

Nov. 30, 1943.

R. L. PENNEY

ROTARY HAIR CLIPPER

Filed Jan. 7, 1939

2,335,607

2 Sheets-Sheet 1

Fig. 1.

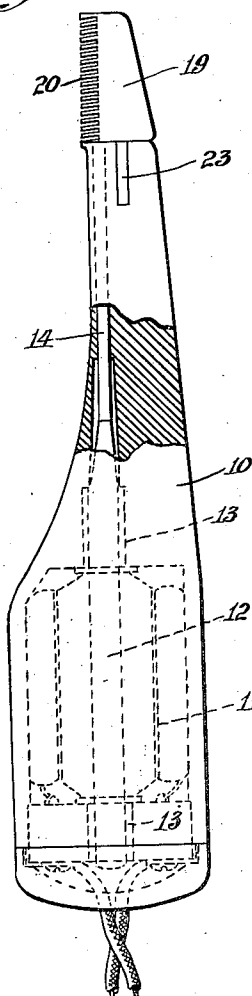


Fig. 3.

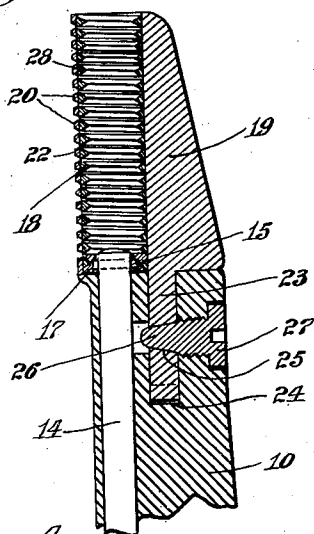


Fig. 2. $\frac{1}{3}$

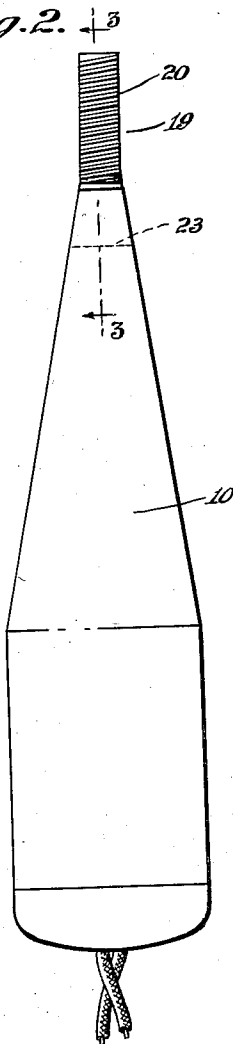


Fig. 4.

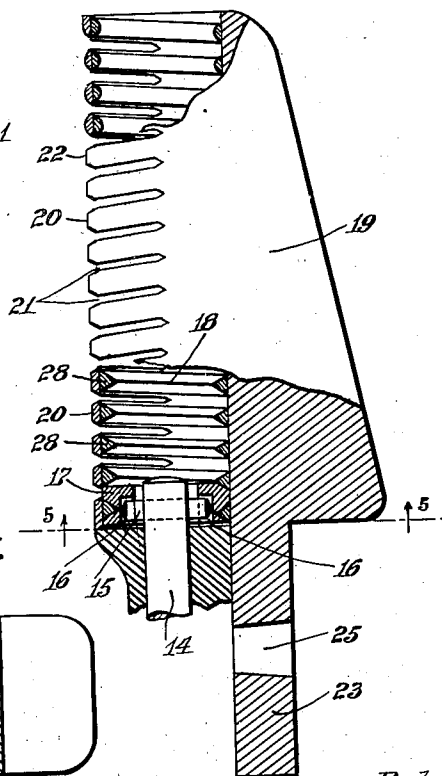
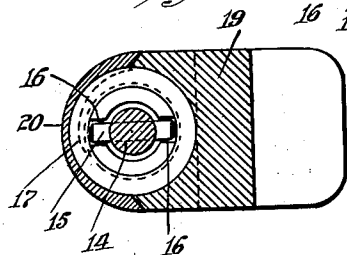


Fig. 5.



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2 Sheets-Sheet 2

Fig. 6.

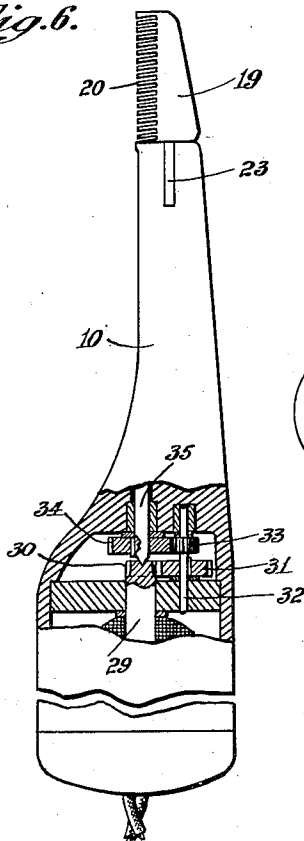


Fig. 9.

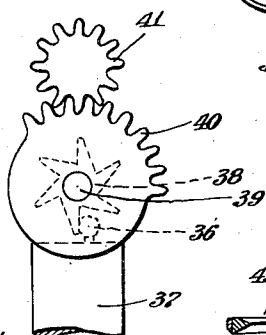


Fig. 7.

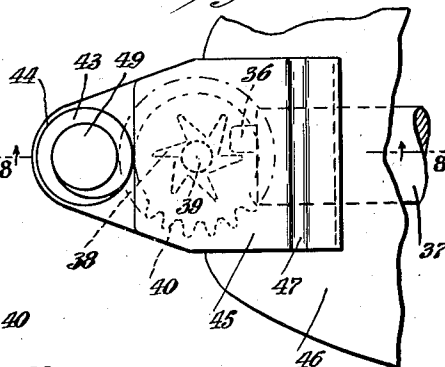


Fig. 8.

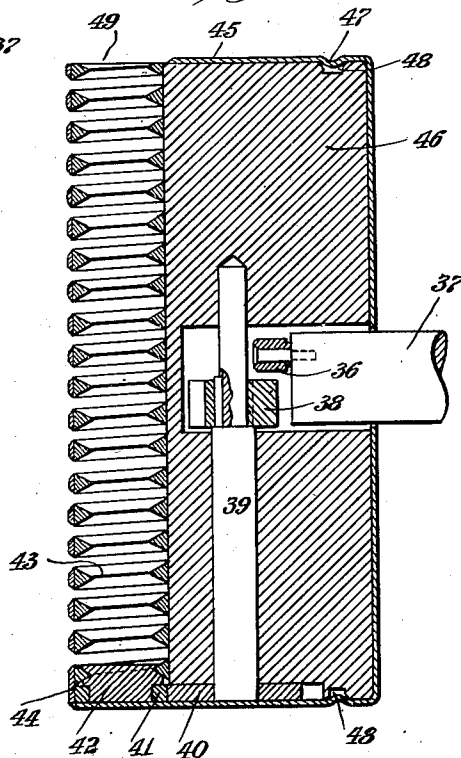


Fig. 10.

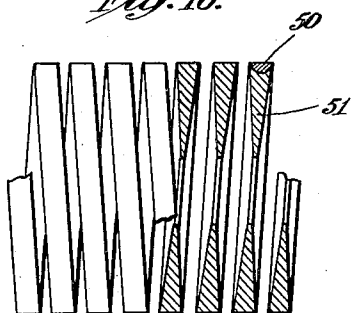
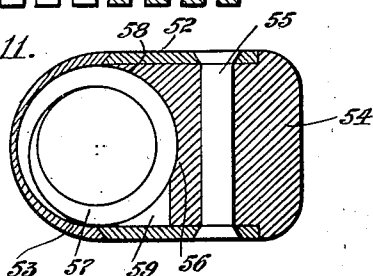


Fig. 11.



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2,335,607

ROTARY HAIR CLIPPER

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Application January 7, 1939, Serial No. 249,747

6 Claims. (Cl. 30—43)

This invention relates generally to improvements in hair clippers and particularly to power driven devices which are adapted to be used for shaving human hair.

The prior art relating to such devices, with which applicant is aware, shows two general classes of construction. In one class, a shearplate, having a longitudinal slot and cutting edge, cooperates with a rotating cutter embodying two or more blades approximately parallel to the shearplate slot. In the other general class, a shearplate, having a plurality of transverse slots for the admission of hair, cooperates with a reciprocating cutter containing slots which form teeth or blades which are coactive with the shearplate teeth to clip hair.

In all such previous constructions, the hair is caught and chopped off by and between these cooperating teeth, blades or other edges. While some certain constructions exhibit attempts to attain a shearing action, as differentiated from a chopping action, as by using a cutter having angled or spiral blades in one general class, or by either forming or setting over to a relative angle one or both sets of teeth in the other general class, the result in each case remains a mere chopping action and not a true shear. Basically, in each case, the hair is caught, squeezed and finally either broken or chopped off between these translated cutting edges or teeth, whether such edges are parallel to each other or relatively angled.

These various constructions are made practical and usable to some extent by the use of very thin and sharp cutting edges and by the use of very high velocities of the cutting edges. As an instance, all these previous devices employ a high number of feet per minute of the engaging blades or teeth which eliminates, to some degree, tangible evidence of the catching, squeezing and pulling action of these teeth on the hair. But if such constructions are made to operate at relatively slow speeds, there is much discomfort to the skin and the ragged pull of the chopping effect is readily apparent.

The principal object of this invention is to eliminate these adverse characteristics inherent in previous constructions by providing a hair clipper having a true shearing action.

Another object is to provide a hair clipper embodying this true shearing action and which will be simple, commercially practical and easy and inexpensive to manufacture.

A further object is to provide a hair clipper of this character that is non-clogging and self-cleaning.

A still further object is to provide such a hair clipper that is light in weight and compact in structure.

Another object is to provide a hair cutter which will not jam if bent or curved.

In the present construction, a cutter tooth moves across and through a hair in one direction while simultaneously this same cutter tooth moves across and through the same hair in a direction at right angles to the first direction so that, assuming the edge of the cutter tooth to be divided and marked off into tenths of its length, and a cross section of the hair to be divided and marked off in tenths along its diameter in a direction at right angles to the cutting edge, then the first tenth of the cutting edge will cut the first tenth of the diameter of the hair, the second tenth of the cutting edge will cut the second tenth of the hair, etc. From this it will be seen that, if the cutting edge and the hair were to be marked off into an infinite number of equal divisions, no single point of the edge will cut more than one single line of the hair. This action constitutes a true shearing cut, similar in principle to the large rotating disc and tubular knives used in the paper industry, the cork industry, etc., in which a very long cutting edge enters and divides a relatively small thickness area of work in each revolution, the cutting edge moving at right angles to the direction of feed and the dimensions of the knife and the work being of such proportion that, even though the work is cut through in less than one revolution of the knife, the length of knife edge which passes through the work is many times greater than the thickness or the diameter of the work. Such a method of cutting produces a very smooth and straight surface of cut area with a minimum of tool pressure to the work and therefore a low shearing stress, so that the work is not displaced or distorted or, in the instance of a hair, is not bent, squeezed or pulled while being cut. A simple analogy, which demonstrates the essential difference between a chopping and a shearing cut, is shown by the operation of slicing a loaf of bread, using an ordinary hand knife. Even though the knife be very sharp, if it is merely pressed straight through the bread, which with speed would constitute a chopping action, it will be found that much force is required to cut a slice. The bread being, like hair, flexible and elastic, it is displaced and distorted before and during the cut. And if the surface of a slice cut in this manner is examined, it will be found to be very rough, torn and uneven. It will also be noted that there is no discernible

difference in the ease of cut or in the quality of cut if the knife is held at an angle to the bread or if a curved knife is used. But if, with the same knife and the same bread, the knife is drawn back and forth over the bread at right angles to the direction of cutting force or feed, it will be found to require relatively little cutting pressure, the loaf will not be bent or squeezed while being cut and the cut surface will be smooth and straight.

In the preferred constructions shown in the drawings, there is but a single moving part and this part is directly coupled to the shaft of the source of power.

Referring to the drawings,

Fig. 1 is a side elevation of my improved razor, showing one method of drive by a small electric motor contained in the handle, parts being shown in section.

Fig. 2 is a front elevation.

Fig. 3 is an enlarged longitudinal section of the upper half of Fig. 2 taken along the plane of the line 3—3.

Fig. 4 is a greatly enlarged elevation of the shear plate and the cutter, partly in section.

Fig. 5 is a cross section of Fig. 4 on the plane of the line 5—5.

Fig. 6 is a view similar to Fig. 1 but partly in section to illustrate the use of a geared motor.

Fig. 7 is an enlarged end view of a modification of my invention.

Fig. 8 is a cross section of Fig. 7 taken along the plane of the line 8—8.

Fig. 9 is a diagrammatical plan view showing an alternate method of drive for the modification shown in Figs. 7 and 8.

Fig. 10 is a greatly enlarged fragmentary view, partly in cross section, of a modified form of cutter.

Fig. 11 is an enlarged cross sectional view of a cutting assembly illustrating a modified shear-plate construction.

The preferred form of construction, as shown in Figs. 1-5, comprises a housing 10, the bottom tubular section of which encloses a small electric motor 11 having a rotor shaft 12 which is suspended in suitable bearings 13 contained in the housing 10. The shaft 12 includes an extension 14, the upper end of which includes a cross pin 15 which cooperates with diametrically opposite slots 16 in the lower portion of the cutter plate 17.

The cutter 18 is in the form of a helical compression spring wound with triangular wire. The cutter plate 17 is externally threaded to receive the first turn of the wire of the cutter 18 which is silver soldered or otherwise permanently fastened, as can most clearly be seen in Fig. 4. The cutter 18 is contained in the housing 19 which is offset bored to leave a thin front wall which forms the shearplate 20, as shown in Figs. 3, 4 and 5.

The shearplate 20 has helical semi-circular slots 21, cut in screw-thread form to make the teeth 22 of the same pitch and lead as the turns of the wire of the cutter 18. In the drawings, for the sake of simplicity, these slots and teeth are shown as straight, but in greater detail they actually would appear helical in elevation, as a screw-thread or as a worm, as regards both the cutting helix and the shearplate. The shearplate 20 and integral housing 19 have a depending lug 23 which is removably contained in the recess 24 of the motor housing 10. As shown in Fig. 3, this lug 23 has a tapered hole 25 which

receives the tapered portion 25 of the screw 27 threaded into the motor housing 10 in such manner that the screw 27 retains the housing 19 from movement in any direction and also tends to keep this housing 19 securely seated flush on the top surface of the motor housing 10.

As is best illustrated in the lower cross section of Fig. 4, the teeth 22 are so cut or ground as to be isosceles trapezoids in cross section so that, when cooperating with the cutter teeth 23 formed by the triangular wire of the cutter 18, the co-acting edges of both shearplate and cutter teeth have back bevels or rakes which tend to facilitate the cutting action. One or both of these sets of teeth 22 and 23 may alternately be half-round or semi-circular in cross section, as shown in the upper cross section of Fig. 4. In this case, the cutter is first wound of ordinary round music wire and this round wire is ground on a threaded arbor to half its diameter or less, to form in effect a backed-off cutting edge.

It will be noted that the cutter is not spring-pressed to the shearplate in the conventional manner used in previous devices in the art, as by means of separate coil or leaf springs. Instead, the outside diameter of the cutter is ground to such dimension as to be a press fit in the bore of the shearplate, in the manner of a coil-spring over-running clutch or a coil load-brake. As an instance, if the bore of the shearplate be $\frac{1}{4}$ " exact and the cutter be ground to .251", it will be found that the cutter will enter the bore of the shearplate only by turning it in a direction opposite to the hand in which it is wound, due to the fact that as a helical spring is loaded in torsion its coil diameter decreases so that the act of assembling the cutter spring in its bore stores up torque in this cutter, the compression-wound spring now acting as a torsion spring having frictional arms.

When in place in the shearplate, the cutter will be inherently spring-pressed due to loaded torsion, and will always tend to expand its diameter and therefore will hug the bore of the shearplate and will be resiliently urged against the teeth of the shearplate without any additional spring means. By varying the diameter of the cutter, and so increasing or decreasing the torsional load at assembly, any desired spring pressure may be provided between the teeth of the cutter and the teeth of the shearplate. This spring pressure is necessary to maintain the co-acting teeth 22 and 23 in proper shearing contact and also to compensate for wear on these teeth. Because this method is here used, although the cutter 18 is not held from axial movement by the coupling 15-16, no mechanical stop or abutment is necessary at the top or open end of the bore to retain the cutter in position in the bore as it will always tend to move down against the cutter plate 17 which acts as a thrust bearing on the housing 10. This is accomplished by having the motor rotate to the left if the cutter is wound to the right and vice versa, when the torsion loaded in the cutter will spring-press the turns of the cutter against the bore of the shearplate and the frictional contact of these parts will cause a screw-in-a-nut effect, the cutter always tending to unscrew itself from the shearplate bore in a downward direction thereby causing an end thrust downwardly.

Because of this combination of automatic spring pressure in a bore having no openings, recesses or clearances other than the slots 21 and of a cutter having a winding hand opposite to the

direction of drive, this device is self-cleaning to a great degree. A cut hair falling into the bore is immediately picked up and carried to the top or open end of the bore by the spiral-conveyor action of the cutter. It will be found that a great majority of the cut hairs will fall on the surface of the bore between adjacent turns of the cutter and will be carried by the cutter teeth along the bore to its open end in the manner of a screw conveyor or as chips are carried up from a hole by the spiral flutes of a twist drill.

Also, since there is no clearance whatsoever between the cutter and the shearplate, this device is absolutely non-clogging. It is unlike previous constructions in that a few hairs cannot become lodged between the walls of the cutter and the walls of the shearplate and having a wedging and frictional effect which would retard the speed of the motor, make it run hot or perhaps stall it and burn it out, due to the overload imparted by this friction.

While the present construction shows a removable head, these parts are made quickly detachable primarily for sanitary reasons and not for the removal of clogged hair. Should the user wish to sterilize the head, by boiling or otherwise, screw 27 is removed, when the head 17-18-19 as a unit may be removed from the recess 24. This unit can then be sterilized as it is; it need never be disassembled for either sterilizing or cleaning. The ease with which the head can be removed from the motor and the fact that the head need not be taken apart is of especial merit for surgical use or for common use by a number of persons where it might be necessary to clean or sterilize the head frequently.

In operation, the motor 11 turns the rotor shaft 12 and the extension shaft 14 which is rotatably loose-coupled by means of the pin 15 and slot 16 to rotate the cutter plate 17 and the cutter 18 journaled in the bore of the shearplate 20. As the cutter 18 rotates, the teeth 28 of the cutter will have a relatively upward movement in the bore past and over the slots 21 and teeth 22 of the shearplate. For a period of time during each revolution of the cutter 18, the teeth 28 will be parallel to and aligned with the teeth 22 of the shearplate so that the spaces between the teeth 28 will coincide with the slots 21 of the shearplate 20, allowing a hair to enter and extend into the bore of the shearplate between adjacent turns of the cutter winding or adjacent teeth 28. As the cutter 18 continues its rotational movement, the teeth 28 will move over and across the slots 21 and across and through the hairs in these slots, clipping said hairs with a true shearing action. Assuming a certain construction of this type having 32 pitch teeth and $\frac{1}{4}$ " bore and assuming a hair .003" thick, then a length of cutting edge more than 20 times the diameter of the hair will move through and shear the hair.

Because a true shear is attained in the present construction, high speed driving means are not necessary for satisfactory operation, the nature of the cut being such that no appreciable difference is noted in the use or operation of this device whether the cutter is rotated at high or relatively low speeds. This being so, a smaller, lighter and cheaper motor may be used to drive the cutter, the necessary torque being attained by reduction gearing as shown in Fig. 6, where the rotor shaft 29 includes a pinion 30 which meshes with a gear 31 keyed to a countershaft 32. This shaft includes the integral pinion 33 which meshes with a gear 34 keyed to the cutter shaft 35, so that

a plurality of revolutions of the motor will rotate the cutter one revolution only, reducing the speed of rotation but increasing the torque of the drive. In a motor housing of normal size, intended to be held in the hand, small, simple gearing may be used to effect a considerable reduction, making possible the elimination of a costly motor and lessening the weight of the device, both of these features being necessary for the commercial success of an apparatus of this type.

Figs. 7 and 8 illustrate a modified form of this invention showing how this device may be adapted to various constructions. In this form, the conventional eccentric roller 36, set in the motor shaft 37, cooperates with a toothed wheel 38 which acts as a circular ratchet, turning the shaft 39 and gear 40. This gear 40 meshes with the stub pinion 41 integral with the cutter plate 42. The cutter 43 is restrained from movement in the bore 44, due to inherent end thrust, by the spring plate 45 which snaps on the shearplate housing 46, being held and positioned by the heads 47 and channels 48 and completely enclosing the thrust end and bottom of the housing 46 but leaving the top of the opposite end open so that the open end 49 of the cutter is clear, allowing cut hairs to fall out of this end.

In operation, the motor turns the shaft 37 and eccentric 36 which moves the ratchet 38 that part of a revolution directly proportionate to the number of teeth in said ratchet, in this construction, $\frac{1}{6}$ of a revolution. Movement of wheel 38 rotates shaft 39 and gear 40 thereby rotating pinion 41, plate 42 and cutter 43. Like the modification shown in Fig. 6 using a geared motor, this construction may also be used with a high ratio of motor revolutions to cutter revolutions so that a smaller and less powerful motor may be used without affecting the efficient operation of this device.

In the construction shown in Figs. 7 and 8, there is a six to one reduction from the shaft 37 to shaft 39 and an interrupted drive to the cutter 43 so as to lengthen the period of time in which the spaces between the teeth of the shearplate and the teeth of the cutter are matched and aligned to permit hair to enter the head. As is shown diagrammatically in Fig. 9, this is accomplished by having the gear 40 so made that for a part of its circumference teeth are cut away. Then, for a part of each revolution of the gear 40, no motion will be imparted to the gear 41. Assuming gear 40 to be twice the pitch diameter of gear 41, then, though these gears each have the same number of teeth of equal circular pitch, it will be seen that, although one revolution of gear 40 will turn gear 41 one full revolution, this revolution will take place in the same time that gear 40 completes one-half of its revolution. During the other half of this revolution of gear 40, gear 41 will be motionless as these gears will then be out of mesh. Assuming further that gear 40 turns one revolution in $\frac{1}{2}$ second, then gear 41 will turn one revolution in $\frac{1}{4}$ second and will be at rest for $\frac{1}{4}$ second. If the cutter 43 and its gear 41 are assembled in the bore of the shearplate and meshed with gear 40 in such a manner that the motionless period of gear 41 coincides with the alignment of the spaces between the teeth of the cutter and the teeth of the shearplate, then, when these teeth are positioned as shown in Fig. 8, there will be a time-lag of $\frac{1}{4}$ of a second when there will be no movement of the cutter 43 and the cutting head will then be conditioned to most easily admit hair in the spaces.

This same method of facilitating entry of hair to the cutting head may be applied to the construction shown in Fig. 6 by so arranging the gearing that the gear 33 is of greater pitch diameter than its driven gear 34 and by then cutting away part of the teeth of the gear 33. An alternate method which may be used in this construction is to decrease the speed of the cutter at its hair-entering period instead of stopping it altogether. This may be accomplished by the use of elliptical gearing in a suitable gear train, a method well known in the art and not illustrated here. By such an arrangement, the cutter speed during the hair-entering period may be considerably reduced relative to the speed of the cutter for the remainder of its revolution.

It will be understood that the teeth and slots of the shearplate and the teeth and spaces of the cutter are shown exaggerated in width in the various drawings for the sake of clarity. In practice, the cutter is wound to such a number of turns-per-inch relative to its outside diameter as to have a comparatively short lead or low pitch and therefore a small helix angle. As an instance, if the major diameter of the cutter were to be $\frac{1}{4}$ ", it would preferably be wound to some number of turns-per-inch greater than 20 which would produce a helix angle only a few degrees from a perpendicular to the axis of the cutter, a desired condition. Since this device should be easily usable with either right or left hand and on either side of the face, a preferred helix angle would be less than 3 degrees. To exaggerate, if the helix angle were to be 30 degrees, the user would be forced to hold this device in an awkward manner in order to shave one side of his face. The upper limit for a cutter of this diameter would be approximately 40 turns-per-inch when the wire size would necessarily have to be so small that the cutter would be mechanically weak, would not be self-supporting and would not have the required torsion for self-tensioning in the bore of the shearplate.

For either the equilateral triangular or the half-round wire used in such a cutter, as shown in Figs. 1 to 8, the smaller the outside diameter of the cutter and the greater the number of turns-per-inch, the smaller must be the wire size. To overcome this limitation of a cross-sectional wire size which varies directly as the diameter of the cutter and inversely as the number of turns-per-inch, a cutter could be wound with ribbon wire which is either a rectangle or a modified keystone in cross section, as shown in Fig. 10. This ribbon wire would be edge-wound in a push type mandrelless forming machine so that the inner edges of each turn would tend to overlap the opposite inner edges. By this method, a cutter could be made with the desired combination of small outside diameter and relatively large number of turns-per-inch without reducing the cross-sectional size of the wire and thereby decreasing the torsion necessary for the proper spring-pressed effect between the cutter and the shearplate. This is made possible by the unique screw-conveyor action inherent in the cutter. The turns of the edge-wound wire could be so wound as to leave a very small hole through the cutter or none at all, as the deeper the teeth or turns of the ribbon wire, the greater will be the screw-conveyor action. Applicant has determined by experiment that the depth of a turn of the ribbon wire may be nearly half the outside diameter of the cutter with no tendency of the cut hairs to clog the cutter as

the spiral conveyor effect substitutes for and offsets the relatively large air space or hole through the cutter as when made with triangular or half-round wire. In a certain construction with a small outside diameter and a large number of turns-per-inch, both limiting the thickness of the wire as measured along the axis of the cutter, three or more times greater cross-sectional area of wire may be gained by the use of ribbon wire instead of half-round wire, as can be seen in Fig. 10 where a half-round cross section of wire 50 is shown superimposed on a keystone cross section of ribbon wire 51, both wires having the same dimension as measured parallel to the axis of the cutter.

Many variations in construction are possible using the principles involved in this invention. One instance would be the use of a shearplate having teeth of twice the lead of its coacting cutter, as a 32 pitch shearplate in conjunction with a 16 pitch cutter, so that at each revolution of the cutter, one cutter tooth would pass over and coast with two shearplate teeth, doubling the shearing speed and allowing free access of hair to any certain shearplate slot for the time required for one-half of each revolution. While this method provides the apparent equivalent of the interrupted drive heretofore described, the operation in this instance would not be identical to the interrupted drive due to the different helix angles of the teeth of the shearplate and the cutter in this instance, as these teeth are here of different leads. In other words, the coacting tooth edges would not be parallel, so that one end of a shearplate slot would be open while the other end would be closed by the cutter tooth under it, defining an angle between the two cooperating teeth which might catch and pull a hair in the open end of the slot by an external wedging action.

Another instance of a variation in construction would be the use of a cutter with twin turns, similar to a two-thread worm.

Another variation is shown in Fig. 11, which is a cross sectional view similar to Fig. 5, but where the shearplate is composed of a thin sheet 52 having teeth cut at 53 and then bent into a half-round and fastened to the block 54 as by the rivets 55. This block 54 has a segment of arc ground out at 56 to accommodate the cutter 57. If this arc 56 is cut deep enough to form a semi-circle and so meet and blend with the semi-circle formed by the shearplate 52, as shown at 58, then this construction produces the equivalent of that shown in Figs. 4 and 5 except that the shearplate 52 and housing 54 are here made of two assembled pieces while in Figs. 4 and 5, the corresponding parts 19 and 20 are integral. But if the arc 56 is ground less deep, for example to only 60 degrees, so as to leave a space 59, then, while it is obvious that the screw-conveyor action described in the preferred construction is nearly totally eliminated, the area of frictional surface contact between the cutter and the shearplate may be reduced one-third or more so as to decrease the amount of power necessary to drive the cutter while still not affecting the spring pressure between the cutter and the shearplate. Also, in this construction, the block 54 could be made of oil-bearing bronze or other similar anti-friction material so as to further decrease the frictional load and, in addition, to apply a film of oil between the teeth of the cutter and the teeth of the shearplate without danger of any oil getting on the sides

or bottoms of the cutter teeth, which oil would tend to make cut hairs cling to these teeth and so clog the cutter.

Another variation would be to wind ribbon wire on a small threaded shaft but it is obvious that such a modification necessitates the use of an external spring pressure on the cutter as by means of a spring-pressed roller contacting the side of the cutter opposite the shearplate teeth. To be practical, the cutter in this modification would have to be made larger in diameter than the small cutter it is possible to use in the preferred constructions shown in the drawings because the shaft used must necessarily fill some of the air space which is part of the cutter diameter in the preferred variations, leaving only the radial space between the diameter of the shaft and the diameter of the cutter. If the cutter used in this modification were to be made as small in diameter as a cutter practical for use in the preferred constructions, cut hairs might clog these small spaces as the addition of the central shaft tends to pocket the cut hairs.

Many other variations, based on the principles disclosed herein, can be constructed without departing from the scope of the appended claims.

The cutter spring being resilient can be bent or curved and therefore can rotate in the casing even if the casing is bent or curved. It is therefore possible in fact to employ a shear-plate casing which is curved longitudinally of the axis, its cross-section of course being circular and the torsional cutter rotating smoothly in the curved chamber or recess of the casing.

I claim:

1. A hair cutter comprising a handle member, a carrier detachably connected to the handle member and having an elongated cylindrical recess one wall of which has a plurality of narrow screw-thread-shaped slots, the metal between the slots constituting screw-thread-shaped cutter bars, a hollow continuous helical cutter member in said recess and the helices thereof having a pitch corresponding with the pitch of the cutter bars and rotatable in a direction to contract said cutter member, said cutter member being free to expand longitudinally and open at one end.

2. A razor comprising a shearplate having a cylindrical bore with a continuous wall except for a plurality of screw-thread-shaped slots across

a portion of the wall and a longitudinally expandible and rotatable helical cutter torsionally spring-pressed fitted in the bore.

3. A shaving device comprising a one-piece cylindrical shearplate having a tubular bore with teeth in screw-thread form through part of the wall of the shear plate and a rotatable helical cutter self-supported in the bore and fitted therein under torsional stress and having teeth corresponding to the teeth of the bore said cutter being rotatable in a direction tending to reduce its diameter.

4. An electric hair cutter including a shearplate having a recess with the wall thereof provided with teeth and slots in screw thread formation, a continuous helical cutter member in said recess having the pitch of its helices and slots corresponding with the pitch of the teeth and slots of the shearplate; said cutter member having one free end and being driven in a direction tending to contract the helices thereof, said cutter member being fitted in said recess under radial torsional stresses tending to expand the helices of said cutter against the interior walls of the recess, said contractive and said expansive tendencies thereby opposing one another when said cutter member is rotated.

5. An automatic hair cutter comprising a casing having a cylindrical bore with slots and teeth in helical form, a resilient, bendable helical cutter of normally greater diameter than the interior of the bore, compressed radially within the bore and means for rotating said cutter in a direction to reduce its diameter while in the bore of the casing and to force the cutter endwise into said bore.

6. In a razor of the rotary cutter type, a rotary cutter shaped as a helical spring, a shearplate constituting part of the wall of a substantially cylindrical well for housing said cutter spring, said cutter spring being wound so that its diameter when no external force is acting thereupon is slightly greater than the interior diameter of said cylindrical well, said cutter being rotatable within said cylindrical well by means coupled to one end of said cutter spring and rotating it in a direction tending to wind said spring tighter, whereby rotation of said cutter tends to decrease the effective diameter thereof.

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