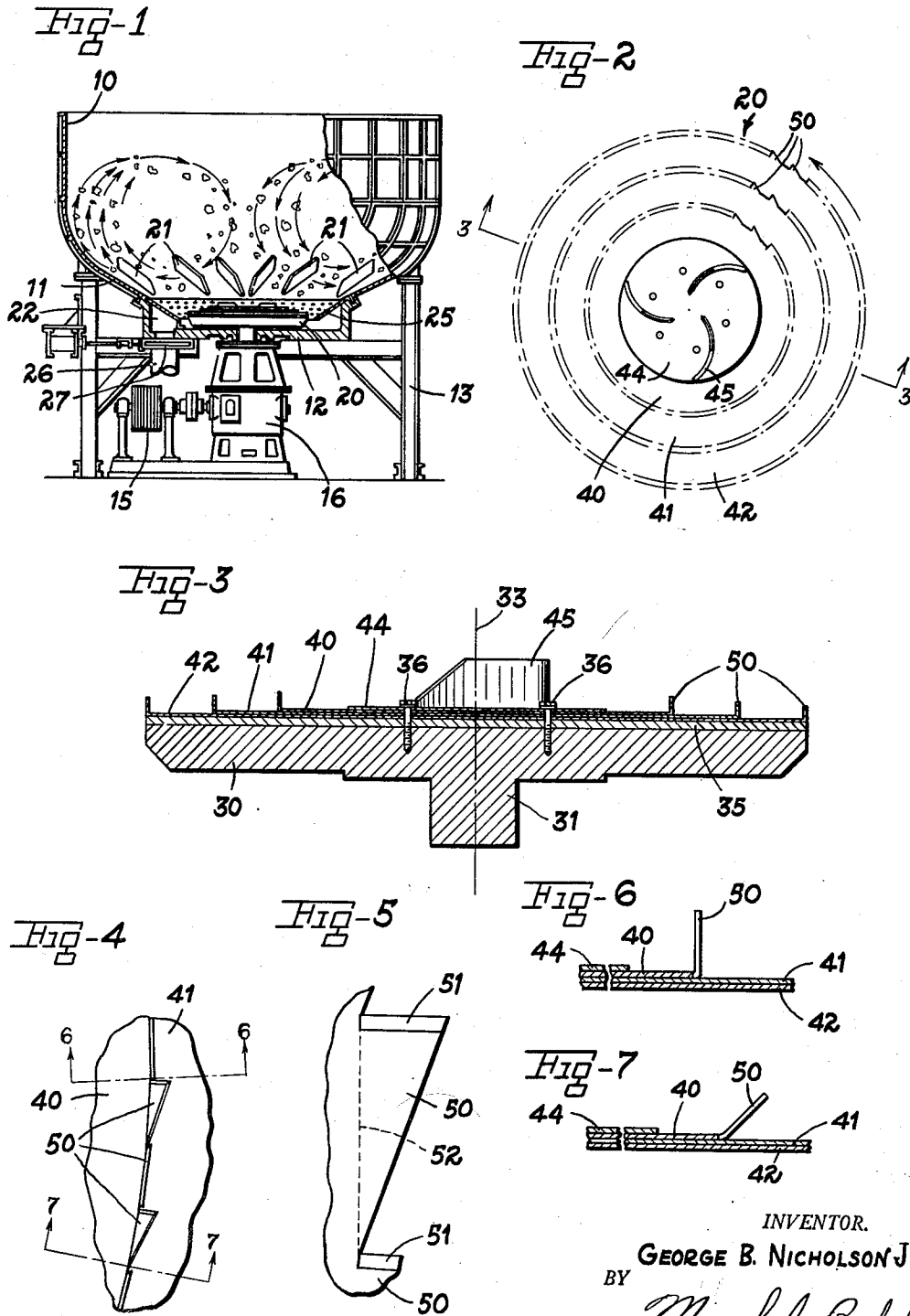


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TOOTHED CUTTING IMPELLER FOR PULPING
SOLID MATERIALS IN LIQUID SUSPENSION
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TOOTHED CUTTING IMPELLER FOR PULPING SOLID MATERIALS IN LIQUID SUSPENSION

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This invention relates to apparatus for pulping or disintegrating solid materials in liquid suspension.

The invention has special application to apparatus for mechanically disintegrating or pulverizing solid materials such particularly as materials which are not soluble in water but are readily handled in water suspension and which it is desired to reduce to particles of relatively small size without crushing or bruising. For example, the invention has been practiced successfully with varied materials of this general nature such as chunks or large particles of cellulose acetate for reduction to substantially uniform small particle size, large pieces of orange peel for reduction to slurry form in preparation for further processing, and particles of animal fat or fatty tissue for disintegration of the fat globules and connecting tissues to facilitate rendering of the fat, and the invention has as a major objective the provision of apparatus for effect-disintegrating or pulverizing of solid materials of the above type under controlled conditions giving substantially small particle sizes at economical cost in terms of the requirements of both power and operating time while avoiding crushing or bruising of the material.

This general objective is accomplished in accordance with the invention by treating the solid materials in liquid suspension in pulping apparatus provided with a chamber adapted to contain a quantity of the suspension and equipped with an impeller having special structural and operational features such that it causes continuous radial circulating movement of the suspension and at the same time subjects the solid particles therein to repeated cutting action by a plurality of rapidly moving blades which operate both to sever the particles and also to cause these severed particles to be comingled at high speed and with high turbulence creating a further disintegrating effect. Thus both inertia and hydraulic pressure cooperate with the cutting blades in performing the disintegrating operation, and since both of these factors decrease as the sizes of the particles become smaller, it is possible in the practice of the invention to establish a desired size of the particles and to reduce all the solid material to this predetermined size with a high degree of uniformity.

It is accordingly an object of the invention to provide disintegrating apparatus for operation on solid materials in liquid suspension which includes an open chamber having an impeller mounted for rotation therein and formed with a

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plurality of thin blades arranged in such relation to its rotational axis that as the impeller rotates and causes the suspension to circulate continuously across its surface in generally radial directions, the cutting blades intersect the path of travel of the suspension substantially at right angles to effect repeated cutting action on the particles coupled with a high propulsive action causing the cut particles to rush against each other for further disintegration.

Another object is to provide disintegrating apparatus of the above character for solid materials in which the impeller is formed with two or more radially spaced circumferential rows of cutting blades adjacent its periphery, and in which adjacent blades in each row are arranged at different angles to the rotational axis of the impeller to give a high number of blades with intervals therebetween in each row for high cutting action with minimum bruising.

It is also an object of the invention to provide an impeller for disintegrating apparatus as outlined above which may be readily fabricated from sheet metal in different sizes and different numbers of rows of cutting blades and relative sizes of blades in accordance with a given material to be treated and the desired conditions of operation thereon.

Other objects and advantages of the invention will be apparent from the following description, the accompanying drawings and the appended claims.

In the drawings—

Fig. 1 is a view partly in side elevation and partly in vertical section showing pulping apparatus including an impeller constructed in accordance with the invention;

Fig. 2 is a plan view of the impeller;

Fig. 3 is an enlarged section on the line 3—3 of Fig. 2;

Fig. 4 is a fragmentary view of one of the rows of blades on the impeller;

Fig. 5 is an enlarged fragmentary view showing structural details of one of the cutting blades; and

Figs. 6 and 7 are enlarged fragmentary sections on the lines 6—6 and 7—7 respectively of Fig. 4.

Referring to the drawing, which illustrates a preferred embodiment of the invention, Fig. 1 shows a pulping apparatus generally of the construction disclosed in Martindale Patent 2,371,837, issued March 20, 1945, to the assignee of this application. This pulper includes a tub or vat having a cylindrically extending upper wall portion 10, an inwardly tapered lower wall

portion 11 and a bottom wall 12, and it is carried by supports 13 of any suitable character. Arranged below the tub is a drive such as a pulley 15 adapted for connection to a motor, not shown, and connected through a suitable gear transmission mechanism indicated at 16 to a rotatable shaft which extends up through an opening in the bottom 12 of the tub and carries a rotatable pulping impeller 20 arranged adjacent the bottom of the tub and above its bottom wall. The rapid rotation of the impeller 20 provides an effective circulation outwardly and then upwardly along the outer portions of the tub with a return downflow towards the impeller, as indicated by the arrows, and vanes or plates 21 are mounted on the wall portion 14 to guide the upward flow of the pulp or stock. Adjacent the bottom of the tub is an annular chamber or compartment 22 partitioned from the space above the impeller by a perforate extractor plate 25 of frusto-conical form which permits the passage of the fine pulp to the compartment 22, from which it may be withdrawn as desired by way of the conduit 26 shown as provided with a shutoff valve 27.

The impeller 20 includes a main plate or disk 30 having a shaft portion 31 for connection to the drive for rotation as described about its central axis 33. An adapter plate 35 is secured to the upper surface of plate 30 by means such as bolts 36, and the impeller is also provided on its upper surface with a plurality of nested disks each formed with a row of cutting blades around its periphery. Three of these disks are shown and are identified as 40, 41 and 42 respectively, and they are of different diameters and are mounted on the impeller by means of the bolts 36 and a central holddown plate 44. A plurality of curved vanes 45 are shown as mounted near the center of the impeller to serve as pumping vanes urging the pulp radially outward across the surface of the plate as the impeller rotates in operation, the use of these vanes being optional depending upon the particular materials and operating conditions desired.

The construction and arrangement of the individual blades 50 on each of the disks or plates 40-42 are shown in Figs. 4 to 7. These blades 50 are generally saw-toothed in shape, and each is formed on its leading edge with a sharpened cutting edge 51 extending initially generally radially of the plate. Each blade is bent upwards out of the plane of the remainder of the plate, satisfactory results having been obtained with the bend lines 52 substantially tangent to a circle centered on the axis of the impeller. In addition, desirable results have been obtained by alternating the angle of adjacent blades in each row in order to provide intervals between alternate blades in the row, satisfactory results having been obtained with adjacent blades at angles of 45° and 90° respectively to the plane of the plate as shown in Figs. 6 and 7.

The sizes and number of the blades on each disk vary with the diameter of the disk, but in general satisfactory results have been obtained with pulping apparatus of the type shown in Fig. 1 of different sizes, requiring impellers of correspondingly different diameters, wherein the blade disks are formed of 16-gauge stainless steel, and wherein the cutting edge of each blade is approximately $\frac{3}{4}$ of an inch in length and is inclined slightly backwards, for example about 2°, from a radius traversing its innermost end. The length of the blades measured along the fold line 52 may be varied in accordance with

the diameter of the disk and the desired number of teeth, satisfactory results having been obtained with this dimension varying from approximately $\frac{3}{4}$ of an inch to two inches or more.

As one example of the type of disintegrating or pulverizing action for which the apparatus of the present invention has proved highly successful, it has been used for reducing large chunks of cellulose acetate to a substantially uniform small particle size. In one series of test runs for this purpose, using pulping apparatus of the type shown in Fig. 1 having the tub five feet in diameter was used, the cellulose acetate particles, which varied from sizes of the order of a head of cabbage down to approximately the size of a grain of sugar, were added in a solution of water and glacial acetic acid, with the total weight of the cellulose acetate varying from 240 to 430 pounds and with the total volume of the suspension being of the order of 400 gallons. In some runs, the impeller was constructed as shown in Fig. 3 with three disks respectively 18, 24 and 30 inches in diameter, and in other runs only the smaller two disks were used. In each case with the impeller rotating at a rate giving a peripheral speed of 5100 feet per minute for the largest disk, reduction of the cellulose acetate to an extent such that less than 2% was retained on a 5-mesh screen was accomplished in from 10 to 15 minutes with economical expenditure of power.

Another use for which apparatus in accordance with the invention has been satisfactorily used is the mechanical disintegration of the residual fatty tissue resulting from rendering raw animal fats by a combined rapid heating and agitating treatment. In such treatment in a kettle heated to a temperature of the order of 300° F., as much as 80% pure fat may be recovered in from 15 to 20 minutes, but the remaining adipose fatty tissue, which comprises approximately 70% fat, is more difficult to break down. Highly satisfactory physical disintegration of this fatty tissue and release of the remaining fat has been accomplished in a pulping apparatus constructed as described above, with the rapid rotating impeller blades acting to disintegrate the tissues and thereby to rupture the fat cells and permit release of the fat and recovery of the valuable protein residue without damage such as would tend to result from the prolonged heating usually relied on for this purpose.

Tests of the above character indicate that in the operation of the apparatus of the invention, the peripheral speed of the cutting blades is of material importance in obtaining effective cutting action with a minimum of bruising. In general the preferred blade speed appears to be not substantially less than approximately 5000 feet per minute, computed for the outermost row of blades where more than one row of blades is used, speeds of this order having been found highly satisfactory for such widely differing materials as the cellulose acetate and animal fat residue mentioned above. In this speed range, the paths of the radially circulating particles and the blades cross at angles of the maximum size, and the relative speeds of both particles and blades are sufficiently high for the desired shearing action of the blades on the particles without bruising and also for the desired high turbulence and the resulting reducing action of the particles themselves on each other which has been found to produce substantially uniform disintegration to small particle sizes.

While the form of apparatus herein described

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constitutes preferred embodiments of the invention, it is to be understood that the invention is not limited to this precise form of apparatus, and that changes may be made therein without departing from the scope of the invention which is defined in the appended claims.

What is claimed is:

1. An impeller adapted for use in disintegrating solid materials substantially without bruising thereof in apparatus of the character described including a chamber adapted to contain a quantity of relatively large particles of said materials in liquid suspension, comprising a plate adapted for rotation in said chamber about an axis substantially normal to said plate to subject said suspension to centrifugal force causing said suspension to circulate radially across the surface of said plate, means forming a plurality of relatively thin cutting blades adjacent the periphery of said plate and extending at substantial angles with respect to the plane of said plate, each said blade having a cutting leading edge thereon facing in said direction of movement to cross said radially circulating suspension at relatively large angles for effective shearing action on said particles therein, said blades being generally saw-toothed in shape and extending generally in line with the direction of movement thereof with said impeller to present minimum surface area to the radial flow of said suspension in use for avoiding bruising of said solid materials therein, and said blades being located adjacent the periphery of said plate to provide substantially maximum linear velocity therefor for a given angular velocity of said plate.

2. An impeller adapted for use in disintegrating solid materials substantially without bruising thereof in apparatus of the character described including a chamber adapted to contain a quantity of relatively large particles of said materials in liquid suspension, comprising a plate adapted for rotation about an axis substantially normal thereto in said chamber to subject said suspension to centrifugal force causing said suspension to circulate radially across the surface of said plate, means forming a plurality of circumferential rows of thin cutting blades concentrically arranged in radially spaced relation on said plate and extending at substantial angles with respect to the plane of said plate, each said blade having a cutting edge facing in the direction of movement thereof with said impeller and having the radially inner edge thereof substantially tangent to the same circle concentric with said plate as the other said blades in the same said row therewith to align the remainder of said blade generally with said direction of movement to avoid bruising of said solid materials in use, and the outermost of said rows being located substantially at and in said tangential relation with the periphery of said plate to provide maximum linear velocity therefor for a given angular velocity of said plate.

3. An impeller adapted for use in disintegrating solid materials substantially without bruising thereof in apparatus of the character described including a chamber adapted to contain a quantity of relatively large particles of said materials in liquid suspension, comprising a plate adapted for rotation about an axis substantially normal thereto in said chamber to subject said suspension to centrifugal force causing said suspension to circulate radially across the surface of said plate, a disk of sheet material secured to the upper surface of said plate, said disk having a plurality of cutting blades formed along the

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periphery thereof each having a cutting edge thereon facing in the direction of movement thereof with said impeller, said blades being bent out of the plane of the remainder of said disk along lines substantially tangent to a common circle to cross said radially circulating suspension at relatively large angles for effective shearing action on said particles therein and to locate the remainder of each said blade generally in line with said direction of movement thereof, and said blades being generally saw-toothed in shape with said cutting edges thereof generally radially arranged with respect to said plate axis for maximum cutting action on said solid materials while presenting minimum surface area to the radial flow of said suspension to avoid bruising of said solid materials therein.

4. An impeller adapted for use in disintegrating solid materials substantially without bruising thereof in apparatus of the character described including a chamber adapted to contain a quantity of relatively large particles of said materials in liquid suspension, comprising a plate adapted for rotation in said chamber about an axis substantially normal to said plate to subject said suspension to centrifugal force causing said suspension to circulate radially across the surface of said plate, a disk of sheet material secured to the upper surface of said plate, said disk having a plurality of cutting blades formed along the periphery thereof and bent out of the plane of the remainder of said disk, and each said blade having a cutting edge thereon facing in the direction of movement thereof with said impeller to cross said radially circulating suspension at relatively large angles for effective shearing action on said particles therein, adjacent said blades being arranged at different angles to the plane of said disk to provide an interval between alternate said blades.

5. An impeller adapted for use in disintegrating solid materials substantially without bruising thereof in apparatus of the character described including a chamber adapted to contain a quantity of relatively large particles of said materials in liquid suspension, comprising a plate adapted for rotation in said chamber about an axis substantially normal to said plate to subject said suspension to centrifugal force causing said suspension to circulate radially across the surface of said plate, a plurality of superimposed disks of sheet material secured to the upper surface of said plate, said disks being generally circular and each being of smaller diameter than the adjacent disk therebelow, each of said disks having a plurality of cutting blades formed along the periphery thereof and bent out of the plane of the remainder of said disk, and each of said blades having a cutting edge thereon facing in the direction of movement thereof with said impeller to cross said radially circulating suspension at relatively large angles for effective shearing action on said particles therein.

6. An impeller adapted for use in disintegrating solid materials substantially without bruising thereof in apparatus of the character described including a chamber adapted to contain a quantity of relatively large particles of said materials in liquid suspension, comprising a plate adapted for rotation in said chamber about an axis substantially normal to said plate to subject said suspension to centrifugal force causing said suspension to circulate radially across the surface of said plate, a plurality of superimposed disks of sheet material secured to the upper surface of said plate, said disks being generally circular

and each being of smaller diameter than the adjacent disk therebelow, each of said disks having a plurality of cutting blades formed along the periphery thereof and bent out of the plane of the remainder of said disk, and each of said blades having a cutting edge thereon facing in the direction of movement thereof with said impeller to cross said radially circulating suspension at relatively large angles for effective shearing action on said particles therein, adjacent said blades being arranged on each said disk at different angles to the plane of said disk to provide an interval between alternate said blades on the same disk.

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