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ABSTRACT: Fibrous material is discharged from a digester into a discharger tank which has a perforated plate in one of its walls for discharging the fibrous material into a first exit chamber. From the first exit chamber, the fibrous material passes through a restricted passageway defined by a frustoconical shaped bore and a selectively movable frustoconical shaped plug into a second exit chamber. A rotor, located in the discharger tank adjacent the perforated plate, wipes oversized chips and fibrous bundles from the perforated plate. The holes of the perforated plate are tapered outwardly towards the first exit chamber to prevent clogging thereof. The fibrous material is simultaneously defibered by steam pressure differentials existing between the tank and exit chambers.

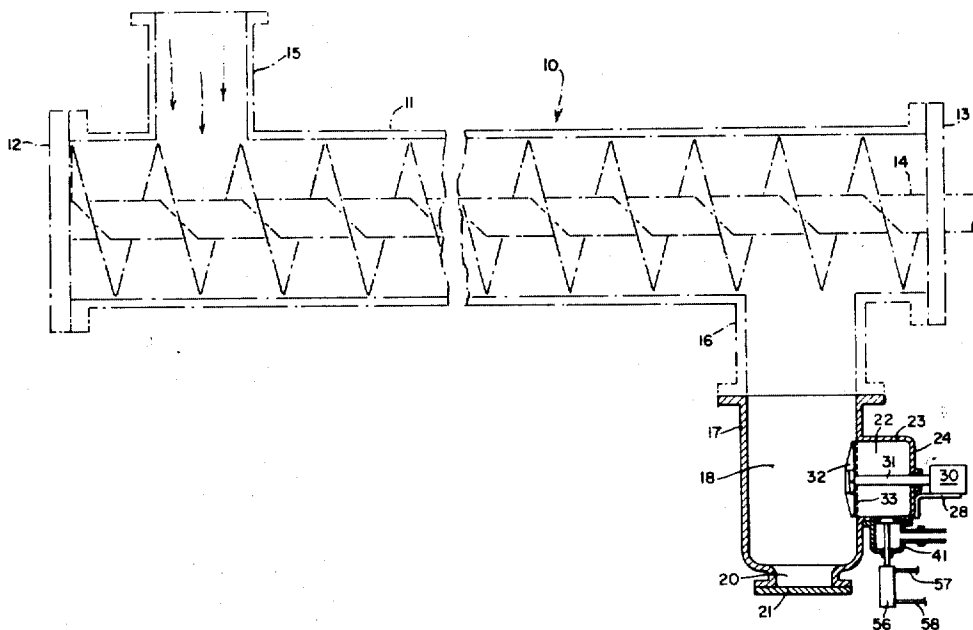


Fig. 1

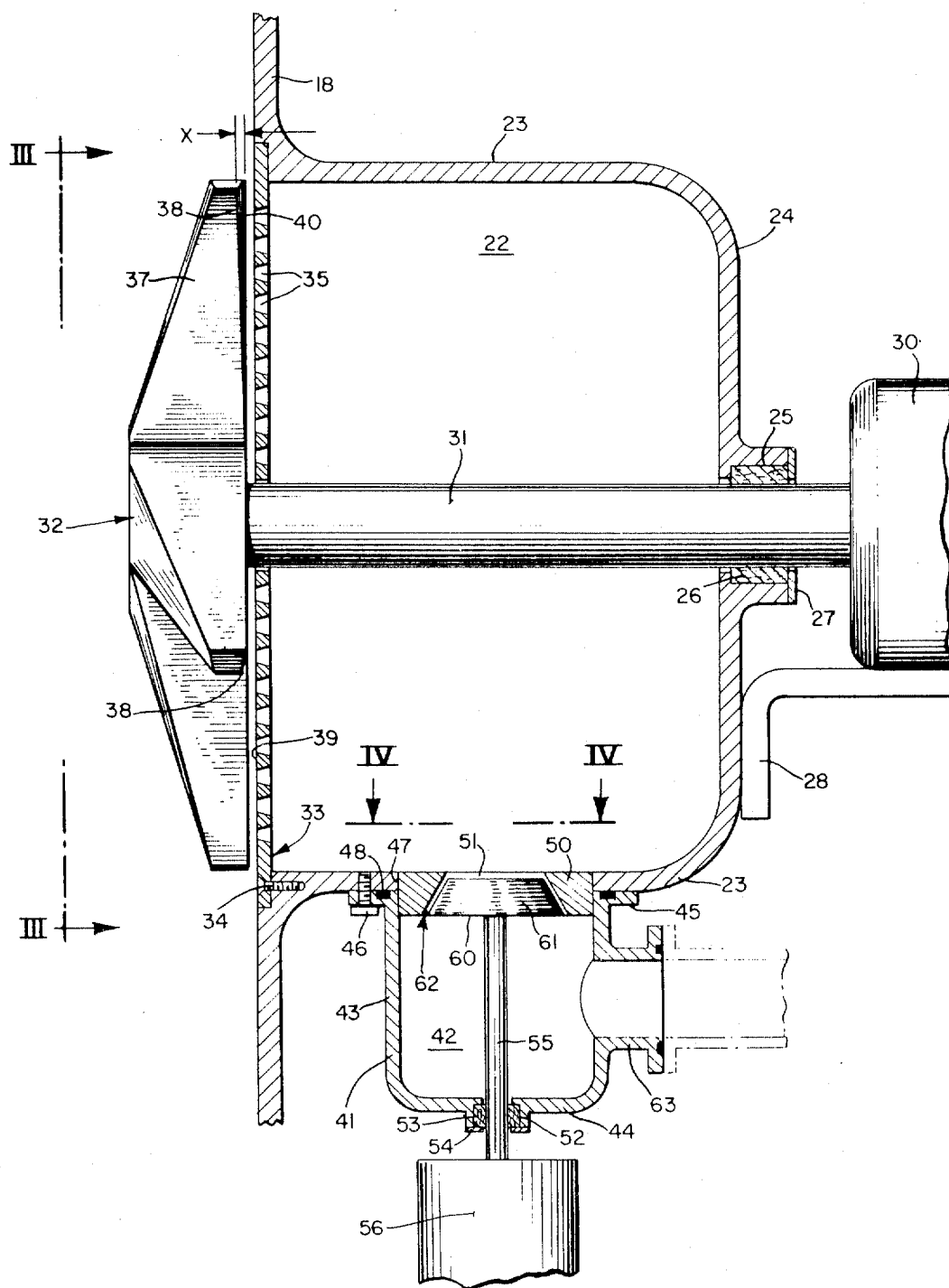
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DEFIBERING DISCHARGER FOR CONTINUOUS DIGESTERS

BACKGROUND OF THE INVENTION

In industries, such as the papermaking industry, it has become conventional to utilize wood chips as the cellulose fibrous material for forming the slurry from which paper is made. It has also become conventional to utilize a chip digester of the type which comprises an elongated tubular member having a rotary screw conveyor disposed therein, for receiving chips in a hopper at one end thereof, along with saturated steam for softening the wood chips. Because the steam is above a temperature of 212° F., as the chips are conveyed along the screw conveyor, through the elongated tubular member, the chips are cooked and softened. It is also commonplace to add suitable chemicals to the digester, to facilitate the breaking down of the chips. At the discharge end of the digester, the chips and steam generally enter a discharger tank, for further defibering. Depending upon the degree of defibering which is effected by the digester, the fibrous material which enters the discharger may be either of the softened chip form, or in the form of fibrous bundles. In any event, separation of the fibers is generally still required at this point.

One of the methods used to obtain this additional defibering of chips or fiber bundles is to utilize a disk mill, for example of the type having abrasive disks which define a gap therebetween, wherein all particles pass through the mill, and are subjected to the same degree of abrasive working, regardless of their size and degree of cooking, a process which may often result in mechanical overtreatment of small fibrous particles, and undertreatment of large fibrous particles. Such overtreatments can result in reduced fiber quality, and hence may prove to be undesirable.

Other types of defiberization utilize a tank in which a rotary impeller, for example, may be mounted, to continually impel the chips back and forth within the tank, such that the chips, in striking one another and in being deflected back and forth across the tank walls, will gradually become reduced in size, sufficient to be carried away by a vapor stream or the like.

It is thus apparent that prior art types of defibering which rely upon mechanical working means such as abrasive disks, impellers, and the like, may cause an undesirable shear of the chips and fibrous bundles across grain lines, thereby destroying fiber strength, as well as reducing fiber length to an undesirable size.

SUMMARY OF THE INVENTION

The present invention is directed toward obviating the above and other undesirable features of prior art types of defibering dischargers in providing a means for breaking-up soft chips or fibrous bundles, whereby such a means is substantially free of mechanical components which perform abrading actions and wherein nonshear techniques of expansion, fiber interfriktion, and fiber friction striking surfaces, and even fibrous bundle explosion techniques are employed on the fibers to exert pressures and forces on the chips and fibrous bundles which will permit the fibers to break away from one another along natural lines, thereby retaining fiber length. This invention utilizes a rotor principally for reducing only substantially oversized fibrous particles to a size sufficient to permit passage of the particles through a perforated plate, such passage being the initial defibering step in the further reduction of fiber size. The fibers are thus propelled by the vapor, which is generally steam and not by a rotor, the rotor being thus used only to provide a minimum of abrading and to keep the perforated plate at the exit of the discharger tank clear, this invention thereby resulting in fibers that are desirably long and of high quality for papermaking processes and the like.

Accordingly, it is a primary object of this invention to provide an apparatus for discharging fibrous material from a digester, wherein a chamber is provided outside the discharger

tank, at a reduced pressure, and wherein fibers are carried from a discharger tank to the chamber, the vapor entering the chamber undergoing an expansion for facilitating defibering, and wherein a perforated plate or the like separates the discharger tank from the chamber, with a size-controlling rotor rotatably disposed adjacent the perforated plate for keeping the plate clear and controlling the size of fibrous material to be passed through plate openings.

It is a further object of this invention to accomplish the above object, wherein means are provided at the bottom of the discharger tank for collection of, and ready access to tramp metal and the like, to preclude the passage of the same into the discharger exit chamber.

It is another object of this invention to accomplish the above objects, wherein the perforated plate has a selected cross-sectional area which is dependent upon the desired fiber size, but which is substantially reduced with respect to the cross-sectional area of the exit chamber, whereby the working vapor and carried fiber particles passing through the perforated plate will increase in velocity and thereby increase the particle friction while passing through the plate, and whereby upon expansion of the vapor inside the exit chamber such expansion will effect a further defiberization of the fiber particles.

It is another object of this invention to provide an apparatus for a discharger tank, for use in combination with a continuous digester, which is adapted to utilize vapor expansion caused by pressure differentials to break up fibers, chips and bundles, wherein the apparatus utilizes a rotor in combination with a perforated plate, the rotor being adapted to size fibrous particles for passage through the plate, and to keep the perforated plate free of fiber buildup, in that the rotor moves across the plate with a pulsating action.

It is yet another object of this invention to provide a discharger tank exit apparatus, utilizing a pair of successive chambers for facilitating vapor expansion and consequent defiberization of fibrous particles carried by a vapor passing from a discharger tank through the successive chambers, wherein the successive chambers represent successive decreased pressure zones, with respect to the discharger tank.

It is a further object of this invention to accomplish the above object, wherein one such chamber is provided with an annular restricted passage, constructed to maximize the surface area against which fibers carried in vapor passing therethrough may contact for increased defiberization.

It is another object of this invention to accomplish the above object, wherein means are provided for adjusting the opening defined by the above-mentioned restricted passage.

It is another object of this invention to provide a novel method for defibering fibrous material leaving a digester, wherein a rotor and a perforated plate are operative to select properly sized particles, which particles then are carried by vapor under pressure through restricted inlets into successive expansion zones, wherein fiber interaction within the restrictive inlets, and expansion within the successive expansion zones provide defiberization.

Other objects and advantages of the present invention will be readily apparent to one skilled in the art following a study of the following brief descriptions of the drawing figures, detailed description of the drawings and operation of this invention, and the appended claims.

In the drawings:

FIG. 1 is a vertical sectional view through the discharger tank and defibering apparatus of this invention, illustrated in connected relation to a continuous digester, with the digester illustrated in phantom to particularly indicate the novel portions of the apparatus of FIG. 1.

FIG. 2 is an enlarged vertical sectional view of a portion of the defibering apparatus of FIG. 1.

FIG. 3 is a front view of the rotor and perforated plate of this invention, taken generally along the line III—III of FIG. 2, and wherein preferred rotor construction is illustrated.

FIG. 4 is a fragmentary view of a portion of the apparatus illustrated in FIG. 2, taken generally along the line IV—IV of FIG. 2, and wherein the restricted annular passage between the first and second discharger chambers is best illustrated.

Referring now to the drawings in detail, reference is first made to FIG. 1, wherein there is illustrated a continuous digester, generally designated by the numeral 10, comprising an elongated tubular member 11, having closed ends 12 and 13 which rotatably carry therebetween a rotary screw conveyor 14. An inlet 15 for wood chips and the like is illustrated at one end of the digester 10, and an outlet 16 for digested chips and fibrous bundles is illustrated at the opposite end of the digester tank.

A discharger tank 17 is illustrated, disposed at the outlet 16 of the digester 10, the tank 17 having a generally right circular cylindrical inner surface 18, and terminating in a reduced lower end 20, having an end plate 21 secured thereto.

A first exit chamber 22 from the tank 17 is provided, substantially spaced above the bottom portion 20 of the tank 17, having a generally cylindrical sidewall portion 23, and an integral end wall 24.

The end wall 24 is provided with a bore 25, in which is received a packing 26, retained within the blind bore 25 by a suitable clamping washer 27.

A motor mount 28 is welded, or otherwise suitably connected to the end wall portion 24, with the motor mount 28 carrying a motor 30 thereon. The motor 30 is provided with an output shaft 31, which has a rotor 32 thus fixedly secured to the leftmost end thereof, as viewed in FIG. 2.

A perforated plate 33 is provided at the leftmost end of the exit chamber 22, separating the interior of the tank 17 from the chamber 22, and suitably secured to the chamber wall 23 by screw-type fasteners 34 or the like.

The perforated plate 33 is provided with a plurality of holes 35, extending therethrough, which are relieved at the rightmost side of the plate 33, as illustrated in FIG. 2, such that each of the holes 35 is of tapered bore construction, the relief of the holes 35 being adapted to prevent clogging of the holes 35 by fibrous material, and to assure free passage of fibrous material therethrough.

The rotor 32 is positioned in closely adjacent relationship to the plate 33, for wiping oversized chips and fibrous bundles from the plate 33, during rotation of the rotor 32 therepast.

The rotor 32 comprises a central boss 36, from which emanate four radially offset rotor blades 37. It is to be noted that more or fewer than four such blades 37 may be utilized, as desired, or as dictated by the particular wood stock being utilized, the desired fiber size, or by other parameters such as steam pressure and the like. Each of the rotor blades 37 has a forward edge 38 more widely spaced from the adjacent surface 39 of the perforated plate 33 than the trailing edge 40 of the blade 37, in order that the blade 37 may act as a foil, and during its rotation, tend to drive fibrous particles toward the plate 33, with the trailing edge 40 being adapted to create a partial vacuum or back draft therebehind, which would tend to "suck" or withdrawal fibrous particles from the surface 39 of the plate 33 which may otherwise tend to cling to the plate 33 and possibly prevent free passage of fibrous particles therethrough.

At the lower end of the first exit chamber 22, and attached to the chamber sidewall 23, is a second cuplike member 41, which provides a second exit chamber 42, having a generally right circular cylindrical sidewall 43, and integral bottom wall 44. The upper end of the cuplike structure 41 is provided with a flange 45 for securing the member 41 to the wall 23 which forms the chamber 22, by means of suitable screw-type fasteners 46. The cuplike member 41 is secured to the chamber wall 23, about a bore 47 in the wall 23. A suitable seal 48 is provided between the flange 45 and the wall 23. A ring 50 is secured within the bore 47, as in press-fit relationship thereto, the ring 50 having a frustoconical tapered inner surface 51.

The bottom wall 44 of the cuplike structure is provided with a bore 52, in which is received a packing 53, secured in place by a clamping washer 54, for receiving a vertically movable rod 55 therethrough. The rod 55 is carried by a suitable hydraulically operated piston 56, which is supplied by suitable hydraulic lines 57 and 58, and carries at its uppermost end a disk 60, secured thereto, the disk 60 having a frustoconically tapered surface 61, complementary to the surface 51 of the ring 50. It is readily apparent from the foregoing structural description, that upon desirably setting the piston 56, an infinite number of sized annular openings 62 may be obtained, such openings 62 forming an annular passageway between the chamber 22 and the chamber 42.

An exit line 63 from the second exit chamber 42 is provided, for passing defibered particles to other apparatus, if desired, for further treatment, or directly to a stock chest or the like (not shown).

OPERATION

Wood chips or like cellulose particles (not shown) enter the digester inlet 15, in the direction of the arrows indicated, wherein they are exposed to a heated vapor, such as saturated steam at a temperature above 212° F. The steam may also enter through the inlet 15, or through another inlet, if desired, but the steam is generally necessary for softening the wood chips within the digester 10. Also, chemicals may be added, for example through the inlet 15, to the digester 10, if it is desired to chemically treat the cellulose fibers as part of the digesting process.

Fibrous particles leaving the digester 10 through the outlet 16 are generally substantially softened by the steam and/or other treatment which has been received within the digester 10, and such softened chips or fibrous bundles enter the discharger tank 18. The particles entering the tank 17, accompanied by steam, after cooking within the digester 10 for a period of 11 to 12 minutes, for example, may be discharged from the digester into the discharge tank 17 at a substantial pressure, generally within the range of 150 to 190 lbs. per square inch gauge, but possibly at as high a pressure as 250 p.s.i. gauge.

The positioning of the rotor 32, perforated plate 33, and first exit chamber 22 substantially above the bottom portion 20 of the discharger tank 18, facilitates the collection of undesirable debris at the bottom of the tank 18, such as tramp metal and the like, which may otherwise damage the rotor 32, the perforated plate 33, or other discharger apparatus. An access opening (not shown) may be provided in the discharger tank, for the purpose of removal of such tramp metal and the like.

The fibrous particles entering the tank 18, will thus be driven under the substantial steam pressure (150 to 190 p.s.i. gauge) toward the chamber 22, which is at a reduced pressure. In doing so, the steam and fibrous particles will pass through the holes 35 of the perforated plate 33. The holes 35 may be, for example, of 1/2-inch diameter, and spaced apart from one another, a suitable distance, which will generally be a greater distance than the expected length of the longest fiber, to prevent an individual fiber from attempting to pass through two such holes 35 simultaneously, and thereby becoming "captured," on the outer surface 39 of the perforated plate 33.

The rotor 32 is operative to sweep substantially oversized fibrous particles from the surface 39 of the plate 33, and thus performs a mechanical defibering action only on those chips or fibrous bundles which are too large to pass through the holes 35 of the plate 33. In this manner, no mechanical defibering is done by the rotor 32, on fibrous particles which are of sufficiently small size to pass freely through the holes 35 of the plate 33, and thereby possible undesirable damage to the fibers caused by a mechanical abrading action, or transverse shear of the fibers caused by the rotor 32 is avoided. Also, the rotor 32, when driven at a desirable speed by the motor 30, may be operative such that each of its blades 37

may perform a pulsing action, in driving the fibrous material toward and away from the plate 33, with each passage of each of the blades 37 across a given hole 35. The relief indicated in FIG. 2 by the letter "X," between the blade edges 38 and 40 provides such a driving effect to the fibers, and the draft formed at the trailing edge 40 of each blade 37 cooperates with this driving force, to provide the pulsing action which is operative at a high rate, depending upon the number of blades used and the speed with which the rotor 32 is driven. Thus, an initial slight amount of defibering is done by the rotor 32, in its traversal of the plate 33.

As the steam and the fibrous particles pass from the tank 18, into the first exit chamber 22, from a high-pressure zone into an intermediate pressure zone, they pass through the constriction provided by the aggregate area of the plate holes 35. For example, in a particular discharger design, the diameter of the discharger tank may be 48 inches, thereby presenting a cross-sectional area of approximately 1,800 square inches, such being the passage area of the steam and particles from the digester 10, through the digester outlet 16, and the upper portion of the discharger tank 18. As such steam and particles pass into the first exit chamber 22, which has substantially a 36-inch diameter and approximately 1,000 square inch cross-sectional area, they must pass through the perforated plate 33, traversing the holes 35. Which have an aggregate cross-sectional area, for example, perhaps of 500 square inches. The fibers passing through this substantially reduced area of the perforated plate or screen 33 thus travel at a substantially increased velocity, and at a greater fiber density, thereby causing the fibers to engage one another and such frictional interaction of the fibers causes a further defibering of the particles. Additional defibering is caused by the fibers striking against those portions of the plate 33 immediately surrounding the holes 35. Also, as the fibers pass through the plate 33, entrained within the steam, and as the steam expands upon entering the first exit chamber 22 of increased cross-sectional area, such a sudden expansion exerts forces and pressures on the individual fiber bundles, tending to separate them along natural grain lines. The effect of such a sudden expansion depends upon the pressure drop and the sudden area increase, but may often be so violent as to cause an "explosion" effect, whereby the individual fibers in a given fiber bundle or chip may be subjected to instantaneous high separating forces.

The steam and entrained fibers then pass directly from the first exit chamber 22, into the second exit chamber 42, through a restricted passage means provided by the annular passageway 62, whereby further defibering is effected, again by friction of fibers against the surfaces which comprise the annular passageway 62, by fiber interfriiction caused by the increased velocity of the steam and fibers through the substantially reduced area of the annular passageway 62, and by expansion of the steam and entrained fibers within the exit chamber 42, of substantially increased area, relative to the annular passageway 62. For example, for a first exit chamber of 36-inch diameter, and of 1,000 square inches in cross-sectional area, a suitable annular passageway may be one having a passage area of 3 square inches, which may open into a second exit chamber 42 having for example a cross-sectional area of 24 square inches, which is connected to a blow line 63 having a 12.5 square inch cross-sectional area.

The particular construction of the passageway 62 is such as to allow precise adjustment of the passage size, and also to allow a maximum surface area 61 for engagement of fibers thereagainst, as the fibers are propelled through the passageway 62 by the steam expanding into the chamber 42, such fibers becoming furthered defibered because of the surface friction caused by their engagement against the frustoconical surface 61. The expansion of the fibers within the chamber 42 is generally similar to the expansion within the chamber 22, in that, as the steam and entrained fibers enter the lower-pressure zone 42, the forces acting upon the fibers under such expansion tend to cause separation of the fibers, also often with an "explosive" effect, or violent separation.

Upon leaving the chamber 42, through the blow line 63, the fibers are substantially minimized in size, and thereby substantially defibered, thereby in condition for later utilization for papermaking purposes.

It is thus apparent that, because it is the high-steam flow which forces the fibers through the perforated plate and causes subsequent defibering, and because the rotor is not utilized principally for defibering purposes, mechanical working is effected only on those particles which require work. This results in a more uniform end product at a lower cost, in that very little horsepower is consumed in driving the rotor, even at high-rotational speeds.

It will also be appreciated that other types of perforated plates may be utilized, such as grid type screens and the like, and that rotor arrangements may be selected as desired. Also the various other structural details of this invention are not to be construed as limiting, but are intended to set forth only the preferred embodiment of the structure of this invention. Accordingly, various modifications may be made in the material of construction, arrangement of parts and operational details, without departing from the spirit and scope of the invention as defined in the appended claims.

What is claimed is:

1. Apparatus for discharging fibrous material from a continuous digester by the use of pressurized steam from the digester only, as an impelling agent, comprising discharger tank means for receiving fibrous material and vapor under pressure, first exit chamber means adjacent to said tank means for receiving fibrous material and vapor under pressure from said tank means, perforated means having a plurality of openings therein for permitting passage of desirably sized particles therethrough separating said tank means and said first exit chamber means, rotor means located in said tank means adjacent said perforated means for controlling the size of fibrous material to be passed through openings in said perforated means, second exit chamber means located adjacent said first exit chamber means for receiving fibrous material and vapor under pressure from said first exit chamber means, and restricted passage means sized for increasing velocity and particle friction of material conveyed therethrough separating said first and second exit chamber means.

2. The apparatus defined in claim 1, wherein said restricted means defines an annular opening.

3. The apparatus defined in claim 1, wherein means are provided for adjusting an opening defined by said restricted passage means.

4. The apparatus defined in claim 1, wherein said restricted passage means defines an annular opening and wherein means are provided for adjusting the opening defined by said restricted passage means, said opening being defined by an outer frustoconical shaped bore and an inner frustoconical shaped plug selectively movable toward and away from a seated position within said bore.

5. The apparatus defined in claim 1, wherein said restricted passage means defines an annular opening, and wherein means are provided for adjusting the opening defined by said restricted passage means and wherein said adjustable opening defines means for adjusting the opening area for maximum surface-friction contact of fibrous material passing therethrough.

6. The apparatus defined in claim 5, wherein an exit line is provided from said second exit chamber means for facilitating the passage of vapor and defibered material from said second exit chamber means.

7. The method of defibering fibrous material leaving a digester, comprising the continuous steps of delivering high-pressure vapor and fibrous material to a discharger tank, selectively sizing the fibrous material for further defibering by traversing a perforated plate exit from the tank with a rotor, propelling the fibrous material under pressure through the perforated plate to create frictional defibering during fiber passage through the plate, suddenly expanding the vapor and carried fibrous material in an intermediate-pressure chamber,

propelling the fibrous material under pressure through a restricted opening sized for increasing velocity and particle friction of material conveyed therethrough, from the intermediate-pressure chamber to a low-pressure chamber to impart frictional defibering to fibers passing through the opening, and suddenly expanding the vapor and carried fibrous material in the low-pressure chamber.

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