Jan. 20, 1970 K. RUCKSTUHL 3,490,705

HAMMERMILL FOR GRINDING FIBROUS MATERIALS

Filed Aug. 10, 1967 3 Sheets-Sheet 1

FIG. 1.

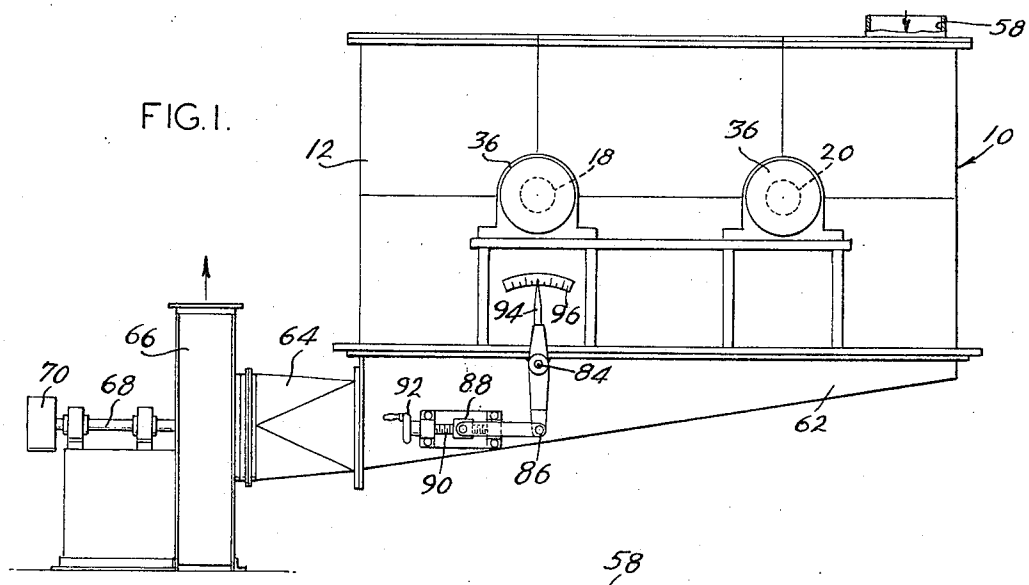
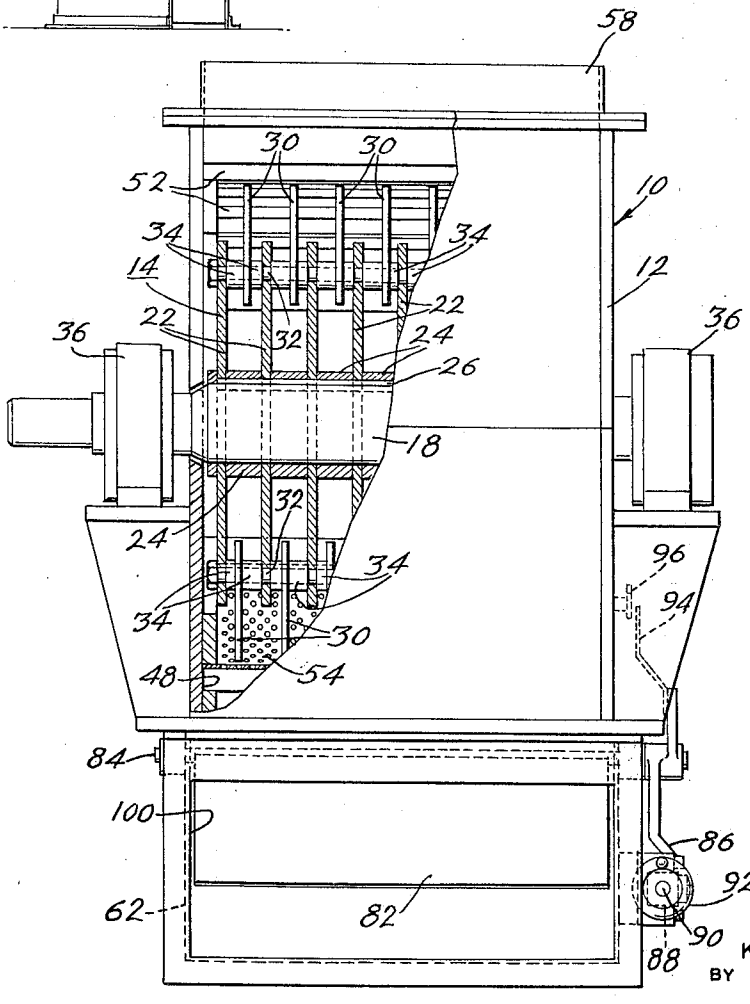


FIG. 2.



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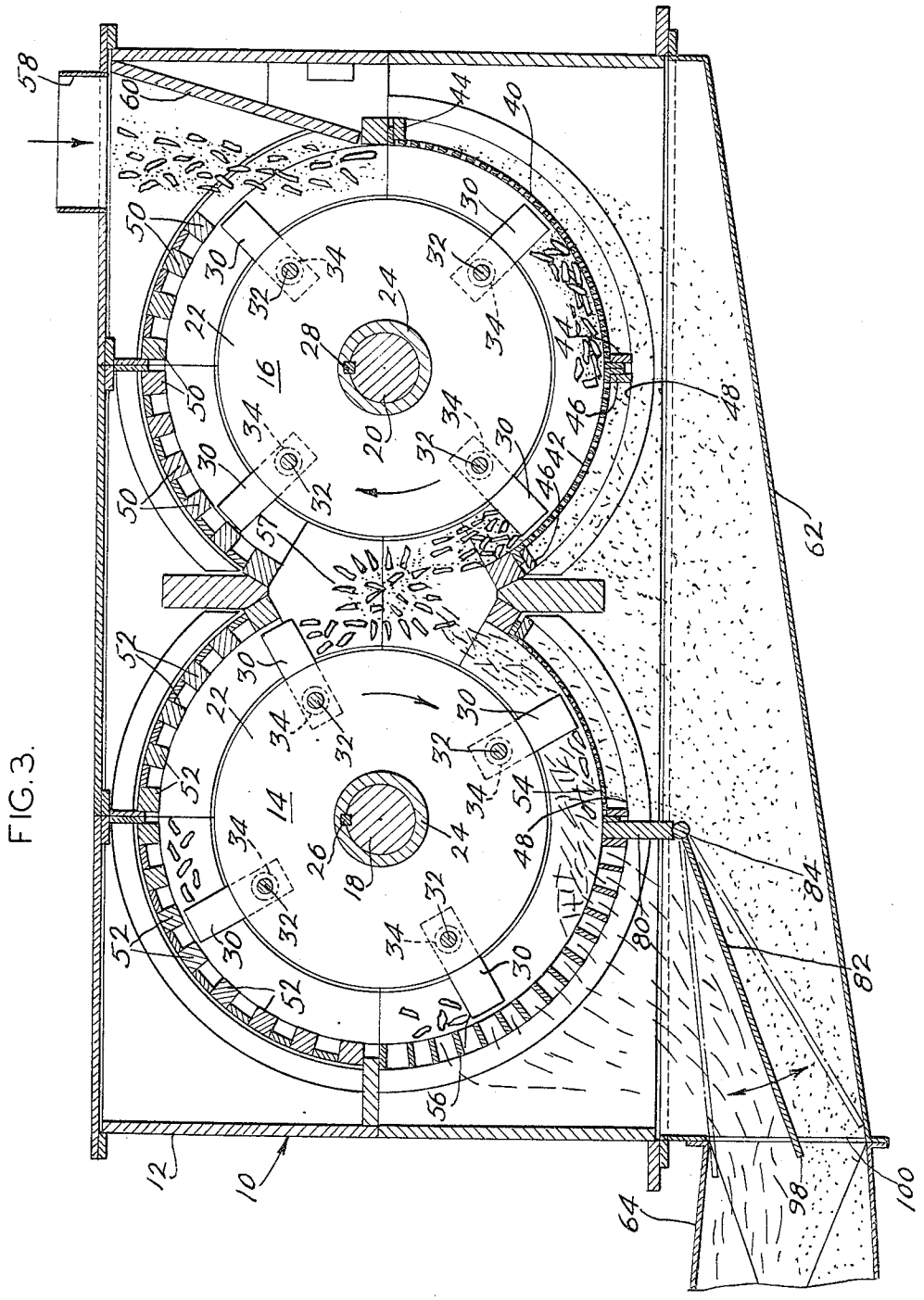


FIG. 3.

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HAMMERMILL FOR GRINDING FIBROUS MATERIALS

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FIG. 4.

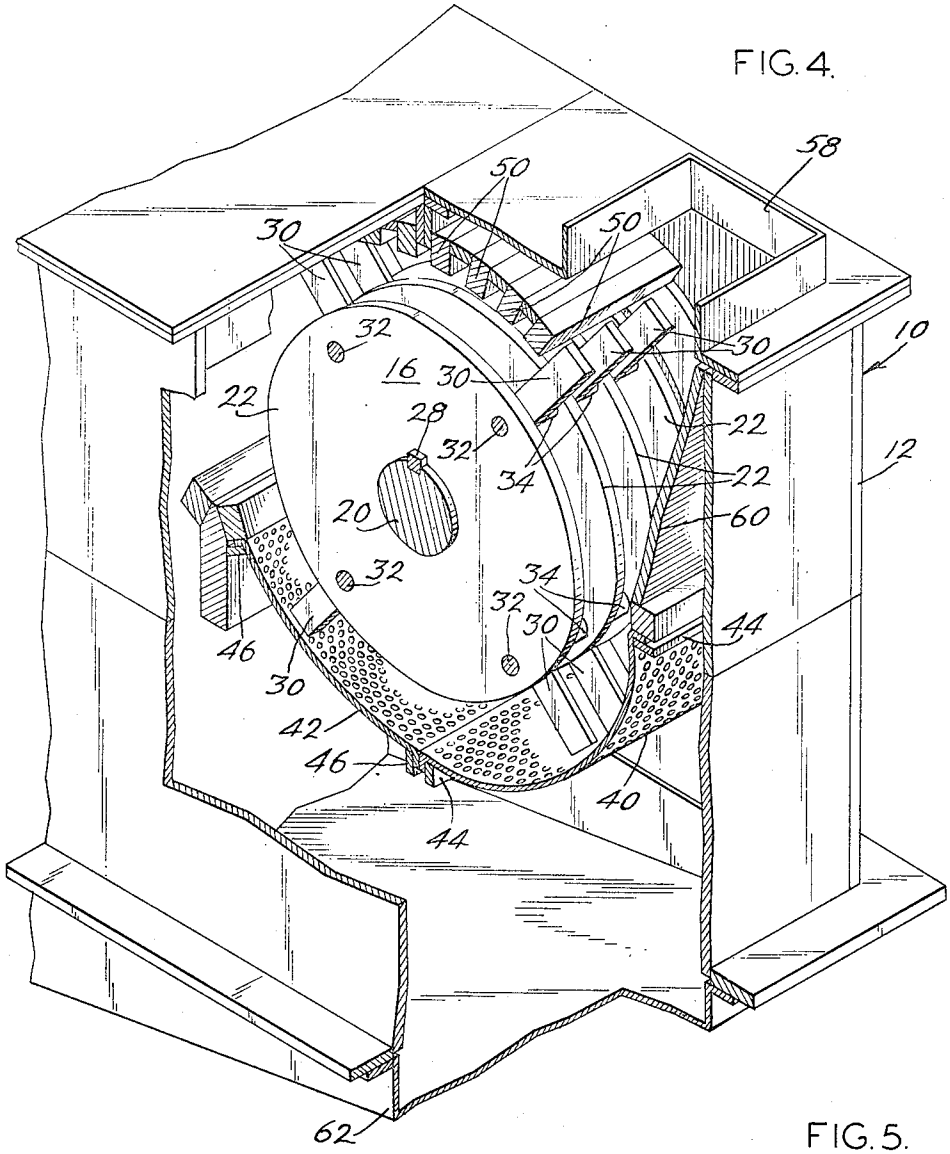
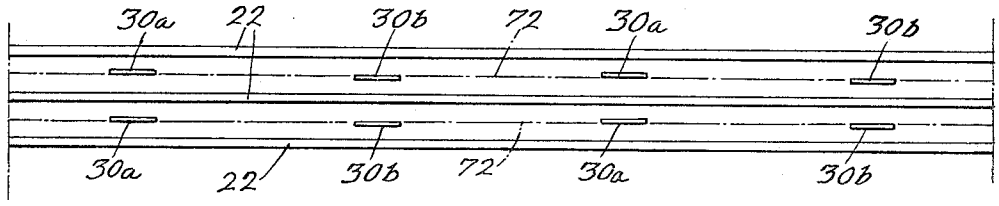


FIG. 5.



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HAMMERMILL FOR GRINDING FIBROUS MATERIALS

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Int. Cl. B02c 13/00, 23/02, 17/02
U.S. Cl. 241—186 7 Claims

ABSTRACT OF THE DISCLOSURE

A hammermill for the grinding of fibrous materials characterized by an arrangement of the hammers whereby only a small percentage of the grinding area, preferably less than 12%, is swept by the hammers. Means are further provided to control the suction on the various hammermill screens to permit a selective withdrawal of ground material.

The present invention relates generally to hammermills and relates more specifically to a hammermill adapted for the grinding of fibrous materials. The invention is particularly adapted for the grinding of the crushed remnants of sugar cane stalks known as bagasse to separate the fibrous portions of the bagasse from the adhering pith.

During the sugar cane harvest season, enormous quantities of bagasse are produced by a sugar mill. While some of the bagasse is used as a fuel in the sugar cane factories, much of it is utilized in the manufacturing of pulp, wall board and other products. Since it is not feasible to immediately process all of the bagasse to be used for manufacturing in its green condition, a large portion of the bagasse must be baled and stored until such time as the processing can be completed. During the storage period, a fermentation of the bagasse fibers takes place which changes the fibers from their tough elastic character to a hard and brittle condition. Furthermore, a certain amount of decay of fibers exposed to the elements takes place and these fibers deteriorate into a condition comaprable to that of rotten wood.

The fresh or green bagasse has a moisture content of approximately 50% and, due to its uniform elastic nature, may be ground in conventional hammermills to separate the bagasse fibers from the pith and produce a relatively uniform dust-free fiber fraction. However, in the bagasse that has been stored for a substantial period, the fibers will not be of a uniform tough elastic structure and difficulties in processing are encountered due to the low moisture content and consequent brittleness of the fibers, the higher proportion of fines and the presence of a certain portion of decayed fiber. When processed in conventional hammermills, this material produces a high percentage of fines and a relatively low fiber yield. It is for the purpose of processing such stored bagasse in a controlled manner to improve the fiber yield and quality that the present invention has been developed.

In the present invention, a hammermill of essentially conventional design is employed with important modifications which provide an unexpectedly improved processing of the bagasse and which permit in one operation a separation of the fibrous and pith fractions without the need for a prior screening of the fines. In brief, the invention is characterized by the limitation of the width and number of the hammermill hammers so that only a small percentage, preferably less than 12%, of the grinding zone is swept by the hammers. It has been found that with fibrous materials such as bagasse an unexpected turbulent attrition effect is established by such a reduction of the area swept by the hammers which it is theorized is caused by an interaction and abrading of the fibers to cause the desired separation of the fibrous fraction. While such an arrangement with other types of materials would be inefficient and clog the screens not swept by the hammers, with fibrous materials this arrangement improves the separation process and permits the timely removal of fragile materials.

A further aspect of the invention involves the provision of a means for varying the suction applied to different screen areas of the hammermill to permit selective control of the timing during which various elements of the material remain in the refining zones. For example, the fines and coarse fibers of highly fermented and hence very brittle material should be removed from the grinding zone very quickly, and this can be accomplished by intensifying the suction in the appropriate discharge chamber. By adapting the suction levels to suit the moisture content and other characteristics of the fibrous material processed, the grinding action of the mill and the resultant quality of the processed material can be selectively controlled.

In view of the above it can be understood to be a primary object of the present invention to provide an improved hammermill for the controlled processing of fibrous materials and particularly adapted for the processing of bagasse fibers to provide an improved fiber yield.

An additional object of the invention is to provide an improved hammermill as described, the operation of which may be selectively controlled to permit the processing of fibrous materials having a wide range of moisture content and fiber characteristics.

Another object of the invention is to provide an improved hammermill as described which is particularly suited for the processing of bagasse and which, in a single operation, can effectively separate the bagasse fibers from the pith fraction and which does not require the prior screening of fines from the bagasse.

Still another object of the invention is to provide hammermill improvements as described which can be inexpensively fabricated and applied to conventional hammermills without extensive modifications.

Additional objects and advantages of the invention will be more readily apparent from the following detailed description of an embodiment thereof when taken together with the accompanying drawings wherein:

FIG. 1 is a side elevational view of a hammermill embodying the present invention;

FIG. 2 is an enlarged end elevational view of the hammermill of FIG. 1 partly broken away and in section to show the details of construction;

FIG. 3 is an enlarged sectional elevational view taken longitudinally through the hammermill shown in FIG. 1;

FIG. 4 is a perspective view of one end of the hammermill shown in FIG. 1 broken away to show the details of one rotor thereof; and

FIG. 5 is a development showing the relation of successive hammers on one of the rotors of the hammermill shown in FIGS. 1–4.

Referring to the drawings, the present invention is embodied in a hammermill generally designated **10** which, in most respects, is of conventional construction. The hammermill includes a box-like casing **12** within which a pair of rotors **14** and **16** are respectively mounted for rotation on parallel shafts **18** and **20** which are disposed in the same horizontal plane. Each rotor comprises a series of spaced discs **22** coaxially mounted on the shaft. the discs being separated by tubular spacers **24** as shown in FIG. 2. The rotors are prevented from rotating with respect to the shafts by means of keys **26** and **28**.

Mounted at spaced intervals around the circumference of the rotors, in the illustrated embodiment at 90°, are rows of hammers **30** which are connected to the discs **22** by means of transverse rods **32** passing through aligned holes in the discs and through holes in the inner end of the hammers. Spacing elements **34** on the rods **32** establish the desired spacing of the hammers between the discs. As will be set forth in more detail below, the width of the hammers **30** and their number and disposition on the rotors is an important part of the present invention.

The shafts **18** and **20** are supported in appropriate bearings **36** attached to the exterior of the casing **12**. Drive means (not shown), for example directly coupled motors, are provided to drive the shafts and rotors in the same direction of rotation as indicated by the arrows in FIG. 3.

Spaced radially outwardly around the lower sector of the path of the hammers of rotor **16** are arcuate screens **40** and **42** which are respectively supported in frames **44** and **46**. The screen frames as shown in FIG. 2 are slidably mounted in grooves **48** of the casing and may be removed without removing the rotor by sliding the screens upwardly out of the top of the casing. Around an upper sector of the hammer paths are positioned arcuate toothed attrition plates **50** which are secured to the casing by means of suitable transverse support members.

The rotor **14** is similarly provided with toothed attrition plates **52** around the upper sector of the hammer paths. Around the lower sector, a first portion is provided with an arcuate screen **54** while a second sector encompassing approximately 90° of the hammer paths is provided with an arcuate screening grate **56**. A region **57** between the adjoining rotors is free of screens and attrition plates to permit a free passage and interaction of material between the adjoining rotors.

Fibrous material is introduced into the hammermill through an inlet port **58** and is channeled by an inclined plate **60** into the rotating hammers of drum **16** whereupon it is passed across the screens **40** and **42**. A substantial amount of the fines is separated through the screens and drops through the bottom of the casing into a discharge duct **62** attached beneath the casing. Material which does not pass through the screens **40** and **42** is thrown by centrifugal force into the path of the hammers of drum **14** and thence across screen **54** where an additional separation of fines takes place. The remaining largely fibrous material is carried across the screening grate **56** through which the separated fibers pass into the discharge duct **62**. The fibers requiring further attrition action are carried around the rotor against the attition plates **52** and again pass through the region **57** between the rotors wherein a turbulent encounter with materials transferred from the rotor **16** takes place.

The material passing into the discharge duct **62** passes through a connecting duct **64** and into a centrifugal extraction fan **66** from which it is discharged to a separator. The fan **66**, which is rotatably driven on shaft **68** by a suitable drive means connected at **70**, creates a substantial suction along the screens **40**, **42** and **54** and the screening grate **56** to extract the processed material from the mill and prevent clogging of the screens and grate.

The hammermill as described thus far is essentially of conventional design and construction and the improvements of the present invention described below can of course be applied to hammermills of other designs to effect an improved processing of fibrous materials.

Of particular importance in grinding fibrous materials such as bagasse is the width, spacing and number of hammers mounted on each rotor of the mill. It has been found that unexpectedly superior results are produced by limiting the path swept by the hammers in the grinding zone to less than 12% of the zone. This is a striking departure from conventional hammermill design in which the path swept by the hammers conventionally approaches 100% of the available grinding width of the mill.

The axial width of the hammers should, in the preferred embodiment, be only about 2½% of the distance between the hammer centers. In the successive rows of hammers, the hammers may be staggered in various arrangements to provide a total swept area which may for example be 5% or 10% of the screen width which defines the grinding zone. As shown in the development of FIG. 5, the hammer rows are alternately offset from the center lines **72** between the spacers **22**, the rows of hammers **30***a* adjoining the center lines on one side while the alternate rows **30***b* adjoin the center lines on the other side. If the individual rows of hammers occupy for example 2½% of the width of the grinding zone, the rotor will then with the arrangement shown in FIG. 5 sweep through 5% of the grinding zone. The rows could alternately be arranged with the hammers sweeping a non-repeating area of the grinding zone in which case the total area swept would be 10%. The schematic development of FIG. 5, which shows only two hammers of each row, due to space limitations is not drawn exactly to scale so that the hammers shown in this view as well as the other views of the drawings appear somewhat larger than the preferred with of 2½% of the available space.

As a specific example of how the invention might be applied to a conventional hammermill having a screen width or grinding zone width of 30", and in which the mill would normally be provided with 30 hammers ¾" thick between the discs to fill 75% of the grinding zone, for the application of the present invention, the 30 hammers in each row are removed and are replaced by just three hammers per row having a thickness of ¼" each. The three hammers would then sweep through only 2½% of the grinding zone. If four rows of hammers were employed as in the present invention and staggered as shown in FIG. 5, the total area swept would be 5%. In an alternative arrangement, the rows could each sweep through a different path and in this instance would sweep through 10% of the grinding zone.

An additional aspect of the present invention is the provision of means for controlling the suction affecting the various screens through which the processed material passes into the discharge duct **62**. As shown in FIG. 3 of the drawings, a downwardly extending transverse divider **80** separates the discharge from the screen **54** from the material passing through screening grate **56**. A suction control plate **82** is pivotally mounted on shaft **84** at the lower end of the divider **80**. As shown in FIG. 1, the shaft **84** extends through the side of the discharge duct **62** and is connected by a linkage **86** to a threaded element **88** on shaft **90** which is rotatable by means of hand wheel **92** to adjust the position of the suction control plate **82**. A pointer **94** on the linkage **86** indicates the position of the suction control plate by means of a scale **96**. The range of possible movement of the suction control plate **82** is indicated in broken lines in FIG. 3 where it is seen that the free end **98** of the plate may be selectively positioned in the passage **100** connecting the discharge duct **62** with the connector **64** to vary the proportionate suction applied to the screens **40**, **42** and **54** with respect to that applied to the screening plate **56**.

By varying the position of the suction control plate and hence the suction applied to the screens and screening grate, the length of time during which the material will remain within the several grinding zones and within the hammermill can be controlled. By periodically sampling and testing the processed material, the hammermill can be appropriately adjusted for the characteristics of the fibrous material being processed. This adjustability of the mill is particularly important in the processing of bagasse, since the moisture content of the bagasse varies with the prevailing climate and depending on weather conditions may vary enough to substantially change the brittleness of the fibers.

In the processing of bagasse in the above described embodiment of the invention, the newly introduced pieces of bagasse except for those fines which pass out through

the screens **40** and **42** are accelerated by the rotor **16** into the region **57** wherein they collide with material returned around the rotor **14**. The interaction of the unprocessed material with the partly processed material produces a very selective and effective grinding process, especially if fermented bagasse is present. The brittle portion of the bagasse is practically completely pulverized whereas the stronger fibrous portions are separated from the pith and reduced with the larger fibers passing through the screen grate and the smaller fibers through the screens. If desired, the divider **80** could alternately be placed between the two rotors to thus enlarge the area of the screen grate for discharge of the larger fibrous portions.

Manifestly, changes in details of construction can be effected by those skilled in the art without departing from the spirit and the scope of the invention as defined in and limited solely by the appended claims.

I claim:

1. A hammermill for the processing of fibrous materials, said hammermill comprising a casing, a material inlet duct in the top of said casing, and a discharge duct forming the bottom of the casing, a pair of rotors mounted in parallel relation on horizontal axes in said casing for rotation therein, means for driving said rotors in the same rotational direction, a plurality of hammers arranged in rows on said rotors, arcuate screens closely spaced adjacent the paths of said hammers and defining a grinding zone swept by said hammers, said hammers of each rotor sweeping through an area of said grinding zone comprising 12% or less of the width of the grinding zone, means producing a suction in said discharge duct to effect a free passage of material through said screen, said screens being of different sizes, and means for selectively varying the suction applied to the different sized screen to permit selective control of the attrition effect imparted to the material fractions.

2. A hammermill as claimed in claim **1** wherein said means for selectively varying the suction applied to the screens comprises a suction control plate pivotally mounted in the discharge duct, and means for selectively positioning said suction control plate.

3. In a hammermill having material discharge screens of different sides opening into a common discharge duct and upon which a suction is applied to effect a free movement of material through the screens, the improvement for the processing of fibrous materials comprising means for selectively varying the suction applied to the different sided screens to permit selective control of the attrition effect imparted to the material fractions.

4. A hammermill as claimed in claim **3** wherein said means for selectively varying the suction applied to the screens comprises a suction control plate pivotally mounted in the discharge duct, and means for selectively positioning said suction control plate.

5. A hammermill as claimed in claim **4**, said hammermill including a screening grate for discharge of large fibrous portions, and a screen for discharge of fines and small fibrous portions, a divider in said discharge duct separating the material discharged from said grate and screen, said suction control plate being pivotally mounted at the lower end of said divider.

6. In a hammermill comprising at least one rotor rotatably driven adjacent a screen and having a plurality of hammers arranged in rows around the periphery thereof adapted to sweep in closely spaced proximity to the screen surface for the grinding of material therebetween, the improvement for the processing of fibrous materials comprising the restriction of the width of the grinding zone swept by the hammers to 12% or less of the screen width, the rows of hammers being alternately staggered.

7. A hammermill as claimed in claim **6** wherein the individual hammers each are in width approximately 2½% of the axial distance between hammers.

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U.S. Cl. X.R.

241—86, 191

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(5/69)

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,490,705 Dated January 20, 1970

Inventor(s) Konrad Ruckstuhl

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 2, line 13, change "timing" to --time--.
Column 4, line 23, change "with" to --width--.
Column 5, line 43, change "sides" to --sizes--.
Column 6, line 5, change "sided" to --sizes--.

SIGNED AND
SEALED
JUN 16 1970

(SEAL)
Attest:

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