

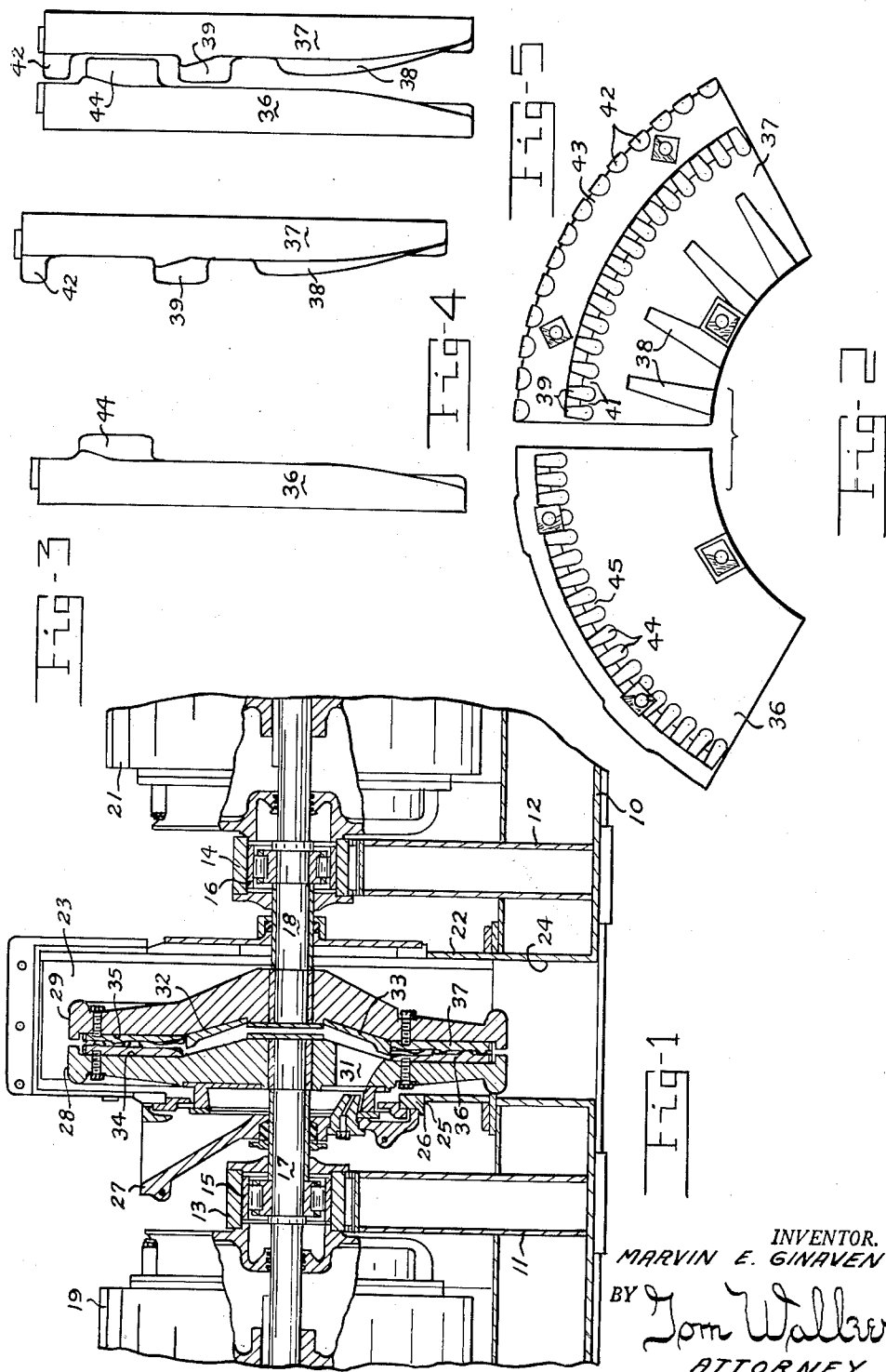
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DISC MILL

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DISC MILL

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This invention relates to relatively revolving disc mills of the attrition type, and particularly to an adaptation thereof to impact milling. While not so limited the invention has especial application to the art of cornstarch manufacture wherein a principle of impact is utilized to expose or free starch substances in fiber and corn fragments for subsequent removal by washing.

The object of the invention is to simplify the construction as well as the means and mode of operation of disc mills, whereby such mills may not only be economically manufactured, but will be more efficient and satisfactory in use, adaptable to a wide variety of applications, and be unlikely to get out of order.

It is an object of the invention to adapt an attrition type mill for impact milling of improved efficiency and results, it being the objective to accomplish by passage through a single mill of the instant invention results heretofore requiring multiple passes through fiber reduction apparatus.

Another object of the invention is to achieve a high degree of liberation of the starch substances without excessive fragmentation whereby the subsequent washing step may be carried out in the presence of coarse fibers to facilitate the movement of the wash water through the fibrous material and to restrict the carrying off of fine fibers with the starch material.

A further object of the invention is to bring about a substantial reduction in the residual starch in washed fiber as compared to prior art percentages.

Still another object of the invention is to obtain the benefits of attrition mill operation in a device of the kind described, particularly in respect of the use of separable work performing plates which can readily and quickly be replaced, an improvement accordingly being made over the stone dressing of Buhr mills and the like requiring skilled labor and days of work.

Still another object of the invention is to introduce a generally new attrition type mill characterized by double revolving discs turning in directions counter to one another and having interfitting rows of teeth or projecting lugs carrying out work upon the material to be milled in two stages in a single pass through the mill.

A further object of the invention is to provide a disc mill possessing the advantageous structural features, the inherent meritorious characteristics and the mode of operation herein mentioned.

With the above and other incidental objects in view as will more fully appear in the specification, the invention intended to be protected by Letters Patent consists of the features of construction, the parts and combinations thereof, and the mode of operation as hereinafter described or illustrated in the accompanying drawings, or their equivalents.

Referring to the accompanying drawing wherein is shown one but obviously not necessarily the only form of embodiment of the invention,

FIG. 1 is a fragmentary view in longitudinal section of a double disc revolving mill adapted for impact milling in accordance with features of the instant invention;

FIG. 2 is a view in side elevation of plates as mounted upon the respective discs and illustrating the relationship of the rows of projecting lugs thereon;

FIG. 3 is a side view of one of the pair of plates;

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FIG. 4 is a side view of the other one of the pair of plates; and

FIG. 5 is a detail view in side elevation of the pair of the plates in an operating position as assumed when installed upon the discs.

Like parts are indicated by similar characters of reference throughout the several views.

Referring to the drawing, a double disc revolving mill of the kind illustratively embodying the present invention comprises a base 10 upon which are mounted longitudinally spaced apart uprights or standards 11 and 12. These mount at their upper ends respective bearing housings 13 and 14. Within the housings 13 and 14 are respective roller bearing assemblies 15 and 16 while projecting longitudinally through the housings and rotatably mounted in the bearings therein are respective shafts 17 and 18. The latter are axially aligned with one another and project respectively from motor units 19 and 21 which when energized effect a powered rotary movement of the shafts. The motor units 19 and 21 are stationarily mounted upon the base 10.

Also mounted on the base 10 in an upright position between the bearing housings 13 and 14 is a fabricated disc housing 22 defining a substantially closed interior chamber 23 which opens at its bottom into a passage 24 through the base 10. At what may be considered to be the front of the housing 22 there is a central opening 25 into which is fitted a stationary ring 26 providing a mounting for a hopper 27. In wet milling for starch removal the material for milling is supplied to the hopper 27 in the form of a slurry which may typically be comprised of 10% starch, 10% corn fiber and 80% dilute steep water. This slurry, admitted to the chamber 23, is acted upon by discs 28 and 29 therein and permitted to pass out of the mill by way of base passage 24. The discs 28 and 29 are mounted respectively upon the inner ends of shafts 17 and 18 which project into the chamber 23 in axially aligned spaced relation to one another. The discs are fixed to their respective shafts for rotation therewith. The shafts are counter-rotating, that is, they are driven by their respective motor units in opposite directions. The discs 28 and 29 accordingly rotate counter to one another in adjacent parallel relation. The disc 28 substantially closes the front housing opening 25 and is provided near its axis with openings 31 through which the slurry from hopper 27 may be admitted to a space 32 between the discs. The openings 31 lie opposite a vaned structure 33 on the inner face of the disc 29 which supplements the natural centrifugal influence set up by the revolving discs in urging the incoming slurry radially outward for discharge at the periphery of the discs into the chamber 23. This flow-through from the central area between the discs to the peripheral discharge conventionally is used in attrition mills to carry out work upon the flowing material.

To this end peripheral portions of the discs are formed on their inner faces with circumferential planar surfaces 34 and 35. Seated on the surface 34 is a circular series of segmental plate elements 36. Seated on the surface 35 is a like series of segmental plates 37. The plates 36 and 37 are bolted otherwise removably secured to their respective discs. Thus, although constituting an integral part of the discs, the plates simplify the construction of the discs, facilitate accuracy of adjustment in the mating of opposing work surfaces and obviate the necessity for replacing entire discs when work surfaces become worn or damaged.

The plates 36 and 37 are in aligned, opposed relation with their exposed or working faces in adjacent spaced relation, portions of the respective working surfaces being adapted to interfit as will hereinafter more clearly appear. The several segments of each series of plates are identical

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so that a description of one will suffice for both. The plate segments have, as shown in FIG. 2, outer peripheries lying adjacent to the peripheries of the discs proper and inner peripheries lying adjacent to the periphery of chamber 32 between the discs. Under centrifugal influence material supplied to the chamber 32 travels radially outward between the plates 36 and 37 and is subjected to working effects by configurations on the plate surfaces. These configurations comprise, in the case of plate element 37, an arcuate series of radial vanes 38 which appear on the surface of the plate element as raised projections circumferentially spaced apart appreciable distances and of elongated extent. In concentric, radially spaced relation to the vanes 38 is a row of raised projections or lugs 39 shorter in length than the vanes 38, more closely spaced apart and having curved ends facing the inner periphery of the plate or in a direction opposed to outward travel of the material to be milled. Further, from their curved ends as noted the sides of the lugs 39 incline toward one another with the result that passages 41 are formed between the lugs which are more restricted at what may be considered their inlet ends than at their outlet ends. The arrangement is one obviating congestion of the passages since material which may enter a passage may even more easily leave it. Still further on the working surface of the plate element 37, and also in concentric radially spaced relation to the projections 38 and 39 is a further row of lugs 42. These have outer ends coinciding approximately with the outer periphery of the plate and present continuously curved surfaces to material reaching these lugs after flow through the passages 41. Radially spaced from the row of projections 39 the lugs 42 form passages 43 between them through which the flowing material may escape into the chamber 23 and be discharged from the machine as described.

The working surface of the plate element 36 as formed thereon raised projections or lugs 44 constructed like the lugs 39 on plate 37 and arranged in an arcuate row for alignment with the arcuate space between the lugs 39 and 42 on plate 37. The assembly of the mill places the discs 28 and 29 in such spaced relation as to permit the lugs 44 to be received in such space on the plate element 37, as may be seen in FIG. 3. The row of lugs 44, which defines through passages 45, may thus be described as being in interfitting relation to the rows of lugs 39 and 42 on plate 37.

In the use of the mill the material is as heretofore described admitted to the space 32 centrally of and between the discs 28 and 29. There it flows under centrifugal influence into the plate section where it is picked up by the vanes 38 and accelerated in its centrifugal force. Encountering the row of teeth or lugs 39 the material is distributed in a circumferential sense thereby and admitted to the passages 41 wherein it is given an expelling action further accelerating its movement. The material expelled from the passages 41 is directly discharged into the path of counter rotating teeth or lugs 44. These perform a function like that of the lugs 39 and develop a final acceleration of the material in which it is forcibly expelled from the passages 45 and impacted upon the surfaces of the peripheral lugs 42. The spacing and size of the lugs of the several rows have effects on the amount of action developed, these being additionally variable with variations in mill speed. The work performed upon the material, it will be understood, is due chiefly to impact which is carried out in multiple stages as the material flows through the several rows of teeth. High speed shear and cavitation effects also are developed although a cutting action is not contemplated. In an actual embodiment of the invention for purposes of starch fiber processing, radial clearances on the order of $\frac{3}{16}$ of an inch have been selected between the teeth of the outer rows, this being slightly less than the size of a kernel of corn of average dimension. The clearances between the teeth have a controlling effect on the volumetric capacity (hydraulic ca-

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capacity for wet milling) and the spacing and size of the teeth are based upon design experience.

It will be understood that a complete circle of counter rotated plates is provided on each disc, with the lugs on the exposed surfaces of the circles forming continuous rows of impact faces. The plates are bi-symmetrical in design and are, therefore reversible in rotation.

In further regard to the function of the mill it will be understood that the impacting of the fibers upon the teeth or lugs of the work plates effectively loosens the starch material without however appreciably reducing the size of the fibers, there being no appreciable grinding or attrition effects carried out thereon. As a result, the fibers remain of a large or coarse size and are more readily cleansed of the starch material. Also, fine fibrous fragments, requiring subsequent separation from the liberated starch, are not produced.

The invention as noted has specific application in the art of starch production from corn fibers. It has other applications, however, and in its concept of embodiment in an attrition type mill substantially enlarges the field of use of such mills. Wherever high impact forces are suitable for component separation or a reduction of material size, or where a thorough mixing or dispersion is required without cutting, modified attrition mills in accordance with the present inventive concept find an apt use. In connection with mixing or dispersion it will be appreciated that this is a necessary result of putting material through interfitting rows of teeth on counter-rotating discs.

In accordance with a broad aspect thereof, the invention contemplates an attrition type mill having opposing plates with raised lugs which provide rounded, leading impact surfaces, and which are elongated with tapered sections to accelerate radial flow of material being processed, which material impinges upon countermoving lugs on the opposing plate in two stages. This objective is, of course, realized through the configuration of the lugs or teeth 39, 44 and 42, and through the interfitting relationship therebetween, as will be clear from the foregoing descriptions. Facilitating the impacting concept, the through passages 43 between the teeth 44 are formed as inclined surfaces directing and deflecting the flowing material toward and into the adjacent row of teeth on the companion disc.

From the above description it will be apparent that there is thus provided a device of the character described possessing the particular features of advantage before enumerated as desirable, but which obviously is susceptible of modification in its form, proportions, detail construction and arrangement of parts without departing from the principle involved or sacrificing any of its advantages.

While in order to comply with the statute the invention has been described in language more or less specific as to structural features, it is to be understood that the invention is not limited to the specific features shown, but that the means and construction herein disclosed comprise but one of several modes of putting the invention into effect, and the invention is therefore claimed in any of its forms or modifications within the legitimate and valid scope of the appended claims.

Having thus described my invention, I claim:

1. A mill, including counter-rotating discs in side by side facing relation, a circumferential row of spaced apart lugs on the inner face of one of said discs at the periphery thereof, means for supplying material for milling between said discs centrally thereof, the rotating motion of said discs exerting a centrifugal influence upon the material, and other rows of spaced apart lugs on the inner faces of said discs delivering the material for impact upon the first said row of lugs under conditions of accelerated motion and circumferential distribution, said other rows including lugs substantially longer radially than circumferentially having their one ends facing toward said periphery, said lugs terminating at their other ends in con-

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vex shapes facing the outwardly moving material, the sides of said lugs tapering gradually toward said one end thereof to define between adjacent lugs radially elongated passages broader at their exit ends than at their entrance ends.

2. An impact mill having a pair of counter-rotating discs in side by side facing relation, means for introducing material for milling between said discs centrally thereof, the material moving radially outward between the discs for peripheral discharge; characterized by radially spaced apart means on one of said discs to distribute and accelerate motion of said material and to provide surfaces upon which the material is impacted, and a row of lugs on the other one of said discs interfitting with said means on said one disc, said lugs having curved inner ends facing in opposition to the outward travel of the material and outwardly converging sides thereon providing passages between adjacent lugs of tapering shape, broader at their outer discharge ends than at their inner entrance ends.

3. An impact mill having a pair of counter-rotating discs in side by side facing relation, means for introducing material for milling between said discs centrally thereof, the material moving radially outward between the discs for peripheral discharge, characterized by interfitting rows of projecting lugs on adjacent faces of said discs, certain of said rows having motion accelerating and distributing functions and certain others providing impact surfaces, said rows of projecting lugs including a first row on one of said discs, the individual lugs of which are spaced apart for passage of the material between them, a second row on the other one of said discs like said first row and radially outward thereof, the lugs of at least one of said rows being substantially longer radially than circumferentially and formed with tapering sides defining radial passages between adjacent lugs which are broader at their one end than at their others, and a third row on said first

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disc at the periphery thereof and radially outward of said second row, the material emerging from the passages between the lugs of said first and second rows being impacted against the lugs of said third row.

4. An impact mill having a pair of counter rotating discs in side by side facing relation, means for introducing material for milling between said discs centrally thereof, the material moving radially outward between the discs for peripheral discharge, characterized by interfitting circumferentially extending rows of projecting lugs on adjacent faces of said discs, the lugs of one row on one of said discs being formed with convex impact surfaces at their inner ends and substantially longer radially than circumferentially with a radially outward tapering formation to accelerate radial flow of the material, a row of like teeth on the other disc presenting counter moving impact surfaces upon which the material passing between the lugs of the first said row impinges.

5. An impact mill according to claim 4, characterized by an outer row of teeth on said one disc radially outward of the row of teeth on said other disc whereby the interfitting rows of teeth are arranged to effect impact milling in the manner defined in two stages.

6. An impact mill according to claim 4, characterized in that the surfaces of said plates between the lugs of at least certain rows are inclined to direct the outwardly moving material into and upon the lugs of an adjacent counter moving row.

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