May 23, 1933. W. T. DOYLE 1,910,382

METHOD OF AND APPARATUS FOR SLUSHING PULP SHEETS

Filed Aug. 5, 1932 2 Sheets-Sheet 1

Fig. 1.

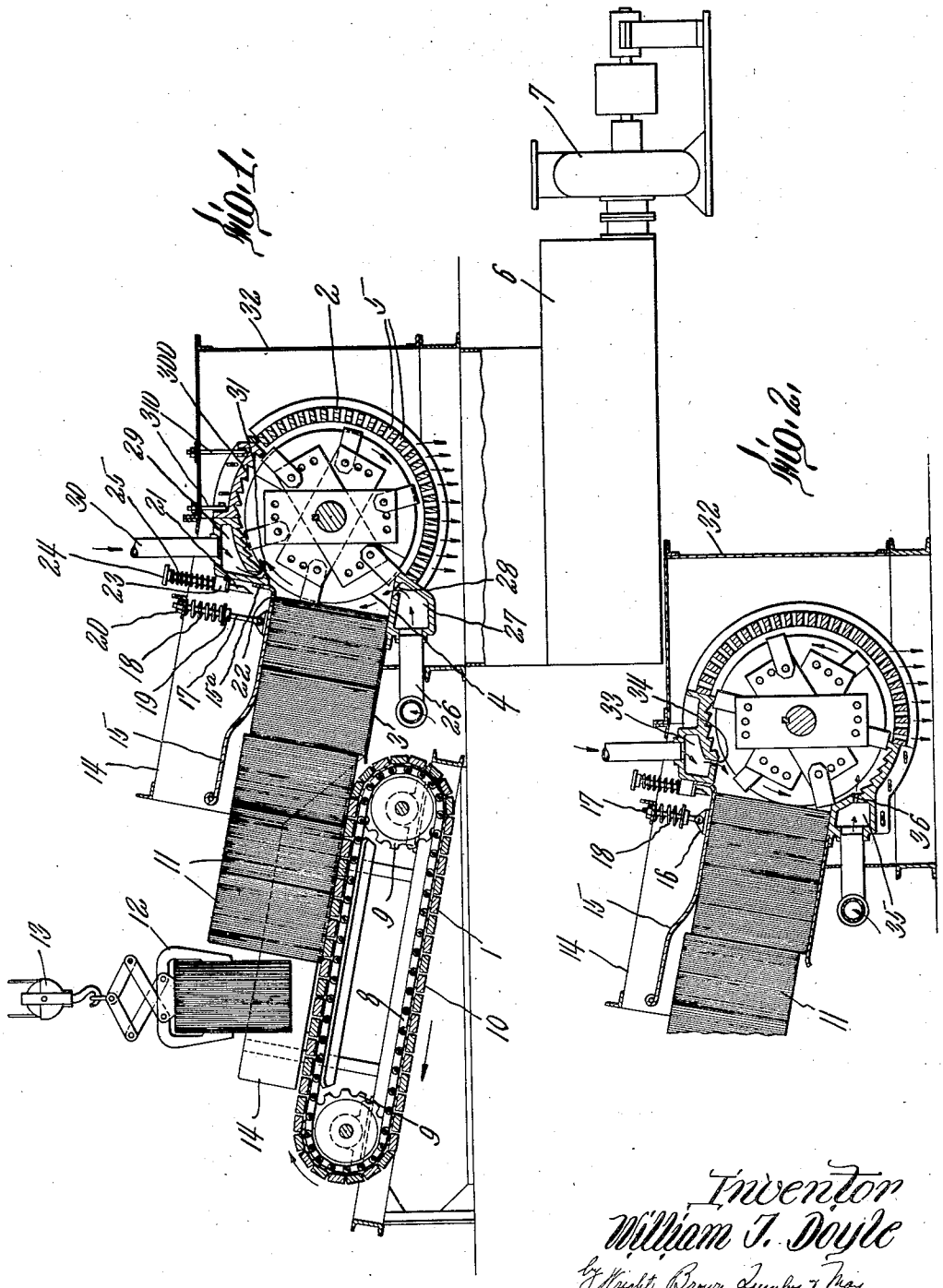


Fig. 2.

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METHOD OF AND APPARATUS FOR SLUSHING PULP SHEETS

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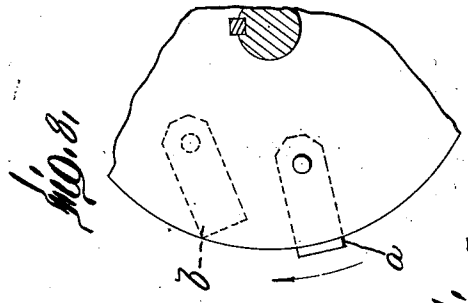


Fig. 8.

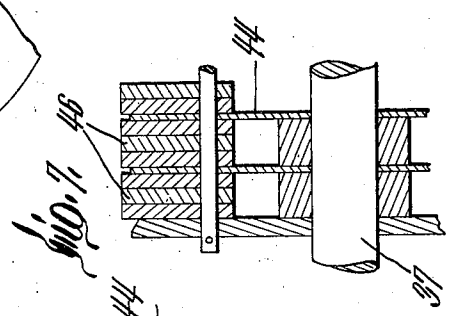


Fig. 7.

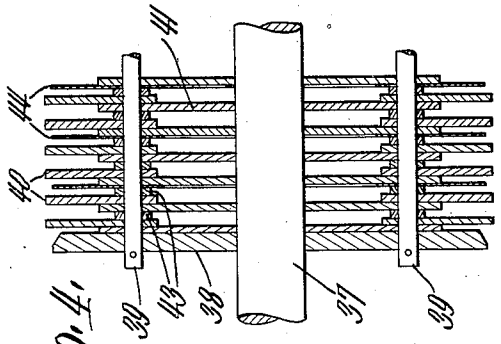


Fig. 4.

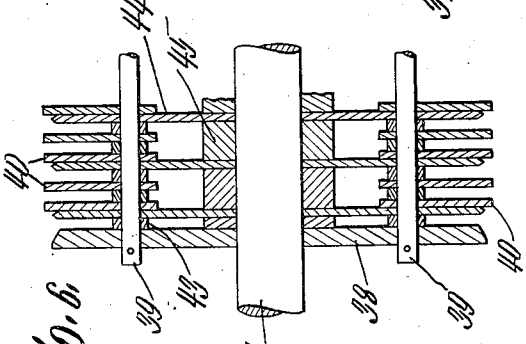


Fig. 6.

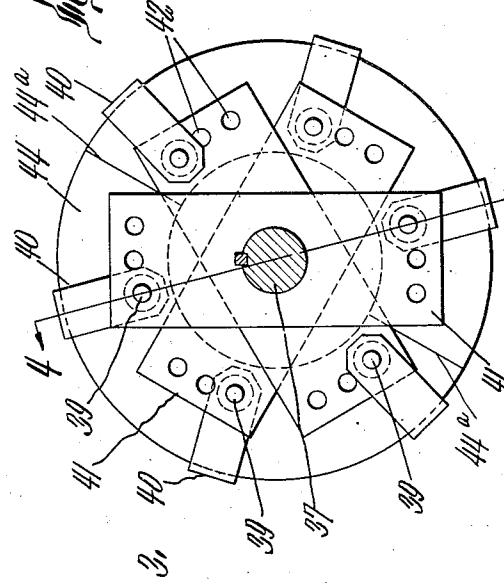


Fig. 3.

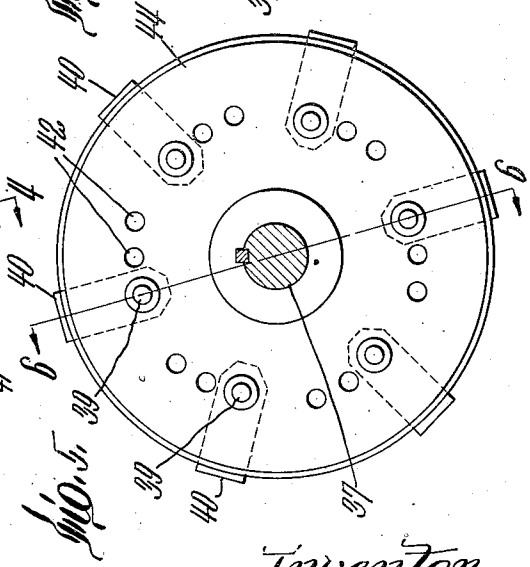


Fig. 5.

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UNITED STATES PATENT OFFICE

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METHOD OF AND APPARATUS FOR SLUSHING PULP SHEETS

Application filed August 5, 1932. Serial No. 627,547.

In the papermaking industry, the stock used as raw material sometimes comes in baled sheet form. The usual chemical wood pulp, such as kraft and sulphite, is generally marketed in this condition, and hence must be slushed in water and hydrated by the papermaker preparatory to conversion into paper or similar manufactures. Heretofore, the usual beater engine of hollander has been relied upon by the papermaker for disintegrating the pulp, as well as for hydrating the pulp fibers to the condition desired in papermaking. The beater engine is, however, ill adapted to operate upon pulp sheets, not only because the sheets must be introduced gradually by an operator into the engine in order to avoid overloading of the engine, but further because the efficiency and capacity of a beater engine in doing this kind of work is poor.

I have found that a rotary hammer mill can be made to operate with high efficiency and at a high capacity in the slushing of pulp sheets in water, provided that the sheets and water are fed thereto in the proper way and that the mill is designed to accommodate the sheets without sudden overload or choking as they are being fed thereto. The rotary hammer mill which I employ has an intake opening capable of accommodating a whole sheet of pulp as well as having a restricted discharge made up of one opening or a plurality of small discharge openings through which the resulting slushed pulp can pass. In accordance with my invention, a succession of sheets constituting the contents of a number of bales are fed progressively in contacting face-to-face relationship facewise to the intake opening of the mill. This means that each sheet is successively exposed to the disintegrating action of the mill, and that as the sheets are being consumed by the mill, whole bales may be furnished to replace them. I have found that this sort of practice makes for high efficiency, because of the smoothness of action of the hammer mill on the sheets as they are presented individually in flat condition to the hammers. In other words, the hammer mill is under a substantially steady load, because the hammers constantly encounter the resistance of what is in effect an unvarying work area. A hammer mill thus run has a large production capacity and needs little, if any, attention by an operator.

The hammer mill is supplied with water at its intake opening, so as to promote the disintegrating action of the sheets, as well as to carry the stock through the mill, wherein it is reduced to the desired aqueous slush passing through the small discharge openings. The water is preferably delivered as a stream over the face of each sheet as it is exposed to the disintegrating action of the mill essentially in the direction of rotation of the mill, in order to assist the desired flow of the stock through the mill.

With the foregoing and other features and objects in view, the present invention will now be described in conjunction with the accompanying drawings, wherein

Figure 1 represents largely a longitudinal section through apparatus embodying the present invention and including a rotary hammer mill running upwardly past the pulp supply.

Figure 2 is a similar view at the hammer mill end of similar apparatus, wherein the hammer mill is designed to run in the opposite direction.

Figure 3 is an end view of the hammer mill rotor, the end plates of which are removed for the sake of clarity.

Figure 4 constitutes a fragmentary section on the line 4—4 of Figure 3.

Figure 5 illustrates, like Figure 3, another rotor construction.

Figure 6 constitutes a section on the line 6—6 of Figure 5.

Figure 7 shows a modified hammer construction on a rotor such as shown in Figure 6.

Figure 8 depicts schematically how a hammer reacts when it comes in contact with the mass of pulp sheets.

Referring first to Figure 1 of the drawings, 1 represents an endless conveyor, which may be arranged at a slight angle of inclination to a rotary hammer mill 2. Bales of pulp sheets are placed on the conveyor, which takes them

to an inclined platform 3 leading to the intake opening 4 of the mill. The stock carried into the mill is reduced to an aqueous slush, which passes through small discharge openings 5 to a storage tank 6, from which it may be removed by a pump 7 to a beater or Jordan, preparatory to papermaking.

The conveyor 1 may be of any sturdy type, say that shown, comprising a chain 8 passing over terminal sprockets 9, and a series of closely spaced slats 10 fixed transversely to the chain links and affording a flat, rigid support for the pulp sheets. The contents of a number of bales 11 are constantly kept on the conveyor and on the platform 3 while the apparatus is in operation so as to provide adequate pressure of contact between the sheets and the hammers. The sheets, which are kept in the same face-to-face contact as they were in the bales, proceed facewise toward the intake opening 4 of the mill, which is of a size capable of accommodating a whole sheet at once. An entire bale may, as shown, be transported to the conveyor as by tongs 12 suspended from hoisting mechanism 13, which may be run on a track (not shown). Suitable partitions 14 may be provided at the sides of the conveyor, to keep the sheets properly aligned as they are moving toward the hammer mill. The conveyor moves the sheets at substantially the same rate as they are being slushed by the hammer mill, for which purpose either sprocket 9 of the conveyor may be rotated at the proper speed by suitable driving means (not shown).

It is desirable to close that portion of the intake opening unfilled with pulp sheets as well as to prevent an upward movement of the sheets as they are being acted upon by the hammers. This can be done by providing an adjustable plate 15 which bears upon the upper edges of the front sheets, through the action of a presser foot 16 pivoted at the lower end of a rod 17. A compression spring 18 encompassing the rod 17 and held between a collar 19 and a nut 20 in threaded engagement with the upper end of the rod, furnishes a yielding resistance, which can be varied by turning the nut 20. The supply of sheets to the hammer mill may be cut off momentarily without stopping the hammer mill, as by a spring-pressed plunger 21 having a beveled lower edge adapted to pass through an opening 22 in the plate 15 and to stop the progress of the sheets. The plunger, which is preferably stationed near the intake opening of the hammer mill, can conveniently pass through a bearing 23 projecting from the hammer mill casing and serving, together with the handle portion 24 of the plunger, to confine a compression spring 25 therebetween. While the hammer mill is in operation, its intake opening is completely closed against leakage, since, as shown, the front marginal portion 15*a* of the plate 15 is bent upward so as to abut tightly against the upper edge of the casing and the sheets between the platform 3 and the plate 15 effectively block the opening.

The front sheet of the pulp supply receives a rapid succession of hammering, abrading or combing impacts and is thereby disintegrated and carried into the mill. To promote this disintegration, as well as to assist the hammers in carrying the stock into the mill, a stream of water is preferably played over the face of the sheet. With the hammers moving upwardly past the pulp supply, as shown in Figure 1, it is preferable to introduce the water from a pipe 26 into a chamber 27 near the lower edge of the intake opening and having a discharge orifice 28 designed to deliver a stream of water upwardly over the sheet in the general direction of rotation of the mill. As the wet stock enters the mill, it may be diluted to the desired consistency by water streaming into the mill from a chamber 29 arranged near the upper edge of the intake opening. This chamber may be supplied with water from a pipe line 30 and have a discharge orifice 31 also delivering the water in the general direction of rotation of the mill. The inside of the mill casing is preferably ribbed or serrated over a substantial zone, especially near the upper edge of the intake opening, so as to cooperate effectively with the hammers in reducing the stock to the desired slushed condition. The ribbed section of the casing may be adjustable toward and from the hammers so as to permit the reducing action on the stock to be regulated, but only a portion 300 of this section is shown on the drawing as being adjustable by means of fastening bolts 310. The rest of the casing may be slotted transversely to provide the small discharge openings 5, through which the slushed pulp passes to the tank 6. The hammer mill is shown mounted within a suitable enclosure 32 serving to direct the material discharged from the mill into the tank 6.

I have found that in operating a hammer mill as shown in Figure 1, it is distinctly preferable that the center line through the successive sheets be offset below the axis of rotation of the mill. Otherwise, there is a tendency for the upper portions of the sheets to be left as an overhanging block presenting many sheet edges, which interfere with the smooth running of the mill. With the center line through the sheets offset downwardy of the axis of rotation of the mill, as shown in Figure 1, the sheets are completely and smoothly disintegrated in succession, particularly since water impinges first on the lower end of each sheet and then rises upwardly so as to sweep the disintegrated stock into the mill. When the hammer mill rotates downwardly past the sheets, as shown in Figure 2, the center line through the

sheets is preferably offset upwardly of the axis of rotation of the mill, as shown in that figure. In such latter case, it is desirable that the flow of water past the sheets be in a downward direction, so as to sweep the disintegrated stock into the mill. The upper water chamber 33 of the mill is shown provided with an orifice 34, from which water streams essentially in the direction of rotation of the mill. So, too, the lower water chamber 35 emits water through an orifice 36 in the direction of rotation of the mill. The interior of the mill near both the upper and lower edges of the intake opening may be ribbed or serrated, as shown, whereas the rest of the mill may be slotted to permit the discharge of the slushed stock. This means that upon entering the mill, the stock will undergo reduction, and if this reduction is insufficient to cause its discharge, it will have further opportunity to be broken up before it is circulated past the fresh supply of pulp stock, thereby ensuring smooth action on the fresh supply.

The rotor of the hammer mill may be constructed in any suitable way, but I have shown rotors especially effective in their action on the pulp sheets fed as hereinbefore described. As shown in Figures 3 and 4, the rotor may include a shaft 37 and enlarged head-plates 38 keyed thereto and serving as the supports for rods 39 on which rows of hammers 40 are swingably mounted in suitably spaced relationship. The rods 39, which extend axially of the rotor, may be equispaced about the head plates and be sufficiently removed from the axis of the rotor so that the hammers 40 need be comparatively short and yet barely clear the casing of the hammer mill in radially extended position. The spacers between successive hammers of a row include bars 41 keyed to the shaft 37. Each bar preferably has a number of openings 42 near each end for receiving each rod 39. These openings, which are arranged at different distances from the axis of the rotor, permit remounting of the hammers after they have become worn, so that their outer ends clear the rotor casing to the desired slight extent. These openings also permit control of the depth of the cutting or shredding action on the sheets by the hammers, thereby preventing irregular shredding or disintegration. The headplates 38 are also preferably provided with a number of openings aligned with those in the bars 41. Washers 43 are shown on the rods 39 next to each bar 37, and so, too, annular plates 44 of an outer diameter substantially corresponding to the head plates 38 are preferably arranged between every other washer 43 and bar 41. These plates may be apertured like the bars 41 and the head-plates 38 to permit the rods 39 to pass therethrough and may be split on the lines 44*a* so that they may be easily assembled and disassembled on the rods 39. They serve the function of keeping the front sheets of pulp from flexing and falling into the rotor before they have been properly disintegrated. The outer ends of the hammers preferably project only slightly beyond the marginal edges of the head-plates 38 and the plates 44. It is preferable that the hammers of the successive rows be staggered so as to act upon substantially the entire area of each pulp sheet. This can be readily done by assembling the rotor so as to have the hammers of one row occur where the bars and/or washers and/or disks of a preceding or succeeding row occur.

A rotor of simpler construction is shown in Figures 5 and 6. Here there are no bars 41, but the hammers 40 are mounted on the rods 39 between the washers 43, and, as in the rotor just described, the plates 44 are provided next to every other hammer. If desired, suitable rings 45 may be mounted on the shaft 37 between the plates 44, to hold them steady. The plates 44, and so, too, the head-plates 38, may have a plurality of the openings 42 therein, permitting reassembly of the hammers when they have become worn. A still simpler type of rotor is shown in Figure 7, wherein the washers 43, as well as the bars 41, are omitted, and wherein a gang of hammers 46, say three, are mounted between the plates 44, which serve as the only spacing elements between the gangs of hammers.

Using any one of the types of rotors herein described, the action of the hammer mill is as depicted in Figure 8. Upon initially striking the front sheets of the pulp supply, a row of hammers in radially extended position *a* meets with such resistance that the hammers are gradually deflected and caused to swing inwardly to the position *b*, where their tips or outer ends coincide with the marginal edges of the disks 44. The disks 44 thus serve to maintain the sheets substantially vertically and thus to avoid the presentation of sheet edges to the rotor. After the hammers have moved past the pulp supply, this resistance is, of course, immediately removed and they swing back to their radially extended position to effect the desired disintegrating and brushing action on the stock. The combined action of the hammers 40 and the disks 44 on the pulp supply is to break up the sheets into pieces and/or ribbons as they are successively exposed, the rate of disintegrating depending upon the force with which the sheets are fed, and accordingly the resistance with which the hammers meet them.

In operating with comparatively dense sheets of pulp, I have observed that each sheet presented to the rotor tends to become displaced and to enter the zone of action of the hammers. Indeed, when the hammer mill is run as shown in Figure 1, there is a successive movement of the sheets into the zone of

action of the hammers, so that, while one sheet is undergoing the initial stages of disintegration, a preceding sheet has already moved forward and is undergoing the finishing stages of disintegration prior to going into the mill. This upward movement of the sheets is promoted, not only by the action of the stream of water impinging against the lower portion of each exposed sheet, but also by the incompletely slushed pulp constantly circulated past the exposed sheets. What I have said concerning the action of the rotor on the sheets when the rotor is moving in the clockwise direction shown in Figure 1, holds true when the rotor is progressing in the anti-clockwise direction shown in Figure 2. In the latter case, however, there is a tendency for the water to pass through the discharge openings prematurely, that is, before complete pulping has been realized. This means a lower output of pulped stock with a given size of discharge opening. Consequently, it is preferable to operate the mill with the rotor moving in an upward direction past the sheets. With the rotor moving upwardly past the sheets, the force of gravity assists the discharge of the slushed pulp from the mill. With a rotor moving downwardly past the sheets, it becomes necessary to carry the water and pulp against gravity to those discharge openings on the side of the hammer mill. Inasmuch as the casing of the mill is preferably provided with as large a discharge area as possible, and hence with discharge openings on the side opposite to the intake opening of the mill, it is desirable to invoke the assistance of gravity in discharging the slushed pulp through the side discharge openings and thus to reduce the power consumption of the apparatus.

The hammer mill of the present invention can be efficiently operated at a rotor speed of 1200 revolutions or more per minute. The diameter of the rotor may, in such case, be two feet, wherefore the tips of the hammers may move at a speed of 7200 or more feet per minute. One of the advantages of using a hammer mill in acordance with my invention it that although the pulp fibers become individualized and suspended in water to form a pulp suspension or slush, the fibers are not cut or reduced in length. On the contrary, the tendency is to hydrate the fibers, with no appreciable diminution of fiber length. The extent to which the fibers become hydrated depends upon the size and number of discharge openings in the hammer mill, and accordingly upon the number of times that the pulp is recirculated through the mill. By operating with comparatively small discharge openings, it is possible to effect the hydration of the pulp fibers to such an extent that little, if any, subsequent beating will be necessary to condition them for papermaking. This, however, involves a sacrifice in the output of the mill. By operating with comparatively large discharge openings, say, of about ¼ inch width or greater, it is possible to slush the pulp sheets at a high capacity and with a minimization of the power subsequently expended in a beater or Jordan to condition the slush for papermaking. The amount of water fed into the mill may be varied, but I propose to use sufficient to yield a slush of about 5% stock concentration. Such a slush flows readily and is of a consistency to be acted upon at once by a beater or Jordan.

It is thus seen that in accordance with my invention, I feed sheeted pulp forcibly toward the intake opening of the hammer mill as a succession of superposed layers presenting practically no sheet edges to the hammers. As one layer is broken away and carried into the mill by the water, the next layer is prepared for similar action. I have found that unless I avoid the presentation of sheet edges to the hammers, the action of the hammers is irregular and the friction of the sheet edges against the hammers leads to comparatively poor slushing action on the sheets and high power consumption for a given output of slushed pulp. The action of the mill on each pulp sheet is initially that of shredding the sheet substantially only facially while water is being played on the face thereof, whereupon, the shredded stock enters the mill wherein it undergoes the further reducing action in the presence of water to form a completely slushed pulp which is discharged from the mill. The condition of the pulp discharged from the mill depends upon the size and number of discharge openings, for if these factors of design be such as to permit of recirculation of the stock a number of times before its discharge, the pulp being discharged will of course require less beating and/or Jordaning to acquire the proper condition for papermaking.

I claim:

1. A method of slushing sheeted pulp in water which comprises introducing the sheet into a rotary hammer mill under conditions to effect substantially only a facial shredding thereof, playing water onto the sheet while it is undergoing such shredding action, and then subjecting the shredded stock to the action of said hammer mill in the presence of water to produce a completely slushed pulp.

2. A method of slushing sheeted pulp stock in water by the action of a rotary hammer mill having an intake opening and a restricted discharge, which comprises forcibly feeding such pulp to the intake opening as a succession of superposed layers presenting practically no edges to the hammers, and introducing water into the mill while such feeding is taking place and while carrying the disintegrated stock into the mill, wherein it is reduced sufficiently to be discharged.

3. A method of slushing sheets of pulp in water by the action of a rotary hammer mill having an intake opening of a size substantially accommodating a whole sheet and a restricted discharge, which comprises forcibly feeding a succession of said sheets in contacting face-to-face relationship facewise toward said intake opening, thereby exposing each sheet successively to the disintegrating action of said mill, and delivering a stream of water over the face of each sheet while it is thus exposed and while carrying the disintegrated stock into the mill, wherein it is reduced sufficiently to be discharged.

4. A method of slushing sheets of pulp in water by the action of a rotary hammer mill having an intake opening of a size substantially accommodating a whole sheet and having a plurality of small discharge openings, which comprises forcibly feeding a succession of said sheets in contacting face-to-face relationship facewise toward said intake opening, thereby exposing each sheet successively to the disintegrating action of said mill, and delivering a stream of water in the direction of rotation of said mill over the face of each sheet while it is thus exposed and while carrying the disintegrated stock into the mill, wherein it is reduced to a slush passing through said small discharge openings.

5. A method of slushing sheets of pulp in water by the action of a rotary hammer mill having on one side an intake opening of a size substantially corresponding to a sheet and on the opposite side a plurality of small discharge openings, which comprises forcibly feeding a succession of said sheets in substantially vertical contacting relationship facewise toward said intake opening, thereby exposing each sheet successively to the disintegrating action of said mill, and delivering a stream of water upwardly over the face of each exposed sheet and simultaneously rotating the mill in a direction corresponding to the upward flow of the stream of water to reduce the disintegrated stock to a slush passing through said small discharge openings.

6. Apparatus for slushing sheeted pulp in water, comprising in combination a rotary hammer mill having an intake opening and a plurality of small discharge openings, means for forcibly feeding a succession of layers of such pulp in contacting face-to-face relationship toward said intake opening, and means for delivering a stream of water over the pulp as it is undergoing the disintegrating action of said mill.

7. Apparatus for slushing sheets of pulp or the like in water, comprising in combination a rotary hammer mill having on one side an intake opening of a size substantially corresponding to a whole sheet and a plurality of small discharge openings, an endless conveyor arranged to feed a succession of said sheets in substantially vertical contacting relationship facewise toward said intake opening, and means for delivering over the face of each sheet as it is exposed to the disintegrating action of said mill a stream of water in the general direction of the rotation of said mill.

8. Apparatus for slushing sheets of pulp or the like in water, comprising in combination a rotary hammer mill having on one side an intake opening of a size substantially corresponding to a whole sheet and a plurality of small discharge openings, and means for forcibly feeding a succession of said sheets in substantially vertical contacting relationship facewise to said intake opening, the rotor of said hammer mill including a series of spaced annular plates, rods passing through said plates, and hammers swingably mounted on said rods between said plates and projecting only slightly beyond the marginal edges of said plates, whereby when said hammers are caused to retract within said marginal edges by impact with said sheets, said sheets will be supported substantially vertically by said plates.

9. Apparatus for slushing sheets of pulp in water comprising in combination a rotary hammer mill having an intake opening capable of accommodating substantially a whole sheet of pulp and a plurality of small discharge openings, means for forcibly supplying a succession of said sheets in contacting face-to-face relationship facewise toward said intake opening with the center line through said sheets offset from the axis of rotation of said hammer mill, and means for introducing water into said hammer mill during its operation, to wet the front end of said pulp supply.

10. A method of slushing bales of fibrous material in water by the action of a rotary hammer mill having an intake opening and a restricted discharge, which comprises forcibly feeding said bales to the intake opening while presenting substantially an entire face of the bales to the action of the hammers, and introducing water into the mill while such feeding is taking place and while carrying the disintegrated fibrous material into the mill, wherein it is reduced sufficiently to be discharged.

11. A method of slushing bales of cellulose fiber stock in water by the action of a rotary hammer mill having an intake opening of a size substantially corresponding to an entire face of the bales, which comprises forcibly feeding said bales while presenting said entire face to said intake opening and exposing it to the disintegrating action of said mill, and delivering a stream of water over said face of the bales while it is thus exposed and while carrying the disintegrated stock into the mill, wherein it is reduced sufficiently to be discharged.

12. A method of disintegrating bales of

fibrous material by the action of a rotary hammer mill having an intake opening and a restricted discharge, which comprises forcibly and progressively feeding said bales to the intake opening while presenting substantially an entire face of the bales to the action of the hammers, and progressively running a fluid medium through the mill while such feeding is taking place and while carrying the disintegrated fibrous material into the mill, wherein it is reduced sufficiently to be swept out of said discharge by said fluid medium.

In testimony whereof I have affixed my signature.

WILLIAM T. DOYLE.