June 19, 1945. J. L. HUTCHINGS 2,378,481

METHODS AND DEVICES FOR SHREDDING MATERIALS

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FIG. 1.

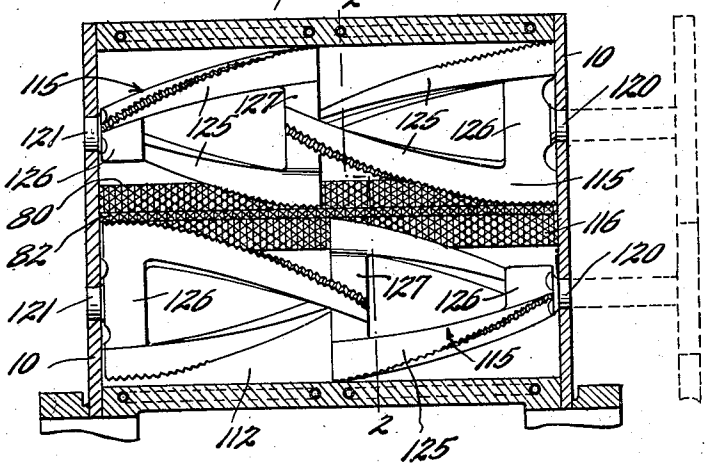
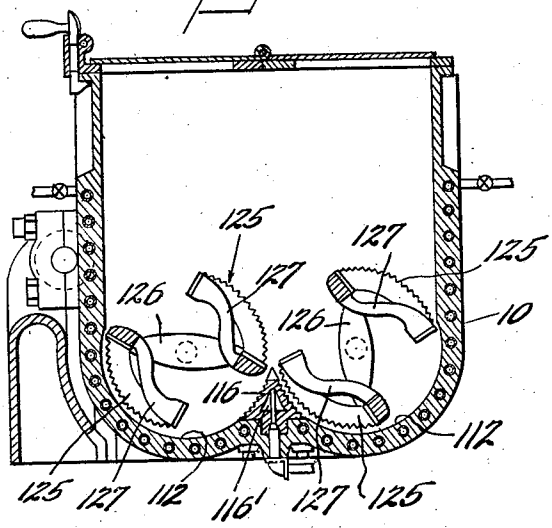


FIG. 2.



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FIG. 3.

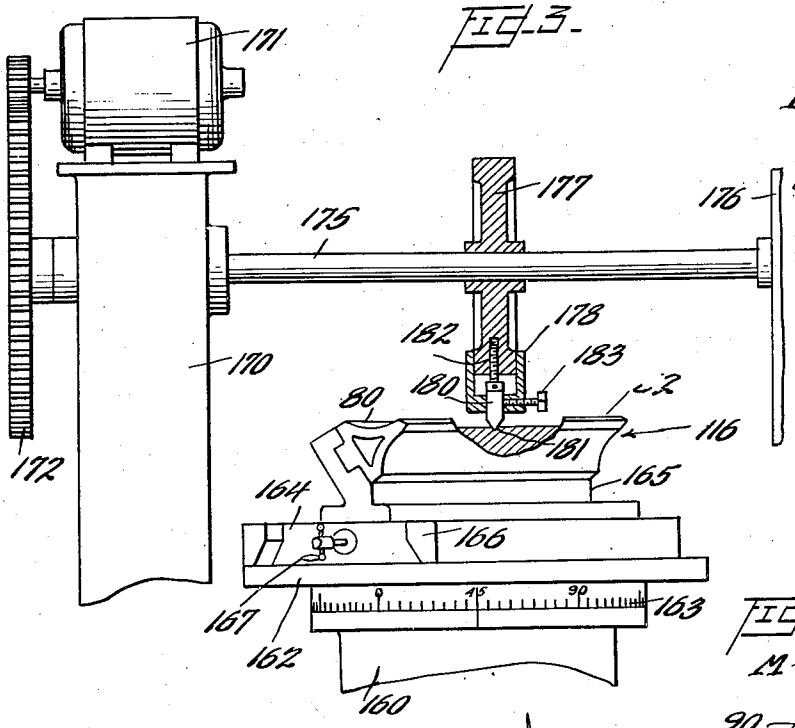


FIG. 8.

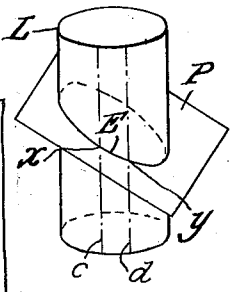


FIG. 6.

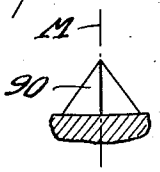


FIG. 7.

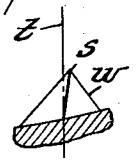


FIG. 4.

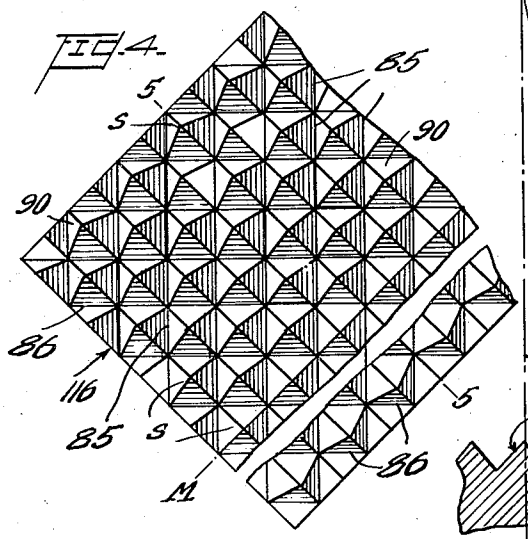


FIG. 5.

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FIG. 9.

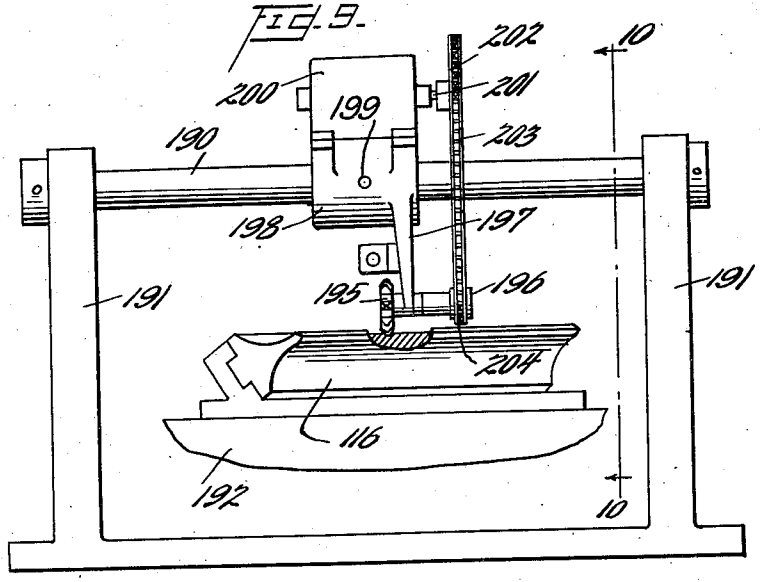
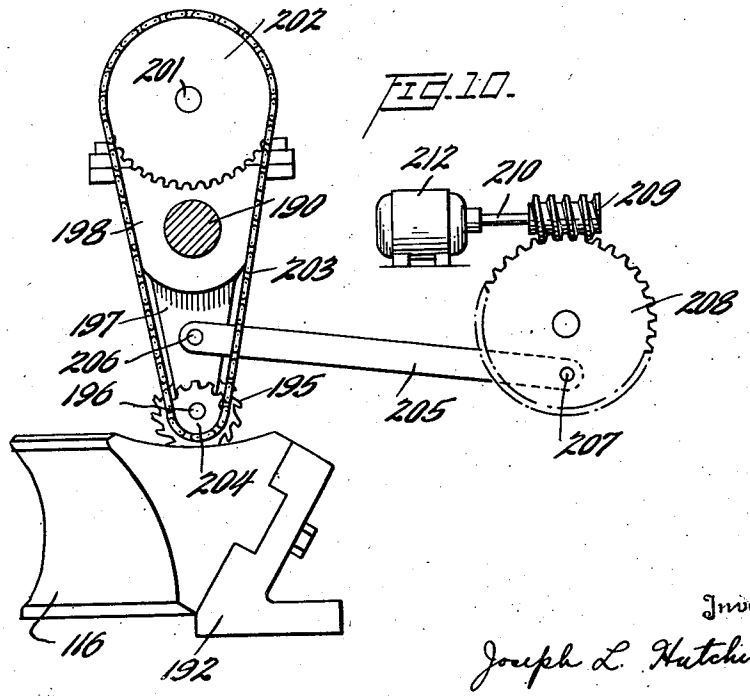


FIG. 10.



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METHOD AND DEVICE FOR SHREDDING MATERIALS

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Original application September 1, 1939, Serial No. 293,135, now Patent No. 2,309,594, dated January 26, 1943. Divided and this application May 25, 1942, Serial No. 444,450

3 Claims. (Cl. 76—101)

This invention relates to shredding devices and more particularly to methods and apparatus for forming the shredder saddle of such devices.

This application is a division of my co-pending application, Serial No. 293,135, filed September 1, 1939, which matured as U. S. Patent No. 2,309,594, granted January 26, 1943.

In that patent, certain novel shredding devices are described which are particularly adapted for the treatment of certain raw or intermediate materials at certain stages in the production of viscose for the manufacture of artificial silk or the like. An important element of the shredder described is a saddle member which cooperates with the rotating blades of the shredder to thoroughly disintegrate or shred the soda cellulose or similar material, and it is with this member that the present divisional application has to do. The configuration of the saddle member by which certain advantages are attained, especially in connection with the treatment of the cellulose material described, is covered by the above mentioned patent, and it is an object of the invention in its present aspect to provide novel processes and apparatus for making these saddles. Although peculiarly adapted to the shredding of the materials mentioned in the above cited patent, it will be understood that the saddles produced by the present methods and apparatus can be used in the shredding of any analogous or similar materials and in connection with any suitable type of moving blades or shredder members.

In the case of shredder devices now extant, the shredder members are either made of hard cast metal with the serrations or teeth formed therein during the casting process or, as in the case of one known device, the teeth are machined in a relatively soft metal plate which is then bent or warped into the cylindrical shape desired.

In the former and more conventional case, the diamond-shaped serrations are cast directly in the curved portion of the saddles, adjacent to the blades. It is well-known that the uniformity of clearance between all points of the serrations on the saddles and the serrated edges of the rotating blades has a great deal to do with successful and speedy reduction of the material being shredded. Where the diamond-shaped, or pyramidal teeth or serrations are formed on the curved surfaces by a casting process, it has been found that due to warpage and shrinkage of the castings themselves, it is practically impossible to maintain all the points of the pyramids cast in the curved section accurately with the cylindrical surface having the same center or axis of curvature as the center of rotation of the blades. It is, therefore, impossible to maintain the necessary clearance exactly uniform between the rotating blade and the saddle surfaces as defined by the points or apices of the pyramids. Hence, it can be seen that if the clearance between the paddle blades and the saddle at the top of the saddle curve would be set for .010", it might be .060" at the bottom of the saddle curve, or the blades may even touch the saddle at the bottom. Therefore, clearances larger than those desired have had to be accepted since molded iron castings cannot be held to the tolerances required. Therefore, machines of the class described above, with cast saddles, have had to be run longer than necessary than if the proper clearances could have been obtained, to reduce a batch of pulp to the proper shredded consistency.

The other expedient involving the bending or curving of a relatively thin malleable plate into which the teeth have already been machined, is subject to the same inaccuracies due to uneven shrinkage or warping, and a further disadvantage arises from the necessity of sealing off or properly packing the serrated insertable plates with respect to their mountings in the container to prevent leakage of material or cooling water.

One of the objects of the present invention, therefore, is to provide a novel and improved method of manufacturing shredder elements such as the saddles described.

The invention in its preferred embodiments, contemplates the provision of a saddle which is preferably made of a special hard iron casting having two cylindrically curved surfaces accurately machined thereon to correspond with the surface of rotation of the blades, allowing for the proper clearance. Into these curved surfaces are then cut two series of parallel V-shaped grooves, the grooves of the respective series being at 90° to each other and all of the grooves being disposed at 45° to the vertical median plane which passes through the saddle surface and which contains an element of said cylindrical surface. When cut to the proper depth there results a group of staggered substantially diamond-shaped or pyramidal teeth or projections on each curved surface, all of the points of which lie in a substantially cylindrical surface the axis of which coincides with the axis of the blade assemblies or paddles. The blades carried by the paddles may then be adjusted to any desired clearance and this clearance distance will be uniform at any point on the saddle surface. Also, the edges of the serrations produced by machining, will naturally be sharper

than those produced by casting the serrations in the curved surfaces. It has been proved in actual operation that these sharp edges tend to expedite the shredding of the material. It has also been found in actual tests that a saddle of the above construction greatly reduces the time of shredding and, when employed in connection with blades as hereinafter described, effects a still further reduction in the time required for shredding or disintegrating a batch of material.

Furthermore, by certain of my improved methods for forming the working surfaces of these saddles, the pyramidal teeth may be so cut that, while those which are on the median line of the surface are symmetrical, the apices of the others are offset in a direction away from the median line of the surface and to a degree proportional to their distance from said line. Thus the teeth nearer the oncoming material are provided with more abrupt cutting edges than those adjacent the median line.

Other objects and features of novelty will be apparent from the following specification when read in connection with the accompanying drawings in which certain embodiments of my invention are illustrated by way of example.

In the drawings:

Figure 1 is a view in horizontal section of a shredding device having a saddle embodying the principles of the invention;

Figure 2 is a view in vertical transverse section taken on line **2—2** of Figure 1;

Figure 3 is a somewhat diagrammatic view in side elevation of one type of machine for cutting the teeth or serrations in the shredder saddle, a portion of the machine being shown in vertical section;

Figure 4 is a fragmentary plan view of one working face of the saddle as cut by the machine in Figure 3;

Figure 5 is a fragmentary view in transverse section of the same saddle, as taken on line **5—5** of Figure 4;

Figure 6 is a diagrammatic view showing one of the symmetrical teeth adjacent the median plane of the working surface of the saddle;

Figure 7 is a similar diagrammatic view showing one of the teeth adjacent the margin of the working surface and having its apex displaced from the median plane;

Figure 8 is a diagram illustrating the approximate curvature of the path of the tool diagonally across the cylindrical working surface of the saddle as developed from the intersecting plane and cylinder;

Figure 9 is a somewhat diagrammatic view in elevation of another embodiment of saddle cutting machine; and

Figure 10 is a view of the same machine in transverse vertical section as taken on line **10—10** of Figure 9.

One exemplary embodiment of the shredding machine, having a saddle or shredder element of the type described, is illustrated in Figures 1 and 2 of the drawings. In this device duplex blades are employed for cooperating with the saddle member for shredding and disintegrating the material placed in the container **10**. A cooling system may be employed if desired and such a system is fully described in my patent to which reference has been made.

The saddle **116** in this embodiment may be provided with a cooling duct **116'**. The exact form of the serrations in this saddle and the method of forming them will be described hereinafter.

In the parallel, substantially cylindrical troughs **112** of this machine there are disposed for rotation in opposite directions, the duplex blade or paddle members **115**, these members being trunnioned in the end walls of the receptacle by means of the stub shafts **120** and **121**, the former being provided with suitable driving means. Each of the paddle members **115** comprises essentially two blade members **125** which extend from end to end of the paddles and comprise two spirally formed blade elements or sections which have twists of opposite hand, each of the sections being carried by the radial elements **126** which carry the trunnions or stub shafts **120** and **121**, and extending toward each other where they are joined together adjacent the mid-portion of the paddle by means of the curved connecting bars **127**. These connecting bars or braces **127** are disposed adjacent the general periphery of the paddle elements so as to keep the axis of the paddle members clear of obstruction to the passage of the material being shredded.

The radial supporting elements or spokes **126** at the opposite ends of the paddles are disposed at right angles to each other and the blades **125** at each end of the device are positioned 180° apart. The twist of each blade section **125** is substantially 90° from one end of the device to the central portion. The ends of all four of the blade sections **125** which overlap to some extent at the mid-portion of the paddle member are disposed 90° apart as clearly shown in Figure 2 of the drawings.

The direction of twist of the interrupted spiral blade sections is such that the material being shredded is moved from the ends of the trough towards the central portion thereof, just as in the case of a previously described embodiment.

As previously pointed out, shredder saddles have heretofore been provided with teeth or serrations which have been cast therein during the formation of the saddle member. To avoid the inaccuracies mentioned in connection with this type of saddle, the saddle **116** in the present embodiment is first cast to the general configuration required and then the cylindrical working surfaces **80** are machined accurately to correspond with the cylindrical surface of revolution of the blades. The peak **82** of the saddle member is provided with a series of teeth or serrations, and intersecting grooves are accurately machined in the working surfaces **80** to provide pyramidal teeth.

As shown most clearly in Figures 4 and 5 of the drawings, the V-shaped grooves **85** and the grooves **86** are cut in the surface **80** in opposite directions so that they intersect at angles of 90°. The grooves are also preferably arranged so that they intersect the median plane of the working surface **80** (indicated at M) at angles of 45°. These intersecting V-shaped grooves result in the formation of a multiplicity of pyramidal teeth **90**, and in this particular embodiment, the teeth are so cut that those along the median plane M are symmetrical as indicated at R. In other words, the apices of these pyramids coincide with the radius of the curved surface **80** at this point. However, the teeth which are disposed at points at varying distances from the median plane have their apices offset in a direction away from said median plane, and in amounts which vary according to their distance from said plane. This effect is more clearly shown in the enlarged diagrammatic views in Figures 6 and 7 and is due to the method of cutting the teeth in the cylindrical surface by the employment of a rotary tool operating in a single plane which is disposed at a 45°

angle with the median plane M. Also, the radius of the cutting tool is greater than the radius of the cylindrical surface **80** of the saddle. This cutting tool radius is adopted as that which will provide a circular arc which will most nearly approach the curvature of the shallower or flatter arc of an ellipse resulting from the intersection of the plane of the cutting tool with the cylindrical surface of the saddle. The development of this arc is shown in Figure 8 of the drawings in which L represents the theoretical cylinder of which the surface between the lines *c* and *d* represents the actual area of the working surface of the saddle which, it will be noted from Figure 2 of the drawings, is less than $\frac{1}{12}$ of the total circumference of the cylinder L. For this short segmental angular extent, the arcs of the tangent circle and ellipse are identical within the accuracy which it is desired to obtain. The plane P is the plane of rotation of the cutting tool and intersects the cylinder L to form an ellipse E. The arc of the ellipse between the points *x* and *y* indicates the diagonal path of the cutting tool along the surface of the saddle and for practical purposes this arc may be considered a circular arc and the radius thereof is adopted as the length of the arm of the cutting tool. This length will obviously be greater than the radius of the cylindrical saddle surface. The actual length of the tool arm may be obtained by measuring the chordal width of the cylindrical segments *c d* and the depth of the segment in the center thereof. Knowing the chordal length of *c d* and the angle of intersection of the plane P with the axis of the cylinder L, the chordal length of the tool path *x y* may be determined. Then using the same depth of segment and applying it to the chordal length *x y*, a circle may be erected having a radius which is equal to the length of the tool arm. The arc of this circle which is subtended by the angular width of the saddle segment (approximately 30 degrees) will be found to coincide with the flat arc of the theoretical ellipse marking a line of intersection of the plane P and the cylinder L.

At the median plane M as shown in Figure 5 of the drawings, the position of the axis of the cutting tool and that of the surface **80** coincide and the teeth are therefore symmetrical as shown in Figure 6. At points further away from the median plane, however, the radius of the surface **80** and that of the cutting tool necessarily diverge and the teeth assume the general form shown in Figure 7 with their apices *s* displaced from the radius *t* of the surface **80**. This effect provides a steeper or more abrupt cutting edge *w* on the teeth nearer to the edge of the working surface **80**, which faces the oncoming material being swept across the surface **80** by the shredding blades. Of course, the pyramidal teeth will assume an opposite apparent distortion on the other side of the median plane and this is utilized at times when the direction of rotation of the paddle members may be reversed.

In Figure 3 of the drawings there is illustrated somewhat diagrammatically one type of machine by means of which the teeth or serrations may be cut in the working surfaces of the saddle in order to attain the effect just described. A bed **160** is provided upon which a rotatable work supporting table **162** is mounted. Suitable graduations **163** are provided for determining accurately the angular adjustment of the table **162** with relation to the bed **160**. Upon the top of the table **162** there is disposed a slide **164** which supports the fixture **165** to which the saddle **116** is secured. The gibs **166** serve to guide the member **164** and suitable conventional feeding means actuated by the handle **167** may be provided for feeding the fixture **165** along the table **162** during the cutting of the several grooves. A head frame **170** supports a driving motor **171** and driving gearing **172** operatively connected to the rotating tool shaft **175**. A tail support for the shaft is provided at **176**. Upon the shaft there is keyed a tool carrying wheel **177** upon which a substantially U-shaped tool holder **178** is secured. A tool **180** having a V-shaped cutting edge **181** is disposed in an opening in the bottom of the holder **178** and is adjustable therein by means of the screw **182**. When set at proper point for taking a cut the tool is secured by means of the bolt **183**. As shown in Figure 3 the saddle is held in the fixture **165** so that the working surface **80** is in a substantially horizontal position but disposed at an angle of 45° with the plane of cut of the tool. As each groove is cut the fixture **165** is moved forwardly into the position for cutting the next one by means of the crank handle **167**.

Another machine for effecting the same type of cut is shown in Figures 9 and 10 of the drawings. In this embodiment a rock shaft **190** is supported in the frame **191** above the work support **192**, the latter having similar arrangements to those shown in Figure 3 for adjusting and advancing the work with respect to the cutting tool. The tool in this case is a milling cutter **195** which has a stub shaft **196** rotatably mounted in the depending bracket arm **197** carried by the block **198** rigidly secured to the shaft **190** as by means of the pin **199**. Upon this block **198** there is mounted the driving motor **200**, the shaft **201** of which carries the sprocket **202** which is operatively connected by means of the chain belt **203** with the sprocket **204** on the end of the stub shaft **196** upon which the milling cutter is mounted. The block **198** carrying the cutter **195** is oscillated diagonally across the work by means of the link **205** which is pivotally connected as at **206** with the bracket arm **197** and at **207** with the crank gear **208**. This is a worm gear which is driven by the worm **209** mounted on the shaft **210** of the motor **212**. It will be obvious that this arrangement will produce the same type of teeth or serrations as the one described in connection with Figure 3.

It is understood that various changes and modifications may be made in the embodiments of the shredding machine and the various appurtenances thereof which have been illustrated and described herein, as well as in the methods and machines for preparing the saddle element for those devices, without departing from the scope of the invention as defined in the following claims.

Having thus described the invention, what is claimed as new and desired to be secured by Letters Patent is:

1. The method of forming a shredding saddle for a device of the class described, which comprises machining a concave cylindrical surface of relatively small angular extent on a blank casting, and cutting in said surface two series of parallel V-shaped grooves which intersect at right angles and which make angles of 45° with a median plane which plane is perpendicular to said cylindrical surface and contains an element thereof, by rotating a cutting tool in successive parallel planes each disposed at a 45° angle with said median plane of said surface for cutting said grooves, and selecting as the radius of the cutting tool a length equal to the radius of a circle

the curvature of which is substantially identical with that of the small minimum-curvature arc of the ellipse describing the angular intersection of the plane of movement of the tool with the complete cylinder of the saddle surface, the arc of the circle which coincides with said elliptical arc comprising the actual path of the tool along the relatively narrow working surface of the saddle.

2. The method of forming a shredder member of the class described which comprises the steps of providing a concave substantially cylindrical working surface of limited angular extent on a metal blank, and cutting in said surface two series of parallel substantially V-shaped grooves, the grooves of the respective series intersecting each other at the same angles, and each series intersecting any element of said cylindrical surface at an angle which is equal to one-half of said first named angle, by rotating a cutting tool in successive planes each disposed at the same angle with any element of said cylindrical surface as said series of grooves, and selecting as the radius of rotation of the cutting tool a length equal to the radius of a circle the curvature of which is substantially identical with that of the small minimum-curvature arc of the ellipse describing the angular intersection of the plane of movement of the tool with the complete cylinder of the saddle surface, the arc of the circle which coincides with said elliptical arc comprising the actual path of the tool along the relatively narrow working surface of the saddle.

3. The method of forming a shredding member of the class described, which comprises the steps of machining a concave substantially cylindrical surface of an angular extent of not more than 30 degrees on a blank casting, and then cutting in said surface two series of parallel V-shaped grooves which intersect each other at a predetermined angle, and each of which makes an angle with any element of said cylindrical surface which is equal to one-half of said first named angle, said cutting being effected by rotating a cutting tool in successive parallel planes each disposed at the same angle with an element of said cylindrical surface as said series of grooves, and selecting as the radius of rotation of the cutting tool a length equal to the radius of a circle the curvature of which is substantially identical with that of the small minimum-curvature arc of the ellipse describing the angular intersection of the plane of movement of the tool with the complete cylinder of the saddle surface, the arc of the circle which coincides with said elliptical arc comprising the actual path of the tool along the relatively narrow working surface of the saddle.

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