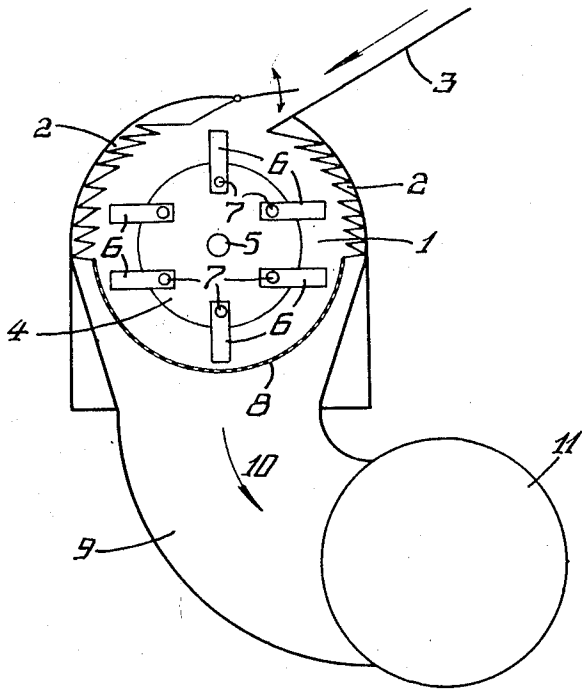
Oct. 27, 1964 G. V. C. VAN DOOSSELAERE 3,154,464

PLANTS FOR WASHING AND DEFIBERIZING FIBROUS MATERIAL

Filed June 25, 1959 5 Sheets-Sheet 1

Fig. 1.



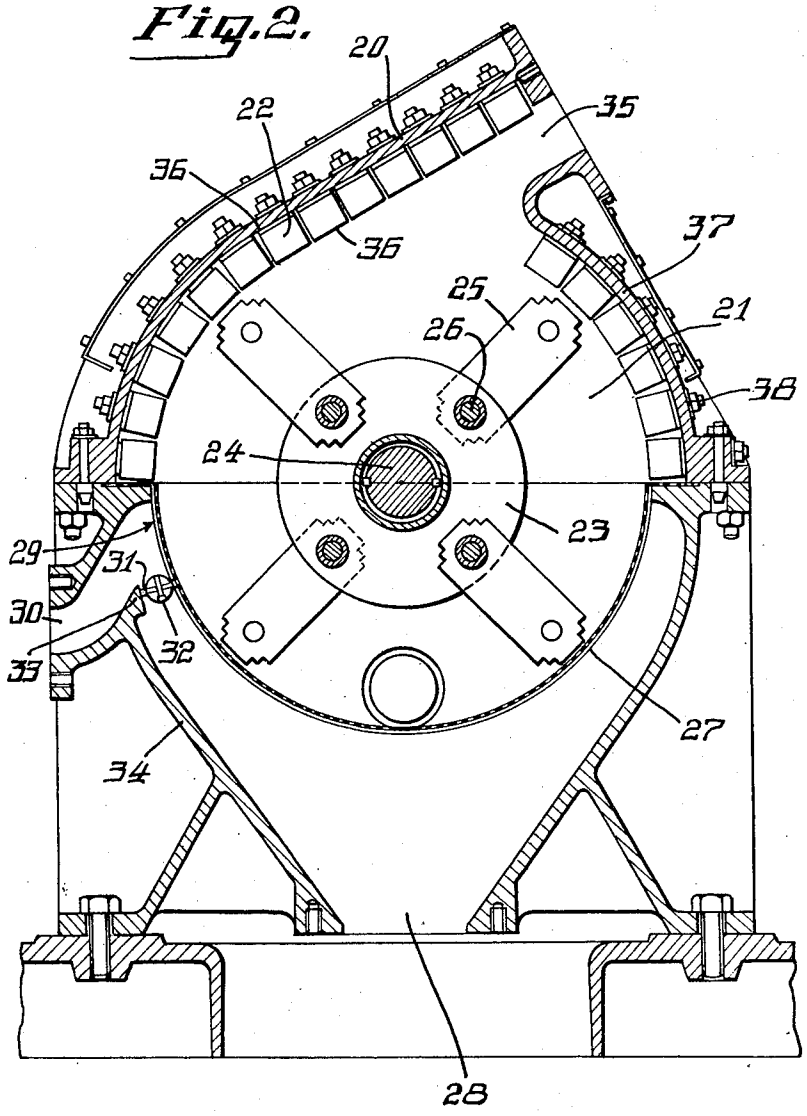
INVENTOR:
GUY VICTOR CONSTANT VAN DOOSSELAERE
By
Richardson, David and Wardon
Atty's.

Oct. 27, 1964 G. V. C. VAN DOOSSELAERE 3,154,464

PLANTS FOR WASHING AND DEFIBERIZING FIBROUS MATERIAL

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Fig. 2.



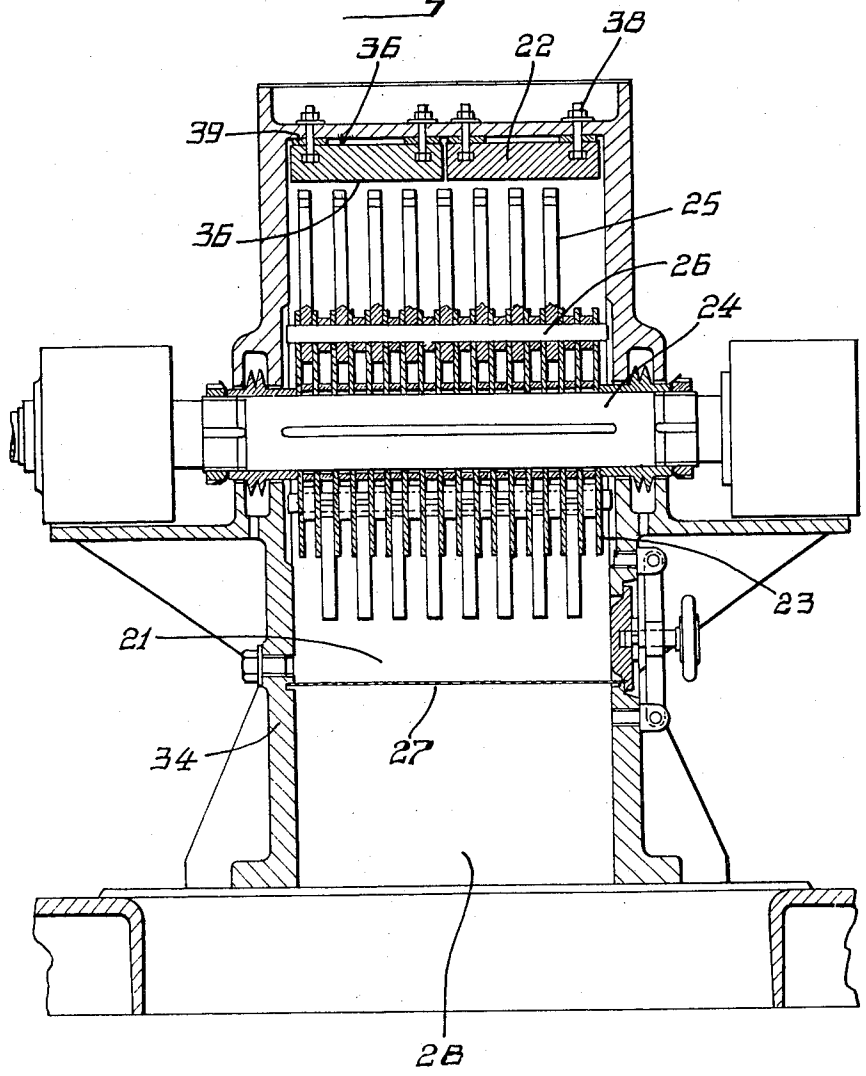
INVENTOR:
GUY VICTOR CONSTANT VAN DOOSSELAERE
BY
Richardson, David and Nordon
ATTY'S.

Oct. 27, 1964 G. V. C. VAN DOOSSELAERE 3,154,464

PLANTS FOR WASHING AND DEFIBERIZING FIBROUS MATERIAL

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Fig. 3.



INVENTOR:
GUY VICTOR CONSTANT VAN DOOSSELAERE
By
Richardson, David and Vordon
Attys.

Oct. 27, 1964 G. V. C. VAN DOOSSELAERE 3,154,464

PLANTS FOR WASHING AND DEFIBERIZING FIBROUS MATERIAL

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Fig. 4.

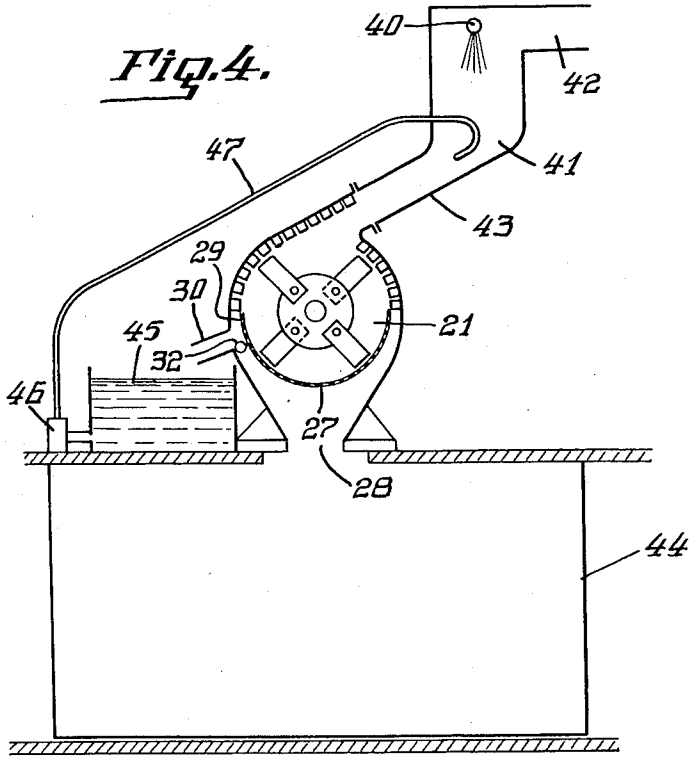
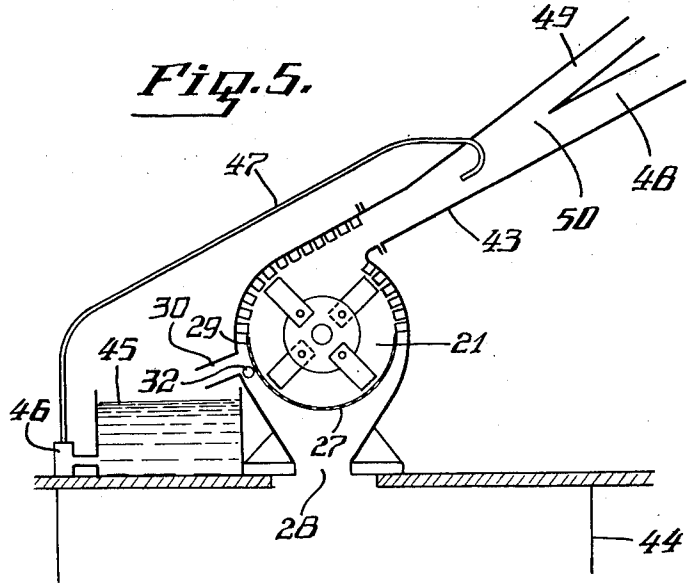


Fig. 5.



INVENTOR:
GUY VICTOR CONSTANT VAN DOOSSELAERE
By
Richardson, David and Vardon
ATTYS.

Oct. 27, 1964 G. V. C. VAN DOOSSELAERE 3,154,464

PLANTS FOR WASHING AND DEFIBERIZING FIBROUS MATERIAL

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Fig.6.

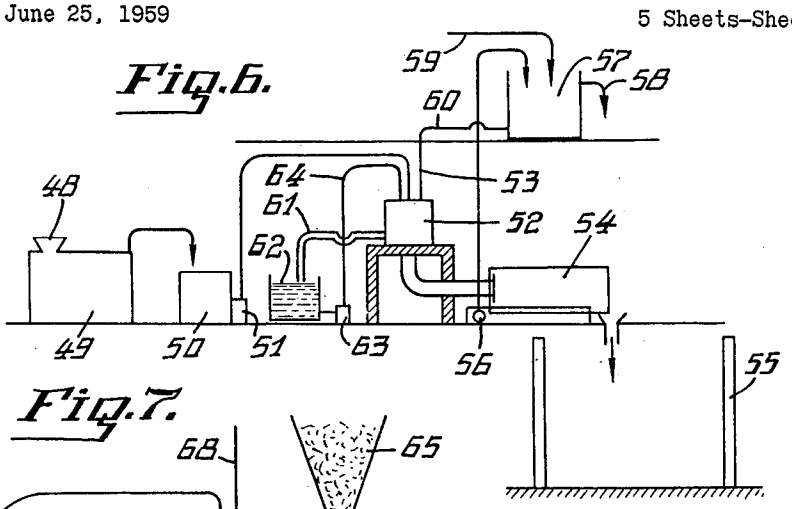


Fig.7.

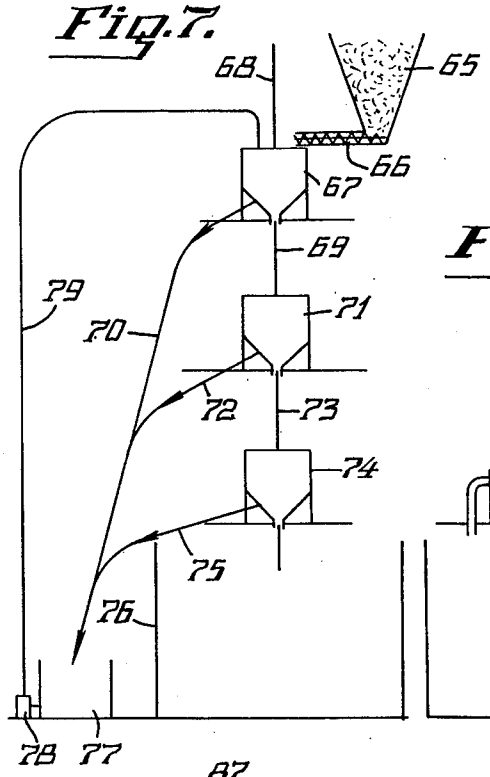


Fig.8.

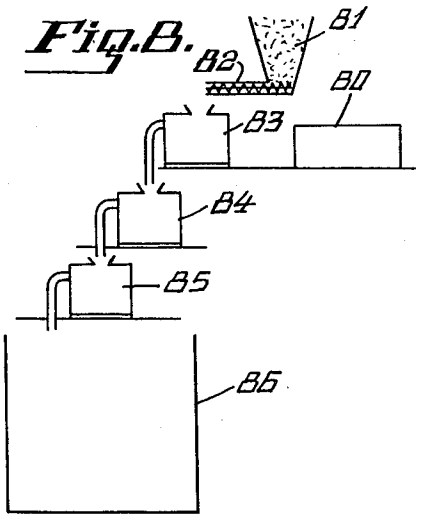
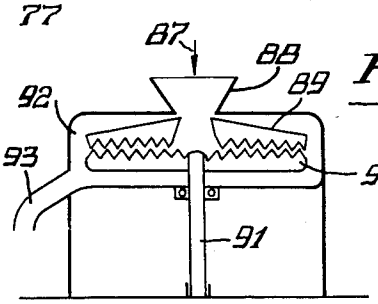


Fig.9.



INVENTOR:
GUY VICTOR CONSTANT VAN DOOSSELAERE
By
Richardson, David and Nerdon
Atty's.

United States Patent Office 3,154,464 Patented Oct. 27, 1964

3,154,464

PLANTS FOR WASHING AND DEFIBERIZING FIBROUS MATERIAL

Guy Victor Constant van Doosselaere, 8 Rue de Merode, Grimbergen, Belgium

Filed June 25, 1959, Ser. No. 822,928
Claims priority, application Belgium, Apr. 25, 1953, 406,781, Patent 519,479
2 Claims. (Cl. 162—26)

The present invention relates to a hydrokinetic apparatus for simultaneously washing and breaking up fibrous materials of animal, vegetable or mineral nature.

It also relates to the refining or hydration of slushed leather, textile or other fibers for papermaking and other purposes.

The main object of the invention is to provide an improved apparatus for carrying out the aforesaid operations.

It consists essentially in the provision of one or more rotary hydrokinetic hammer mills, each equipped with cooperating abrasive parts, as will be explained hereinafter in which the materials are treated in the presence of quantities of a liquid such as water in amounts preferably between 100 to 1000 litres of water for each kilogram of material in the dry state.

By the term hammer mill, it must be generally understood any type of rotary mill in which the comminution of the treated material is effected by the impact of hard moving bodies or impact members, which strike the treated materials at very high speed and which cause them to be broken up into their component fibers, essentially through the effect of multiple hammer blows.

It includes beater cross mills, carr mills and other machines based on the same principle of comminution through impact which are too well-known to warrant a description.

The hammer mill with swinging hammers mounted on pivots and free to swing in planes perpendicular to the rotational axis of the shaft of the machine is the most modern form of apparatus for comminuting by impact.

FIGURE 1 illustrates diagrammatically, an example of a typical modern hammer mill with swinging hammers.

This type of machine is best suited to the object of the present invention and will allow the best results to be obtained, while at the same time it is the easiest to modify to produce a hydrokinetic hammer mill in accordance with the present invention.

Usually, hammer mills of the type shown in FIG. 1 are used on dry or only slightly wet materials, without any addition of water or other liquids.

They then have the effect of breaking, grinding crushing and pulverizing the treated materials, whether the texture of the material being treated is fibrous, granular or continuous.

As opposed to an ideal defiberizing action in which the individual fibre is left undamaged, the action of a hammer mill operating on a dry fibrous material, without large amounts of water will mechanically destroy the fibres more or less completely according to the intensity of the dry impact treatment.

It may be said that it is impossible to reduce a dry material to its individual fibres in a hammer mill, without shortening and breaking these component fibers to such an extent that they become unfit for most papermaking applications.

There are, however, instances when hammer mills have been fitted with watertight bodies and have been used with an aqueous suspension of fibrous materials, or on dry fibrous materials, which were fed into the mills simultaneously with large amounts of water or other liquids, the weight of which was in the range between 10 times and 100 times the weight of the dry materials.

In such cases, the type of action exerted by the hammer mills on the fibrous materials undergoing treatment undergoes a complete change.

Firstly the presence of large amounts of water surrounding the fibrous materials, and rapidly incorporated into their structure, completely damps the impacts to which the materials are subjected. The water acts as a plasticizer both around and into the fibers, preventing the brutal and excessive comminution, bursting and cutting of the fibers which takes place in hammer mills when the materials are treated in the dry state.

Secondly, the hammers rotating and swinging rapidly in the liquid medium, give rise to high speed water laminas, the directions of which are continually changed or broken by the interactions between treated materials, water, hammer tips and inside surfaces of the breaking chamber of the hammer mills.

Besides its action as a plasticiser for the fibres and its own hydrokinetic disintegrating action under conditions of high turbulence, the water acts as an extracting medium, thereby replacing pressurized air, which in most modern hammer mills, equipped with extractor fans, is used to help the discharge of the dry treated materials through the outlet sieves.

Practically, using hammer mills with large amounts of water on fibrous materials, it becomes possible to defiberize the latter very thoroughly with very little damage to, but good separation of, the individual fibers.

The resulting pulp has longer fibers than would be the case, had it been defiberized by more conventional means like edge runners, beaters, etc.

Moreover, the output of the hammer mill is substantially free of bundles and other agglomerations of fibers, and it is possible to hydrate the pulp when using such hammer mills with much less cutting, for the same degree of hydration, than is possible when using conventional pulp preparation equipment.

However, hammer mills have never become popular for wet stock preparation in the paper and pulp industry, and this in spite of attempts to commercialize various types especially constructed or modified, to work with large amounts of water.

The reason for this lack of commercial success of such hammer mills lies in the fact that their power consumption, relative to output has always been very high, thereby more than offsetting the advantages offered from the view-point of fiber quality.

According to the present invention, it is possible to defiberize and/or hydrate fibrous materials or slurries through a hammer mill, with much higher efficiency, better quality of fiber output and lower power consump-

tion than was heretofore possible with either conventional pulp preparation machines, or hammer mills modified according to the prior art.

The essential feature of the invention is that the working surfaces of the breaking chamber of a suitably watertight hammer mill are lined with abrasive blocks made of resin bonded, or aluminous cement bonded, Carborundum or "Corindon" blocks, whereby directional changes of the water laminas are caused to take place by the interaction between the tips of the rotating hammer, the fibrous material being treated and the rough abrasive surfaces of the lining.

The Carborundum or "Corindon" used for making these blocks consists of a mixture of grains, the size of which ranges from number 12 to number 16.

These size numbers relate to the accepted commercial classification of Carborundum and "Corindon" grains according to their average sizes.

The provision of abrasive lining blocks of suitable composition, suitably placed in the hammer mill, creates a considerably increased hydraulic agitation, which causes defiberizing and/or hydrating actions to take place much more rapidly than even was the case before.

An important point of the present invention is that the distance between the working surfaces of the abrasive blocks and the tips of the hammers, when the latter are in their fully extended radial positions should be in the range between 10 and 12 mm., at which distance the best output per input horsepower for any given material is obtained from the mill.

If the surface of the abrasive blocks is closer to the hammer tips, the output of treated material per input horsepower applied to the mainshaft of the mill decreases rapidly.

This is of course quite contrary to what might be expected at first sight, but it is caused by the completely novel and purely hydrokinetic type of work effected in the hammer mill by the abrasive linings of the breaking chamber.

It is obvious that, if the action of the abrasive surfaces of the blocks or linings involved the mechanical cutting action that they normally perform, the operational efficiency of the machine would be increased by having the circumferences described by the tips of the working hammers brought as close as possible to the abrasive surfaces, or in other words by reducing the clearance distance between abrasive surfaces and hammer tips.

This reduced clearance would increase the mechanical rubbing of the treated pump against the abrasive surfaces and thereby enhance the speed of disintegration, if the action of the abrasive linings were a purely mechanical one.

The optimum clearance distance between abrasive linings and hammer tips, in a hammer mill working on a liquid pulp has been found experimentally to be the unexpectedly large distance of 10 to 12 mm. which clearly establishes that the action of the cooperating hammer tips and abrasive linings is purely hydraulic.

The optimum clearance is consequently that distance where the interactions between the tips of the rotating hammers, the fibrous materials being treated and the rough abrasive surfaces of the lining, cause the maximum amount of directional changes or turbulence of the water laminas to take place.

The function of the rough surfaces of the abrasive linings thus consists exclusively in increasing the hydraulic turbulence or violent agitation in the working chamber of the hammer mill.

When a hammer mill, rendered watertight, is equipped with abrasive blocks of a suitable nature and grain, located to provide an optimum clearance distance from the circumference described by the tips of the rotor hammers, it is still possible to improve its efficiency by the following arrangement.

The sieve of the hammer mill is divided into two parts one of which has perforations of a larger diameter than the other.

Each part of the sieve communicates separately with an individual discharge outlet from the mill.

The pulp coming out of the outlet which corresponds with the larger perforations is continuously recycled into the mill by means of a pump of any suitable type.

This recycling causes an increase in the output of usable pulp per input horsepower applied to the mill shaft which according to the type of pulp being treated, may amount to from 10 to 50%, as compared with the pulp output of the same mill, operating on the same pulp without recycling.

This may be explained by the fact that, while on the one hand the pulping water and the completely separated fibers will flow easily through the perforations of a sieve suited to the type of material treated, the yet unseparated bundles of fibers or partially defiberized pieces of material being treated will not pass through the smaller holes but will pass through the larger holes and be subjected to further treatment.

The accumulation of partially treated material on the inside surface of the sieve, which would exert a powerful mechanical braking action on the hammer tips and correspondingly higher power consumption is hereby avoided.

If the sieve is previously provided with a section or zone where the perforations are larger, the partially defiberized and undefiberized parts of the stock, instead of rotating in the mill as a very much thickened pulp and braking the hammers, will pass through the large perforations, and be recycled inside the mill mixed with the rest of the fresh supply of incoming pulp. The recycled material will then eventually be defiberized by the hydrokinetic agitation, with low power consumption instead of by a mechanical impact and rubbing action which would require a higher input power.

Besides the points already covered, it is important to note that the angular speed of the beating rotor of a hammer mill constructed in accordance with the present invention, should preferably be kept at or above 3,000 revolutions per minute.

The annexed drawings show several illustrative embodiments of the invention given only by way of examples:

FIGURE 1 is a diagrammatic vertical section through a typical modern hammer mill with swinging hammers as built for dry operation.

FIGURE 2 shows a transverse vertical cross section through the same hammer mill, as modified in accordance with the present invention.

FIGURE 3 shows an axial vertical cross-section through the same hammer mill.

FIGURE 4 shows an embodiment suited to the defiberizing of dry materials which are fed into the mill in dry form while water is fed into it simultaneously.

FIGURE 5 shows an embodiment suited to the treatment of slushed pulp or materials already suspended in water.

FIGURE 6 is a flow sheet diagram of a plant as used for defiberizing and washing rags, ropes or other strong fibrous materials.

FIGURES 7 to 9, inclusive, are schematic showings of various applications of the invention.

Referring to FIG. 1, there is shown a conventional hammer mill comprising a breaking chamber **1** provided with metallic elements **2** which constitute the inner linings or working surfaces of the breaking chamber and which may be serrated as shown. An inlet or delivery chute **3** for the incoming material to be treated communicates with the upper portion of the breaking chamber **1**. Centrally disposed in the breaking chamber **1** is a hammer bearing rotor **4** which is rotatably mounted on a power driven shaft **5**. The rotor **4** carries a plurality of out-

wardly extending hammer members 6 each of which is individually pivoted to the rotor 4 at 7. At the bottom of the breaking chamber 1, there is provided a semicylindrical screening member 8 through which the treated material is delivered to a discharge duct 9. The treated material travels in the direction of the arrow 10 under the influence of suction provided by an extractor fan or blower 11.

As shown in FIGS. 2 and 3 and in accordance with the present invention, the conventional hammer mill of FIG. 1 is modified to such extent as may be required so that it is water-tight instead of merely relatively airtight, the water tight housing being designated 20. The water tight housing 20 defines a water tight breaking chamber 21. The upper portion of the water tight breaking chamber 21 is lined with the abrasive blocks 22, the grains of which range in size from number 12 to number 16. The abrasive linings 22 replace the usual metallic linings 2 shown in FIG. 1.

Centrally disposed in the water tight breaking chamber 21, is a hammer-bearing rotor 23 which is shown keyed on a power driven rotatable shaft 24. The rotor 23 rotates clockwise as viewed in FIG. 2 and carries a plurality of outwardly extending hammer members 25 each of which is individually pivoted to the rotor 23 at 26.

The sieve or perforated plate, through which the stock is forced by the centrifugal action of the rotor, is divided into two sections. A first section 27 communicates with discharge outlet 28, and a second section 29 communicates with discharge outlet 30.

To prevent the stock to be recycled which passes through section 29 of the sieve and flows into outlet 30, from mixing with the finished stock passing through section 27 of the sieve into outlet 28, provision is made of a rubber sealing member 31, held by shaft 32, which can be rotated to free the sieve when it is necessary to remove or replace the latter.

This sealing member 31 is pressed against the sieve throughout the entire width of the latter. It is also pressed against the beak-shaped portion 33 of the base 34 of the machine.

The stock to be recycled which passes through section 29 of the sieve will thus flow over the assembly of pieces 31 and 32, into outlet 30, from where it can be fed into a pump and recycled into the input of the machine. Both the incoming untreated stock and the recycled pulp are fed into the mill through inlet 35.

Reverting to the abrasive linings, it has been found convenient and practical to make them out of a number of separate quadrangular abrasive blocks 22 connected to the walls 36 and 37 of the treating chamber 21 by bolts 38, washers or shims 39 being provided to ensure that the working surfaces 36 of the abrasive blocks 22 are set at the proper clearance distance from the tips of hammers 25 when these are in the fully extended radial position as shown in FIGURE 2.

In the embodiment shown in FIG. 4, water is supplied by an inlet pipe 40 arranged at the upper end of a watertight funnel 41. The upper end of funnel 41 communicates with a horizontal duct 42 through which the fibrous material to be treated is supplied in a dry or semi-dry state. The lower end of funnel 41 communicates with the upper portion of the watertight breaking chamber 21 through an inclined watertight chute 43.

No blower, fan or similar device is provided; the stock forced by the centrifugal force through sections 27 and 29 of the sieve being thrown into outlets 28 and 30 and from there by gravity into chests 44 and 45 respectively.

Chest 44 contains completely defiberized and/or refined finished stock while the incompletely finished stock going into the small intermediate chest 45 is constantly recycled into inlet funnel 41 through pump 46 and pipe 47.

FIG. 5 shows a modified form of the invention for use with slushed or semi-slushed stocks. The inlet duct comprises an inclined portion 48 through which the slushed or semi-slushed stock is delivered to the watertight breaking chamber 21. Additional water if necessary, is delivered through a water supply duct 49 which merges tangentially with the stock supply duct 48 at 50. The apparatus of FIG. 5 is otherwise similar to that of FIG. 4 described above.

The flow sheet of FIG. 6 illustratively shows an example of a plant adapted to be used for the washing and defiberizing of, for instance, rags.

The textile waste conveyed to entry 48 is cut by a ragcutter 49, according to the usual practice; it is then roughly shredded in a dry condition, either in a disk mill or in a hammer mill 50 fitted with an outlet sieve having round perforations of between 30 and 40 mm. diameter.

After having been shredded, the rags are ready for the principal defiberizing and washing treatment.

To that end, in the example shown, the roughly shredded rags are conveyed by the blower 51 of the hammer mill 50 to a watertight hammer mill 52, which is of the general type shown in FIGS. 4 and 5, and to which pulping water is supplied by a pipe 53.

This watertight hammer mill 52 discharges the finished treated pulp into a thickener 54 of any suitable type which thickens the pulp to a suitable consistency for storage and which at the same time extracts the dirt and impurities which are dispersed or dissolved in the dilution water.

While the finished material flows or falls from the thickener 54 into a stock chest 55, for instance, the dilution water used for defiberizing and washing the stock in the watertight hammer mill 52 may be recycled to be used again.

For this purpose, a pump 56 pumps the water up to a water storage tank 57, which is fitted to an overflow pipe 58 for the outlet of the surplus dirt bearing water and with a fresh water inlet pipe 59. A pipe 60 connected to pipe 53 brings the pulping water from the tank 57 to the watertight hammer mill 52.

The partially finished material flowing out of the section of the sieve of hammer mill 52 equipped with the larger perforations flows through pipe or duct 61 into recycling chest 62 from where it is recycled by pump 63 through pipe 64 into the inlet of mill 52, when it combines with the incoming shredded rags and pulping water.

Other combinations of elements may be utilized comprising several hammer mills arranged either in parallel or preferably in series to provide consecutive treatments.

For instance, one or several hammer mills can be placed after the thickener 54 to perform an extra washing and pulping action or to achieve other results which are later described.

The flow sheet of FIGURE 7 illustratively shows an example of a plant adapted to be used for the defiberizing of hard leather scrap.

The leather scrap, roughly precut, is conveyed from the hopper 65 through the screw conveyor 66 into a hammer mill 67 in accordance with the invention.

Water is fed into the mill from pipe 68.

The finished pulp discharged through the finer perforations of the sieve falls into pipe 69 and the partially finished pulp discharged through the larger perforations falls into pipe 70.

The rest of the plant is clearly described by FIGURE 7, with the arrangement of the two hammer mills 71 and 74 according to the invention, placed one after the other, both of them being serially connected after the first hammer mill 69. The recycling arrangement through pipes 70, 72 and 75 into the recycling chest 77 and from there, through the pump 78 and the pipe 79 back into the first hammer mill 67, is also clearly shown.

The completely defiberized pulp falls into the chest 76.

At this point it may be desirable to set forth dimensional information which will help to understand the ap-

plication of the hammer mills according to the present invention.

(1) Outlet Sieves

If only one hammer mill in accordance with the present invention is used for a defiberizing operation, the perforated steel plates which are used as outlet sieves will have circular perforations, the diameter of which may vary between 1 and 20 mm. according to the results desired and the type of materials treated.

For instance:

For complete defiberization of sulphite pulp, smaller holes of 1 to 2 mm. diameter, larger or recycling holes of 3 to 4 mm. diameter.

The same for well cooked chemical straw pulp. For thorough separation of chrysotile asbestos fiber, smaller holes of 3 to 6 mm., with recycling holes of 7 to 8 mm.

For defiberizing and washing cooked rope stock, smaller holes of 3 to 4 mm., with recycling holes of 6 to 7 mm.

If several hammer mills are used in a sequence, the diameter of the perforations will decrease from the first to the last mill.

For instance, in a three stage arrangement as shown in FIGS. 7 and 8:

For uncooked and roughly preshredded textile waste, smaller holes of 20, 1 and 8 mm. with recycling holes of 30, 20 and 14 mm. respectively. For roughly precut hard leather scrap in order to obtain a completely defiberized pulp, smaller holes of 5, 4 and 3 mm., with recycling holes of 6, 5 and 4 mm. respectively.

The number and arrangement of hammer mills and the mesh of the sieves will of course be determined experimentally in accordance with the nature of the materials to be treated and the results desired concerning quality, output, etc.

(2) Power Consumption

The power consumption may vary, according to the nature of the treated materials, to the previous treatment to which they have been subjected, and to the results desired from the impact treatment from 0.03 to 0.3 input horsepower per kg./hour of dry material fed into each hammer mill.

(3) Water Consumption

For a rag defiberizing and washing installation, the consumption of fresh water may vary between 10 and 50 litres per kg. of dry pulp discharged.

It is possible, by using some of the usual water purification units, which are now used by most paper mills (save-alls, rotary vacuum filters, etc.) to reduce fresh water consumption to a minor fraction of the aforesaid figures.

In addition to the advantages already mentioned and which are obtained generally for all fibrous materials, the method makes it possible, in the special case of cellulose fibres, and especially of textile fibres, to obtain a perfectly washed and defiberized half stuff, which combines high fibre length and good dewatering properties with some of the qualities of a hydrated pulp.

For instance, sheets made of rag half stuff, defiberized in accordance with this method, and without any subsequent beating show exceptional breaking length, tear, burst resistance, and "rattle." These desirable properties, in the case of rags defiberized by conventional means, are obtained only after relatively long beating times.

This is due to the fact, that although the work of hammer mills embodying the invention does not shorten the fibres to any significant extent, the latter can be considerably bruised and fibrillated lengthwise, if the treatment is sufficiently intense.

To summarize, the hydrokinetic hammer mill of the present invention makes it possible to prepare a perfectly defiberized and absolutely clean pulp which possesses unusually good mechanical properties, while at the same time effecting important economies of time, power and water consumption, even though starting the operation with relatively impure raw materials.

The method can be employed not only for defiberizing and preparing half-stuffs but also for hydrating stocks which have already undergone a defiberizing treatment.

The following results, which are typical, have been observed in the course of strictly controlled tests.

A cotton rag pulp defiberized by a conventional method in a breaker beater, and a pulp made from absolutely identical raw materials and brought to the same degree of disintegration by the method of the present hydrokinetic hammer mill have both been submitted to a beating treatment under the same controlled conditions, in a Banning and Seybold precision test beater.

The specific power consumption in the breaker beater was of 0.5 input horsepower per kg. of rags, while it was only of 0.42 horsepower per kg. of rags by the method used in accordance with the invention.

The following table gives the results of comparative measurements effected on both pulps after identical beating treatments.

Beating Time	A. Pulp made from uncooked rags according to conventional method			B. Pulp made from same uncooked rags but having been hammer milled twice according to invention once through sieve with 10 mm. perforations, the second time through sieve with 4 mm. perforations. Consistency: 2% for each pass.		
15 seconds	Schopper-Riegler wetness	14		Schopper-Riegler wetness	34	
	Lhomme and Argy Bursting	0		Lhomme and Argy Bursting surface	14.8.	M2
30 seconds	S.-R. wetness	15		S.-R. wetness	49	
	L. & A. surf.	0		L. & A. surf.	12.4	M2
45 seconds	S.-R. wetness	18		S.-R. wetness	59	
	L. & A. surf.	8.9	M2	L. & A. surf.	14.4	M2
60 seconds	S.-R. wetness	21		S.-R. wetness	66	
	L. & A. surf.	8.9	M2	L. & A. surf.	13.9	M2

It must be noticed that, before any beating, pulp B had a Schopper-Riegler wetness number of 25, higher than that of pulp A after a 60 second beating cycle.

Other tests have proved conclusively, that for a given S.R. wetness number, a cellulose pulp defiberized or refined by the method and in the apparatus which embodies the subject matter of the invention, has superior mechanical properties to an identical pulp treated by conventional means.

It is possible widely to vary the type of refining performed by the apparatus herein described.

One may simply effect a separating and dispersing action in the fibrous suspension, or, alternatively a very high degree of hydration can be obtained, if so desired.

All other factors being unchanged, the degree of hydration will be determined by the working consistency.

To refine with a separating and dispersing action on the fibres and to eliminate nodules with very little hydration, the pulp should be treated at a consistency preferably lower than 1%.

On the contrary, if the result to be obtained is not only a full separation and dispersion of the individual fibres, but also a degree of hydration, the pulp should be worked at consistencies in the range from 1% to 5% according to the ultimate hydration desired.

Further data relating to prolonged and extensive tests on the defiberizing of leather scrap will better illustrate the superiority of the apparatus according to the present invention.

To prepare leatherboard pulp in a leatherboard mill, four different methods have been used, each of them being applied for periods of several months.

Firstly, a plant was used according to FIGURE 8.

Sole leather scrap, roughly cut in a rotary rag cutter 80, was fed from the hopper 81, through the screw conveyor 82, into a series of three rotary disc mills 83, 84 and 85 especially built and equipped for leather defiberizing.

The defiberized stock fell by gravity from the last mill 85 into the chest 86.

The mills were of the type illustrated by FIGURE 9, which is too well known to require detailed description.

Water is fed through pipe 87, simultaneously with the leather scrap into the inlet 88. The leather is defiberized between the fixed toothed disc 89 and the rotating disc 90, which latter disc is rotated at about 800 r.p.m. by the vertical shaft 91. The pulp leather is thrown by centrifugal force from between the discs into the outlet chamber 92 and the pulp then flows out of the mill through the outlet 93.

In the plant according to FIGURE 8, all three mills were equipped with electric motors of 100 metric horsepower each.

The first mill 83 had rough-toothed steel discs, the second mill 84 had fine-toothed steel discs and the third mill 85 had special discs made of Carborundum abrasive. This arrangement is quite conventional and is generally used for leather defiberizing. After having been used day and night for several months, this arrangement hereinafter referred to as "arrangement A" was modified in the following manner.

The rotary disc mills 83, 84 and 85 were replaced by hammer mills especially modified to make them watertight and equipped with sieves with round perforations of 6, 4 and 3 mm. respectively.

These hammer mills the rotors of which were rotated at 3,000 revolutions per minute, were actuated by motors of 100 metric horsepower each.

These hammer mills were of the type illustrated at FIGURE 1, but were not equipped with extracting fans, the watery fibrous suspension falling by gravity from one mill into the following one.

This arrangement of hammer mills will hereinafter be referred to as "arrangement B."

It was later modified according to the present invention, the metal linings 2 of breaking chamber 1 being replaced by abrasive blocks 22 arranged in the manner illustrated by FIGURE 2.

The grain size of these abrasive blocks was comprised between No. 12 and No. 16 according to the present invention, and the clearance distance between the working surfaces of these blocks and the hammer tips was set between 10 and 12 mm.

All the other elements of arrangements A and B that is to say rag cutter 80, hopper 81, conveyor 82 and chest 86 were unchanged. The same sieves were used as in arrangement B. This third arrangement will hereinafter be called "arrangement C."

After having been in use for about six months, arrangement C was modified by fitting the hammer mills with twin outlets, as per FIGURE 2, dividing each of the sieves into two sections, one with small holes and the second one with larger holes. A recycling system was installed.

The arrangement was then exactly as per FIGURE 7. The same rag-cutter was kept as in arrangements A, B and C. The motors were still the same 100 horsepower electric motors. The hopper and screw feeding system remained the same. The diameters of the perforations were as follows.

First hammer mill according to invention: small holes 6 mm., large holes 8 mm.,

Second hammer mill according to invention: small holes 4 mm., large holes 6 mm.,

Third hammer mill according to invention: small holes 3 mm., large holes 4 mm.

This last arrangement will hereinafter be called "arrangement D."

The following table gives the specific outputs of the four arrangements on sole leather scrap.

Arrangement A	Arrangement B	Arrangement C	Arrangement D
1 H.P. per kg. of leather scrap.	1. 2 H.P. per kg. of leather scrap.	0. 9 H.P. per kg. of leather scrap.	0. 7 H.P. per kg. of leather scrap.

Tests were made daily on the pulp obtained from each of the four arrangements. The following table shows the average results of these tests.

	Arr. A	Arr. B	Arr. C	Arr. D
Average Fiber length, mm.	1.5	2.3	2.5	2.6
Average Number of Undefiberized Nodules per liter of pulp	27	32	7	6

These figures show clearly the advantages derived from the present invention.

The largely superior fiber length obtained from arrangements C and D show the novel and purely hydrokinetic action of the abrasive linings, as opposed to the mechanical cutting action of the abrasive discs in arrangement A.

The lack of mechanical action of the abrasive blocks being proved by the superior fiber lengths in arrangements C and D, the higher specific output per input horsepower of arrangement C, as compared with arrangement B, can only be explained by the considerable increase in hydraulic turbulence caused by the abrasive linings in their novel functions.

What I claim is:

1. A plant for defiberizing, washing and improving fibrous material, especially raw material for papermaking, comprising in combination: a watertight breaking chamber of the hammer-mill type, said chamber having an inlet portion, a rotor in said breaking chamber, hammers pivotally mounted on said rotor for swinging in planes perpendicular to the axis of said rotor, means to introduce material to be treated and large quantities of water into said breaking chamber, a lining of abrasive material in at least a portion of said breaking chamber, means arranged at the lower portion of said breaking chamber to discharge material subjected to the combined action of shocks produced by said hammers and hydrokinetic action produced by the abrasive lining and the water, a sieve arranged to receive material from said last-named means, said sieve having an area of relatively large perforations and an area of relatively small perforations, and means for collecting and recirculating material discharge through said area of large perforations back to said inlet portion of said chamber.

2. A plant for defiberizing, washing and improving fibrous material, especially raw material for papermaking, comprising in combination: a watertight breaking chamber of the hammer-mill type, said chamber having an inlet portion, a rotor in said breaking chamber, hammers pivotally mounted on said rotor for swinging in planes perpendicular to the axis of said rotor, means to introduce material to be treated and large quantities of water into said breaking chamber, a lining of abrasive material in at least a portion of said breaking chamber, means arranged at the lower portion of said breaking chamber to discharge material subjected to the combined action of shocks produced by said hammers and hydrokinetic action produced by the abrasive lining and the water, selective means disposed to receive material from said last-named means, said selective means collecting material which exceeds predetermined dimensional limitations and discharging all other material, and means for recirculating material collected by said selective means back to said inlet portion of said chamber.

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DONALL H. SYLVESTER, *Primary Examiner.*

RICHARD D. NEVIUS, MORRIS O. WOLK, *Examiners.*