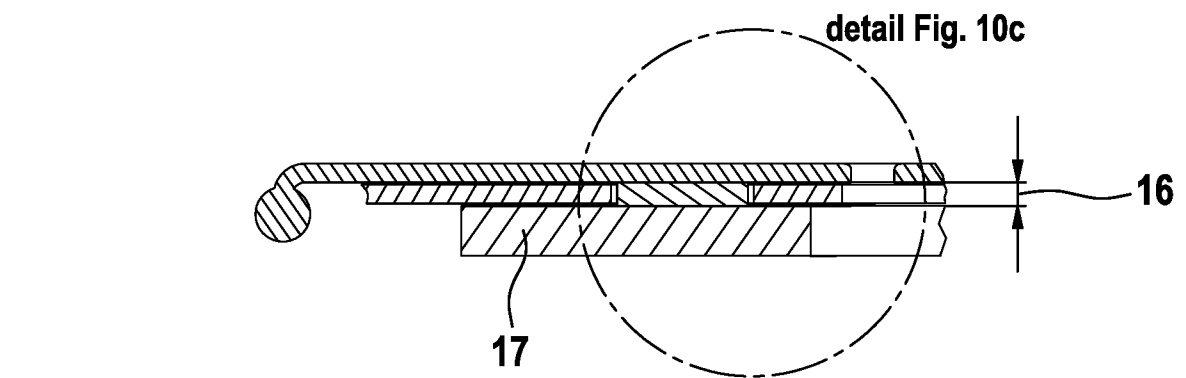
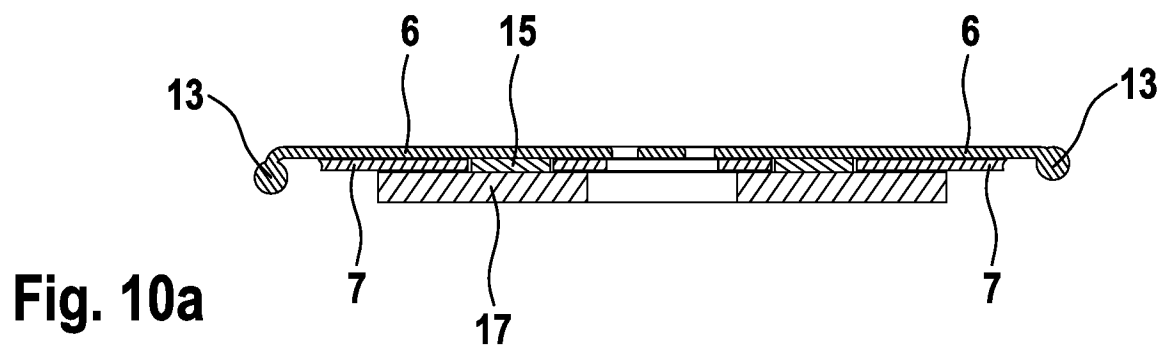


Fig. 8e



11 / 17



12 / 17

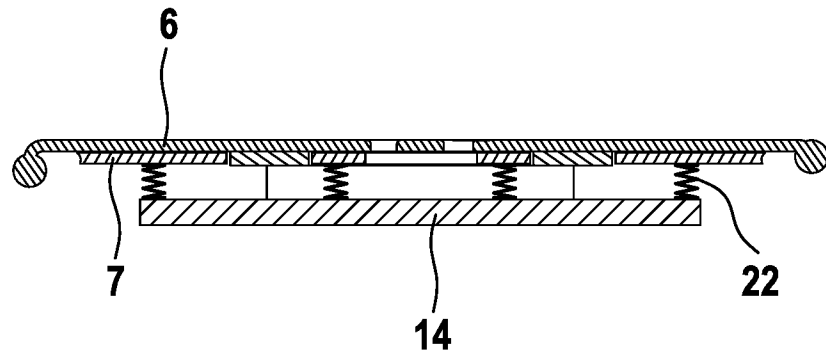


Fig. 11a

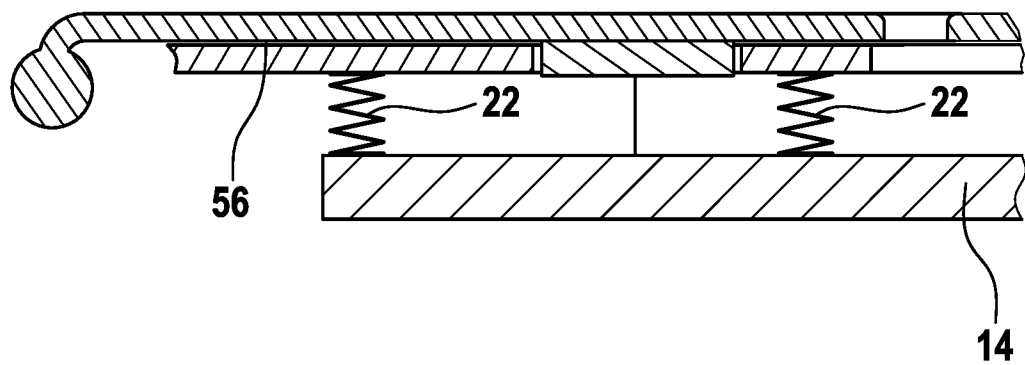


Fig. 11b

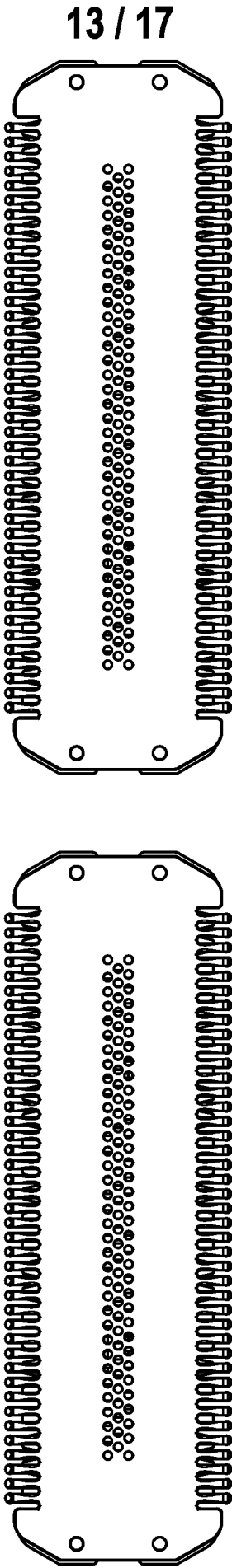


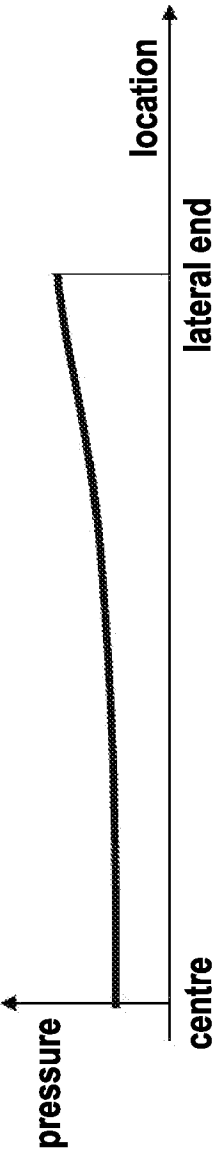
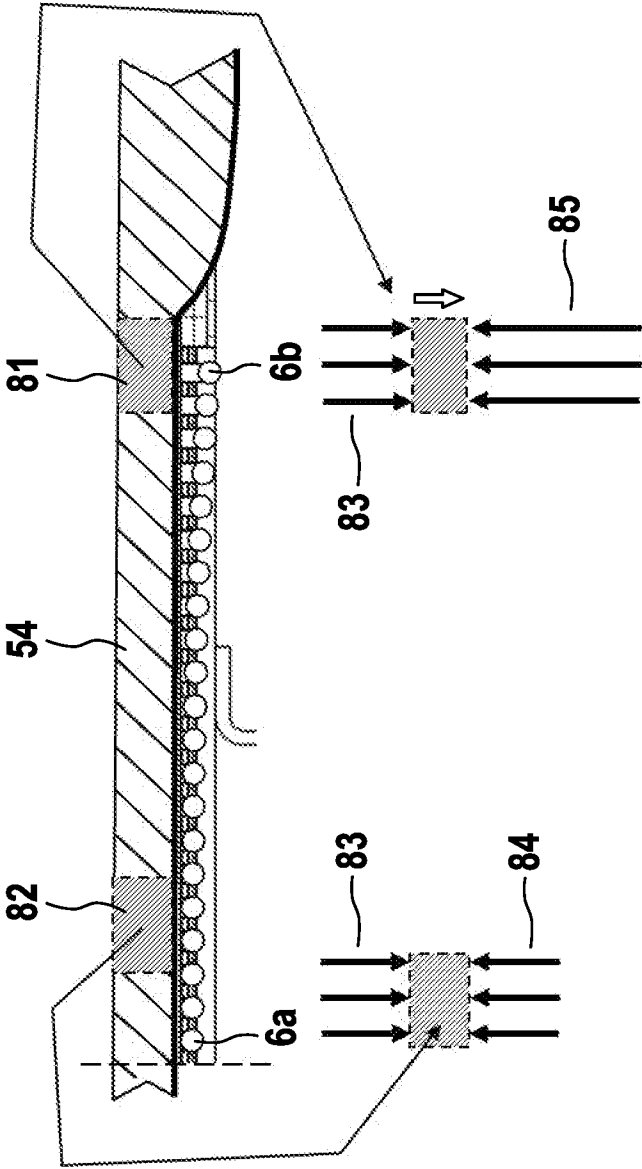
Fig. 12b

Fig. 12a

Fig. 13a

Fig. 13b

Fig. 13c



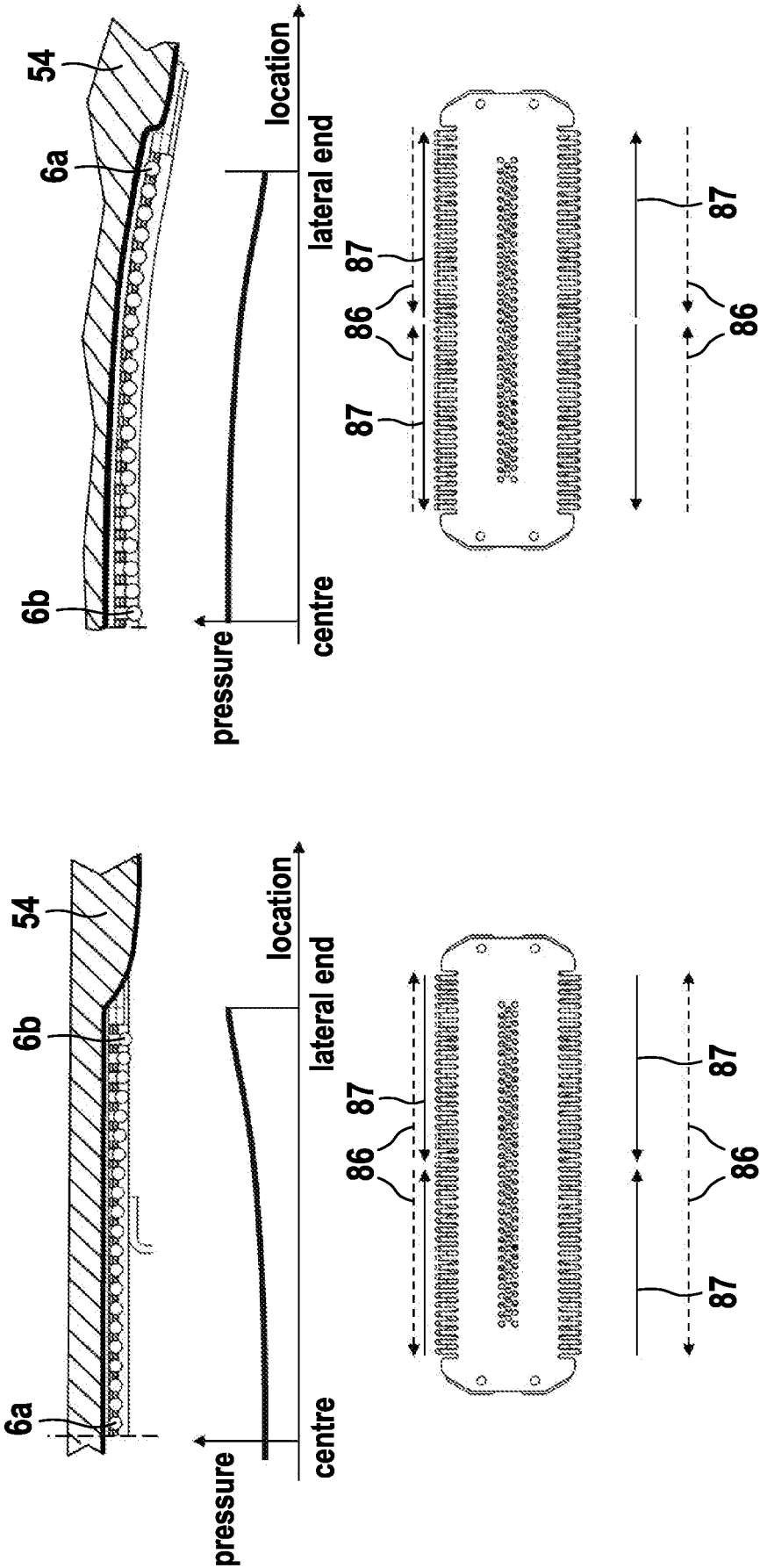


Fig. 14b

Fig. 14a

Fig. 15a

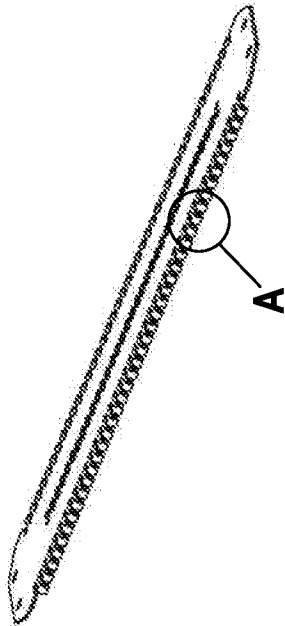


Fig. 15c

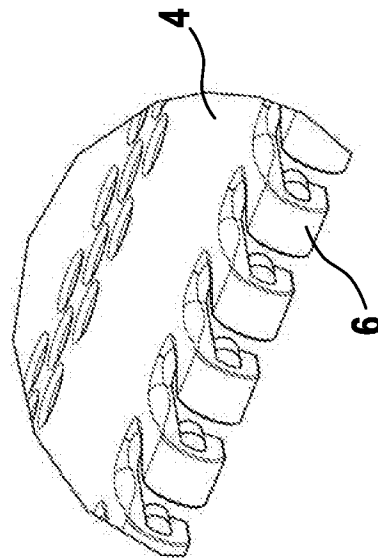


Fig. 15b

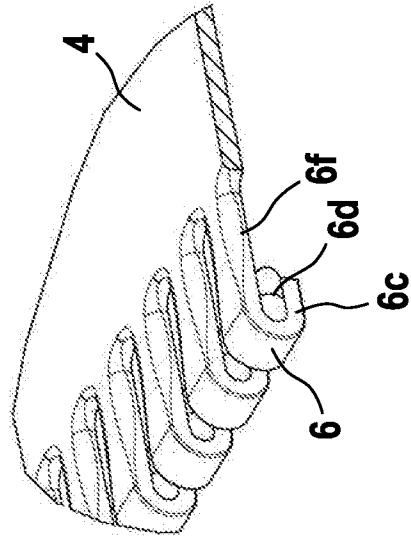


Fig. 16a

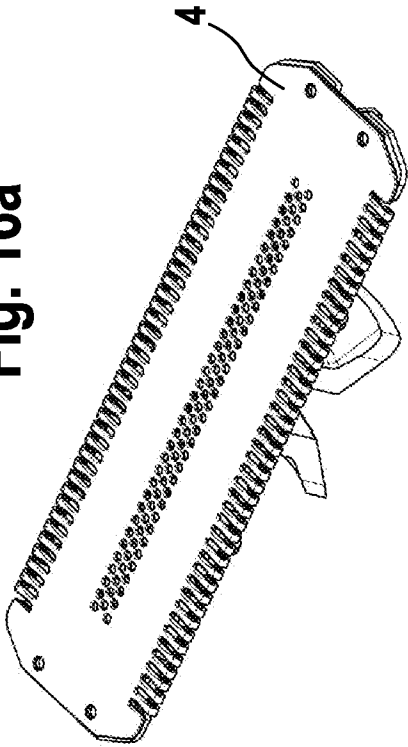


Fig. 16b

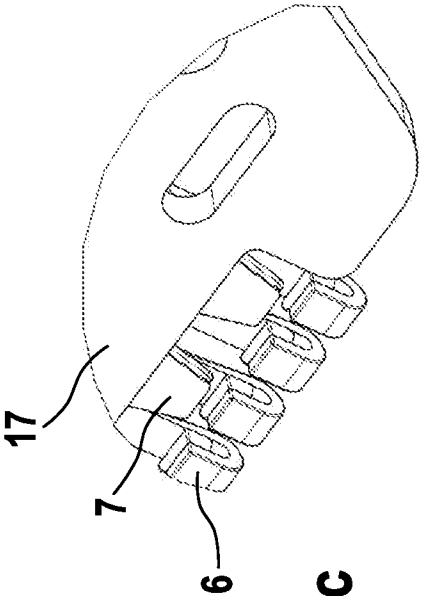
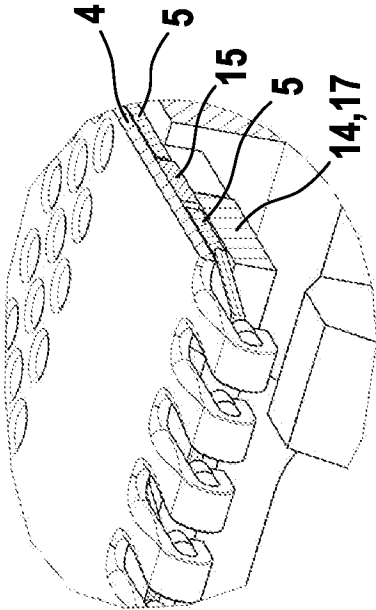


Fig. 16c

# INTERNATIONAL SEARCH REPORT

International application No  
PCT/IB2021/050560

A. CLASSIFICATION OF SUBJECT MATTER  
INV. B26B19/38 B26B19/06  
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)  
B26B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, WPI Data

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                                                                    | Relevant to claim No. |
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Further documents are listed in the continuation of Box C.



See patent family annex.

\* Special categories of cited documents :

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"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

25 March 2021

Date of mailing of the international search report

07/04/2021

Name and mailing address of the ISA/

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Fax: (+31-70) 340-3016

Authorized officer

Rattenberger, B

## INTERNATIONAL SEARCH REPORT

International application No

PCT/IB2021/050560

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                                                                                                    | Relevant to claim No. |
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| A         | page 18, line 5 - page 19, line 14;<br>figures 2, 3<br>-----                                                                                                                          | 10-13                 |
| X         | WO 2016/134979 A1 (KONINKLIJKE PHILIPS NV [NL]) 1 September 2016 (2016-09-01)                                                                                                         | 9,12,15               |
| A         | page 19, lines 19-31; figures 3-13<br>page 22, line 7 - page 23, line 17<br>-----                                                                                                     | 10,11,<br>13,14       |
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## INTERNATIONAL SEARCH REPORT

International application No.  
PCT/IB2021/050560

### Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:
  
2. ☐ Claims Nos.:  
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
  
3. ☐ Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

### Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1. ☐ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☒ As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

#### Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☐ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☐ No protest accompanied the payment of additional search fees.

**FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210**

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-16

Cutter system comprising a pair of comb-like cutting elements each with at least one row of cutting teeth and movable relative to each other, wherein one of said cutting elements has thickened and/or rounded tooth tips overhanging the tooth tips of the other cutting element, wherein said overhanging tooth tips are provided with a two-step rounding including a spherical or drop-shaped or pearl-shaped thickening and a bent or curved portion connecting said thickening to a main tooth portion and bent or curved away from the skin contact surface of said main tooth portion, wherein a concave depression is formed in the transitional section between said thickening and said bent or curved portion on the skin contact side of the teeth.

1.1. claims: 9-14

Cutter system comprising a pair of comb-like cutting elements each with at least one row of cutting teeth and movable relative to each other, wherein one of said cutting elements has thickened and/or rounded tooth tips overhanging the tooth tips of the other cutting element, wherein said overhanging rounded tooth tips include a composite thickening which includes an outer shell surrounding an inner core, said shell and said core being made from different materials.

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# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/IB2021/050560

| Patent document<br>cited in search report | Publication<br>date | Patent family<br>member(s) | Publication<br>date           |
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