# United States Patent

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[54] ECCENTRIC ROTARY GROUNDWOOD MILL
17 Claims, 21 Drawing Figs.


[52] U.S. Cl. ..... 241/146, 241/252, 241/278
[51] Int. Cl. ..... B02c 7/10
[50] Field of Search ..... 241/135, 146, 206, 252, 260, 296, 278—279



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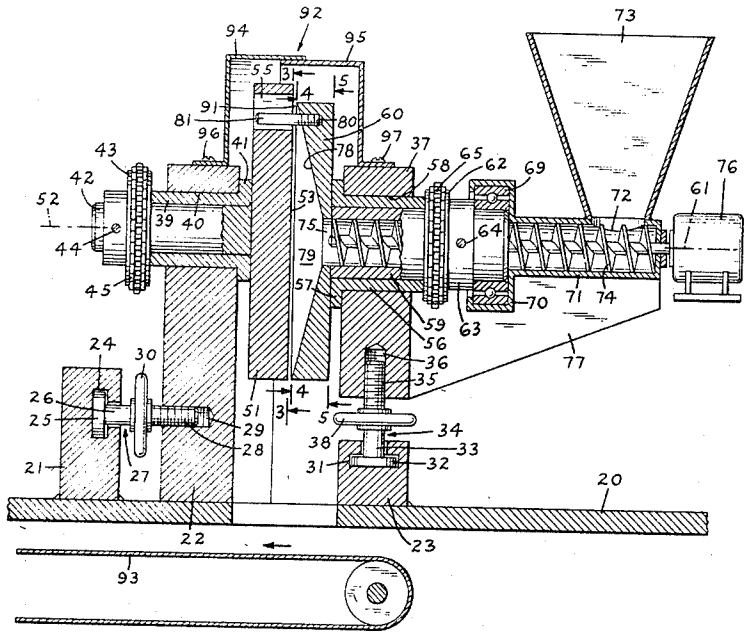
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*Primary Examiner*—Donald G. Kelly
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**ABSTRACT:** A rotary groundwood mill comprising two discs arranged to face each other and rotated in their major planes about eccentrically located axes. The discs are rotated at exactly the same speeds and in the same rotational direction. The mill structure is such that a piece of wood entrapped between the discs will be subjected to epicyclic abrasion.

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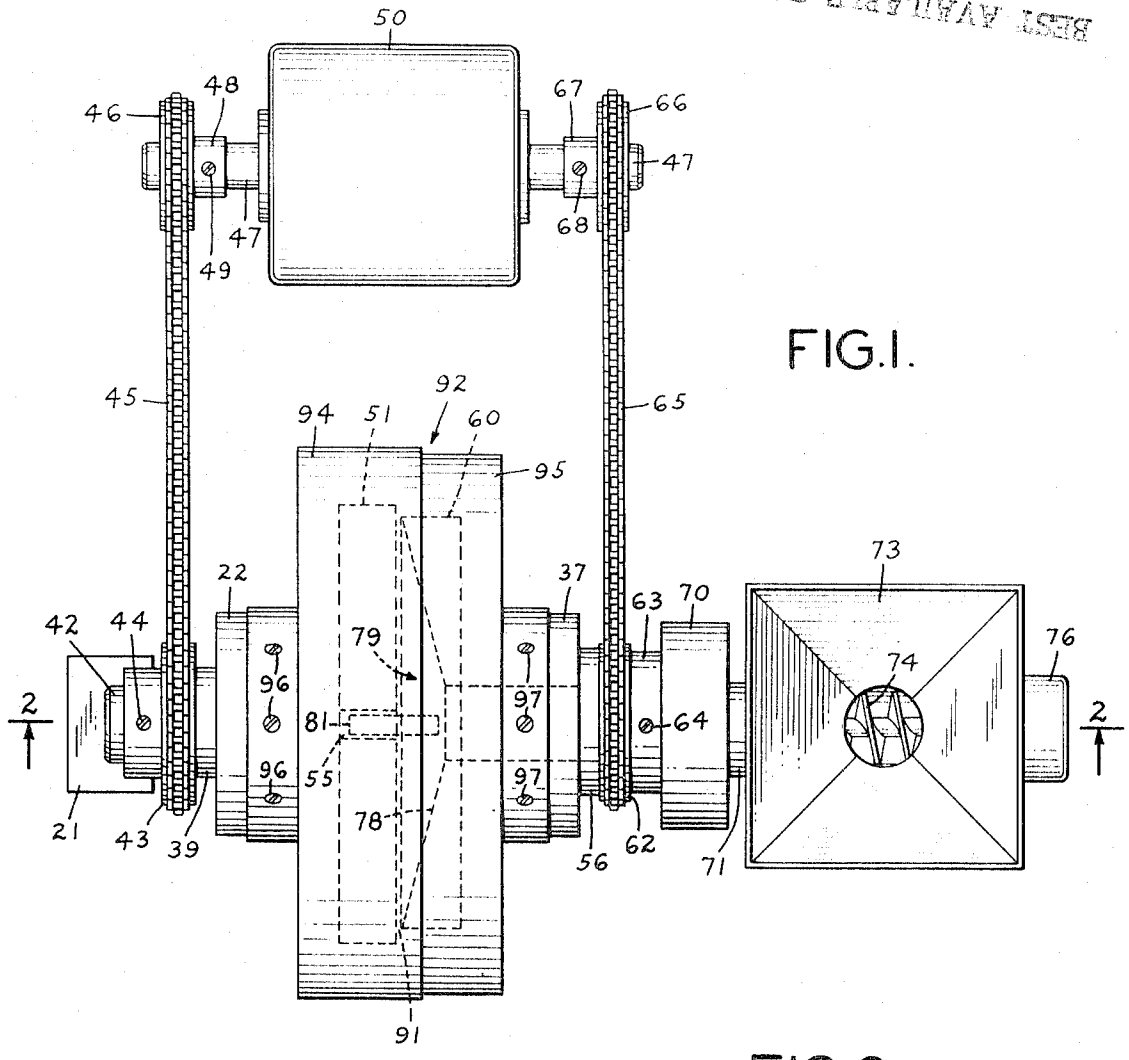



FIG.1.

FIG.7.

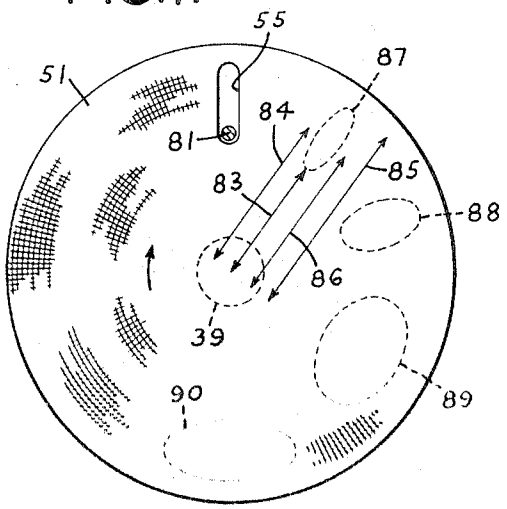
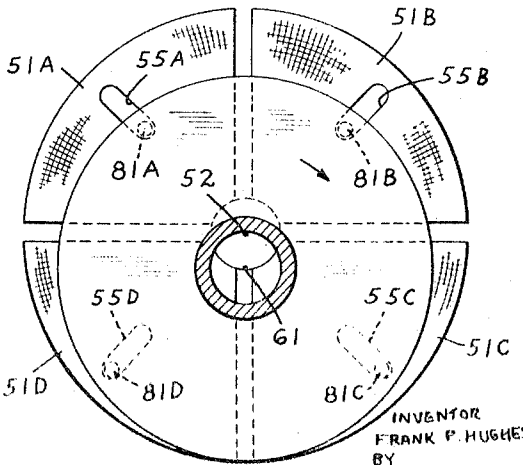



FIG.8.




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FIG.2.

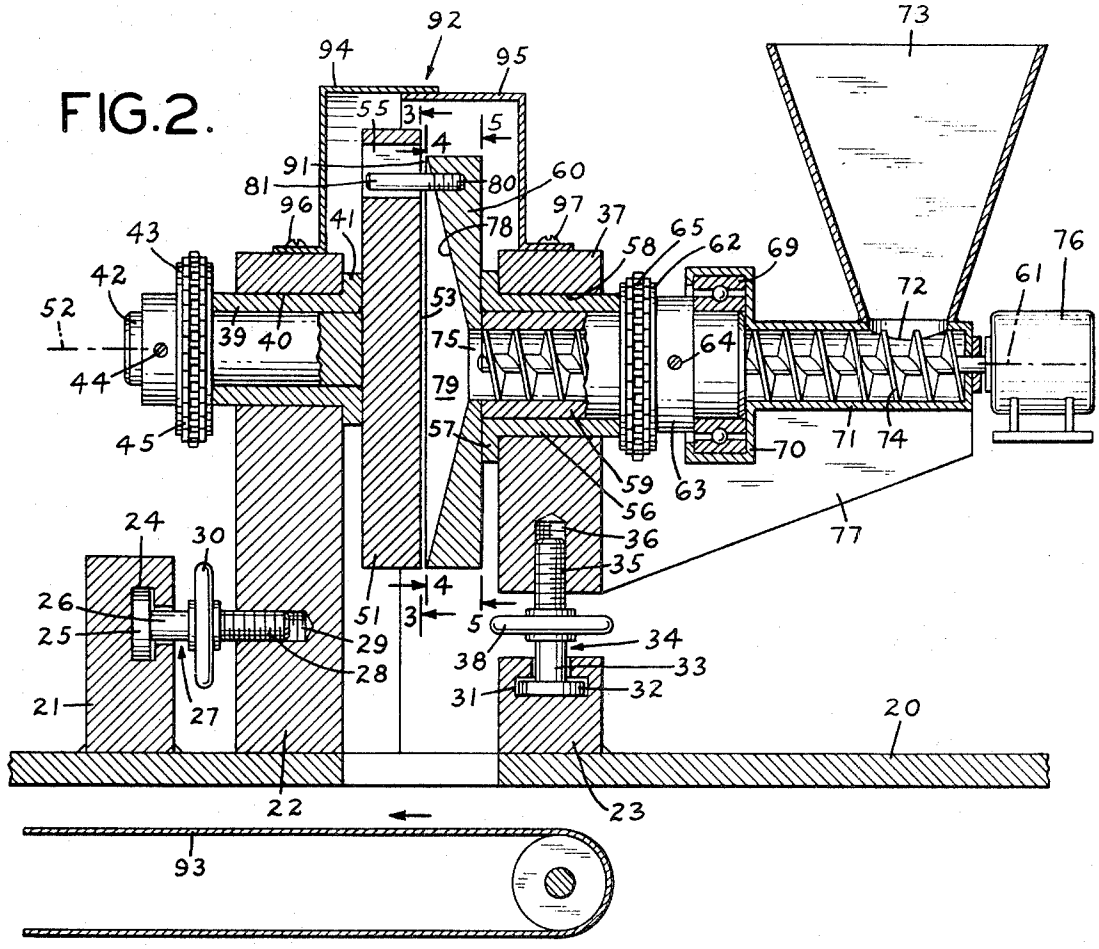



FIG.3.

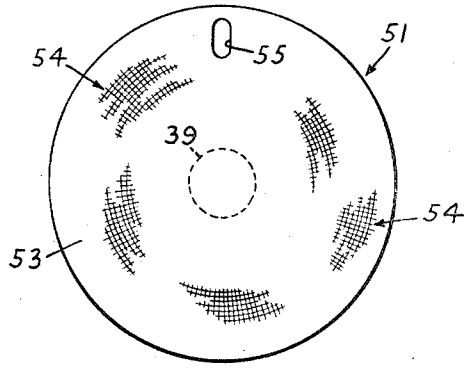
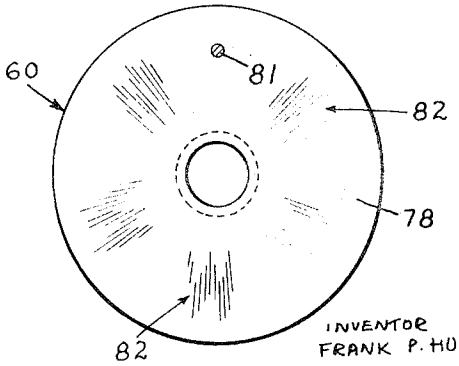



FIG.4.




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FIG.5.

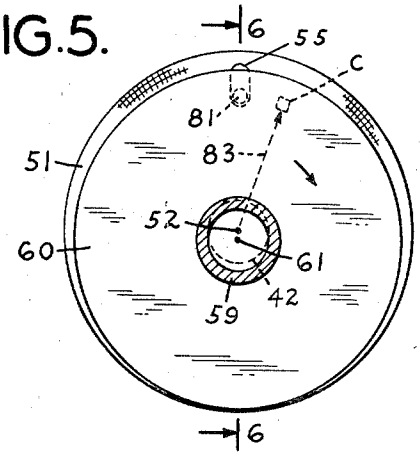



FIG.5A.

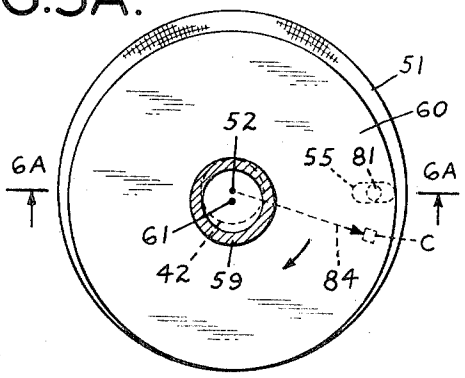



FIG.5B.

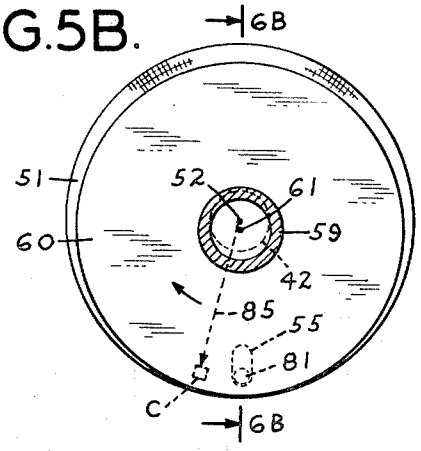



FIG.5C.

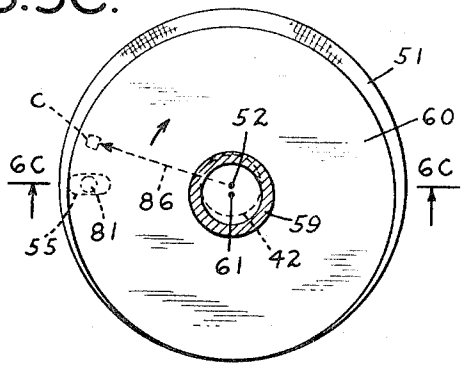



FIG.6.

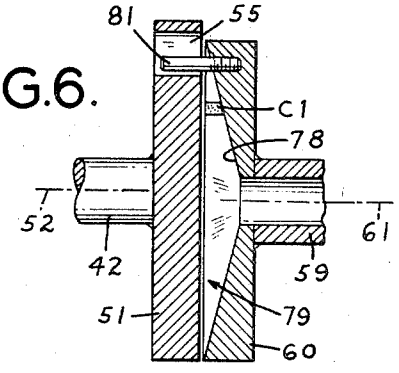



FIG.6A.

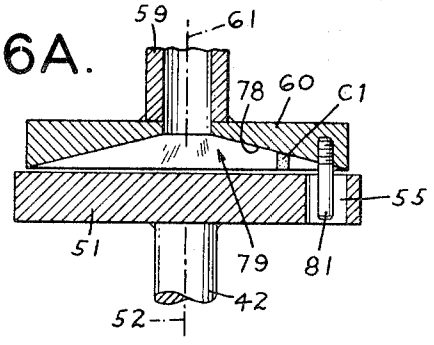



FIG.6B.

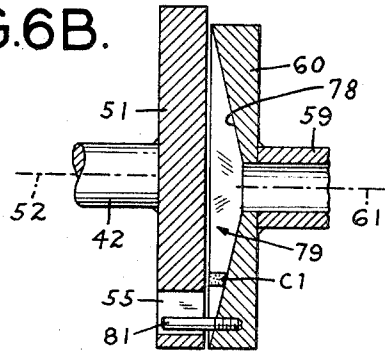
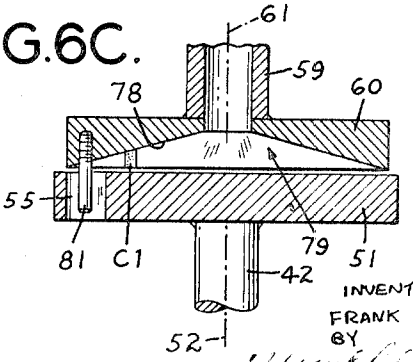



FIG.6C.




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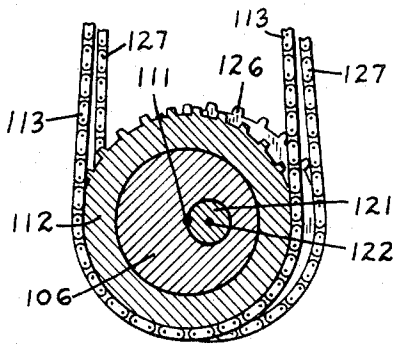



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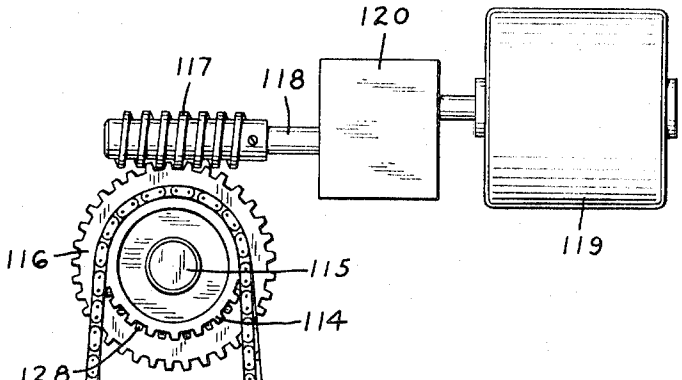
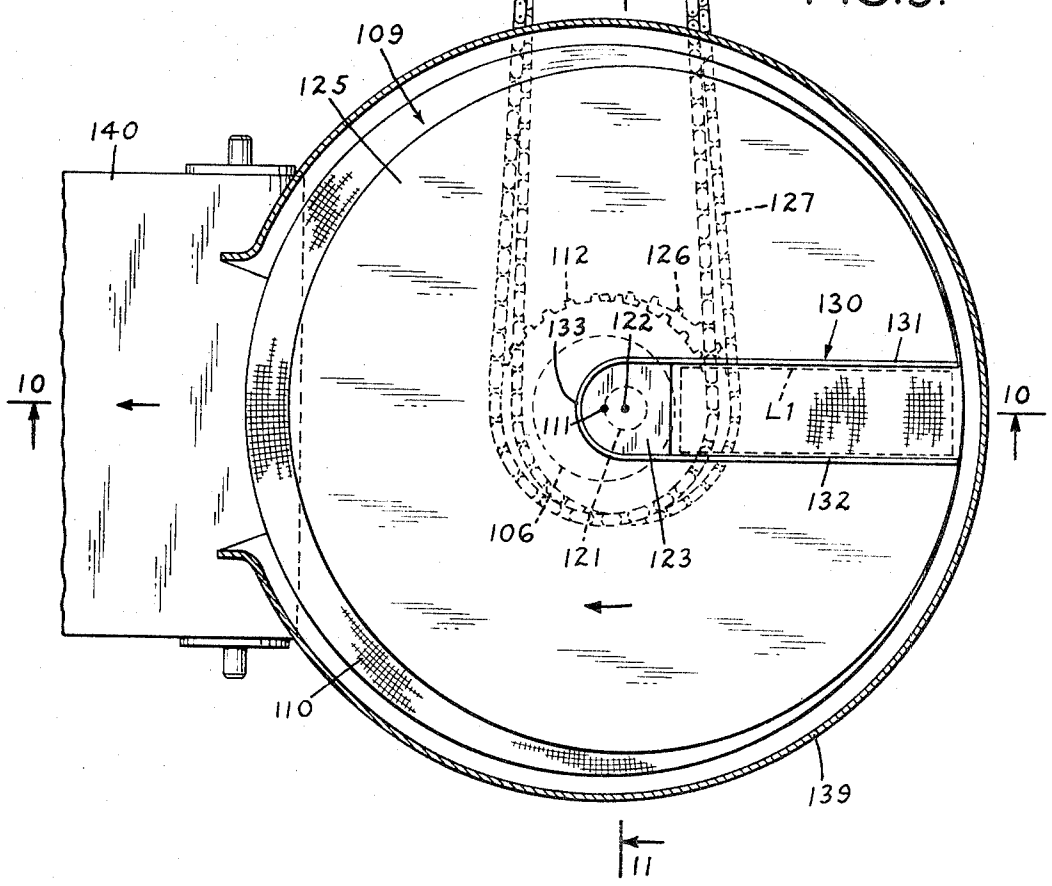



FIG.9.




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FIG.10.

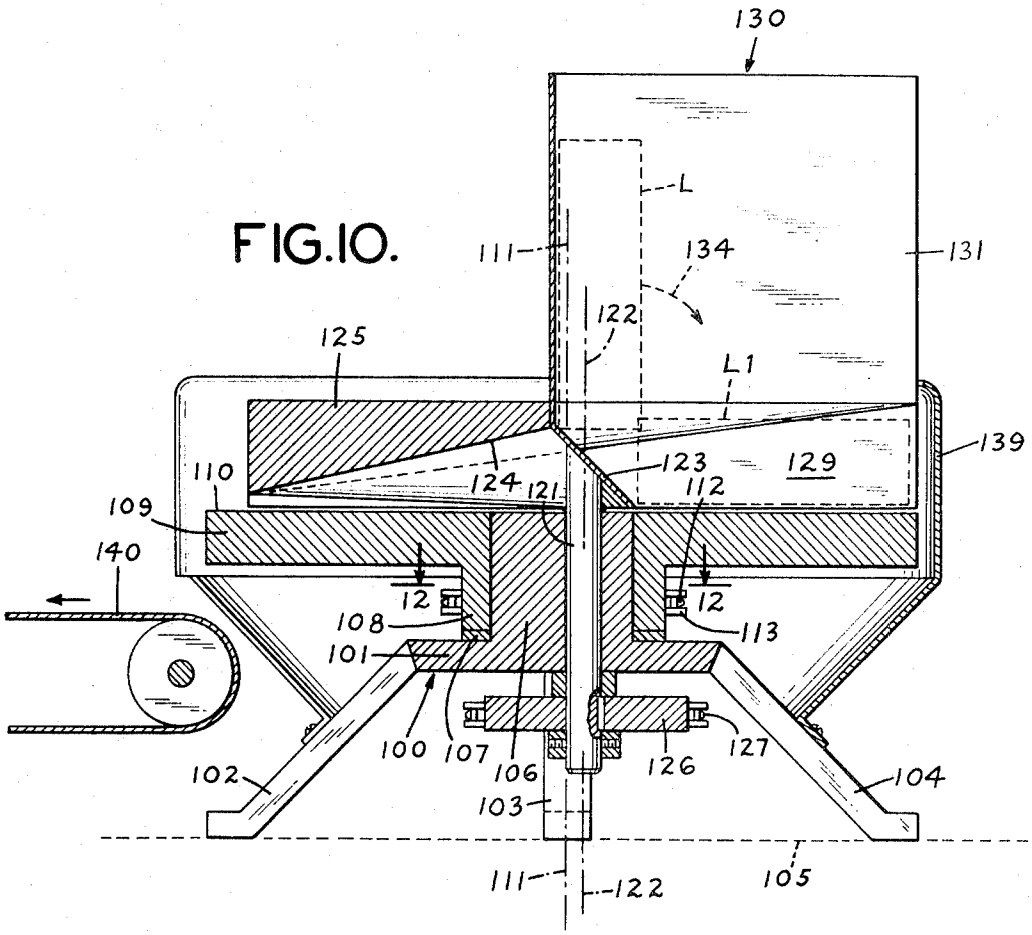
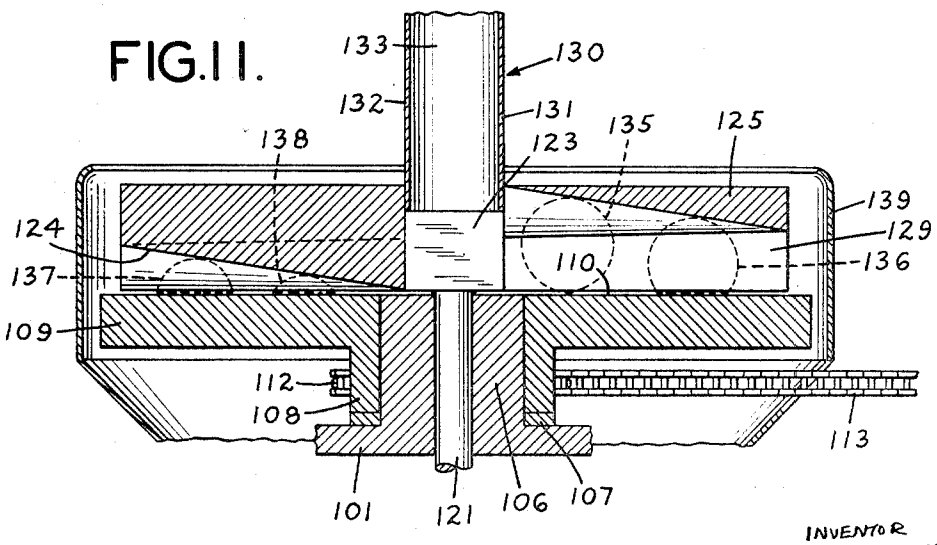



FIG.11.




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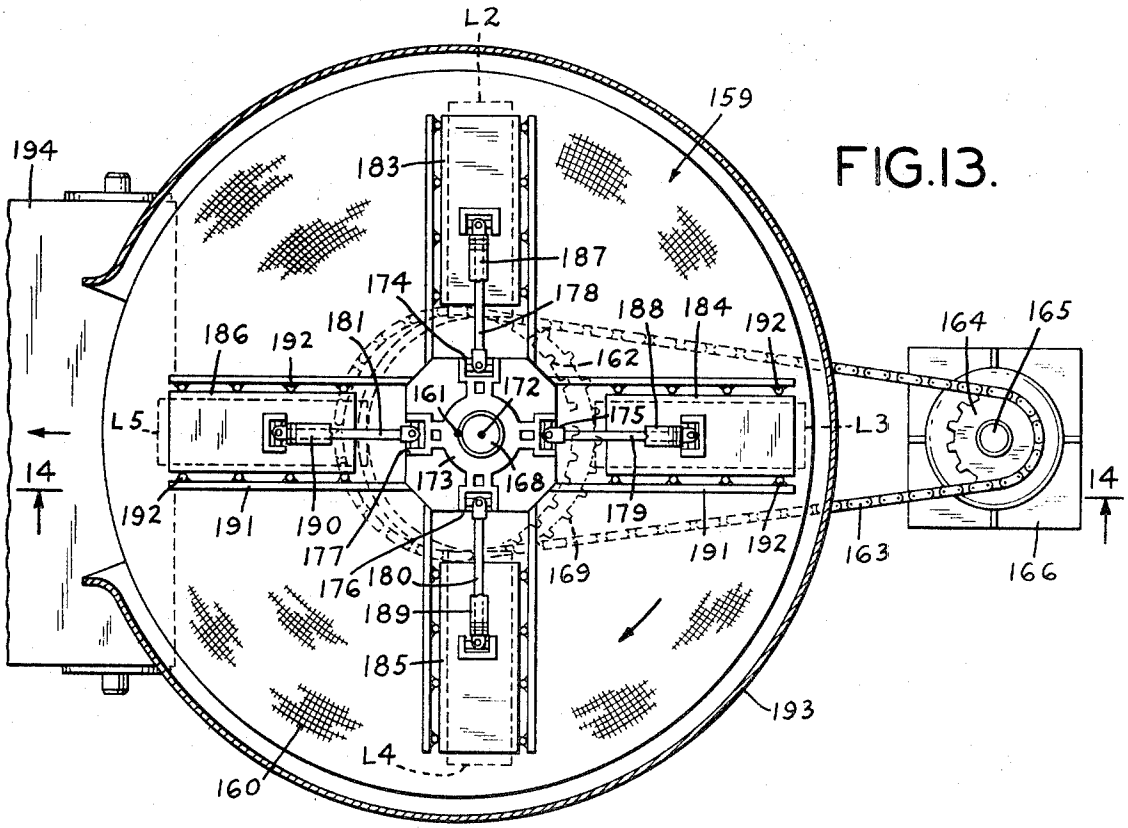



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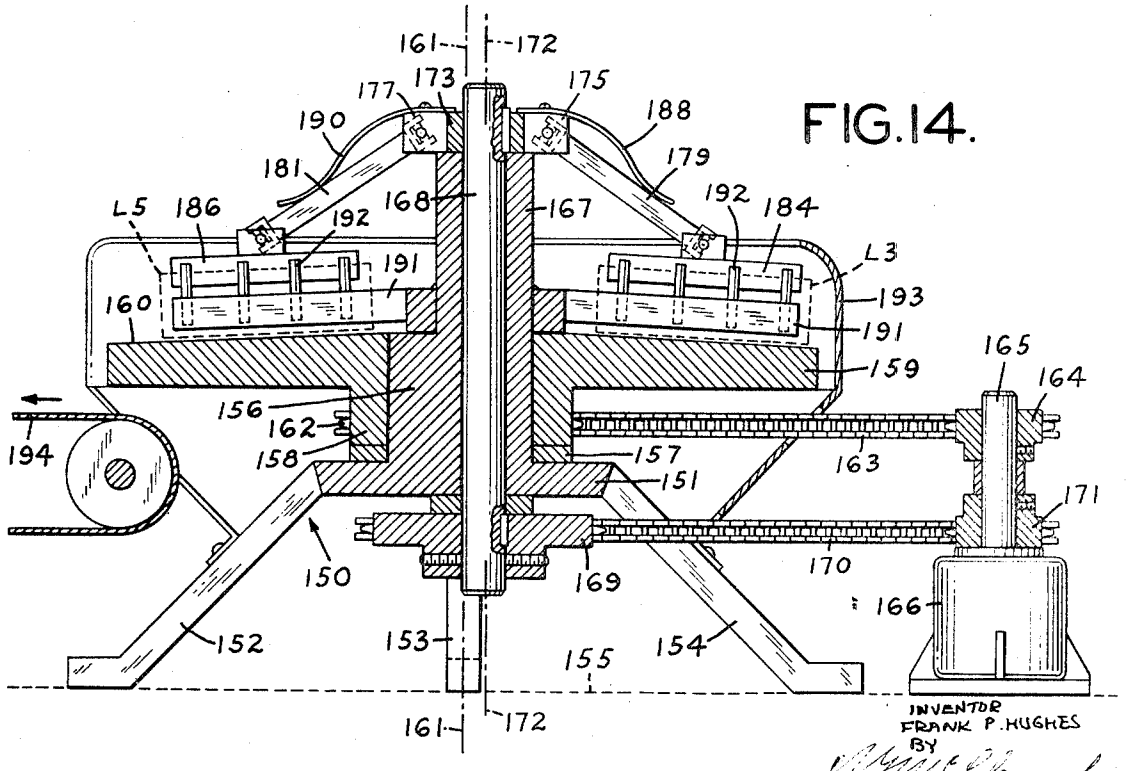
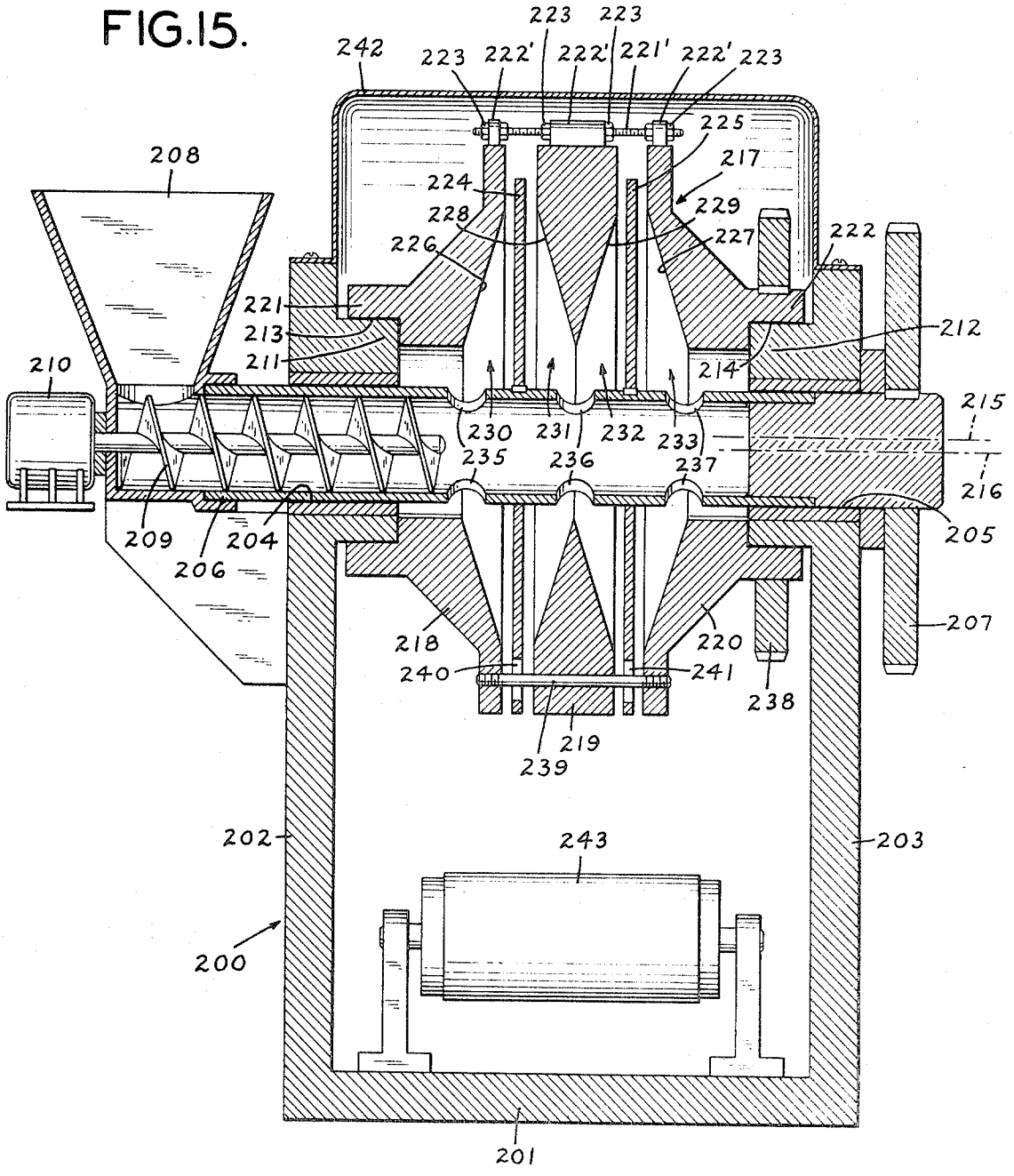



FIG.14.

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FIG.15.




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# ECCENTRIC ROTARY GROUNDWOOD MILL

## BACKGROUND OF THE INVENTION

It has been suggested that a pulp having superior properties would be produced by reciprocating an abrader across a piece of wood. A report to this effect is contained in an article entitled "A Laboratory Study of a New Mechanical Pulping Process" by W. D. May and D. Atack of the Pulp and Paper Research Institute of Canada in the *Pulp and Paper Magazine of Canada* for Aug. 1965, pages T–422 to T–435. Another report on this subject is contained in an article by W. D. May entitled "Mechanical Pulping at the Institute Part II–What Happens in Grinding," contained in pages 7 to 13 of the Winter 1966 (No. 9) issue of *Trend*, a publication of the Pulp and Paper Research Institute of Canada The latter article, at page 11, brings out what was considered to be the unworkable nature of the process on a commercial scale.

The principal object of the invention has been the provision of a novel and improved rotary groundwood mill.

More particularly, it has been an object of the invention to provide such a mill which, on a commercially usable basis, can take advantage of the benefits available from reciprocal motion of an abrader across wood by affording relative reciprocal motion.

Another object of the invention has been the provision of a novel and improved rotary groundwood mill which provides a pulp of improved quality and which decreases the specific energy consumption required to produce the pulp.

Other and further objects, features and advantages of the invention will appear more fully from the following description of the invention.

## SUMMARY OF THE INVENTION

In accordance with the invention these objects are achieved by providing a rotary groundwood mill having an abrader disc rotatable about a first axis and having an abrader face, a magazine element disposed in juxtaposition with the abrader face of the abrader disc and being rotatable in the same rotational direction as the abrader disc about a second axis parallel to the first axis and eccentric with respect thereto, the magazine element being constructed to hold a piece of wood in contact with the abrader face and to prevent substantial movement of the piece of wood in a circumferential direction relative to the second axis, and means to rotate the abrader disc and the magazine disc about their respective axes at the same rotational speed and in the same rotational direction so that a piece of wood held by the magazine element is subjected essentially to epicyclic abrasion by relative motion between the piece of wood and the abrader face of the abrader disc resulting from the eccentricity of the axes.

## BRIEF DESCRIPTION OF THE DRAWINGS

The invention will now be described in greater detail with reference to the appended drawings in which:

FIG. 1 is a plan view of a rotary groundwood mill embodying the invention;

FIG. 2 is a longitudinal cross-sectional view taken generally along the line 2–2 of FIG. 1;

FIG. 3 is a reduced scale elevational view of the abrader disc of FIG. 2 taken along the line 3–3 of FIG. 2;

FIG. 4 is a reduced scale elevational view of the magazine disc of FIG. 2 taken along the line 4–4 of FIG. 2;

FIG. 5 is a cross-sectional view taken along the line 5–5 of FIG. 2 and illustrating the abrader and magazine discs in one relative position thereof;

FIG. 5A is a cross-sectional view similar to FIG. 5 but illustrating the abrader and magazine discs rotated clockwise 90° from their FIG. 5 positions;

FIG. 5B is a cross-sectional view similar to FIG. 5 but illustrating the abrader and magazine discs rotated clockwise 180° from their FIG. 5 positions;



FIG. 5C is a cross-sectional view similar to FIG. 5 but illustrating the abrader and magazine discs rotated clockwise 270° from their FIG. 5 positions;

FIGS. 6, 6A, 6B and 6C are cross-sectional views taken along the lines 6–6, 6A–6A, 6B–6B and 6C–6C, respectively, of FIGS. 5, 5A, 5B and 5C, respectively;

FIG. 7, which appears on the same sheet as FIG. 1, is a diagrammatic illustration of typical paths experienced by chips or small pieces of wood relative to the face of the abrader disc of FIG. 1 as the abrader and magazine discs are rotated;

FIG. 8, which appears on the same sheet as FIG. 1, is a view similar to FIG. 5 but illustrating a modified construction in accordance with the invention in which the abrader disc is segmented;

FIG. 9 is a plan view, partly in cross section, of another form of rotary groundwood mill embodying the invention;

FIG. 10 is a cross-sectional view taken along the line 10–10 of FIG. 9;

FIG. 11 is a cross-sectional view taken along the line 11–11 of FIG. 9;

FIG. 12, which appears on the same sheet as FIG. 9, is a fragmentary sectional view taken along the line 12–12 of FIG. 10;

FIG. 13 is a plan view, partly in cross section, of still another form of rotary groundwood mill embodying the invention;

FIG. 14 is a cross-sectional view, taken generally along the line 14–14 of FIG. 13; and

FIG. 15 is a longitudinal sectional view of still another form of rotary groundwood mill embodying the invention.

## DETAILED DESCRIPTION OF PREFERRED EMBODIMENTS OF THE INVENTION

Referring now to the drawings, and particularly to FIGS. 1 and 2, the groundwood mill illustrated comprises a baseplate 20 (omitted in FIG. 1), a standard 21 affixed to baseplate 20, a standard 22 mounted on baseplate 20 and a standard 23 affixed to baseplate 20. The standard 22 is slidable from left to right (FIG. 2) along plate 20 but suitable means such as guide rails (not shown) should be provided to prevent standard 22 from moving in any other direction.

The right-hand side (FIG. 2) of standard 21 is provided with a horizontal slot 24 which is T-shaped in cross section and which accommodates an enlarged head 25 and body 26 of a screw jack 27. Right end 28 of jack 27 is threaded and is engaged in a threaded hole 29 provided in standard 22. A hand wheel 30 affixed to jack 27 permits the latter to be rotated. Rotation of jack 27 causes standard 22 to slide from left to right or from right to left in FIG. 2 depending on the direction of rotation of handwheel 30. Suitable closure means (not shown) may be provided for the ends of slot 24.

The top of standard 23 is provided with a horizontal slot 31 which is T-shaped in cross section and which accommodates an enlarged head 32 and body 33 of a screw jack 34. Upper end 35 (FIG. 2) of jack 34 is threaded and is engaged in a threaded hole 36 provided in the underside of a block 37. A handwheel 38 affixed to jack 34 permits the latter to be rotated to in turn raise and lower block 37 relative to standard 23. While only one jack 34 is shown, it will be understood that two or more such jacks may be provided to afford better support for block 37. Similarly, one or more additional jacks 27 may be provided to move standard 22. The ends of slot 31 may be closed by any suitable means, not shown. Guide rails or other suitable means (not shown) may project upwardly from standard 23 or base 20 to guide block 37 and to prevent the latter from moving except in a vertical direction.

A cylindrical sleeve 39 is mounted in a circular opening 40 in standard 22. The sleeve 39 has an enlarged annular head 41 at the inner end thereof. A shaft 42 is journaled for rotation in sleeve 39. The outer end of shaft 42 carries a sprocket wheel 43 which is affixed to shaft 42 by means of set screws 44.

An endless drive chain 45 passes about sprocket wheels 43 and 46. The sprocket wheel 46 is mounted on one end of a

shaft 47 by means of a collar 48 and set screws 49. The shaft 47 is the output drive shaft of an electric motor 50 which may be suitably mounted on base 20 or may be separately mounted.

A circular abrader disc 51 is affixed to the inner end of shaft 42 so as to rotate with shaft 42 and about centerline 52 thereof. The inner face 53 of abrader disc 51 is provided with a roughened surface as indicated at 54 of FIG. 3. The roughened or abrading surface of disc 51 may be any of the usual abrading surfaces commonly employed in groundwood mills, e.g., carborundum or a pattern of engraved crosslines. A radially elongated slot 55 is provided in disc 51 adjacent the radially outer edge thereof.

Suitable bearings other than sleeve 39 and flange 41 may be provided to facilitate rotation of shaft 42 and to absorb axial thrust imposed in operation.

A cylindrical sleeve 56 having an enlarged annular head 57 at the inner end thereof is mounted in a circular hole 58 in block 37. A hollow shaft 59 is journaled for rotation in sleeve 56. The inner end of shaft 59 is affixed to the outer surface of a circular magazine disc 60 so that the disc 60 will rotate about the centerline 61 of shaft 59.

A sprocket wheel 62 is mounted adjacent the outer end of shaft 59 by means of a collar 63 and setscrews 64. Sprocket wheel 62 and a sprocket wheel 66 carry an endless drive chain 65. The sprocket wheel 66 is affixed to the right-hand end of motor output shaft 47 by means of a collar 67 and setscrews 68.

The outer end of shaft 59 is carried in a ball bearing assembly 69 enclosed within an annular housing 70 provided at one end of a feed pipe 71. The feed pipe 71 is provided with a hole 72 in its upper surface which communicates with the interior of a feed hopper 73.

A feed screw 74 is mounted in pipe 71 and extends through the center of hollow shaft 59. The inner end of feed screw 74 communicates with a central opening 75 provided in magazine disc 60. Feed screw 74 is rotated by an electric motor 76. Disc 60, shaft 59, sprocket 62 and feed screw 74 are all concentric, being arranged to rotate about axis 61. The feed pipe 71 and hopper 73 are supported from block 37 by a projecting bracket arm 77.

The sprocket and chain drive 43–45–46 and the sprocket and chain drive 62–65–66 are arranged to rotate the shafts 39 and 59 at identical speeds so that the abrader disc 51 and the magazine disc 60 will rotate at identical speeds. However, the rotation of disc 60 will be eccentric relative to disc 51 because the axes of rotation 61 and 52 are vertically displaced relative to each other by an amount determined by the setting of jack screw 34. The eccentricity is preferably of the same order of magnitude as a typical wood chip, e.g., between about one-fourth inch and 1 inch.

The inner face of magazine disc 60 is an inclined annular surface 78 and may, if desired, be made concave. The incline is radially outward and toward the inner face 53 of disc 51 so that a maximum spacing occurs between the discs at the opening 75 and a minimum spacing occurs between the discs around the periphery of disc 60. The inner face of disc 60 is thus dished. As shown in FIGS. 1 and 2, the circular space 79 between the opposing faces of the discs is, in cross section, essentially a trapezoid with vertical bases.

The inner face 78 of disc 60 is provided with a threaded hole adjacent the outer periphery thereof. The threaded hole accommodates the threaded end 80 of a pin 81. The pin 81 is aligned with and enters slot 55. There is preferably a sliding fit between pin 81 and slot 55. The pin 81 acting in slot 55 impels the magazine disc 60 and the abrader disc 51 to rotate at precisely the same speeds.

In operation, wood chips loaded into hopper 73 fall into feed pipe 71 and are advanced by screw conveyor 74 through the hollow shaft 59 into space 79 between discs 51 and 60. Chips entering space 79 are urged toward the periphery of disc 60 by the combined action of gravity, centrifugal force and pressure exerted by following chips.

As is best shown in FIG. 4, the inner face 78 of disc 60 is provided with a series of radially extending ribs 82. The ribs 82 serve to prevent chips from moving circumferentially along surface 78. Instead, the chips are trapped between ribs and can move only in a radial direction.

Until the chips are worn down by abrasion resulting from contact with face 53 of disc 51, the chips cannot progress far in a radial direction. However, as they become smaller they can move radially outward toward the periphery of disc 60.

The position of the axis 61 of disc 60 may be varied in the vertical direction by means of the screwjack 34. If the screwjack 34 is adjusted to set disc 60 in exact concentricity with disc 51, then the chips between then will experience no abrasion, for the two discs 51 and 60 will rotate as a unit, both of the discs rotating in the same direction.

But if the screwjack 34 be lowered, say one-half inch, there will be relative motion between the two discs, and the chips will be abraded. The path of a chip referred to the abrader disc 51 will be an oval, or slightly irregular ellipse of dimensions depending upon the eccentricity set by jackscrew 34 and upon the position of the ellipse on disc 51. This path may be followed through FIGS. 5, 6 and 7. The ratio of the eccentricity of the axis to the diameter of the discs is exaggerated for clarity in these figures. A typical value of the eccentricity might be one-half inch.

Referring to FIG. 5, a wood chip C is shown located at the same radial location from the center of rotation 52 of magazine disc 51 as the pin 81. In the position shown in FIG. 5, the chip C will be at a radius from the center of disc 51 represented by vector 83. Now consider the discs rotated through 90° to the position shown in 5A. Here the chip C is unmoved with respect to the pin 81 in disc 60, but has moved one-half of an inch across the abrader disc 51 and is now at a distance from the center of rotation 52 of disc 51 represented by vector 84, which equals vector 83—one-half inch in length. These vectors are drawn on FIG. 7 for comparison.

Let the discs be rotated a further 90° to the position shown in FIG. 5B. Now the pin 81 has travelled down the slot 55 the full 1 inch, twice the eccentricity as set by jackscrew 34, and the chip C, still in the same position as before with respect to disc 60, has moved 1 inch toward the periphery of disc 51, or the vector 85 equals vector 83—1 inch in length.

FIG. 5C represents the situation after 270° rotation where the chip C has moved back from the periphery of disc 51 by one-half inch, yielding a vector 86 equal to vector 83—one-half half inch in length. Finally, 360° of rotation brings chip C back to its starting point on disc 51, as shown in FIG. 5.

The chip has now described an elongated ellipse on the abrader disc 51 and on further rotation will repeat the same path over disc 51 exactly, which is the optimum condition for the separation of fibers.

Amplifying this explanation, if an observer could be located on disc 51, rotate with it and note the path traced by the chip C, he would observe it as the elongated ellipse shown as 87 in FIG. 7. Other chips in other positions about disc 60 would trace typical paths as 88, 89 and 90, as shown in FIG. 7.

A different viewpoint is shown in FIGS. 6—6C. Referring to FIG. 6B, the pin 81 is at the bottom of its stroke in slot 55. Consider a chip C1 held by disc 60 in such a position that it just touches the slot 55 in disc 51. Rotation of the discs through 90° moves the chip C1 away from the slot 55 (FIG. 6C) by an amount equal to the eccentricity. A further 90° rotation moves the chip C1 to a distance of twice the eccentricity from the edge of the slot, as shown in FIG. 6. After 270° of rotation (FIG. 6A) the chip C1 moves back toward the slot by an amount equal to the eccentricity and after a full rotation the chip (FIG. 6B) again touches the edge of the slot.

As the chips abrade, the fibers removed from them form balls. After a time each ball will free itself from the continually depleted parent chip and will travel toward the periphery of the discs and slip between them through the space 91 at their edges. The space 91 (between discs 51 and 60) is adjustable by jackscrew 27. The fiber balls are flung outward by centrifu-

gal force, are caught by a housing or slinger **92** and fall on a conveyor **93** to be carried to the next stage of the process. This next stage is usually referred to as clearing and involves dispersing the fiber bundles into single fibers, as in well known in the art.

The slinger **92** is preferably formed by two overlapping housing elements **94** and **95** suitably affixed to standard **22** and block **37**, respectively, as by screws **96** and **97**, respectively, acting in flange projections of the housing elements. The slinger **92** surrounds the discs **51** and **60** except for the bottom portion thereof which is open for fibers to fall onto conveyor **93**.

A better grade of pulp may be made by forming the abrader disc **51** into four radial sectors or sections as shown in FIG. **8** at **51A**, **51B**, **51C** and **51D**. These quadrants **51A—51D** are mounted concentrically about centerline **52** and are counterbalanced. The magazine disc **60** in this case carries four pins, **81A—81D**, which fit into respective slots **55A—55D** and synchronize the respective quadrants **51A—51D**. This formation insures that the paths of the chips all approximate **87** and **88** (FIG. **7**).

Referring now to the embodiment of the invention illustrated in FIGS. **9—12**, there is shown a construction in which logs rather than chips may be subjected to the epicyclic abrasion action.

A frame element **100** is provided with a circular plate **101** and downwardly and outwardly extending support legs **102**, **103** and **104** which may be affixed to the floor or a baseplate indicated diagrammatically by the dashed line **105**. A cylindrical body **106** projects upwardly from the center of plate **101**. The body **106** is preferably an integral part of the frame element **100**.

An annular bearing element **107** is mounted on plate **101** and surrounds the lower portion of body **106**. Bearing element **107** supports the lower end of an annular flange **108** which projects downwardly from an abrader disc **109**. The disc **109** has an upper abrading surface **110** which corresponds to the surface **53** of disc **51**. The center of disc **109** is bored so that the disc can be mounted on and be rotated relative to body **106**. Body **106** will be provided with a suitable bearing surface for this purpose. The centerline about which disc **109** rotates is shown at **111**.

The outer surface of annular flange **108** carries a toothed sprocket wheel **112**. An endless drive chain **113** passes around wheel **112** and connects the latter to a drive sprocket wheel **114** carried on a shaft **115**. Shaft **115** also carries a spur gear **116** which meshes with a worm gear **117** mounted on a shaft **118**. The shaft **118** is driven by an electric motor **119** through a reduction gear box **120**. The motor **119** thus serves to rotate abrasion disc **109** about centerline **111**.

As is best shown in FIGS. **10** and **12**, cylindrical block **106** is eccentrically bored to accommodate a shaft **121** which rotates about a centerline **122** which is eccentric with respect to centerline **111**.

Shaft **121** is affixed at its upper end to an inclined striker plate **123** which in turn is affixed to the under surface **124** of a magazine disc **125**. Rotation of shaft **121** about centerline **122** will thus produce corresponding rotation of disc **125** about centerline **122**.

Shaft **121** extends downward below the bottom of plate **101** and has affixed thereto a sprocket wheel **126**. An endless drive chain **127** passes around sprocket wheel **126**. Chain **127** also passes around a sprocket wheel **128** mounted on shaft **115**. The sprocket wheels are arranged so that motor **119** will cause discs **109** and **125** to rotate at the same r.p.m.

As is best shown in FIGS. **10** and **11**, under surface **124** of magazine disc **125** is shaped in the form of a one turn screw. Hence the magazine space **129** between surface **110** and **124** will have a height varying in accordance with the one turn screw shape of surface **124**.

A guard plate **130** projects upwardly from magazine disc **125**. The plate **130** has parallel sidepieces **131** and **132** joined by a semicircular piece **133** forming an open channel to receive logs. The radially inner end of guard plate **130** is approximately aligned with centerline **111** of abrader disc **109**.

Logs from a suitable source (not shown) are dropped vertically essentially in alignment with axis **122** of disc **125**. A log L in such a position is illustrated in dashed lines in FIG. **10**. As the lower edge of the log L hits striker plate **123**, the log falls sideways, as indicated by arrow **134**, into the open channel formed by guard plate **130**. The guard plate **130** is located so that logs falling into the magazine space **129** will be at the low point of the pitch of the one turn screw surface **124**. A log in this position is shown at L1 in FIG. **10**. As the log L1 abrades from action of abrasion disc **109**, the log will be carried along into the magazine space. Four successive positions of log L1 in the magazine space are shown at **135**, **136**, **137** and **138** in FIG. **11**. As a log moves on into the magazine it leaves room for a succeeding log to enter the magazine. The direction of rotation of the discs must be such as to drive the logs into the turn of the screw.

The fiber abraded from the logs by contact with abrader disc **109** escapes from between the discs **109** and **125** and is directed by a slinger or housing **139** onto a discharge conveyor belt **140**.

Since logs generally present a much larger surface than a single chip, a greater degree of eccentricity can be accommodated. Thus in handling chips, as in FIG. **1**, a typical eccentricity will be of the order of one-half inch. A typical eccentricity for the arrangement of FIG. **10** would be 2 inches. Moreover, in handling logs, as distinguished from chips, a larger error in the precision of equality of rotation can be tolerated.

In the arrangement of FIGS. **9—12** each log will be held by the magazine walls so as to be subject essentially only to straight line motion between the log and the abrader surface. However, better control of the log in this respect is afforded by the modified construction illustrated in FIGS. **13** and **14**.

Referring now to FIGS. **13** and **14**, a frame element **150** is provided with a circular plate **151** and downwardly and outwardly extending support legs **152**, **153** and **154** which may be affixed to the floor or to a baseplate indicated diagrammatically by line **155**. A cylindrical body **156** projects upwardly from the center of plate **151**. The body **156** is integral with plate **151**.

An annular bearing element **157** is mounted on plate **151** and surrounds the lower portion of body **156**. The bearing **157** supports the lower end of an annular flange **158** which projects downwardly from an abrader disc **159**. The disc **159** has an inclined upper abrading surface **160** which corresponds to the surface **110** of disc **109**. The center of disc **159** is bored so that the disc **159** can be mounted on and be rotated relative to body **156**. Body **156** will be provided with a suitable bearing surface for this purpose. The centerline about which disc **159** rotates is shown at **161**.

The outer surface of annular flange **158** carries a toothed sprocket wheel **162**. An endless drive chain **163** passes around wheel **162** and also a sprocket wheel **164** carried on a shaft **165** of a motor **166**.

Cylindrical block **156** is provided with an eccentrically located annular projection **167**. The projection **167**, block **156** and plate **151** are eccentrically bored to accommodate a vertical shaft **168**. The lower end of shaft **168** carries a sprocket wheel **169** about which passes an endless drive chain **170**. The chain **170** also passes around a sprocket wheel **171** on shaft **165**. The arrangement is such that motor **166** drives disc **159** and shaft **168** at identical r.p.m. The centerline of shaft **168** is indicated at **172** and the distance between centerlines **161** and **172** establishes the abrader-magazine eccentricity.

At its upper end shaft **168** carries a collar **173** having four yokes **174**, **175**, **176** and **177** spaced apart 90°. Each of the yokes **174—177** is connected by a universal joint to a respective one of arms **178**, **179**, **180** and **181**. The other ends of arms **178—181** are similarly connected by universal joints to yokes provided in the upper surfaces of respective ones of

channel shaped clamp elements **183, 184, 185** and **186**. The arms **178—181** are each urged to swing downwardly by a respective one of bowed spring elements **187, 188, 189** and **190** which are affixed at one end thereof to collar **173** and which bear at the other ends thereof against the corresponding ones of arms **178—181**.

Each of the clamp elements **183—186** holds a respective one of logs L2, L3, L4 and L5 firmly against surface **160** of abrader disc **159**. The relative motion of the abrader discs and the logs resulting from the eccentricity between the axis of rotation **172** of the logs and the axis of rotation **161** of the abrader disc produces the desired abrasion. As the logs become worn away by the abrasion, the arms **178—181** will be urged to swing downwardly to hold the logs against the abrasion surface **160**.

In order to control the relative motion between the logs and the abrader disc **159**, a set of ways **191** and bearing elements **192** are provided to constrain each clamp. The ways **191** are rigidly affixed to the abrader disc **159** which produces a rectilinear motion of each log with respect to the abrader disc due to the eccentricity of the abrader disc relative to shaft **168**. It will be evident that disc **159** need not be complete since an abrasion surface is only required where the logs contact the abrader disc.

Abraded fibers escape over the edge of disc **159** and are carried by a slinger or housing **193** onto a conveyor belt **194**. To avoid fibers missing the belt, the slinger **193** may be spaced very close to the periphery of disc **159** or a chute may be provided to carry fibers onto the belt.

To increase the throughput of the grinder illustrated in FIGS. **13** and **14**, additional arms and channels may be provided to hold additional logs in contact with the abrader disc. To increase the throughput of a chip grinder of the type illustrated in FIGS. **1—4**, additional discs may be mounted on common shafts, as illustrated in FIG. **15**.

Referring now to FIG. **15**, there is shown a frame **200** comprising a base **201** and spaced, parallel, upright standards **202** and **203**. The standards **202** and **203** are provided with aligned circular holes **204** and **205**, respectively, which afford bearing surfaces for a hollow shaft **206**.

A drive gear **207** is carried on the right end of shaft **206** and is arranged to be rotated through a suitable power train (not shown). The left end of hollow shaft **206** communicates with a wood chip hopper **208**. A feed screw **209** located within shaft **206** and driven by a motor **210** advances wood chips to the right along the center of shaft **206**.

The standards **202** and **203** are provided with inwardly extending annular flanges **211** and **212**, respectively, around holes **204** and **205**, respectively. The horizontal annular bearing surfaces **213** and **214** of flanges **211** and **212**, respectively, are concentric about a centerline **215** which is eccentric with respect to centerline **216** of shaft **206**.

The magazine disc of FIG. **15** is indicated generally by the reference numeral **217** and comprises three separate annular segments **218, 219** and **220**.

The segments **218** and **220** each have a projecting annular flange **221** and **222**, respectively, which rides on a respective one of annular bearing surfaces **213** and **214** to support magazine disc **217**. Segments **218—220** are held rigidly in the parallel, spaced-apart positions shown in FIG. **15** by a series of circumferentially spaced threaded bolts **221'** acting in bored flange projections **222'** extending from the periphery of the segments. The assembly is locked together in the position shown by nuts **223**.

A pair of abrader discs **224** and **225** having abrasion surfaces on both sides thereof are mounted on shaft **206** for rotation with shaft **206**. Abrader disc **224** is located midway between magazine disc segments **218** and **219** while disc **225** is located midway between magazine disc segments **219** and **220**.

Magazine disc segment **218** has an inclined annular face **226** which corresponds to the face **78** of magazine disc **60** of FIG. **2**. Magazine disc segment **220** has a similar but oppositely inclined face **227**. Magazine disc segment **219** is provided with oppositely inclined annular faces **228** and **229** opposing abrader discs **224** and **225**, respectively. The annular space between face **226** and disc **224** is designated **230**; the annular space between face **228** and disc **224** is designated **231**; the annular space between face **229** and disc **225** is designated **232**; and the annular space between face **227** and disc **225** is designated **233**. The spaces **230—233** each corresponds to the space **79** of FIG. **2**. Each of the faces **226—229** is ribbed to hold chips as described in connection with the ribs **82** of FIG. **4**.

Hollow shaft **206** is provided with spaced apertures **235, 236** and **237** communicating with the spaces **230, 231—232**, and **233**, respectively, so that chips advanced by feed screw **209** will enter the spaces **230—233**.

A drive gear **238** which may be mounted on or be integral with magazine disc segment **220** is arranged to be rotated through a suitable power train (not shown) which will drive magazine **217** at the same r.p.m. as shaft **206**.

To insure exact equality of r.p.m., a pin **239** is rigidly carried by segments **218, 219** and **220**. The pin **239** passes through elongated slots **240** and **241** provided in abrader discs **224** and **225**, respectively, and which correspond in shape and function to the slot **55** of FIG. **2**. If more than one of the pins **239** are provided they will be spaced circumferentially, preferably an equal angular distance apart and the abrader discs must be split into as many sectors as there are pins.

Fibers thrown out from between an abrasion disc and the corresponding magazine disc segment face are carried by a slinger **242** onto a discharge conveyor belt **243**.

The term "concave" as used herein to describe the face of the magazine disc which faces the abrader face of the abrader disc is intended to include both a curved concave surface and a polygonal surface having an exterior angle greater than 180°. For example, considering the magazine disc **60** of FIG. **2** to be a polygon, the exterior angle formed by the junction of the inclined portions of the surface **78** is greater than 180°. The term "epicyclic" as used herein is intended to refer to the relative motions involved resulting from eccentricity of the axes of rotation. Thus the term has reference to the conventional meaning of the motion of a small circle the center of which moves around within the circumference of a larger circle.

While the invention has been described in connection with specific embodiments thereof and in a specific use, various modifications thereof will occur to those skilled in the art without departing from the spirit and scope of the invention as set forth in the appended claims.

What I claim is:

1. A rotary groundwood mill, comprising:
   a. an abrader disc rotatable about a first axis and having an abrader face disposed transversely of said first axis;
   b. a magazine element disposed in juxtaposition with said abrader face of said abrader disc to provide a magazine space therebetween and being rotatable about a second axis parallel to said first axis and eccentric with respect thereto, said magazine element being constructed to hold a piece of wood in contact with said abrader face without substantial circumferential motion of said piece of wood relative to said second axis; and
   c. means to rotate said abrader disc and said magazine element, said means comprising a mechanical intercoupling of said abrader disc and said magazine element to compel rotation of said abrader disc and said magazine element at substantially the same rotational speeds so that said piece of wood held by said magazine element is subjected to substantially epicyclic abrasion by relative motion between said piece of wood and said abrader face of said abrader disc resulting from said eccentricity of said axes.

2. A rotary groundwood mill, comprising:
   a. an abrader disc rotatable about a first axis and having an abrader face disposed transversely of said first axis;
   b. a magazine disc disposed in juxtaposition with said abrader face of said abrader disc to provide a magazine

space therebetween and being rotatable about a second axis parallel to said first axis and eccentric with respect thereto, said magazine disc being constructed to hold wood chips in contact with said abrader face without substantial circumferential motion of said wood chips relative to said second axis; and

c. means to rotate said abrader disc and said magazine disc said means comprising a mechanical intercoupling of said abrader disc and said magazine disc to compel rotation of said abrader disc and said magazine disc at substantially the same rotational speeds so that said wood chips held by said magazine disc are subjected to substantially epicyclic abrasion by relative motion between said piece of wood and said abrader face of said abrader disc resulting from said eccentricity of said axes.

3. A rotary groundwood mill as set forth in claim 2 in which said magazine disc has a generally concave face facing said abrader face, said generally concave face having radial ribs for preventing substantial circumferential motion of said wood chips relative to said second axis.

4. A rotary groundwood mill as set forth in claim 2 in which said means to rotate said magazine disc comprises a hollow shaft communicating at one end thereof with said magazine space and in which means are provided to force wood chips through said hollow shaft and into said magazine space.

5. A rotary groundwood mill comprising:

a. an abrader disc rotatable about a first axis and having an abrader face disposed transversely of said first axis;

b. a magazine disc disposed in juxtaposition with said abrader face of said abrader disc to provide a magazine space therebetween and being rotatable about a second axis parallel to said first axis and eccentric with respect thereto, said magazine disc being constructed to hold wood chips in contact with said abrader face without substantial circumferential motion of said wood chips relative to said second axis; and

c. means to rotate said abrader disc and said magazine disc at substantially the same rotational speeds so that said wood chips held by said magazine disc are subjected to substantially epicyclic abrasion by relative motion between said piece of wood and said abrader face of said abrader disc resulting from said eccentricity of said axes, said means comprising a radially elongated slot in one of said discs radially spaced from the axis of rotation thereof and an axially extending pin projecting from the other of said discs in alignment with said slot, said pin extending into said slot to compel rotation of said discs at identical rotation speeds.

6. A rotary groundwood mill as set forth in claim 2, comprising means to adjust the eccentricity of said axes.

7. A rotary groundwood mill as set forth in claim 2 comprising means to move one of said discs in an axial direction relative to the other of said discs to thereby adjust the circumferential gap between said discs.

8. A rotary groundwood mill as set forth in claim 2 in which said abrader disc comprises a plurality of radial sectors and in which separate means is provided intercoupling each of said radial sectors and said magazine disc to prevent each of said radial sectors from rotating at a speed different from the speed of said magazine disc.

9. A rotary groundwood mill, comprising:

a. a first shaft rotatable about a first axis;

b. an abrader disc mounted on said first shaft for rotation therewith about said first axis; said abrader disc having an abrader face disposed transversely of said first axis, said abrader disc having a radially elongated slot in said abrader face at a radial position adjacent the periphery of said abrader disc;

c. a second shaft rotatable about a second axis parallel to said first axis and eccentric with respect thereto, said second shaft being hollow;

d. a magazine disc mounted on said second shaft for rotation therewith, said magazine disc having an annular face disposed in juxtaposition with said abrader face and having a central opening communicating with the hollow interior of said second shaft, said annular face being concave to define, with said abrader face, a magazine space between said discs;

e. means comprising a series of radially extending ribs on said annular face of said magazine disc to hold wood chips in said magazine space in contact with said abrader face without substantial circumferential motion of said chips relative to said second axis;

f. a pin carried on said magazine disc and projecting axially from said annular face in alignment with said slot, said pin extending into said slot to compel said discs to rotate at identical speeds;

g. means to supply wood chips to the interior of said hollow second shaft;

h. feed means arranged to force said wood chips to move through the interior of said hollow second shaft and into said magazine space; and

i. means to rotate said first and second shafts at substantially the same rotational speeds so that said wood chips in said magazine space are subjected to substantially epicyclic abrasion by relative motion between said wood chips and said abrader face resulting from said eccentricity of said axes.

10. A rotary groundwood mill, comprising:

a. an abrader disc rotatable about a first axis and having an abrader face disposed transversely of said first axis;

b. a magazine disc disposed in juxtaposition with said abrader face of said abrader disc to provide a magazine space therebetween and being rotatable about a second axis parallel to said first axis and eccentric with respect thereto, the face of said magazine disc disposed toward said abrader face being shaped as a one turn screw to hold a log or like piece of wood in contact with said abrader face without substantial circumferential motion of said piece of wood relative to said second axis; and

c. means comprising a mechanical intercoupling of said abrader disc and said magazine disc to rotate said abrader disc and said magazine disc at substantially the same rotational speeds so that said piece of wood held by said magazine element is subjected to substantially epicyclic abrasion by relative motion between said piece of wood and said abrader face of said abrader disc resulting from said eccentricity of said axes.

11. A rotary groundwood mill as set forth in claim 1 in which said magazine element comprises a clamp member constructed to hold a log or like piece of wood in contact with said abrader face without substantial circumferential motion of said piece of wood relative to said second axis and in which means is provided positively to urge said clamp member toward said abrader face.

12. A rotary groundwood mill as set forth in claim 1 in which said magazine element comprises a plurality of concentrically mounted clamp members disposed at spaced circumferential positions about said second axis and each constructed to hold a log or like piece of wood in contact with said abrader face without substantial circumferential motion of said pieces of wood relative to said second axis.

13. A rotary groundwood mill as set forth in claim 12 in which spring means are provided for each of said clamp members to urge the latter positively toward said abrader face.

14. A rotary groundwood mill, comprising:

a. a shaft rotatable about a first axis;

b. a plurality of axially spaced abrader discs mounted on said shaft for rotation therewith and each having an abrader face on each side thereof;

c. a plurality of axially spaced annular magazine discs each having a concave face disposed in juxtaposition with a respective one of said abrader faces to define an individual magazine space between each pair of juxtaposed abrader and concave faces;

d. means to retain said magazine discs as a unit and to support said unit for rotation about a second axis parallel to said first axis and eccentric with respect thereto;

e. means to supply wood chips to each of said magazine spaces;

f. means comprising radial ribs on each of said concave faces to hold wood chips in contact with the corresponding abrader face without substantial circumferential motion relative to said second axis;

g. means to rotate said shaft and said unit of magazine discs at the same rotational speed about said first and second axes, respectively, so that wood chips in each of said magazine spaces are subjected to substantially epicyclic abrasion by relative motion between said wood chips and the corresponding one of said abrader faces resulting from said eccentricity of said axes.



**15**. A rotary groundwood mill as set forth in claim **14** in which each of said abrader discs has a radially elongated slot, said slots being axially aligned, and in which pin means extending through said slots and rigidly held in said magazine discs prevents said magazine discs and said abrader discs from rotating at different speeds.

**16**. A rotary groundwood mill as set forth in claim **15** in which said shaft is hollow and in which said wood chips supply means includes the hollow space in said shaft, said shaft having a plurality of openings providing wood chip passages between the interior of said shaft and said magazine spaces.

**17**. A rotary groundwood mill as set forth in claim **1** in which said abrader face of said abrader disc is substantially flat.