This invention relates to rotary cutters and is herein illustrated as embodied in a toothed cutter having certain novel features that render it superior, for some purposes, to cutters hereuntofore designed to generate outcurved surfaces. An example of work in which cutters of the type herein illustrated have demonstrated their superiority is the so-called "spooling" of wood heels, although it is apparent that cutters of this type are equally capable of generating other outcurved surfaces which may be on work-pieces other than wood heels. Nevertheless, the invention is hereinafter set forth with reference to its operation in the manufacture of wood heels known as "spooling."

A spooling operation, as performed on some types of high heels intended for women's shoes, consists in rounding the two edges previously formed at the junctions of the breast and the sides of a heel. Not all high wood heels are spooled, and so it is the practice to shape them all, in the first instance, so that they will have sharply defined edges at the junctions above mentioned. Those to be spooled are subsequently rounded as described, the rounded surfaces, of course, being outcurved. The spooling operation is commonly performed by a special machine having two spooling cutters spaced apart to receive a heel between them. The cutters, in one well-known type of spooling machine, are mounted respectively on shafts that rotate in opposite directions about separate axes. Heretofore, it has been considered necessary to use "form cutters," that is, cutters having incurved profiles and cutting edges constituting counterparts of the outcurved surfaces to be generated thereby. Cutters of that type involve manufacturing difficulties with respect to backing off the teeth to provide cutting clearance, and with respect to sharpening the teeth so accurately as to insure equal depth of penetration by all the teeth. Moreover, since the front faces of the teeth are the ones that require to be ground when sharpening the cutting edges, the teeth grow thin and lose strength in consequence of considerable grinding. This effect is aggravated by the necessity of grinding the "high teeth" more than the others to take them down so that the cutting burden will be borne equally by all the teeth.

Consequently, to avoid these objectionable causes and effects, an object of the present invention is to provide an improved cutter adapted to generate outcurved surfaces whether for heel-spooling or for other purposes.

To this end and in accordance with a feature of the invention, the illustrated rotary cutter is provided with skewed peripheral cutting teeth arranged in a circular series concentric with the axis of rotation, each of the teeth having top rake and a straight peripheral cutting edge of which one end is circumferentially ahead of the other, whereby the effective profile of the cutter is rendered equivalent to that of an incurved form cutter. In a cutter of this type no cutting edge lies in any plane in which the axis of rotation lies. As herein illustrated, the teeth of the cutter are of a form or profile that permits economy of manufacture, all of the milled faces being flat and capable of being generated in a number of steps equal to the number of teeth in the cutter. Moreover, the circumferential skewing of the cutting edges not only insures smooth cutting but also avoids breaking out splinters as the teeth leave a work-piece, since each individual cut gradually diminishes in length to a single point before any cutting edge leaves contact with the work-piece.

Referring to the drawing, Fig. 1 represents an elevation of the front end of a cutter embodying the present invention; Fig. 2 represents a schematic side elevation of such a cutter partly screened by a wood heel in a position to be spooled thereby; Fig. 3 is an elevation of the rear end of the cutter; Fig. 4 is a front elevation of a portion of the cutter including only one tooth thereof about to take a shaving from a wood heel; Fig. 5 is a view similar to Fig. 4 except that the trailing end of the tooth has been advanced to the position of the leading end of the tooth in Fig. 4; Fig. 6 is a schematic top-plan view corresponding to Fig. 4 with respect to the relation between the cutting edge of the tooth and the heel; Fig. 7 is a top-plan view partly in section corresponding to Fig. 5 with respect to the relation between the cutting edge and the heel; Fig. 8 is a top-plan view of the cutter in outline, the effective profile of the periphery being represented by broken lines; Fig. 9 is a perspective front and side view of the cutter; Fig. 10 is a perspective view of a wood heel in which broken lines represent one of the two portions to be trimmed off by what is known as a spooling operation; and Fig. 11 is a sectional view of the peripheral portions of three cutting disks in gang relation.

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ROTARY TOOTHE CUTTER

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6 Claims. (Cl. 12—47.1)
suitable for milling the teeth of a cutter embodying the present invention.

The illustrated cutter is provided with a cylindrical central bore 12, and with a plurality of uniform and integral peripheral teeth 14 arranged in a circular series concentric with the axis x of rotation. The bore 12 is intended to receive a shaft (not shown) to which the cutter will be affixed and by which it will be driven. Each tooth 14 is provided with a straight peripheral cutting edge 16 which, as shown best in Fig. 2, is oblique or skewed with respect to the axis of rotation whereby one end is placed circumferentially ahead of the other end, the intended direction of rotation being indicated by arrows in Figs. 1, 4, 5, 6 and 8 by the solid arrow in Fig. 2. The circumferential lead of one end of each cutting edge with respect to the other end thereof is represented by the distance a—b in Figs. 1, 2, and 4. The magnitude of this distance, the diameter of the cutter and the axial dimension of the cutter govern the degree of curvature of the surface to be generated by the cutting edges. For purposes of explanation, it will be sufficient to state that the distance a—b in the illustrated cutter is well suited to the requirement of a heel 18 of the type represented.

In Figs. 4 and 5, the axis of rotation of the cutter is represented by dots x, and the dotted lines 20 represent the circle in which the trailing ends of the cutting edges lie. In Fig. 5 a dot-and-dash line 22 represents the circle in which the leading ends of the cutting edges lie. Referring to Figs. 4 and 5, it is to be observed that the leading end of the cutting edge 16 is at the level of the axis x and that the top of the heel 18 is at the same level. It may also be observed that the leading end of the cutting edge 16 is approximately tangent to the left-hand side of the heel. When a cutter and a heel of the type herein represented are set up in a spooling machine, they will occupy the relation represented in Fig. 4 during the early stages of a spooling operation. This relation is otherwise represented in plan view in Fig. 6 wherein the cutting edge appears to be parallel to the axis x, though in reality its rear end is at the level of line b (Figs. 1, 2 and 4) while its forward end is at the level of line a. Now, assuming that the cutter is in rotation and that the tooth 14 represented in Fig. 4 moves downwardly from the position represented in that figure to the position represented in Fig. 5, the cutting edge 16 will penetrate the heel 18 and at the same time it will be increased in size. The cutting face represented in Figs. 8 and 9, in which is shown a part of the corresponding area, at the opposite side of the heel will be simultaneously trimmed off by a mated cutter of similar characteristics in which the skewing of the cutting edges is oppositely pitched and as to which the direction of rotation is counterclockwise.

Although the cutting edges 16 are all straight their skew relation to the axis x whereby one end of each is placed circumferentially ahead of the other has the effect when the cutter is rotating of giving the periphery of the cutter an incurved profile as represented by dotted lines 26 in Fig. 8. This curvature of the effective profile is not apparent when the cutter is stationary (see Fig. 2) but is apparent when it is in rotation. Thus, the curvature of the generated surface 24 of the heel will be counterparallel to the curvature of the effective profiles 26 of the cutters.

The above-described skewed relation of the cutting edges 16 has the additional advantage of removing chips from wood heels without splitting or roughing the wood. In the manufacture of wood heels, it is a common practice, if not a universal practice, to arrange the fibres of the wood so that they will extend from the breasts to the backs. This being so, it is apparent that the described obliquity of the cutting edges 16 is most favorable to spooling heels without splitting the wood, since each cutting edge in the general direction of the length of the wood fibres but with a component of progress toward the longitudinal median plane of the heel. Moreover, the skew or obliquity of the cutting edges with respect to their direction of travel facilitates the cutting action so that each cutting edge enters and leaves the wood most favorably to the production of a smooth trimmed surface and most favorably to the avoidance of chipping or breaking out the wood at the points of emergence, since no two points in any cutting edge enter or emerge from the work-piece at the same time.

All the millings required to form the teeth of a cutter of the type herein shown may be performed with a milling cutter of the form illustrated in Fig. 11. For economy such a milling cutter may conveniently be made in three sections or disks 30, 32 and 34 clamped in gang relation on a common arbor. If, now, the form of this composite milling cutter be compared with the tooth at the top center of Fig. 9 it will be apparent that the disk 30 will generate the flat back face 36, the disk 34 will generate the flat front face 38 of one tooth and the flat back face 40 of the next ahead, and that the disk 32 will generate a flat outer face at the crown of the tooth. This flat face must be subsequently backed off to provide cutting clearance or relief, and may conveniently be altered incidentally to sharpening the tooth so as to provide, in the periphery 42 of a thin circular abrading disk (Fig. 3) arranged to rotate about an axis nearly if not exactly parallel to the edge being abraded. In Figures 1, 3, 4, 5 and 9 the backed-off faces 15 are represented as having incurred or concave profiles the curvature of which corresponds to the circumferential curvature of the abrading disk.

In grinding the faces 15 the cutter is secured in a holder (not shown) by which it is carried across the periphery of the abrading disk with a compound motion one component of which is rectilinear and parallel to the line in which the cutting edge 16 is to be generated, and the other component of such motion is angular motion about an axis that coincides with the said line. The latter component counteracts the circumferential skewing of the cutting edges to provide uniform cutting clearance or relief at all points along the cutting edges. See angle c in Figs. 4 and 5. In consequence of grinding the faces 15...
in the manner above described, these faces are twisted as represented in Figures 1, 4, 5 and 9.

This method of grinding and an apparatus for putting it into practice form the subject-matter of U. S. Letters Patent No. 1,933,581, granted Nov. 7, 1933 on my related application filed concurrently herewith.

Considering the profiles of the teeth, the front face 38 of each tooth is undercut to provide top rake. When, as shown, the front faces 38 are flat in addition to being skewed, the degree of rake or undercut is graduated, the maximum degree being at the trailing ends of the teeth, as represented by the angle \( d \) in Figures 3 and 5. This condition is most favorable to the avoidance of breaking out chips or splinters from wood heels, since the cutting angle of the teeth is thereby rendered most acute at the points last to leave contact with the work.

Having thus described my invention, what I claim as new and desire to secure by Letters Patent of the United States is:

1. A rotary cutter consisting of a single part provided with integral peripheral teeth skewed and arranged in a circular series concentric with the axis of rotation, each of said teeth having top rake and a straight peripheral cutting edge one end of which is circumferentially ahead of the other end.

2. A rotary cutter provided with skewed peripheral teeth arranged in a circular series concentric with the axis of rotation, said teeth having each an outer face and an undercut front face intersecting each other and forming a straight peripheral cutting edge of which one end is circumferentially ahead of the other.

3. A rotary cutter provided with skewed peripheral teeth arranged in a circular series concentric with the axis of rotation, said teeth having each a twisted outer face and an undercut front face intersecting each other and forming a straight peripheral cutting edge of which one end is circumferentially ahead of the other.

4. A rotary cutter provided with skewed peripheral teeth arranged in a circular series concentric with the axis of rotation, said teeth having each an outer face at an angle of clearance and a flat undercut front face intersecting each other and forming a straight peripheral cutting edge of which one end is circumferentially ahead of the other.

5. A rotary cutter provided with skewed peripheral teeth arranged in a circular series concentric with the axis of rotation, said teeth having each a flat front face of graduated rake and a twisted outer face intersecting each other and forming a straight peripheral cutting edge of which one end is circumferentially ahead of the other.

6. A rotary cutter provided with integral peripheral teeth skewed and arranged in a circular series concentric with the axis of rotation, said teeth having each a straight peripheral cutting edge of which one end is circumferentially ahead of the other and having also a greater degree of top rake at its trailing end than at its leading end.

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