

SPECIFICATION

Cutting Unit for a Dry-Shaving Apparatus.

5 The invention relates to a cutting unit for a dry-shaving apparatus of the kind (hereinafter referred to as "the kind described") having a shear plate of foil with hair-entry apertures, and a cutting unit which is movable relative to and cooperates with the shear plate or foil. The invention relates particularly to a cutting unit comprising a plurality of cutters and a corresponding plurality of hair-pulling blades each arranged in front of an associated one of the cutters with respect to the direction of the cutting movement thereof, the hair-pulling blades being arranged for movement with the cutters relative to the shear plate or foil when the cutting unit is in operation in the shaving apparatus, and each hair-pulling blade being arranged in sliding contact with a surface of the associated cutter for movement relative thereto in directions away from and towards the shear plate or foil of the shaving apparatus.

Such a cutting unit known from United Kingdom Patent Specification No. 1,467,557. Owing to dimensional tolerances and inaccuracies during manufacture of these cutting units a hair-pulling blade will generally not assume the correct rest position relative to the associated cutter when the cutting unit is assembled.

30 According to the invention there is provided a cutting unit for a dry-shaving apparatus of the kind described, comprising a plurality of cutters and a corresponding plurality of hair-pulling blades each arranged in front of an associated one of the cutters with respect to the direction of the cutting movement thereof, the hair-pulling blades being arranged for movement of the cutters relative to the shear plate or foil when the cutting unit is in operation in the shaving apparatus, and each hair-pulling blade being arranged in sliding contact with a surface of the associated cutter for movement relative thereto in directions away from and towards the shear plate or foil of the shaving apparatus, wherein each hair-pulling blade, for defining a rest position thereof relative to the associated cutter, is urged by resilient means against a part of this cutter which adjoins said surface thereof so that the hair-pulling blade engages said part of the cutter under pre-stress.

By the application of this pre-stress, play due to manufacturing tolerances can be inhibited, vibrations of the hair-pulling blades are counteracted, and after a movement away from the rest position a hair-pulling blade returns more rapidly to this position.

55 Preferably, the engagement of each hair-pulling blade with said part of the associated cutter defines the rest position of the blade in a direction extending towards the shear plate or foil, and each hair-pulling blade further engages a part of the associated cutter to define the rest position of the blade in a direction extending transversely of the direction of movement of the cutter.

In one embodiment of the invention each hair-pulling blade is formed with an ear which, in the rest position of the blade, engages said part of the

associated cutter which adjoins said surface thereof to define the rest position of the blade in a direction extending towards the shear plate or foil. The ear may be formed with a hooked end portion which engages behind said part of the associated cutter which adjoins said surface thereof, the direction of the engagement extending transversely of the direction of movement of the cutter.

In another embodiment each cutter is provided with a pin which adjoins said surface of the cutter and which engages in a slot in the associated hair-pulling blade and cooperates with the walls of the slot to define the rest position of the blade.

The invention further provides a dry-shaving apparatus of the kind described having a cutting unit according to the invention.

Embodiment of the invention will now be described by way of example with reference to the accompanying drawings, in which,

85 *Figure 1* is a front elevation of a dry-shaving apparatus of the kind described having three shear plates and associated cutting units,

Figure 2 is a side elevation of the shaving apparatus of *Figure 1*, showing one of the shear plates and cutting units and an associated driving means in cross-section, the section being taken on the line II-II in *Figure 1*,

Figure 3 is an exploded perspective view of an embodiment of a cutting unit according to the invention for the apparatus shown in *Figure 1* and 2,

Figure 4 is a plan view of the cutting unit of *Figure 3* in the assembled condition,

Figure 5 is a sectional view taken on the line V-V in *Figure 4*,

100 *Figure 6* is a perspective view, drawn to a larger scale, of one of the cutters and the associated hair-pulling blade of the cutting unit shown in *Figure 3*,

Figures 7 and 8 are views similar to *Figure 6* showing two further embodiments of the means whereby the hair-pulling blades are positioned relative to the associated cutters, and

105 *Figures 9 and 10* are diagrammatic side views, drawn to a greatly enlarged scale, of portions of a cutter and associated hair-pulling blade and a portion of the associated shear plate, illustrating operation of the hair-pulling blade.

The shaving apparatus shown in *Figure 1* and 2 comprises a housing 1 on which is mounted a shear-plate holder 2 for three shear plates 3. The shear plates 3 are of circular form and have hair-entry apertures in the form of slots 4.

A rotary cutting unit 5 (*Figure 2*) is located on the inner side of each shear plate 3 for cooperation therewith. One of the cutting units is shown schematically in *Figure 2* but is shown in detail and on an enlarged scale in *Figures 3* to 6.

120 The cutting units are rotated relative to the shear plates by an electric motor 10 to which each cutting unit is coupled by an associated hollow spindle 6 (*Figure 2*) and gear wheel 7 and a gear wheel 8 fixed on the shaft 9 of the motor 10. The gear wheels 7 are each rotatably journaled on an associated spindle 11 which is fixed in a mounting plate 12. The gear wheel 7 has a cavity 13 which is closed by a cover

plate 14. This cavity accommodates a flange 15 at the end of the hollow spindle 6. The flange 15 has a non-circular, for example, square, shape and the cavity 13 is shaped accordingly, so that a coupling is obtained for the transmission of the rotary movement of the gear wheel 7 to the spindle 6. A coil spring 16, which for the greater part is disposed in the hollow spindle 6 and which is compressed between an end wall of the hollow spindle 6 and an end wall of the cavity 13 in the gear wheel 7, exerts a force on the spindle 6 in the direction of the cutting unit 5. A conical portion 17 of the spindle 6 bears against the cutting unit 5 to transmit this force to the cutting unit and via the cutting unit to the shear plate 3, so that a flange 18 around the periphery of the shear plate is pressed against the shear plate holder 2. During use of the shaving apparatus, the shear plates 3, together with the associated cutting units 5 and spindles 6, can be pressed inwards against the action of the springs 16 under the pressure with which the shear plates are held against the user's skin.

A coupling for the transmission of the rotary movement of each spindle 6 to the associated cutting unit 5 is formed by an end portion 19 of the spindle 6 of substantially rectangular cross-section engaging in a central coupling aperture 20 of corresponding shape in the cutting unit 5.

All three cutting units of the apparatus shown in Figure 1 and 2 are coupled to the motor 10 in the above manner, the three gear wheels 7 meshing with the one centrally disposed gear wheel 8 on the motor shaft 9.

As shown in Figure 3 to 6, each cutting unit 5 comprises a cutting member 21 formed with cutters 25 each comprising a hair-cutting blade 31, and a hair-pulling member 22 formed with hair-pulling blades 23.

The cutting member 21 is constituted by a disc-shaped central body 24, around the periphery of which the cutters 25 are evenly distributed and in which the coupling aperture 20 is formed.

The hair-pulling member 22 is made from resilient sheet material and comprises a substantially annular central portion 26, around the outer periphery of which the hair-pulling blades 23 are evenly distributed. The blades 23, which are equal in number and spacing to the hair-cutting blades 31, are connected to the central portion 26 by arms 27. The central portion 26 has a central opening 28.

As is shown in Figures 9 and 10, each hair-cutting blade 31 has at its front (with respect to the direction P of the cutting movement of the blade) a sloping surface 29 which forms an acute angle A with a surface 45 of the blade which is in sliding contact with the inner side of the respective shear plate 3. The edge 46 at which the surfaces 29 and 45 meet is the cutting edge of the hair-cutting blade and the angle A is the cutting angle. In the operation of the shaving apparatus the sliding surface 45 of each hair-cutting blade travels over the hair-entry slots 4 in the respective shear plate and the cutting edge 46 of the blade, in cooperation with the edges of the shear plate at the boundaries of the slots, severs the hairs which protrude through the slots.

The cutting member 21 and the hair-pulling member 22 are assembled to form a cutting unit 5 by securing the central portion 26 of the hair-pulling member to the central body 24 of the cutting member, for example, by welding or an adhesive, in relative positions such that each hair-pulling blade 23 is in sliding contact with the front surface 29 of an associated one of the hair-cutting blades 31. Owing to the resilience of the connecting arms 27, the hair-pulling blades 23 are movable relative to the hair-cutting blades 31 in directions away from and towards the respective shear plate 3. The hair-pulling blades travel round with the hair-cutting blades relative to the shear plate in the operation of the shaving apparatus. Each hair-pulling blade has a surface 47 which is in sliding contact with the inner side of the shear plate in front of the sliding surface 45 of the associated hair-cutting blade. The edge 44 of each hair-pulling blade at which the sliding surface 47 of the blade meets the front surface thereof is the leading edge of the blade in the movement of the blade over the shear plate, the two forming an acute angle at this edge.

As is shown in Figures 5 and 6 each cutter 25 comprises a rigid arm 30 by which the blade 31 of the cutter is connected to the central body 24 of the cutting member 21. Each hair-pulling blade 23 is formed with an ear 32 which engages a surface 33 of the arm 30 of the associated cutter 25. The arm 30 thus constitutes a stop which limits movement of the hair-pulling blade 23 relative to the cutter 25 in the direction of the arrow P1 towards the shear plate 3 under the resilience of the connecting arm 27 of the blade 23. In the rest position of the blade 23, as is shown in Figures 5 and 6, the connecting arm 27 is slightly elastically deflected, so that the ear 32 engages the arm 30 under pre-stress and thus in the rest position exerts a force on the arm 30 in the direction of the arrow P1.

Each hair-pulling blade 23 has a curved protrusion 34 on one edge, which protrusion engages a surface 35 of the arm 30 of the associated cutting 25 under pre-stress. The arm 30 thus also functions as a stop which limits sideways movement of the hair-pulling blade 23 relative to the cutter 25 in the direction of the arrow P2. The protrusion 34 has a curved shape in order to minimize the area of contact with the arm 30 and thus the frictional resistance to movement of the hair-pulling blade 23 relative to the cutter 25 towards and away from the respective shear plate 3.

The ear 32 of each hair-pulling blade 23 has a hooked end portion 36 which engages behind the arm 30 of the associated cutter 25 so that sideways movement of the hair-pulling blade is also limited in the direction opposite to the arrow P2.

The engagement of the hair-pulling blades 23 with parts of the associated cutters 25 under pre-stress ensures that despite dimensional tolerances of the cutting member 21 and the hair-pulling member 22, for example, manufacturing tolerances, every hair-pulling blade is accurately positioned with respect to the associated cutter 25. The magnitude of the pre-stress may differ for different hair-pulling blades, but this has less influence on the operation of the cutting unit than if one or more hair-pulling

blades were not in engagement with the associated cutter or cutters. Moreover, the pre-stress ensures that after a movement of a hair-pulling blade is returned more rapidly to the rest position.

- 5 As the ear 32 and the protrusion 34 of each hair-pulling blade 23 engage the surface 33 and 35 of the arm 30 of the associated cutter 25 under pre-stress, the rest position of the hair-pulling blade relative to the front surface 29 of the blade 31 of the
10 cutter, on which surface the hair-pulling blade is guided in its movement away from and towards the respective shear plate, is defined in two directions. This positioning, which is essential for the efficient operation of the hair-pulling blade, is consequently
15 no longer dependent on the accuracy with which the hair-pulling member 22 and cutting member 21 as a whole are manufactured, but now depends almost solely on the dimensional accuracy of the hair-pulling blades and the cutters. As the surfaces 33
20 and 35 of each cutter are parts of the cutter which adjoin the front surface 29 of the blade 31 of the cutter, positioning with the aid of these surfaces 33 and 35 is most effective.

Obviously, the construction may alternatively be
25 such that the pre-stress acts on the hair-pulling blades 23 in the direction opposite to the arrow P2, so that the hooked end portion 36 of the ear 32 of each hair-pulling blade, instead of the protrusion 34, engages the arm 30 of the associated cutter 25.

30 In the embodiment of Figure 7 each hair-pulling blade 23 is provided with two ears 37 and 38 which, under the pre-stress acting on the blade 23, engage surfaces 39 and 40 respectively of the associated cutter 25.

35 In the embodiment of Figure 8 each cutter 25 is provided with a pin 41 which engages in a slot 42 in the associated hair-pulling blade 23 and cooperates with the walls of the slot to position the blade 23 relative to the cutter 25 in two orthogonal directions.

40 Figures 9 and 10 illustrate the operation of a hair-pulling blade. When a hair 43 is caught in a hair-entry aperture 4, the leading edge 44 of the hair-pulling blade 23, moving in the direction of arrow P, will contact the hair at location A on the
45 hair. The edge 44 has a sharpness such that it will slightly penetrate the hair 43 at A without severing it. A reaction force is exerted on the hair-pulling blade 23 by the hair 43 in a direction opposite to the direction of movement P of the blade. This force will
50 be counteracted by the component N₁ of the normal force N which is exerted on the hair-pulling blade 23 by the front surface 29 of the associated hair-cutting blade 31 (Figure 9). For the sake of simplicity the slight frictional forces between the two blades 23
55 and 31 have been neglected. The component N₂ of the normal force N will cause the hair-pulling blade 23 to slide along the surface 29 of the hair-cutting blade 31, away from the shear plate 3.

Owing to, *inter alia*, the natural elasticity of the
60 user's skin, the hair 43 will be pulled up from the skin by the hair-pulling blade 23 until the cutting edge 46 of the hair-cutting blade 31 has reached the hair at location B thereon (Figure 10). The hair is then severed by the blade 31 in cooperation with the
65 shear plate 3. Thus, a part of the hair 43 is cut off

which is longer than the part which would have been cut off without the aid of the hair-pulling blade by an amount equal to the distance between A and B, so that a closer shave is obtained.

- 70 Owing to the pre-stress which acts on the hair-pulling blade 23 and the additional force resulting from the elastic deflection of the connecting arm 27 of the hair-pulling blade when the blade is moved away from the shear plate 3, the hair-pulling blade
75 will be returned more rapidly to the rest position when the hair 43 has been cut off.

The pre-stress which, in the rest position of the hair-pulling blades 23, acts on the blades in the direction P₁ (Figure 5) is taken up by the associated
80 cutters 25 and does not cause the hair-pulling blades 23 to be pressed against the shear plate 3 with extra force. Thus, additional frictional losses and wear between the hair-pulling blades and the shear plate are avoided. Moreover, this pre-stress ensures that
85 if, owing to wear or the ingress of particles of dirt, the friction between a hair-pulling blade and the associated cutter increases, the hair-pulling blade, after a movement away from the rest position, can return to the rest position despite the increased
90 frictional resistance.

The pre-stress also yields the advantage that operations performed on the cutting unit during manufacture, such as simultaneous grinding of the
95 sliding surfaces 45 and 47 of the hair-cutting blades and hair-pulling blades respectively (Figure 9 and 10), can be simplified.

The invention is not limited to a cutting unit of the rotary type; it can also be applied to a reciprocating cutting unit, for example.

100 CLAIMS

1. A cutting unit for a dry-shaving apparatus of the kind described, comprising a plurality of cutters
105 and a corresponding plurality of hair-pulling blades each arranged in front of an associated one of the cutters with respect to the direction of the cutting movement thereof, the hair-pulling blades being
110 arranged for movement with the cutters relative to the shear plate or foil when the cutting unit is in operation in the shaving apparatus, and each hair-pulling blade being arranged in sliding contact with a surface of the associated cutter for movement
115 relative thereto in directions away from and towards the shear plate or foil of the shaving apparatus, wherein each hair-pulling blade, for defining a rest position thereof relative to the associated cutter, is urged by resilient means against a part of this cutter which adjoins said surface thereof so that the
120 hair-pulling blade engages said part of the cutter under pre-stress.

2. A cutting unit as claimed in Claim 1, wherein the engagement of each hair-pulling blade with said part of the associated cutter defines the rest position
125 of the blade in a direction extending towards the shear plate or foil, and wherein each hair-pulling blade further engages a part of the associated cutter to define the rest position of the blade in a direction extending transversely of the direction of movement
130 of the cutter.



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110 operation in the shaving apparatus, and each hair-pulling blade being arranged in sliding contact with a surface of the associated cutter for movement relative thereto in directions away from and towards the shear plate or foil of the shaving apparatus,
115 wherein each hair-pulling blade, for defining a rest position thereof relative to the associated cutter, is urged by resilient means against a part of this cutter which adjoins said surface thereof so that the hair-pulling blade engages said part of the cutter
120 under pre-stress.

2. A cutting unit as claimed in Claim 1, wherein the engagement of each hair-pulling blade with said part of the associated cutter defines the rest position
125 of the blade in a direction extending towards the shear plate or foil, and wherein each hair-pulling blade further engages a part of the associated cutter to define the rest position of the blade in a direction extending transversely of the direction of movement
130 of the cutter.



3. A cutting unit as claimed in Claim 1 or 2, wherein each hair-pulling blade is formed with an ear which, in the rest position of the blade, engages said part of the associated cutter which adjoins said surface thereof to define the rest position of the blade in a direction extending towards the shear plate or foil.
4. A cutting unit as claimed in Claim 3, wherein the ear of each hair-pulling blade is formed with a hooked end portion which engages behind said part of the associated cutter which adjoins said surface thereof, the direction of the engagement extending transversely of the direction of movement of the cutter.
5. A cutting unit as claimed in Claim 1 or 2, wherein each cutter is provided with a pin which adjoins said surface of the cutter and which engages in a slot in the associated hair-pulling blade and cooperates with the walls of the slot to define the rest position of the blade.
6. A cutting unit substantially as herein described with reference to Figure 3 to 6 or Figure 7 or 8, and Figures 9 and 10, of the accompanying drawings.
7. A dry-shaving apparatus of the kind described having a cutting unit as claimed in any of Claims 1 to 6.

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