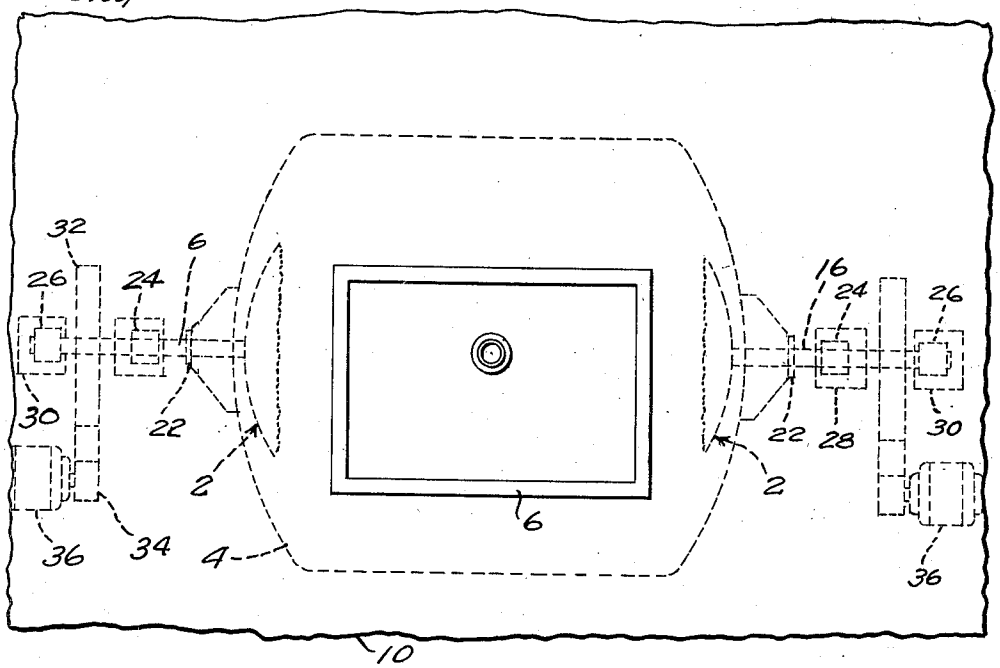
June 9, 1953 K. WANDEL 2,641,165

APPARATUS FOR EFFECTING DISINTEGRATION OF MATERIALS

Filed Oct. 14, 1949 3 Sheets-Sheet 1

Fig. 1.



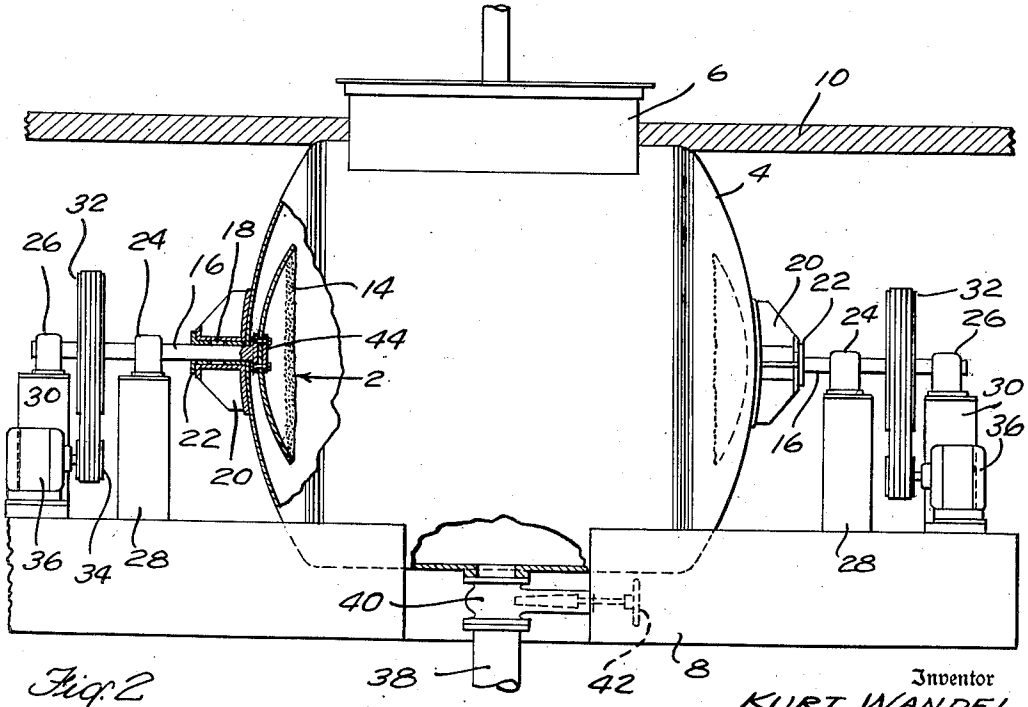


Fig. 2

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APPARATUS FOR EFFECTING DISINTEGRATION OF MATERIALS

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Fig. 3.

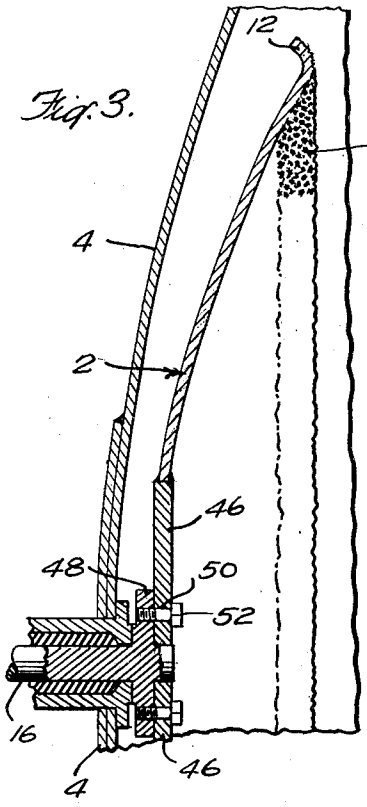


Fig. 4.

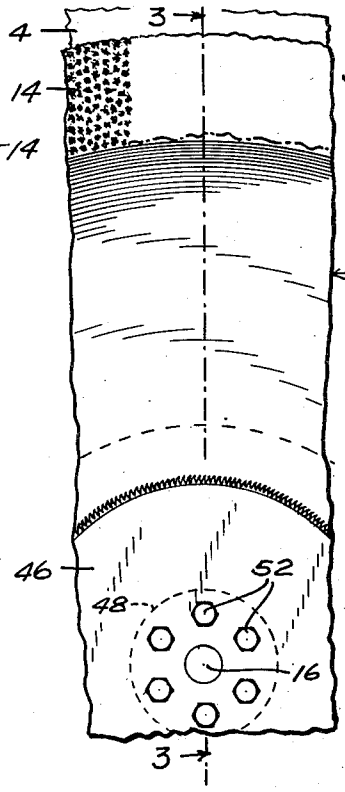


Fig. 5.

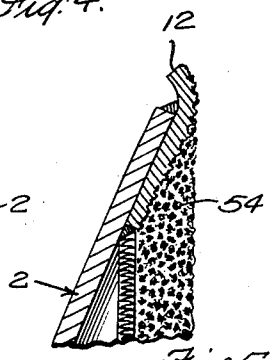
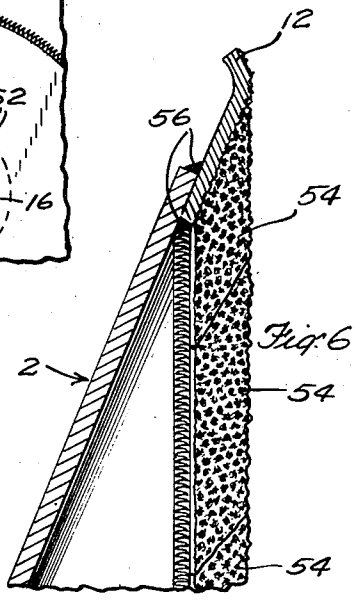


Fig. 6.



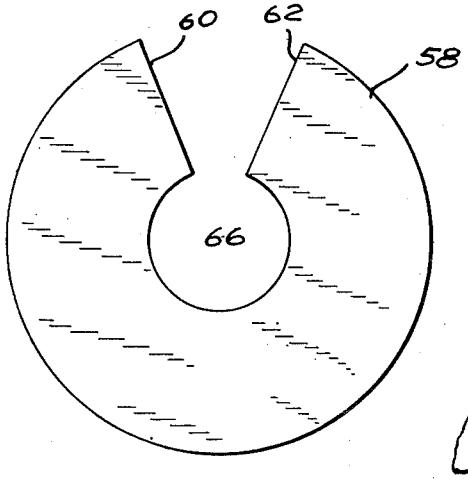


Fig. 7.

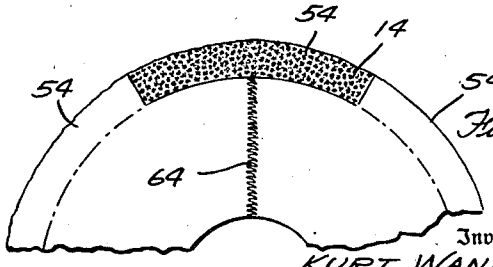


Fig. 8.

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APPARATUS FOR EFFECTING DISINTEGRATION OF MATERIALS

Filed Oct. 14, 1949 3 Sheets-Sheet 3

Fig. 9.

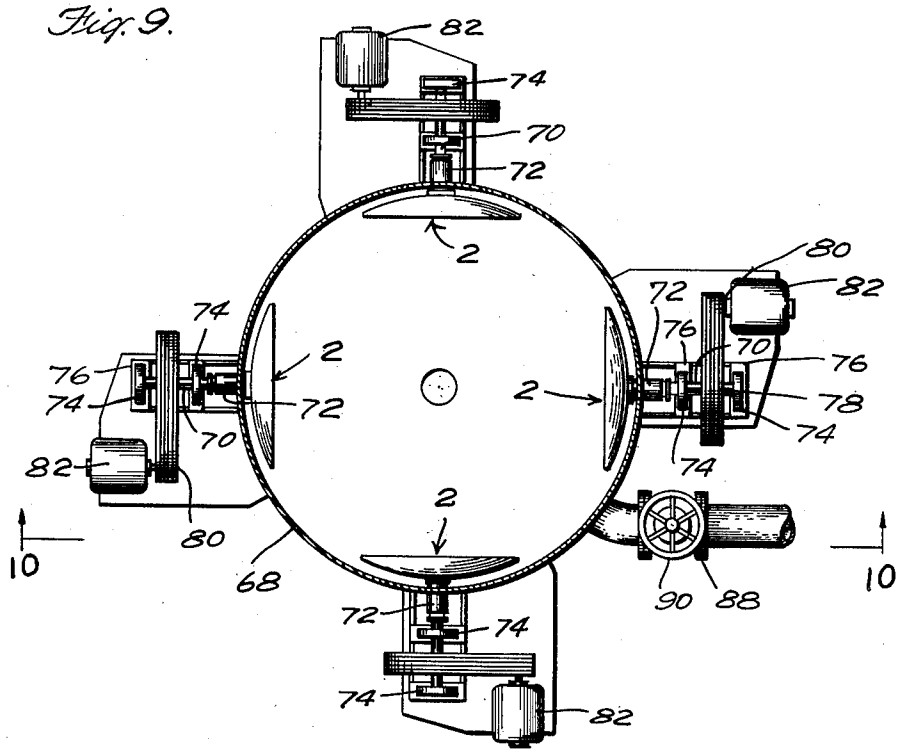
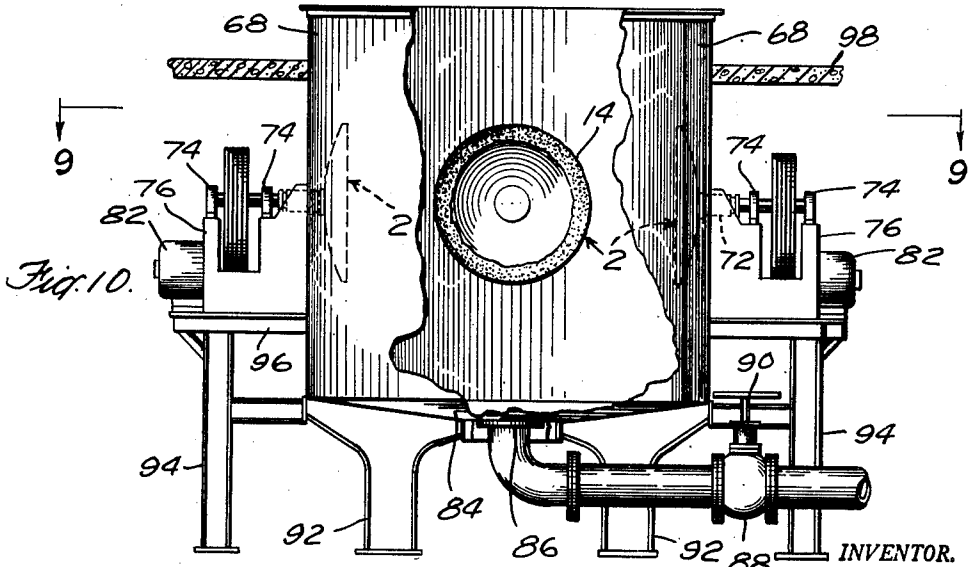


Fig. 10.



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2,641,165

UNITED STATES PATENT OFFICE

2,641,165

APPARATUS FOR EFFECTING DISINTEGRATION OF MATERIALS

Kurt Wandel, Downingtown, Pa.

Application October 14, 1949, Serial No. 121,270

4 Claims. (Cl. 92—26)

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This invention relates to apparatus for effecting disintegration, reduction or separation into their constituent particles or fibres of materials that may be floated, suspended or dispersed in a liquid medium such as water.

The expression "effecting a disintegration, reduction or separation into their constituent particles or fibres" is used broadly and is intended to include disintegration, defiberization, abrading, grating, scraping, rasping, rending, decorticating, comminuting, shredding, carding, combing, blending and mixing.

This application is a continuation in part, both of my copending application Serial No. 603,181, filed July 4, 1945, now Patent No. 2,592,215, for Letters Patent for Improvements in Apparatus for Subjecting Materials to a Disintegrating or Pulping Treatment and of my copending application Serial No. 6,254, filed February 4, 1948, for Letters Patent for Improvements in Machines for Effecting a Refining Treatment of Fibrous Material.

The novel apparatus of the present invention has a wide field of utility and may be used to disintegrate, to reduce or to separate into their constituent particles or fibres, materials of vegetable, animal or mineral origin. For example, it may be used to disintegrate, tear apart and even card the bundles of fibres in paper stock, pulp, rags, leather or asbestos. It may be used to decorticate or remove the outside barks or other coatings from the woody stems of highly ligneous plants such as hemp, jute, China grass, etc. It may further be used to comminute or shred materials such as garbage so as to facilitate the removal and disposal of the heavy and insoluble portions thereof. It may also be used to form suspensions and dispersions containing pulp or other comminuted materials and thoroughly to intermix and blend such materials with various other fibrous and/or non-fibrous materials.

As will appear more fully hereinafter, the apparatus of the present invention is particularly suited for processing waste papers as they are received by the paper manufacturers from the collectors thereof. This has proved to be one of the most important fields of utility of the present invention since the machine is capable of handling the waste papers in the form in which they are recevied from the collectors thereof, with their content of foreign materials such as rags, string, rubberized fabric, rubber, wire and metal parts, besides such apparently harmless things as wet strength paper, parchmentized paper, paper treated with oils, paraffine, asphalt, rubber and synthetic resins and paper laminated with metal foil and insoluble binders. Not only

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has the present invention proved to be useful in effecting the pulping of waste papers and the initial separation of the pulp from the foreign materials, but it effects such pulping more quickly, more thoroughly and with less power consumption than it can be effected by the use of existing machines for such purposes.

An important feature of the invention which, probably more than anything else, contributes to its effectiveness as a disintegrator is the employment of a disintegrating impeller of a hollow or dished or concave rotating disk provided on the marginal portion of its hollow or concave face with particles of a hard cutting or abrasive material firmly fixed thereon, as contrasted with disintegrating devices in the prior art consisting either of ordinary propellers or of flat disks provided with vanes. The impeller of the present invention is so constructed that it insures the movement of the liquid in the vat over the disintegrating surface in such manner that it hugs this surface throughout its movement thereover and therefore forces any material to be disintegrated, which is carried thereby, into abrasive relation to the abrasive coated marginal portion of the hollow face of the disk.

It will be apparent that the hollow impeller may have its hollow face either of concave, that is, of curved segment contour, or of conical or conical segment contour, the important consideration being that the inner face of the impeller disk be inclined to the radius of rotation at substantially all points from the bottom of the hollow to its lip or at least so inclined through the abrasive zone. It will further be apparent that, since the effective abrading action of the impeller takes place on the abrasive coated margin of the hollow disk, the shape of the bottom of the hollow may be varied considerably without effecting the operative efficiency of the disk as a whole. For example, in a concave disk it is not necessary to carry the spherical or other curvature down to the axis of rotation, the disk being equally effective if the curved segment at the bottom be cut off and a flat bottom be provided. Likewise, in the case of a hollow or dished disk having a conical side wall, the bottom of the disk may likewise be flat making the hollow disk have the form of a shallow frustum of a cone.

It will further be seen that by mounting a disk of the character described upon the end of a shaft projecting through a wall of the vat, so that the hollow side of the disk is uninterruptedly exposed to the vat contents, and constructing the disk so that it is symmetrical about the axis of rotation, the aforementioned effective disintegrating operation will be obtained by reason

of the fact that centrifugal force, acting upon the liquid as it passes from the bottom of the hollow toward the lip of the disk, tends to throw the liquid out at right angles to the axis of rotation, such movement of the liquid in a plane perpendicular to the axis of rotation being resisted by the inner face of the concave or frusto-conical disk, which is, at substantially all points from the bottom of its hollow to its lip, inclined to the radii of rotation, and thus the liquid will be pressed against this face by the component of the centrifugal force which is perpendicular to the face. This insures the liquid and its solid content being forced against the abrasive or cutting particles with which a substantial marginal portion of the inner or hollow face of the disk is coated.

I am aware that the prior art discloses disintegrating apparatus consisting of an impeller mounted within a tub for rapid rotation. The impellers in prior art devices however hollow, were not concave or dish-shaped and therefore could not be provided with abrasive coated margins over which the material to be disintegrated is forced to travel in close-pressed relation, by reason of the hollow construction, but were provided at most with a plurality of projecting smooth vanes. The use of prior devices has been limited to those operations, usually on a relatively small scale, in which thoroughness of disintegration, suspension and dispersion as well as power consumption were not of particular importance.

In marked contrast with devices of the prior art, the apparatus of the invention produces practically complete disintegration or tearing action with the consumption of considerably less power and in much less time. In fact, this time saving in effecting a complete disintegration, suspension and dispersion, for example, in the pulping of waste paper is one of the most important advantages of the present invention.

Other objects, important features and advantages of the invention, to which specific reference has not hereinabove been made, will appear hereinafter when the following description and claims are considered in connection with the accompanying drawings, in which—

Figure 1 is a plan view of a disintegrating machine embodying the present invention and which is particularly designed for pulping paper stock;

Figure 2 is a side elevation, with parts broken away to show the interior construction, of the machine shown in Figure 1;

Figure 3 is an enlarged sectional detail of a disintegrating impeller and of the end of the vat in which it is located, this view showing a slight modification of the impeller shown in Figure 2 and being taken on the line 3—3 of Figure 4;

Figure 4 is a detail front elevation of the impeller structure shown in Figure 3;

Figure 5 is a sectional detail of a modified impeller lip construction;

Figure 6 is a view of a modified impeller construction in which the hollow impeller disk is formed of a frustum of a cone instead of a segment of a sphere, this view also showing the modified lip construction of Figure 5;

Figure 7 is a plan view of a blank from which the frsuto-conical disk of Figure 6 can readily be made;

Figure 8 is a plan detail showing the manner of completing the frusto-conical impeller shown in Figure 6;

Figure 9 shows a modified form of the invention in which a plurality of impellers are located on the side wall at equiangular distances about the axis of a vertical cylindrical vat, this figure being a horizontal section on the line 9—9 of Figure 10;

Figure 10 is a partial side elevation of the disintegrator shown in Figure 9, partially in section, the section being taken on the line 10—10 of Figure 9.

In one of the most efficient embodiments of the invention, namely, that shown in Figures 1 and 2 of the drawings, two disintegrating impellers 2 are located in the opposed end walls of a tank or vat 4 of the general contour shown in Figures 1 and 2, this tank or vat having a central substantially cylindrical part connecting two concave ends, in the concavities of which the impellers 2 are located. The radii of curvature of the concave vat ends is preferably somewhat greater than the radii of curvature of the impellers 2, when these are of spherical segment form. The material to be disintegrated by the disintegrating impellers 2 is introduced into the vat 4 through a hopper 6 communicating with the interior of the vat through an opening in the top thereof, the vat being supported against movement by any suitable supporting means such as the concrete or other base 8 upon which it rests. In ordinary installations, particularly where the vat is of substantial diameter, for example 8 feet, the floor or base 8 upon which the vat is supported may be in one room and the material to be disintegrated may be carried to the hopper 6 over the floor 10 of a room above the disintegrator or pulper.

In the form of the invention shown in Figures 1 and 2, the disintegrator comprises a hollow steel disk, preferably having upon its outer margin a turned-over lip 12, a substantial marginal portion of the concave face of the disk and preferably the whole of the turned over lip 12, if the disk be provided with such a lip, being coated with particles 14 of a suitable hard cutting or abrasive material, such as tungsten carbide, these particles being held upon the face of the disk and upon the lip by any suitable flux or binder. I have found in practice that a very satisfactory material for providing the working surfaces of the impeller disks 2 with abrading or disintegrating surfaces is that which is sold under the trade name "Tube Borium." The bonding material of this product which secures the tungsten carbide particles in place on the surface to be treated, that is, the mild steel of the tube in which the tungsten carbide particles are delivered to the user, is stated to have an analysis which shows the non-ferrous ingredients of the steel to be as follows:

Phosphorous	.03
Carbon	.06
Silicon	.15
Sulphur	.03
Manganese	.30

These particles of tungsten carbide, distributed over the working surfaces of the disintegrating impellers and bonded thereto in the manner set forth, provide a most effective means for effecting the disintegration, reduction or separation into their constituent particles or fibres of materials that may be floated, suspended or dispersed in a liquid medium, such as water, and carried in this medium to the points of disintegration. The manner in which this movement of the material to be disintegrated into opera-

tive relation to the disintegrating particles on the operating surfaces of the disintegrating impellers is brought about has been broadly outlined hereinabove and will be pointed out more in detail hereinafter.

The impellers **2** are mounted for rotation in the liquid in the vat **4** on shafts **16** which extend through the end walls of the vat **4**, these shafts extending through stuffing boxes **18** carried by supports **20** secured to the convex outer faces of the end walls of the vat **4**, each stuffing box being provided with a gland **22**. The shaft **16** extends through bearings **24** and **26** mounted on suitable supports **28** and **30** and each shaft has thereon a multiple V-belt pulley **32** driven from a driving V-belt pulley **34** of an electric motor **36**.

Discharge of the pulp stock may be effected through the bottom of the vat **4** into a discharge pipe **38** discharging into any suitable receptacle located, for example, on the floor below, the discharge being controlled by a gate valve **40** operated by any suitable manually controlled means, such as the valve operating wheel **42**.

From the foregoing description of the form of the invention shown in Figures 1 and 2, the operation of the device will readily be understood. It will be understood that these pulpers or disintegrators are of substantial capacity. For example, if the tank **4** be of a cylindrical diameter of approximately 8 feet and of the proportional length shown in the drawings, the impeller disk **2** will be, if in the form of a plain spherical segment, about 56 inches in diameter. If provided with the rounded lips such as shown in greater detail in Figures 3 and 6, it will be of somewhat greater overall diameter, say 60 inches. The radius of curvature of the spherical segment is usually substantially equal to the diameter of the circle defined by its peripheral edge. A commercial embodiment of such a disintegrator, provided with approximately 3200 gallons of water, and with the impeller disks each rotating at 300 R. P. M., which gives a peripheral speed of approximately 4400 feet per minute, will completely defibre 30 to 50 tons per day of waste paper stock, in a dispersion of 5% density, and will require for its operation not more than 50 H. P. The amount of stock treated in a given time will vary somewhat with the density desired. The time of operation for each batch may be from 15 to 30 minutes or even less.

The operation of the impeller and its effectiveness as a disintegrator is perhaps the most important feature of the present invention. It will be seen that, when the impeller is rotated, for example, at a speed such as suggested above, the cutting or abrasive particles **14**, making up the disintegrating surface on the marginal portion of the hollow face of the impeller disk **2**, create a movement in the water in the vat **4** which tends to throw the water and any particles of material carried thereby off the peripheral edge of the disk thus creating an outward stream from the hollow central part of the disk to the peripheral edge or lip of the disk. This stream tends to move in a plane at right angles to the axis of rotation of the impeller disk **2** and thus tends to hug those parts of the inner or hollow face of the disk which are obliquely inclined to the radius of rotation. The centrifugal force thus forces this outwardly moving stream and any particles carried thereby to travel over the particles **14** in forced contact therewith. This insures an effective abrading action of the particles upon any material carried by the water that is moving first into the bottom of the hollow of the disk and being thus thrown out from the periphery thereof.

For many purposes the lip **12** on the peripheral portion of the impeller **2** is not needed. When, however, bundles of papers which might be of sufficient dimensions to bridge the diameter of the disk are thrown into the disintegrator or pulper it is advantageous to have a rounded lip, such as the lip **12** with the abrading particles thereon, since these will serve to disintegrate and cut through the supporting parts of any bridging material and thus insure its eventual movement into the hollow of the impeller and its travel over the margin of the hollow face of the disk which has been provided with the abrasive surface.

In the manufacture of impellers **2** of the form shown in Figures 1 and 2, it is sometimes found difficult to dynamically balance the impellers and to mount them upon the shafts **16** so that they will be sufficiently strongly supported to perform their heavy duties. This is sometimes so even when the impellers have reinforcing pieces **44** welded to their inner faces. Since the bottom of the concavity in a completely concave impeller performs very little useful work in the operation thereof, I have found it advantageous in some cases to construct these impellers in the manner shown in Figures 3 and 4. In the modified form of the impeller construction there shown I cut out a substantial portion of the center of the impeller disk and weld into this cutout, which may be of a diameter of 14 inches or more for an impeller 56 inches in diameter, a flat disk **46** of heavier steel which will give a more rigid connection to the enlarged end **48** of the shaft **16** and will tend to reduce any lateral vibration of the impeller disk **2**. This plate **46** may be provided with screw openings **50** through which machine screws **52** may be screwed into openings tapped into the enlarged end **48** in the shaft **16**.

Since the shaping of the impeller disk **2** to the sectional contour shown in Figure 3, that is, with the lip **12** integral therewith, is a somewhat difficult manufacturing operation, I have found it advantageous to form the lip **12** upon segments **54**, which may also be of radial dimensions sufficient to constitute the inner marginal surface of the disk which is to be covered with the abrasive material. Since the lip **12** can easily be formed on each of these segments **54**, if the segment does not embrace too great an arc of the circumference of the propeller disk **2**, this is an easy way of forming both the lip and the abrasive margin of the disk, these segments being then welded in place as shown at **56**.

A slight modification of the impeller disk construction, which facilitates manufacturing while providing an impeller which is substantially as effective as that shown in Figures 1 to 5, inclusive, is the one shown in Figures 6 to 8 inclusive. In this form of the invention the hollow surface over which the liquid is forced to travel, instead of being formed as a segment of a sphere, is formed as a segment or frustum of a cone, that is, it is frusto-conical. This permits easy manufacture of the disk since a flat annular blank **58** having a sector cut therefrom, such as shown in Figure 7, may be bent up into frusto-conical form, thereby causing its edges **60** and **62** to meet. These edges may then be welded together as shown at **64** and the weld smoothed off, thus providing a hollow disk which may have its marginal surface directly coated or to which coated segment plates **54** may be attached, as shown in Figure 6. The open

center 66 may be provided with a supporting disk 46, welded thereto in the manner shown in Figure 3 in connection with the spherical segment disk there shown.

In the embodiment of the invention shown in Figures 9 and 10 of the drawings, which is particularly suited to treatment of coarser waste materials, there are four disintegrating impellers 2, shown as located 90° apart on the inner wall of a cylindrical vat 68 having a vertical axis. As in the case of the embodiment of the invention shown in Figures 1 and 2, the impellers 2 are mounted on the inner ends of shafts 70 extending through stuffing boxes 72 mounted upon the outer walls of the vat 68, each of the shafts 70 being mounted in bearings 74 on columns 76 and carrying between said bearings 74 a multiple V-belt pulley 78 driven from a small multiple V-belt pulley 80 on the driving shaft of a motor 82.

The vat 68 has a frusto-conical bottom 84 provided with an opening communicating with a discharge pipe 86 controlled by a valve 88 operated by hand wheel 90.

The vat 68 may be supported on a suitable metal framework comprising legs 92 directly supporting the vat. Other legs 94 support platforms 96 for the driving mechanisms for the respective impellers 2.

As in the case of the form of the invention shown in Figures 1 and 2, the open top of the vat 2 preferably projects through a floor 98 into a room above. The material to be disintegrated or pulped can be wheeled over the floor 98 and dumped into the open upper end of the vat 68.

In the operation of either form of the invention, either that shown in Figures 1 and 2 or that shown in Figures 9 and 10, the liquid in the vat, with its content of fibrous material to be disintegrated will be of a depth completely to cover the impeller disks or in other words it will substantially fill either the vat 4 or the vat 68. As the impellers 2 rotate, for example at the speed for a 56 inch diameter impeller hereinabove suggested, namely 300 R. P. M., giving a peripheral speed for said 56 inch impeller of 4400 feet per minute, the liquid moving into the bottom of the hollow of each impeller and then toward the lip thereof under the action of the strong centrifugal force thus created will produce a marked circulation in the tank, liquid to replace that thrown off from the lip of each impeller constantly moving to the bottom of the hollow in the impeller and thus being forced to travel over the abrading surface of the impeller, thereby carrying the material to be disintegrated into engagement with the surface. In the form of the invention shown in Figures 1 and 2 the impellers 2 are usually, but not necessarily, driven in the same clockwise or counterclockwise directions about the axes of their respective shafts which, by reason of their opposed relation, makes their surfaces rotate in opposite directions in the liquid of the tank. This causes the production of an hour glass or figure 8 movement of the material in the vat or tank.

In the form of the invention shown in Figures 9 and 10, the impellers 2 also, preferably but not necessarily, rotate in the same direction about the axes of their shafts. This, as in the case of the invention shown in Figures 1 and 2, causes the surfaces of the opposed impellers to travel in opposite directions through the liquid.

Although junk traps or junk removers may be connected to the vat 4 or to the vat 68, it has been found in practice that the junk can be carried off with the stock and removed by screens outside the vats.

Although, for manufacturing reasons, impellers made up of hollow disks of either spherical segment contour or frusto-conical contour are generally preferable, it will be understood that there is no intention to limit the invention to impellers in which the hollow disks are of either spherical segment or frusto-conical contour. It is apparent that other shapes of hollow disks, such as a segment of an ellipsoid or a hollow disk generated by a hyperbolic curve, would be equally effective so long as the hollow face provided meets the definitions hereinabove given of the surface required for carrying the abrasive material.

What is claimed as new is:

1. Distintegrating apparatus having in combination a vat adapted to contain water and the material to be disintegrated and a disintegrating impeller in said vat comprising a concave disk having its main body portion of hollow spheroidal configuration, the radius of curvature of said body portion being approximately equal to the diameter of the disk, said disk having permanently bonded to the marginal portion of its concave face a covering of crystalline abrasive material of discrete particles, and means supporting the disk for rotation at high peripheral speed about an axis to which said disk is symmetrical including a driving shaft projecting through the wall of said vat upon which said disk is mounted with its concave side fully exposed to the contents of the vat.

2. The disintegrating apparatus of claim 1 wherein the marginal edge of said impeller is curved outwardly away from the surface of the main body of said disk, said marginal edge being covered with abrasive material as described.

3. Disintegrating apparatus having in combination a vat adapted to contain water and the material to be disintegrated and a disintegrating impeller in said vat comprising a concave disk, means supporting the disk for rotation at high peripheral speed including a driving shaft projecting through the wall of said vat upon which said disk is mounted with its concave side fully exposed to the contents of the vat, said concave side forming a cavity for the reception of material moving axially toward said disk with the surface of the marginal portion of said cavity inclined at a small angle away from a plane normal to the axis of rotation whereby material moving outwardly across the face of said disk will be deflected axially, and a covering of crystalline abrasive material of discrete particles permanently bonded to said marginal portion.

4. Disintegrating apparatus according to claim 3 wherein the edge of the disk is curved away from the plane of said marginal portion and is covered with abrasive material as above described.

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