

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 with hair-entry apertures and a cutting unit which is rotatable relative to and cooperates with the shear plate. The invention relates particularly to a cutting unit comprising a cutting member which comprises a central body and a plurality of cutters distributed around said body, the cutting unit further comprising a plurality of hair-pulling blades each of which is arranged in front of an associated one of the cutters with respect to the direction of movement thereof and is carried by an associated arm which is coupled to the central body of the cutting member for rotary movement therewith and which is movable relative thereto to permit movement of the hair-pulling blade relative to the associated cutter in directions away from and towards the shear plate when the cutting unit is mounted in a dry-shaving apparatus, each hair-pulling blade being arranged in sliding contact with a surface of the associated cutter.

Such a cutting unit is known from our prior United Kingdom Patent Specification No. 1,467,557.

According to the invention there is provided a cutting unit for a dry-shaving apparatus of the kind described, comprising a cutting member which comprises a central body and plurality of cutters distributed around said body, the cutting unit further comprising a plurality of hair-pulling blades each of which is arranged in front of an associated one of the cutters with respect to the direction of movement thereof and is carried by an associated arm which is coupled to the central body of the cutting member for rotary movement therewith and which is movable relative thereto to permit movement of the hair-pulling blade relative to the associated cutter in directions away from and towards the shear plate when the cutting unit is mounted in a dry-shaving apparatus, each hair-pulling blade being arranged in sliding contact with a surface of the associated cutter, wherein each of said arms is at least partly elastically deformable and is arranged to urge the respective hair-pulling blade against said surface of the associated cutter.

For the correct operation of the cutting unit in a dry-shaving apparatus of the kind described, it is important that all the hair-pulling blades directly engage the respective surfaces of the associated cutters. However, this demands a high manufacturing accuracy of the components of the cutting unit, particularly if the hair-pulling blades against the cutters in the rest position of the blades through elastic deformation of the arms of the blades, wider dimensional tolerances for the hair-pulling blades and the cutting member are permissible.

In a preferred embodiment of the invention, each of said arms, due to elastic deformation, exerts a force on the associated cutter through the respective hair-pulling blade, which force has a component normal to said surface of the cutter and a component

which is directed along this surface in a direction which extends towards the shear plate when the cutting unit is mounted in a dry-shaving apparatus.

Each of said arms may comprise a first portion which is coupled at one end to the central body of the cutting member and which extends therefrom in a rearward direction with respect to the direction of movement of the cutting unit, which rearward direction is tangential to a circle concentric with the rotational axis of the cutting unit, and an elastically deformable second portion to which the respective hair-pulling blade is connected and which is connected to the first portion and is inclined relative thereto in a forward direction with respect to the direction of movement of the cutting unit.

Each of said arms, during sliding movement of the respective hair-pulling blade along said surface of the associated cutter, may rotate about a point located at or near said one end of said first portion of the arm, and each arm may be so arranged that during movement of the respective hair-pulling blade away from the shear plate when the cutting unit is in operation in a dry-shaving apparatus, reaction forces are exerted on the hair-pulling blade by the associated cutter, which forces produce a counteracting torque on the respective arm.

The first portion also of each of said arms may be elastically deformable.

A cutting unit according to the invention may comprise a hair-pulling member having a central portion to which the hair-pulling members are connected by said arms and which is coupled to the central body of the cutting member for rotary movement therewith by engagement of a projection on one of said members in an aperture in the other member, which engagement prevents relative rotational movement between said members about the rotational axis of the cutting unit under the influence of the forces acting between the hair-pulling blades and the cutters.

The central portion of the hair-pulling member may be of lamelliform construction and said projection may be formed by a torque which is bent from the plane of said central portion at a point spaced from the centre thereof, said aperture being formed in the central body of the cutting member.

Alternatively, the projection may be formed on the central body of the cutting member and the aperture in the central portion of the hair-pulling member.

The projection may be undercut so as to project over one side of the member in which said aperture is formed adjacent the boundary of the aperture in order to connect said members together in the direction of the rotational axis of the cutting unit.

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

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

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 Figures 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 but showing only three of the cutters and associated hair-pulling blades,

Figure 6 shows a detail of Figure 5 drawn to a larger scale,

Figure 7 is a view similar to Figure 6 but drawn to a smaller scale, showing a detail of a different embodiment of the arms which carry the hair-pulling blades,

Figure 8 is a plan view of the detail of Figure 7, and

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 the operation of the hair-pulling blade.

The shaving apparatus shown in Figures 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 situated on the inner side of each shear plate 3 for cooperation therewith. The cutting units 5, of which one is shown schematically in Figure 2, each comprise a plurality of cutters in the form of hair-cutting blades, and a corresponding plurality of hair-pulling blades, as will be described later herein with reference to Figures 3 to 6.

The cutting units 5 are rotated relative to the shear plates 3 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 formed at the end of the hollow spindle 6. The flange 15 is 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 spring 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 Figures 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 Figures 3 to 6, each cutting unit 5 comprises a cutting member 21 formed with hair-cutting blades 25, 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 hair-cutting blades 25 are evenly distributed. The central body 24 is formed with the coupling aperture 20 and with three apertures 26 which are equally spaced about and from the central axis of the cutting member 21.

The hair-pulling member 22 is made preferably in one piece from resilient sheet material and comprises a substantially annular lamelliform central portion 27, 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 25, are connected to the central portion 27 by bent resilient arms 28. The central portion 27 has a central opening 29 and is formed at its inner periphery with three tongues 30 which are equispaced from one another and which are bent from the plane of the central portion 27 of the hair-pulling member to one side thereof. The tongues 30 are equally spaced from the central axis of the hair-pulling member 22 by a distance which corresponds to the distance of the apertures 26 in the cutting member 21 from the central axis of the latter member.

As shown in Figures 9 and 10, each hair-cutting blade 25 has at its front (with respect to the direction P of the cutting movement of the blade) a sloping surface 31 which forms an acute angle α with a surface 42 of the blade which is in sliding contact with the inner side of the respective shear plate 3. The edge 43 at which the surfaces 31 and 42 meet is the cutting edge of the hair-cutting blade and the angle α is the cutting angle. In the operation of the shaving apparatus the sliding surface 42 of each hair-cutting blade travels over the hair-entry slots 4 in the respective shear plate and the cutting edge 43 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 coupling the central portion 27 of the hair-pulling member to the central body 24 of the cutting member in relative positions such that each hair-pulling blade 23 is in sliding contact with the

front surface 31 of an associated one of the hair-cutting blades 25. Owing to the resilience of the arms 28, the hair-pulling blades 23 are movable relative to the hair-cutting blades 25 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 44 which is in sliding contact with the inner side of the shear plate in front of the sliding surface 42 of the associated hair-cutting blade. The edge 41 of each hair-pulling blade at which the sliding surface 44 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 surface forming an acute angle at this edge.

In the assembly of the cutting and hair-pulling members 21 and 22, the two members are first moved axially towards one another to bring the hair-pulling blades 23 into engagement with the front surfaces 31 of the hair-cutting blades 25. The hair-pulling member 22 is then rotated about its central axis relative to the cutting member 21 in the direction of the arrow D in Figure 3, so that the arms 28 of the hair-pulling blades 23 are elastically deformed and the blades 23 are thereby urged against the front surfaces of the hair-cutting blades 25. The hair-pulling member is rotated relative to the cutting member until the tongues 30 on the hair-pulling member are aligned with the apertures 26 in the cutting member. The two members are then moved axially towards one another again to engage the tongues 30 in the apertures 26 and position the central portion 27 of the hair-pulling member against the central body 24 of the cutting member. The engagement of the tongues 30 in the apertures 26 couples the members 21 and 22 in the rotational direction and prevents relative rotational movement between these members about their central axis under the influence of the forces acting between the hair-pulling and hair-cutting blades. Thus, all the hair-pulling blades will be in engagement with the hair-cutting blades despite dimensional tolerances which may arise, for example, during manufacture of the cutting and hair-pulling members, or tolerances in the designed dimensions of these members.

The tongues 30 are each slightly undercut at one side so that they each have an oblique side edge 32 which projects slightly over one side of the central body 24 of the cutting member 21 (the lower side in Figure 5) adjacent the boundary of the respective aperture 26 to connect the members 21 and 22 together in the axial direction. This provides a simple detachable connection between the cutting and hair-pulling members. Alternatively, the central body 24 and central portion 27 of the members 21 and 22 can be fixed together, for example by welding or an adhesive.

It is obviously possible to form the tongues 30 on the central body 24 of the cutting member 21 and the apertures 26 in the central portion 27 of the hair-pulling members 22, instead of *vice versa* as in the embodiment shown.

As shown on a greatly enlarged scale in Figure 6, the arm 28 of each hair-pulling blade 23 comprises two portions 33 and 35, of which the portion 35 of each arm 28 is formed with the respective hair-pulling blade 23 and the portion 33, at its proximal end 34, adjoins the central portion 27 of the hair-pulling member 22 and through this central portion 27 of the hair-pulling member 22 and through this central portion 27 is coupled to the central body 24 of the cutting member 21. The portions 33 of the arms 28 all extend substantially tangentially of a common circle which is concentric with the central axis of the hair-pulling member 22 and hence with the rotational axis of the cutting unit 5 of which the hair-pulling member forms part. The portion 33 extend in a rearward direction from the central portion 27 of the hair-pulling member, i.e. rearward with respect to the direction of movement of the cutting unit. The portion 35 of each arm is connected to the portion 33 thereof by a bent portion 36 of the arm and is inclined relative to the portion 33 in a forward direction with respect to the direction of movement of the cutting unit. As already described, owing to the elastic deformation of the arms 28, which deformation involves bending of the portions 33 and 35 of each arm and of the bent portion 36 which forms the connection between the portions 33 and 35, the hair-pulling blades 23 are urged against the front surfaces 31 of the hair-cutting blades 25. As a result, each hair-pulling blade 23 will exert a force K on the associated hair-cutting blade 25, which force has a component K_1 which is normal to the surface 31 of the blade 25 and a component K_2 which is directed along the surface 31 towards shear plate 3, which is schematically shown by interrupted lines in Figure 6.

The force component K_2 can be counteracted by a frictional force between the surface 31 and the hair-pulling blade 23 or by reaction force exerted on the hair-pulling blade by the shear plate 3, so that the resulting reaction force R exerted on the hair-pulling blade by the hair-cutting blade 25 and, as the case may be, by the shear plate 3, is equal and opposite to the force K and thus produces an equilibrium of forces.

During operation the hair-pulling blade 23 will undergo a slight displacement along the surface 31 of the hair-cutting blade 25 in a direction away from the shear plate 3. Owing to the flexibility of the portion 33 of the arm 28 of the hair-pulling blade, this displacement may be considered approximately as a rotation about a point at or near the end 34 of the portion 33. The resulting reaction force R has a moment arm A relative to this point, so that a counteracting torque is produced as a result of which the hair-pulling blade 23 returns to the rest position shown in Figure 6 once the cause of the displacement no longer exists.

During the displacement the moment arm M will decrease slightly but the resulting reaction force R will increase, for example owing to further deformation of the bent portion 36 and the portion 35 of the arm 28, so that the torque remains substantially constant. This has the advantage that the portion 33 of the arm 28 may take the form of a compara-

tively weak leaf spring, so that during the displacement of the hair-cutting blade owing to the elastic deformation of the arm portion 33 no great counteracting forces are produced, whilst a sufficiently large force or torque is still available to return the hair-pulling blade to the rest position of Figure 6.

The portion 33 of each arm 28 may alternatively be constructed as a rigid part of the arm and be pivotably connected at its proximal end 34 to the central body 24 of the cutting member 21.

In the embodiment of Figures 7 and 8 the arm of each hair-pulling blade 23 comprises two portions 37 and 38 which correspond to the portions 33 and 35 respectively of the arms 28 which correspond to the portions 33 and 35 respectively of the arms 28 in the embodiment of Figures 3 to 6, the portion 38 which is formed with the hair-pulling blade being inclined in a forward direction relative to the portion 37 which adjoins the central portion 27 of the hair-pulling member 22.

The arm portions 37 and 38 are connected by a portion 39 which, when the hair-pulling blade 23 is in the rest position, as shown in Figure 7, lies wholly in the plane containing the portion 37. For the sake of simplicity the hair-cutting blade 25, which is shown schematically in Figure 7, has been omitted from Figure 8. This arm construction, like the arm construction shown in Figures 3 to 6, permits easy manufacture of the hair-pulling member, and it has virtually the same properties as the construction shown in Figures 3 to 6.

Figures 9 and 10 illustrate the operation of hair-pulling blade. When a hair 40 is caught in a hair-entry aperture 4, the leading edge 41 of the hair-pulling blade 23, moving in the direction of arrow P, will contact the hair at point A thereon. The edge 41 has a sharpness such that it will slightly penetrate the hair 40 at A without severing it. A reaction force is exerted on the hair-pulling blade 23 by the hair 40 in a direction opposite to the direction of movement P of the blade. This force will be counteracted by the component N_1 of the normal force N which is exerted on the hair-pulling blade 23 by the front surface 31 of the associated hair-cutting blade 25 (Figure 9). For simplicity the slight frictional forces between the two blades 23 and 25 have been neglected. The component N_2 of the normal force N will cause the hair-pulling blade 23 to slide along the surface 31 of the hair-cutting blade 25, away from the shear plate 3.

Owing to *inter alia*, the natural elasticity of the user's skin the hair 40 will be pulled up from the skin by the hair-pulling blade 23 until the cutting edge 43 of the hair-cutting blade 25 has reached the hair at point B thereon (Figure 10). The hair is then severed by the blade 25 in cooperation with the shear plate 3. Thus, a part of the hair 40 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.

CLAIMS

1. A cutting unit for a dry-shaving apparatus of the kind described, comprising a cutting member which comprises a central body and a plurality of

cutters distributed around said body, the cutting unit further comprising a plurality of hair-pulling blades each of which is arranged in front of an associated one of the cutters with respect to the direction of movement thereof and is carried by an associated arm which is coupled to the central body of the cutting member for rotary movement therewith and which is movable relative thereto to permit movement of the hair-pulling blade relative to the associated cutter in directions away from and towards the shear plate when the cutting unit is mounted in a dry-shaving apparatus, each hair-pulling blade being arranged in sliding contact with a surface of the associated cutter, wherein each of said arms is at least partly elastically deformable and is arranged to urge the respective hair-pulling blade against said surface of the associated cutter.

2. A cutting unit as claimed in Claim 1, wherein each of said arms, due to elastic deformation, exerts a force on the associated cutter through the respective hair-pulling blade, which force has a component normal to said surface of the cutter and a component which is directed along this surface in a direction which extends towards the shear plate when the cutting unit is mounted in a dry-shaving apparatus.

3. A cutting unit as claimed in Claim 1 to 2, wherein each of said arms comprises a first portion which is coupled at one end of the central body of the cutting member and which extends therefrom in a rearward direction with respect to the direction of movement of the cutting unit, which rearward direction is tangential to a circle concentric with the rotational axis of the cutting unit, and an elastically deformable second portion to which the respective hair-pulling blade is connected and which is connected to the first portion and is inclined relative thereto in a forward direction with respect to the direction of movement of the cutting unit.

4. A cutting unit as claimed in Claims 2 and 3, wherein each of said arms, during sliding movement of the respective hair-pulling blade along said surface of the associated cutter, rotates about a point located at or near said one end of said first portion of the arm, and wherein each arm is so arranged that during movement of respective hair-pulling blade away from the shear plate when the cutting unit is in operation in a dry-shaving apparatus, reaction forces are exerted the hair-pulling blade by the associated cutter, which forces produce a counteracting torque on the respective arm.

5. A cutting unit as claimed in Claim 3 or 4, wherein also the first portion of each of said arms is elastically deformable.

6. A cutting unit as claimed in any preceding claim, comprising a hair-pulling member having a central portion to which the hair-pulling members are connected by said arms and which is coupled to the central body of the cutting member for rotary movement therewith by engagement of a projection on one of said members in an aperture in the other member, which engagement prevents relative rotational movement between said members about the rotational axis of the cutting unit under the influence of the forces acting between the hair-



tively weak leaf spring, so that during the displacement of the hair-cutting blade owing to the elastic deformation of the arm portion 33 no great counteracting forces are produced, whilst a sufficiently large force or torque is still available to return the hair-pulling blade to the rest portion of Figure 6.

The portion 33 of each arm 28 may alternatively be constructed as a rigid part of the arm and be pivotably connected at its proximal end 34 to the central body 24 of the cutting member 21.

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The arm portions 37 and 38 are connected by a portion 39 which, when the hair-pulling blade 23 is in the rest position, as shown in Figure 7, lies wholly in the plane containing the portion 37. For the sake of simplicity the hair-cutting blade 25, which is shown schematically in Figure 7, has been omitted from Figure 8. This arm construction, like the arm construction shown in Figures 3 to 6, permits easy manufacture of the hair-pulling member, and it has virtually the same properties as the construction shown in Figures 3 to 6.

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Owing to *inter alia*, the natural elasticity of the user's skin the hair 40 will be pulled up from the skin by the hair-pulling blade 23 until the cutting edge 43 of the hair-cutting blade 25 has reached the hair at point B thereon (Figure 10). The hair is then severed by the blade 25 in cooperation with the shear plate 3. Thus, a part of the hair 40 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.

CLAIMS

1. A cutting unit for a dry-shaving apparatus of the kind described, comprising a cutting member which comprises a central body and a plurality of

cutters distributed around said body, the cutting unit further comprising a plurality of hair-pulling blades each of which is arranged in front of an associated one of the cutters with respect to the direction of movement thereof and is carried by an associated arm which is coupled to the central body of the cutting member for rotary movement therewith and which is movable relative thereto to permit movement of the hair-pulling blade relative to the associated cutter in directions away from and towards the shear plate when the cutting unit is mounted in a dry-shaving apparatus, each hair-pulling blade being arranged in sliding contact with a surface of the associated cutter, wherein each of said arms is at least partly elastically deformable and is arranged to urge the respective hair-pulling blade against said surface of the associated cutter.

2. A cutting unit as claimed in Claim 1, wherein each of said arms, due to elastic deformation, exerts a force on the associated cutter through the respective hair-pulling blade, which force has a component normal to said surface of the cutter and a component which is directed along this surface in a direction which extends towards the shear plate when the cutting unit is mounted in a dry-shaving apparatus.

3. A cutting unit as claimed in Claim 1 to 2, wherein each of said arms comprises a first portion which is coupled at one end of the central body of the cutting member and which extends therefrom in a rearward direction with respect to the direction of movement of the cutting unit, which rearward direction is tangential to a circle concentric with the rotational axis of the cutting unit, and an elastically deformable second portion to which the respective hair-pulling blade is connected and which is connected to the first portion and is inclined relative thereto in a forward direction with respect to the direction of movement of the cutting unit.

4. A cutting unit as claimed in Claims 2 and 3, wherein each of said arms, during sliding movement of the respective hair-pulling blade along said surface of the associated cutter, rotates about a point located at or near said one end of said first portion of the arm, and wherein each arm is so arranged that during movement of respective hair-pulling blade away from the shear plate when the cutting unit is in operation in a dry-shaving apparatus, reaction forces are exerted the hair-pulling blade by the associated cutter, which forces produce a counteracting torque on the respective arm.

5. A cutting unit as claimed in Claim 3 or 4, wherein also the first portion of each of said arms is elastically deformable.

6. A cutting unit as claimed in any preceding claim, comprising a hair-pulling member having a central portion to which the hair-pulling members are connected by said arms and which is coupled to the central body of the cutting member for rotary movement therewith by engagement of a projection on one of said members in an aperture in the other member, which engagement prevents relative rotational movement between said members about the rotational axis of the cutting unit under the influence of the forces acting between the hair-

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pulling blades and the cutters.

7. A cutting unit as claimed in Claim 6, wherein the central portion of the hair-pulling member is of lamelliform construction and said projection is

5 formed by a tongue which is bent from the plane of said central portion at a point spaced from the centre thereof, said aperture being formed in the central body of the cutting member.

8. A cutting unit as claimed in Claim 6, wherein
10 said projection is formed on the central body of the cutting member and said aperture is formed in the central portion of the hair-pulling member.

9. A cutting unit as claimed in Claim 6, 7 or 8, wherein said projection is undercut so as to project
15 over one side of the member in which said aperture is formed adjacent the boundary of the aperture in order to connect said members together in the direction of the rotational axis of the cutting unit.

10. A cutting unit substantially as herein described with reference to Figures 3 to 6 or Figures 7
20 or 8 of the accompanying drawings.

11. A dry-shaving apparatus of the kind described having a cutting unit as claimed in any of Claims 1 to 10.