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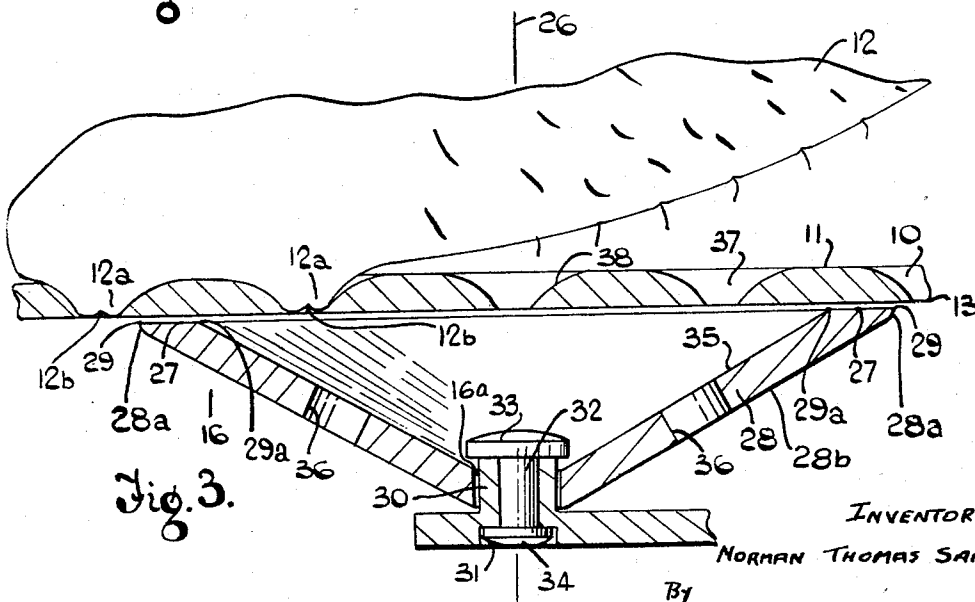
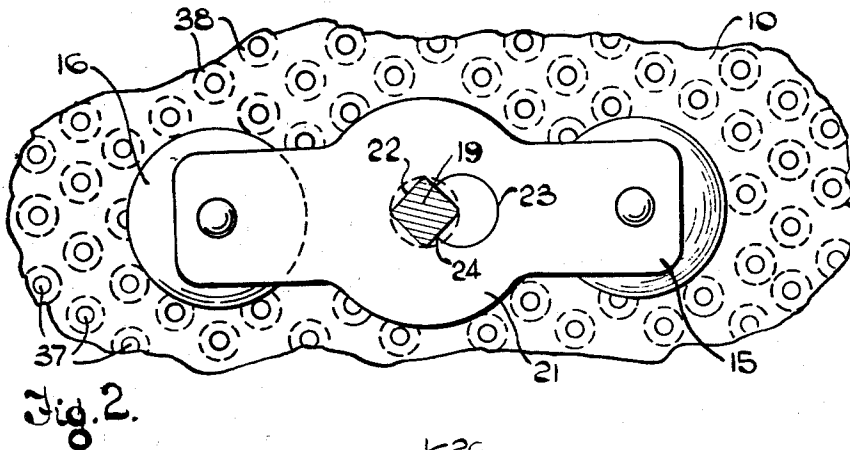
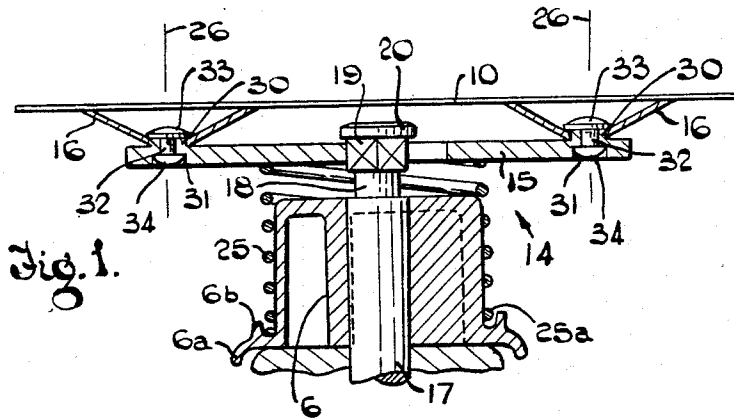
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DRY SHAVERS HAVING CUP-SHAPED CUTTERS

Original Filed June 27, 1961

2 Sheets-Sheet 1



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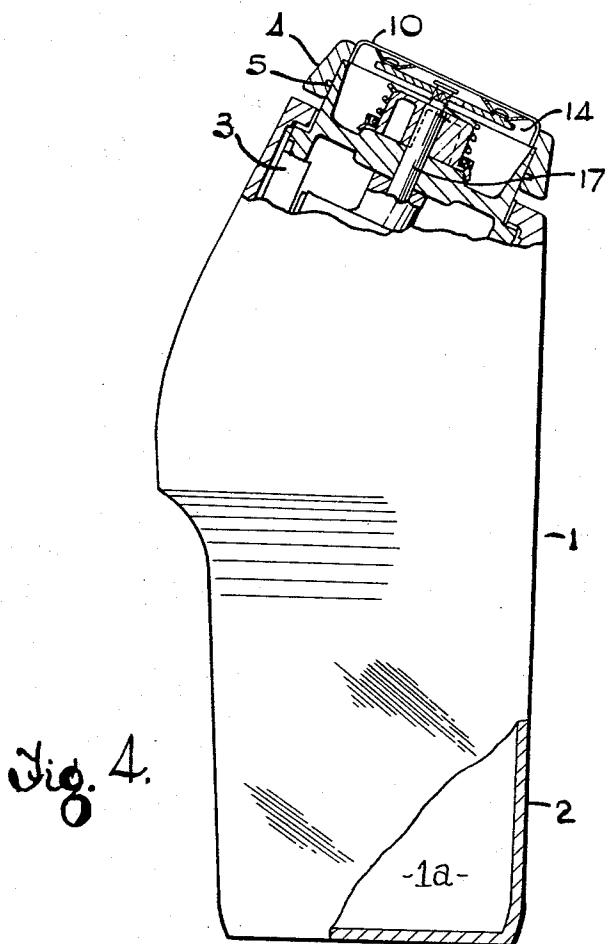
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DRY SHAVERS HAVING CUP-SHAPED CUTTERS

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Continuation of application Ser. No. 119,967, June 27, 1961. This application Dec. 23, 1963, Ser. No. 335,438 Claims priority, application Great Britain, June 30, 1960, 22,860/60

2 Claims. (Cl. 30—43.3)

This application is a continuation of my copending application Serial No. 119,967, filed June 27, 1961, now abandoned.

This invention relates to dry shavers comprising an apertured shear plate in the form of foil, plate, or equivalent member, having an outer face for placing in face-to-face relation with the surface to be shaved, and a blade element disposed at the inner face of the shear plate and movable over the inner face thereof.

One of the problems encountered in such shavers is the provision of a blade element which will cut the hairs protruding through the apertures of the shear plate satisfactorily for an extended period of service of the shaver. In general, dry shavers have one or more blade elements each having an edge face in contact with the inner face of the shear plate, and a back face which meets the edge face in a sharp edge forming the leading cutting edge of the blade element having regard to the direction of motion thereof, the back face being directed away from the inner face of the shear plate and making an acute included angle or sometimes a right angle with the edge face of the element. As the included angle is decreased, the sharpness of the cutting edge is increased, but in general its service life is decreased, and in practice the particular angle adopted is a compromise between two conflicting requirements.

Furthermore, as the value of the included angle is increased to improve the service life, it is normally necessary to increase the contact pressure between the edge face of the blade element and the inner face of the shear plate, and this brings in its train a number of serious disadvantages among which may be mentioned the fact that the power necessary to move the blade element in relation to the shear plate is increased, and the increased contact pressure reduces the service life of the shear plate and especially is destructive of a plated coating of corrosion resistive metal which is normally applied to the shear plate, and which extends over its inner face.

The present invention provides an improved dry shaver in which one or more thin-walled blade elements, preferably cup-shaped, are mounted on a rotary member for free rotation about an axis spaced from the axis of rotation of the rotary member so that rotation of the member causes the blade elements to follow annular paths in contact with the inner face of a shear plate to cut cleanly hairs projecting through apertures in the shear plate. Various advantages flow from the use of such an arrangement, one of which is that only low power is needed to rotate the member so that it may usefully be driven by a battery-powered electric motor. Another advantage is that the blade element or each such element is self-sharpening.

Still another advantage of the invention is that the cutting edge of the or each blade element is of a form which is adapted to effect severing of hairs protruding through the shear plate cleanly and with a minimum of discomfort to the user and as closely as possible to the surface of the skin.

The invention will now be described by way of ex-

ample with reference to a specific embodiment thereof illustrated in the accompanying drawings and wherein:

FIGURE 1 is a view in side elevation and partly in cross section showing a fragmentary portion of a shaver and showing one form of shear plate, blade elements and a carrier therefor in accordance with the invention.

FIGURE 2 is a fragmentary underneath plan view of the parts shown in FIGURE 1.

FIGURE 3 is a fragmentary view on an enlarged scale and in diametral cross section through one of the blade elements showing also the formation of the apertures and shear plate, and

FIGURE 4 is a view partly in cross section of a complete shaver in accordance with the invention.

The shaver illustrated in FIGURE 4 comprises a body 1 which is of any suitable form, for example the lower portion 2 thereof may be cylindrical, and comprises an elongated hollow battery chamber 1a in which are mounted dry cells or batteries for an electric motor. The upper part of the body affords a chamber the axis of which is inclined at an obtuse angle to the axis of the lower portion 2 of the body, and this chamber contains an electric motor 3 from which extends a spindle 17 on which a cutter member 14 is mounted as hereinafter described. The upper end of the chamber which contains the motor 3 is normally closed by a shear plate 10 having a skirt 4 fitting slidably and removably over the upper end of the body of the shaver and normally retained in assembled relation therewith by a retaining ring 5 of elastically deformable material engaging in an internal groove in the skirt 4 and gripping the outer circumferential face of the body.

The shear plate 10 is a thin metal foil member which may be made of a plain carbon steel or, if desired, of an alloy steel, and may have a thickness in the range 0.001 inch to 0.005 inch, a typical value being about 0.002 inch.

As seen particularly in FIGURES 1 to 3 the shear plate has an outer face 11 which is adapted to be brought into contact with the surface to be shaved, for example, a part of the user's face as indicated generally at 12, and has an inner face 13 at which is disposed the cutter member 14 comprising a carrier 15 and a plurality of blade elements 16 mounted thereon. The carrier 15 is mounted on the drive spindle 17.

The spindle 17 is formed at its upper end with a neck portion 18 above which is a driving portion 19 of non-circular form, for example square, formed by milling or grinding flat faces on the initially circular spindle 17.

Above the driving portion 19 the spindle is formed with a head 20 of a diameter somewhat larger than the main part of the spindle 17 itself and which acts as a retaining means for the carrier 15. The carrier 15 comprises a central plate-like portion 21 which is formed with two openings, namely a drive opening 22 of square form which is a sliding fit on the driving portion 19 of the spindle which extends through this opening, and a release opening 23 of circular form communicating with the drive opening 22 and of a diameter such as to allow the carrier, when the opening 23 is moved into coaxial relation with the spindle 17, to be removed from the latter over the head 20.

Where the two openings 22 and 23 communicate with each other the width at the outlet point 24 is slightly greater than the diameter of the neck portion 18, so that the carrier can be transferred from a driving position, as shown in the drawings, to a releasing position by moving it downwardly on to the neck portion 18 and then sliding it laterally.

The cutter member 14 is of course released by withdrawing the carrier 15 axially over the head 20 after re-

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removal of the shear plate 10 by sliding the skirt 4 thereof off the end of the shaver body.

Normally, however, the cutter member is retained in the driving position as illustrated by a coiled compression spring 25 engaging at its upper end with the underside of the carrier 15, and having its lower end coil or coils 25a retained frictionally by engagement with the sides of the groove afforded between an upwardly extending flange 6b and the central body portion of a guide bushing 6. A further flange or skirt 6a extends radially outwardly and somewhat downwardly from the lower end of the guide bushing to overlie the bearing housing of the spindle 17 and prevent or reduce the possibility of shaved material present in the chamber from finding its way into the bearing and the interior of the motor itself.

Referring now more particularly to the blade element 16, any number of these may be provided to traverse an annular cutting zone at the inner face 13 of the shear plate, and in the typical arrangement illustrated two such blade elements are mounted on the carrier member at diametrically opposed positions.

Each of these blade elements 16 is cup-shaped and specifically is depicted as being in the form of a frusto-conical shell having an aperture 16a at the smaller base thereof.

It will be understood that various alternate forms of cup-shaped blade element can be used within the scope of the invention. Thus the generatrix of the outer face of the cup-shaped blade element need not necessarily be a straight line but could be a line which is curved convexly or concavely or a composite line consisting of a plurality of sections of which one or some may be straight and one or some may be curved in either of the modes referred to.

In practice the preferred construction of blade element shown in FIGURE 3 includes a main portion 28 having an outer face 28b of which the generatrix is a straight line and the element has an apex angle such that the acute included angle between the generatrix and the plane of the shear plate is 25° or thereabouts. Immediately adjacent to the cutting edge 29 defined by the intersection of the outer face and the end face 27 of the blade element, the outer face has a portion 28a defined by a generatrix which is also in the form of a straight line but makes a steeper angle, preferably at 45° or thereabouts, than the generatrix of the main face portion 28b with the plane of the shear plate 10. The length of the generatrix defining the portion 28a is short relative to the length of the generatrix defining the main face portion 28b so that the portion 28a constitutes only a very narrow zone, the length of the generatrix defining the portion 28a being typically not greater than about 0.002 inch.

The advantage of the provision of the portion 28a is that effective cutting action is obtained and the cutting edge 29 maintains its sharpness for an extended period of service.

The edge face 27 may be plane, but preferably it is formed by lapping the blade element on a convex spherical abrasive surface of about 2 inch diameter for blade elements of which the diameter measured at the cutting edge is about 0.275 inch, this forms a sharp cutting edge 29.

It is contemplated that in most cases blade elements having outer faces 28b formed as simple surfaces of revolution i.e. of frusto-conical form will be employed, but as a possible alternative each cup-shaped blade element may be of elliptical form in a cross-sectional plane perpendicular to an axis 26 passing through the centre of the element and extending perpendicular to the shear plate 10, or may be of more complex form including, for example, local flutes or corrugations having their lengths extending along the outer faces. Moreover, the centre of gravity of each blade element of whatever form will normally lie on its axis 26, but it would be possible for the centre of gravity to be offset from this axis so that the blade element tends to take up a predetermined angular position rela-

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tively to the carrier member and the axis 26 in response to centrifugal force acting on the blade element during rotation of the spindle 17 and hence of the carrier member 15.

Each blade element may be made from a high carbon steel or an alloy steel capable of being hardened and tempered but is formed to cup-shape by a pressing operation from plain sheet material while the material is in softened or annealed condition.

The cup-shaped element thus formed may have a diameter at its larger end afforded by the inner boundary of its mouth 29a which is substantially greater than the height or dimension of the element measured along the axis 26.

This feature is of importance in ensuring the maintenance of stable contact between the blade element and the inner face 13 of the shear plate. Typically the height of the blade element may be about 1/5 of the diameter of the inner boundary 29a of the mouth.

The blade element may have a wall thickness of from about 0.003 inch to 0.005 inch, i.e. a wall thickness not substantially greater than the thickness of the shear plate.

Each blade element is supported from and connected to the carrier 15 by fastening means permitting a limited degree of rocking and floating movement of the blade elements 16 relatively to the carrier. By rocking movement is meant the ability of the blade element to tilt relative to the axis 26 in any direction relatively to the main position of the element as indicated in FIGURES 1 and 3. By floating movement is meant the ability of the blade element to move axially of the axis 26 to a limited extent relatively to the carrier 15.

The fastening means may comprise collars 30 which may be formed integrally with the carrier by locally deforming the material thereof as by a cold pressing operation to form the collar at the upper side of the carrier and a recess 31 at the lower side thereof. The tubular collar 30 freely extends through the aperture 16a of the blade element 16.

Through the bore of the collar 30 extends the shank 32 of a fastening element in the form of a rivet having upper and lower heads 33 and 34, the former being disposed within the interior of the blade element, and the latter being accommodated in the recess 31. The rivet heads may be a tight fit against the upper and lower faces of the carrier, the requisite clearance to provide for the limited rocking and floating movement of each blade element being provided by making the heights of the collars 30 greater than the corresponding dimension or wall thickness of the blade element 16 at the aperture 16a.

The positioning of the point of connection between each blade element and the carrier in closely spaced relation with the plane of the mouth of the blade element, as well as the form of mounting which permits the latter to have limited rocking and floating movement is advantageous in that it enables the blade elements to follow some deformation of the shear plate 10 from absolutely flat form which does occur in practice owing to the pressure exerted against the shear plate when this is placed in contact with the surface to be shaved, such as the user's face. A deflection in the central region of the shear plate of about 0.005 inch would be typical with some consequent deflection of that portion of the shear plate which constitutes the cutting zone.

Furthermore the spacing between the point of connection and the plane of the mouth which, as will be observed, is somewhat less than half the diameter of the blade element measured at the cutting edge minimises any tendency to instability, that is to say rocking of the blade element out of contact with the inner face of the shear plate at one or more positions along its periphery.

Good contact is thus maintained between the edge face 27 and the inner face 13 of the shear plate despite possible deflection of the shear plate and despite the

very low weight of the blade element, which latter factor permits it to be rotated at a fast rate for a given power input.

In turn this allows the pressure of contact between the two faces 13 and 27 to be kept low, thereby reducing frictional resistance and minimising the power necessary to achieve a given rate of movement between the blade element and shear plate.

Contact pressure between the blade elements and the shear plate is determined in the present construction by the strength of the spring 25, it being understood that in practice the edge faces 27 of the blade elements 16 will engage the inner face 13 of the shear plate before upward movement of the carrier 15 is limited by contact with the head 20.

The carrier itself, as depicted, has a pair of arms on each of which is mounted a blade element, but it will be understood that the carrier may be varied as required it being possible to adopt a single armed construction or a construction involving the use of more than two arms. When two or more arms are employed the blade elements need not necessarily be connected thereto at equal distances from the axis of rotation of the carrier. They could be disposed at different distances so that each sweeps out a cutting zone against the inner face of the shear plate individual to the blade element concerned, and these zones may either have their inner and outer boundaries disposed in co-incidence or may overlap with each other to some extent.

The blade elements may be imperforate or, alternatively, may incorporate one or more openings 36 disposed preferably at or near their inner or lower ends to allow shaved material which may collect in the interior of the blade element to pass out therefrom.

The inner faces 35 of the blade elements are, in the form shown, parallel to their outer faces 28b, that is to say the blade elements are of uniform wall thickness. This is not essential and the inner faces could be non-parallel with the outer faces and of different shape as viewed in cross section if desired.

Although openings 36 have been shown extending through the blade elements these may, if desired, be omitted without the interiors of the blade elements becoming clogged with material removed from the surface to be shaved. The dispersion of such material from the interior of the blade element is believed to be due to the fact that the material is disturbed by the changing forces acting upon it due to rotation of the blade element about its own axis, so that material is carried from the interior between the trailing portion of the edge face 27 and the inner face of the shear plate.

When the shaver is in use, it will be evident that one half of the total length of the cutting edge 29 will be in trailing relation with respect to the direction of relative sliding movement between the edge face 27 of the blade element and the inner face 13 of the shear plate, so that this part of the cutting edge will be continuously lapped to maintain its sharpness.

The leading halves of the edge face 27 and the portion 28a which meet to define the cutting edge 29 are at any given instant operative to produce cutting action whilst the trailing halves of this face and portion are inactive so far as cutting action is concerned but contribute to the stability of the blade element, that is to say the maintenance of the latter in sliding contact with the inner face of the shear plate.

Blade elements comprising cup-shaped shells are simple to manufacture and have a satisfactory degree of stability. Blade elements of this form are found to rotate during operation of the shaver about their own axes, so that each part of the cutting edge 29 is continuously moved from a position where it is active to perform the shaving operation, to a position where it is undergoing lapping, to restore any slight reduction in the sharpness resulting from its preceding period in an active cutting position.

This rotation of each blade element is believed to be due to the frictional turning couple exerted on the blade element by virtue of the smaller speed of relative movement which exists between the part of the edge face 27 situated radially inwardly of the axis 26, in comparison with that which obtains in respect of the outer part of the edge face 27 situated radially outwardly of the axis 26.

The continuous lapping which re-sharpens or produces sharpness of the cutting edge is a principal factor which allows the angle between the edge face 27 and the portion 28a to be reduced to a value which is very substantially less than that employed in blade elements of conventional form, and consequently hairs protruding through apertures of the shear plate tend to be cleanly cut and do not tend to be trapped between the edge face 27 and the inner face 13, or shredded at their outer ends to an extent which is noticeable in conventional shavers.

A further feature of the construction which materially contributes to obtaining proper clean cutting of the hairs and a close shave is the form of the apertures 37 formed in the shear plate 10.

In practice the contact pressure which exists between the outer face 11 of the shear plate and the face 12 of the user results in portions 12a of the latter entering the apertures 37. If the edge or boundary walls of the apertures 37 were of generally cylindrical shape perpendicular to the faces 11 and 13, in practice the part 12a of the user's face would be out of contact with these boundary or edge walls of each aperture, and the hairs such as 12b protruding therethrough may be situated at any position within the aperture.

In conventional constructions of shaver, engagement of hairs such as 12b by a cutting edge may or may not cut or shear the hair cleanly according to whether this happens to be or not to be close to the boundary wall of the aperture remote from the direction of approach of the cutting edge, and moreover there is inevitably some face-to-face engagement of the contact face of the blade element with the part of the user's face 12a which protrudes into or even somewhat through the aperture, but is unsupported by the boundary walls thereof. This frictional engagement tends to deflect the skin and hence the hair in a direction forwardly of the path of movement of the cutting edge, and consequently when the latter comes into contact with the hair it tends to cut it obliquely and in many cases shred it at its outer end.

These undesirable effects are to a large extent overcome in the present shaver by virtue of the extreme sharpness of the cutting edge of each blade element which is capable of severing a hair cleanly even though the hair is not supported directly by contact with a boundary wall of an aperture in the shear plate. However, the boundary walls of the apertures 37 in the shear plate preferably diverge in a direction from the inner face 13 towards the outer face 11 and this allows part of the user's face surrounding the hairs to be shaved to penetrate into the aperture whilst remaining in contact with the boundary walls thereof over an appreciable area local to the hair itself. Thus having regard to the extreme sharpness of the cutting edge 29 and the fact that a hair such as 12b will receive some support from the boundary walls of the aperture in the shear plate wherever the hair 12b may be situated within the aperture, clean cutting of the hair by the cutting edge is achieved with greater reliability than is the case with conventional shavers in which the sharpness of the cutting edge is generally much less and which effects a clean cut only when the hair happens to be positioned in contact with or immediately adjacent to that part of the boundary wall which is remote from the approach direction of the cutting edge.

Moreover the divergent boundary walls of the apertures 37 reduce local deflection of the skin and hence of the hairs 12b. The apertures may be made of smaller diameter at their inner ends or of equivalent smaller

cross-sectional dimensions if of non-circular form, than has hitherto been the case, there is thus less likelihood of any given hair 12b being situated remotely from that part of the boundary wall of the aperture on the side opposite that from which the cutting edge 29 approaches.

The boundary walls 38 of the apertures 37 may be of simple frusto-conical shape or may be of convex shape as viewed in a cross-sectional plane coincident with a reference axis passing through the centres of these apertures as may be desired.

The various features of construction above described permit the contact force or pressure existing between the edge face 27 of a blade element and the inner face 13 of the shear plate to be materially reduced in comparison to that employed in conventional shavers. This lengthens the service life of the blade elements and also reduces the power required to drive the carrier 15 and blade elements 16.

The efficiency of operation of the razor depends in part upon the contact pressure between the blade elements and the shear plate. One of the advantages of having thin-walled blade elements is that a high contact pressure will be obtained on the cutting edge with a small total thrust on the cutter member passing it against the shear plate. Thick-walled blade elements would be unsatisfactory since they would cause the razor motor to stall and would produce an extreme drain of current so that a larger battery would have to be provided and the razor as a whole would become larger and heavier.

The frictional resistance to movement of the blade elements over the inner face of the shear plate is dependent upon the total thrust on the cutter member and thus if the radial width of the edge face is kept to a minimum value, the total thrust can be reduced without producing the contact pressure below the minimum value required to obtain efficient hair cutting. It is essential to maintain the frictional resistance at as low a value as possible so as to give as long a life as possible to the batteries operating the shaver motor. Thick-walled blades encounter higher frictional resistance with two adverse results. The first adverse result is that the current drain on the battery is considerably greater than with thin-walled elements and the second adverse result is that the speed of movement of the blade elements is considerably less than with thin-walled elements so that the shaving performance is much poorer.

A further advantage of thin-walled blade elements is the comparatively small effect of centrifugal force. As the cutter member rotates, the centrifugal forces on the blade elements tend to tilt the blade elements to increase the contact pressure over the inner half of the edge face which is nearest to the axis of rotation of the cutter member and to relax the contact pressure over the outer half of the edge face. With thick-walled blades, this effect can predominate over spring means designed to provide the requisite contact pressure between the edge face and the shear plate which in turn will require greater spring pressure which will in turn produce greater frictional forces and reduced performance.

It is also desirable that the blade elements should rotate about their own axes and if the centrifugal forces are so great that separation occurs between the outer half of the edge face and the shear plate, rotation of the blade elements about their own axes will not occur. Thin-walled blade elements do not separate from the shear plate so that effective rotation of the blade element takes place.

A further factor of importance in the operation of the shaver is that the contact pressure between the blade elements and the shear plate must be carefully controlled to ensure the most effective shaving action. With thin-walled blades, it is immaterial whether the razor is held horizontally or vertically since the weight of the blade elements themselves are insignificant in relation to the spring pressure. If, however, thick-walled blade elements

are used, the weight of the elements can affect the contact pressure depending upon whether the shaver is held vertically or horizontally. The only way to overcome this is to incorporate a strong spring so that the weight of the blade elements is insignificant relative to the spring pressure. However, a spring sufficiently strong to do this with thick-walled blade elements will bring in its train the disadvantages mentioned above of high total thrust and high frictional resistance.

A still further advantage of using thin-walled blades is that by having a very thin edge face, it may remain in contact with the shear plate over the whole surface of the edge face even when the shear plate is deformed. Similar results could not be obtained by thick-walled blade elements.

I claim:

1. A shaver comprising a body, an electric drive motor therein, a battery chamber in said body for containing an electrical battery to operate said motor, a thin-walled apertured metal foil shear plate on said body, a rotatable spindle driven about its own axis by the motor, said axis extending generally perpendicularly to said shear plate, a blade carrier on said spindle, a plurality of cup-shaped blade elements having a wall thickness not substantially greater than the thickness of said shear plate, said blade elements being mounted at angularly spaced positions on said carrier and each spaced radially from said axis and having an edge face at one end facing the shear plate and an outer face meeting said edge face at an acute angle to define a cutting edge, each blade element also having an aperture at the other end thereof, a plurality of collars formed on the carrier and extending towards the shear plate, each collar being received with radial clearance in one of said apertures and the extension of the collar from the carrier towards the shear plate being greater than the wall thickness of the blade element at the aperture, whereby said blade elements are able to rotate about their own axes and to rock to at least some extent relatively to said carrier so as to follow any deflections of said shear plate, fastening elements retaining the blade elements on the collars, and means urging said carrier towards said shear plate to establish contact between said edge faces of said blade elements and said shear plate, rotation of the carrier causing said edge faces to follow annular paths extending generally perpendicular to said spindle axis.

2. A shaver comprising, in combination:

- (a) a body;
- (b) a thin walled shear plate mounted on said body;
 - (1) said shear plate having two substantially parallel faces,
 - (2) said faces of said shear plate being spaced from each other by the thickness of said shear plate,
 - (3) said shear plate being formed with a plurality of apertures therethrough between said faces thereof;
- (c) drive spindle means mounted on said body;
- (d) electric motor means for effecting continuous rotation of said spindle means about a fixed axis of rotation;
- (e) a thin-walled blade element mounted on said spindle means for free rotary movement about an axis spaced from said fixed axis,
 - (1) said fixed axis and said spaced axis extending in a common direction;
 - (2) said blade element having an edge face and an outer face, the latter said face being arcuate about said spaced axis and intersecting at an angle with said edge face to constitute a cutting edge said cutting edge being annular about said spaced axis;
 - (3) the wall thickness of said blade element being not substantially greater than the wall thickness of said shear plate;
- (f) fastening means securing said blade element to said

spindle means for said free rotary movement about said spaced axis and for rocking movement relative to said axis;
(g) means for limiting said rocking movement and forming part of said fastening means; and
(h) resilient means for urging said edge face and one face of said shear plate into movable abutting engagement.

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