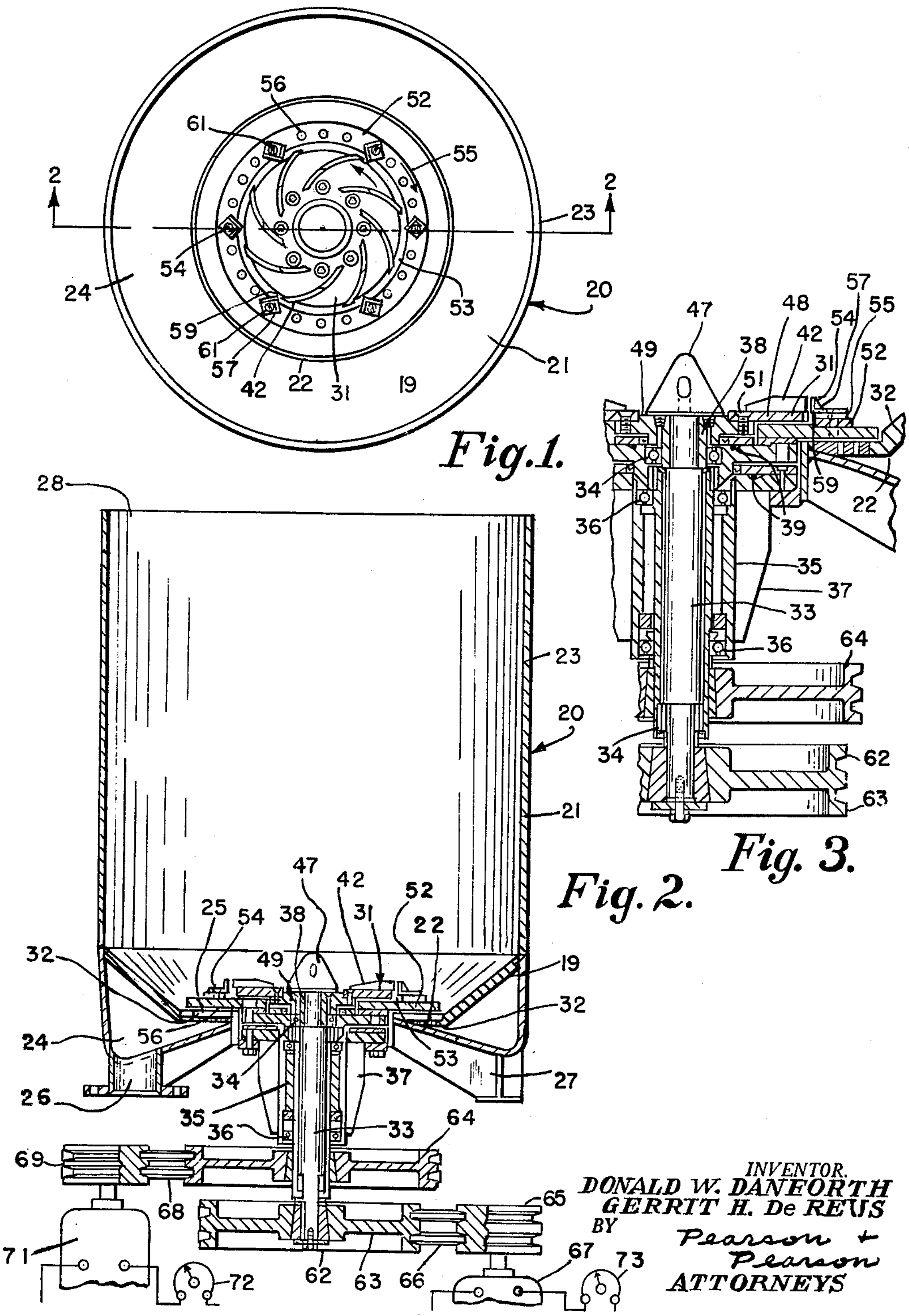
April 16, 1963 D. W. DANFORTH ETAL 3,085,756

APPARATUS AND METHOD FOR PULPING

Filed April 4, 1960 3 Sheets-Sheet 1



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APPARATUS AND METHOD FOR PULPING

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Fig. 4

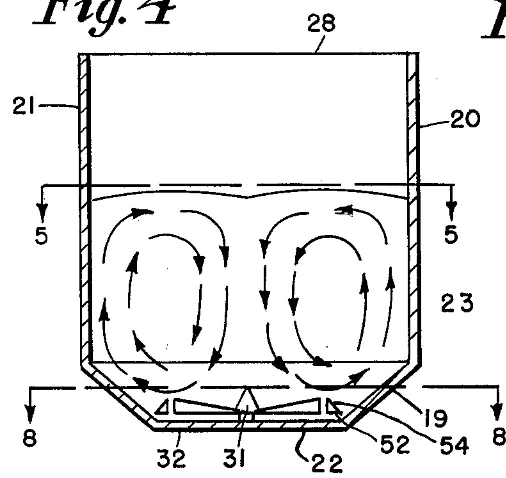

Fig. 5.

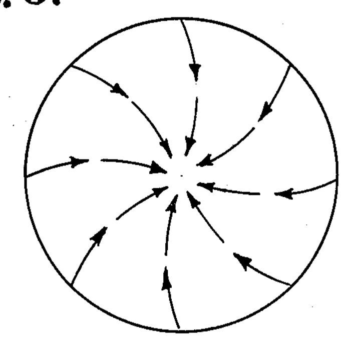

Fig. 6.

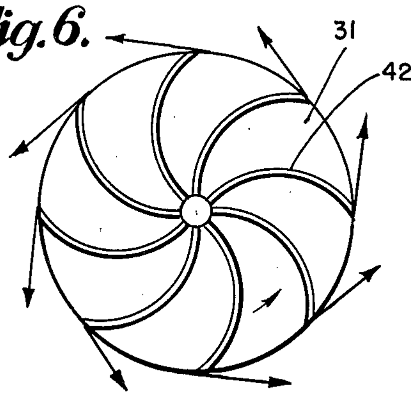

Fig. 7.

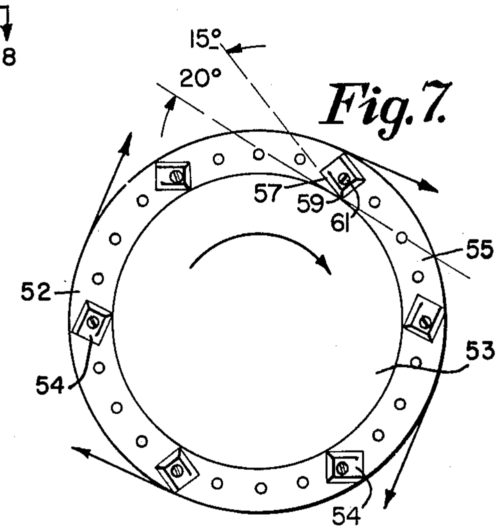

Fig. 8.

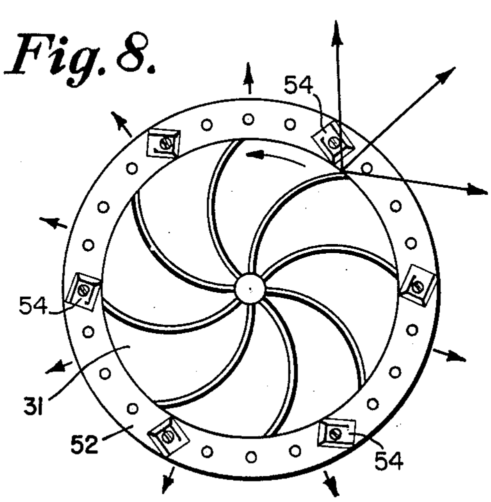

Fig. 9.

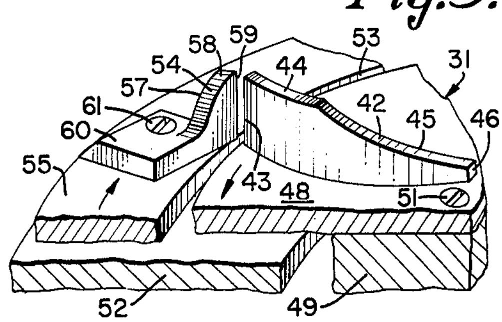

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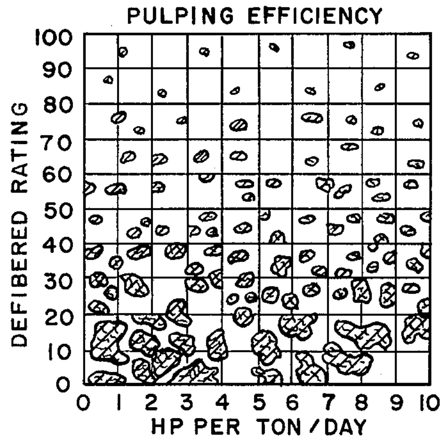
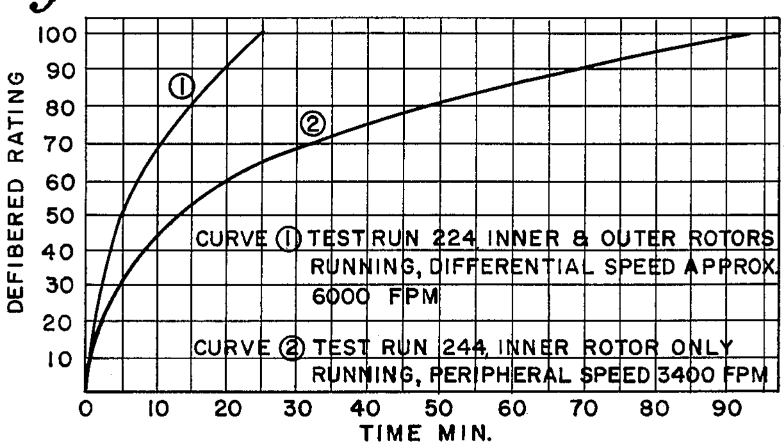
Fig. 10.

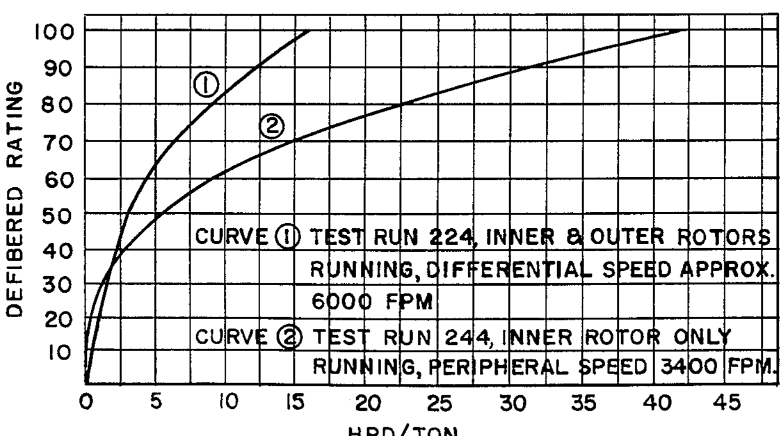


DEFIBERED CONDITION VS ENERGY REQUIREMENT

Fig. 11.



DEFIBERING VS TIME



DEFIBERING VS HPD/TON

Fig. 12.

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APPARATUS AND METHOD FOR PULPING

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Filed Apr. 4, 1960, Ser. No. 19,849

16 Claims. (Cl. 241—5)

This invention relates to an improved disintegrator or pulper of the type having coaxial duel rotors.

The purpose of a pulper is to defiber; i.e., to treat pulp or paper broke in such a manner that fibers are separated so as to prepare them for further treatment in the so-called stock preparation equipments such as Jordan refiners. Most present pulpers are able to slush the pulp or broke; i.e., they are able to break up the materials to such an extent that the suspension of them in water can be pumped, but to completely defiber the pulp, that is, separate all the fibers, is usually prohibitive from an energy input standpoint. The pulp, therefore, must be treated in stock preparation equipment first to defiber the slush before the actual fiber treatment phase can begin.

The disadvantage of defibering in the refiners is that, by the time the furnish reaches the paper machine, part of the fibers have been overtreated and have been reduced to too small a particle size. This results in loss of drainage rate or loss of freeness and minimum fibre damage. The ideal of the paper maker is to treat the fibers with a minimum freeness loss. When part of the defibering is done in a refiner, it usually is not possible to develop the full strength potential of the fibers without an accompanying excessive loss of freeness. The characteristics of a good pulper therefore are:

(1) It must be able to slush the pulp with a minimum of energy input.

(2) It must be able to completely defiber the pulp, if this is desired, with a minimum of energy input.

(3) It must be able to defiber the pulp with a minimum loss of freeness or, in other words, with a minimum amount of damage to the fiber.

Practice has shown that a pulper with a single impeller cannot completely defiber the stock without a prohibitive consumption of energy. Although a single impeller can impart to the stock a great deal of agitation and circulation this, in itself, is not sufficient to completely defiber. In the case of soft fluffy pulps, this agitation may be sufficient for complete defibering. However, in the case of strong papers or pulps or of papers that have been treated so as to make them retain their strength when wet, so-called wet strength papers, such agitation is not sufficient for complete defibering. It is known from experience that rapid circulation in itself will not defiber, that defibering takes place only as the result of the impact of the edges of the vanes on the pulp. Some reflection on this will reveal that circulation in itself is only useful as a means of returning the stock back to the rotor and that any vigorous circulation is wasteful of energy. From this it can be concluded that an efficient pulper would be one that has a maximum of impact on the pulp but in which the circulation is only just sufficient to return the stock to the rotor. Any circulation more vigorous than that will only serve to create turbulence and friction which results in the energy being converted into heat and serving no useful purpose. The paradox in pulper design therefore is that on the one hand it is desirable to have a high degree of impact, which must be obtained by high speed of the rotor and fairly large vanes in order to arrive at the maximum number of edges but this usually results in a great degree of circulation and splashing. This then requires the use of baffles and other devices to restrict this circulation which may solve the problem of splashing but still causes a great deal of wasteful circulation and energy loss.

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It is the purpose of this invention to use the greater part of the available energy to vigorously treat the stock when it passes over the rotor and to have left in the stock only enough energy to move it around the tub and back to the rotor. The principal idea of the invention is to have two coaxial rotors rotating in opposite directions, one controlling the circulation effect of the other. When the stock reaches the inner rotor it is given a high peripheral speed and when it leaves the inner rotor, it is hit by another rotor which is going at the same speed in the other direction and the resulting impact is close to double that speed. After the stock leaves the second rotor the kinetic energy it still has is the difference between the kinetic energy that it was given by the first rotor and the kinetic energy it was given by the second rotor. By proper choice of speed and by proper design of the two rotors it can easily be arranged so that the resulting velocity is such that the pulp travels in a radial path towards the wall of the tub, then upwards along the tub, finally returning toward the center and down to the rotor.

By slightly changing the speed of the outer rotor, this can be changed into a slow spiralling motion, spiralling inward that is. By increasing the outer rotor speed, the spiral will turn with the outer rotor and by decreasing it will turn with the inner rotor. Further increase of the outer rotor speed will eventually result in a spinning of the complete mass of stock in the tub. This spinning sets up centrifugal forces which hinder the proper circulation within the tub and laboratory tests have shown that such a circulation pattern results in decreased efficiency. With the dual rotor design of this invention, therefore, it is possible to closely control the type of circulation that is desired without resorting to baffles or other devices which not only cause turbulence, dead spots, and hang-ups, but at times are a hindrance in the cleaning of the pulper. Another basic feature of this invention is the manner in which the impacting edges are positioned in relation to the flow of the stock. Any rotor in a pulper imparts a centrifugal velocity to the pulp which causes it to travel outward and the circulation in the tub then returns the pulp to the center of the rotor. In other words, with any rotor the flow of the pulp in the vicinity of the rotor is parallel to the plane of rotation. The edges of the vanes are also parallel to the plane of rotation which then means that the edges travel through the flowing pulp in a parallel plane. In this invention, however, the working edges are placed in the perpendicular direction on the plane of rotation and are therefore cutting through the flow in a crosswise direction. This again intensifies the amount of impact that the pulp receives from the two rotors. This too is important in order to obtain complete defibering. Although the top edges of the inner rotor no doubt will participate in the coarse defibering or coarse breaking up and slushing of the pulp in the initial stages of the pulping cycle, the final breaking up of the small pieces into individual fibers can only be accomplished by the high degree of impacting and concentrated agitation which takes place.

There are two main considerations in the performance of a pulper.

(1) The efficiency with which the pulp is defibered. This is usually expressed as the amount of energy which is required to defiber the pulp to a certain degree of defibering.

(2) The speed of defibering which is the time required to defiber a certain amount of pulp to a certain degree of defibering. The first consideration is important because energy represents a considerable part of the cost of the

final product. The speed of defibering is important in that it has a direct effect on the size and the number of pulpers that are required to handle a certain daily production. With most pulpers, in order to increase the speed of defibering, it is necessary to increase the connected horsepower and, therefore, increase either the rotor speed or the rotor diameter in relation to the tub size. This method, however, is limited in that the increase in defibering is accompanied by a proportional increase in circulation which will finally cause a prohibitive amount of splashing and agitation. The result of this is that with most presently available pulpers, the connected horsepower is in the order of 200 H.P./ton of capacity. In the case of counter rotating rotors, however, it is possible to greatly increase the energy input to the two rotors because the circulation is only the result of the difference of the two rotors and, therefore, can still be controlled regardless of the amount of energy input. In the pulper of this invention, therefore, it was possible to use an energy input of 1000 H.P./ton of capacity still maintaining a very steady and smooth circulation. This permits the use of a fairly small pulper producing the same amount of defibered pulp per day as a much larger conventional single rotor pulper.

In the pulping art there have been many proposed pulpers having single rotors, or impellers, rotating in a pulp container on a vertical plane with a side drive and on a horizontal plane with a bottom or a top drive. Side drive rotors have been combined with a stator as in U.S. Patent 2,596,586 to Mordan of May 13, 1952 or with another coaxially recessed rotor as in U.S. Patent 2,888,874 to Jones of July 6, 1954. Among the possible disadvantages of side drive single, or dual, rotors is the fact that small batches are difficult to run because the rotors are not entirely covered with the pulp and vortical or other type circulation may be inefficient while the agitation is violent and noisy. The rotation of dual rotors under independent drives, in opposite angular directions, as disclosed herein, permits circulation energy to be controlled without being directly related to the defibering process and with a minimum of energy expended for pure circulatory purposes.

In this invention the dual rotors are coaxial and mounted to rotate in a horizontal plane at the bottom of the container and the cylindrical container wall is preferably relatively close to the outer periphery of the outer rotor. The inner rotor discharges a horizontal spinning disc of pulp of uniform height outwardly toward the vertical inner face of the outer rotor. The outer rotor is equipped with vertical vanes and is arranged to rotate counter to the inner rotor. This results in a high degree of impact of the outer rotor vanes on the pulp stock and this effectively kills the greater part of the kinetic energy in the moving stock. However, the rotor speeds of the two rotors are such that enough kinetic energy is left in the stock after leaving the outer rotor that it will then travel outwards radially and vertically along the wall of the tub. This will then cause the pulp at the surface to flow inward and down towards the inner rotor. This type of circulation has a very positive submerging action because the pulp travels in a straight line toward the center and from there on down towards the inner rotor. There is no deep open vortex causing the inner rotor to suck in air and thus decrease its efficiency. This is contrary to the circulation in a single rotor pulper where the action of the rotor usually causes the mass of pulp in the tub to rapidly spin, setting up centrifugal forces which impede the travel toward the center. The outer rotor is the defibering member, equipped with upstanding blades substantially entirely in the same plane as the vanes of the inner rotor, for defibering the pulp in the pulp disc emitted from the inner rotor. The outer rotor is arranged to rotate counter to the inner rotor which would normally be expected to interfere with adequate circulation. However, the unexpected result of counter revolution of the rotors has been that circulation is excellent while avoiding violent vortical agitation and the defibering consumes less power and time.

The upstanding defibering blades of the outer rotor are arranged to urge the pulp, emitted from the inner rotor, in the direction of the container wall, while also defibering the pulp. The vertical edges of the vanes of the inner rotor and the blades of the outer rotor have relatively small clearance for breaking up any knots or large fibre bundles caught therebetween.

The principal object of the invention is to provide a dual rotor pulper capable of defibering pulp at a much higher rate of defibering than other pulpers without excessive circulation causing splashing and spilling over the rim of the containers and without exposing the rotors to the air with the consequent air hammering and to accomplish such defibering at less energy consumption per pound of stock. This is accomplished by concentrating the defibering action and the energy consumption at the interface of the two rotors leaving only enough kinetic energy in the stock to accomplish a slow but smooth and positive circulating pattern in the tub.

A further object of the invention is to provide a disintegrator having a disc type vaned impeller, rotatable within a disc type bladed rotor, the vanes and blades rotating substantially entirely in the same plane at equal speeds but in opposite angular directions for creating a disintegrating, or defibering zone in the shape of a cylinder of uniform height at the interface of the two rotors.

Still another object of the invention is to provide an improved dual rotor pulper in which the rotors travel in opposite directions in a horizontal plane at the bottom of the pulp container while all the remaining pulp in the container is subjected to a circulatory action in a vertical, non spinning plane for drawing the same progressively down to the centre of the container bottom.

A still further object of the invention is to provide a dual rotor pulper in which the circulating effect of a small diameter, high speed circulating impeller is substantially countered by the effect of a large diameter defibering rotor travelling at substantial speed, but in the opposite angular direction, thereby eliminating excessive and unnecessary vortical circulation while increasing defibering action.

Other objects and advantages of the invention will be apparent from the claims, the description of the drawings and from the drawing in which:

FIG. 1 is a plan view of a pulper constructed in accordance with the invention.

FIG. 2 is a side elevation, in section on line **2—2**, of FIG. 1.

FIG. 3 is a sectional, fragmentary view similar to FIG. 2 but showing the parts on a larger scale.

FIG. 4 is a diagrammatic side elevation showing the generally radial, non spinnnig, flow in the pulper of this invention.

FIG. 5 is a diagrammatic view on line **5—5** of FIG. 4 showing the non vortical, non spinning, radial flow at the top of the pulper.

FIG. 6 is a diagrammatic plan view showing the vortical stream created by the rotation of the inner circulating rotor in one angular direction.

FIG. 7 is a view similar to FIG. 6 showing the path of stock created by the rotation of the outer circulating and defibrating rotor in the opposite angular direction.

FIG. 8 is a diagrammatic view on line **8—8** of FIG. 4, showing the composite path of the stock as generally radial without spin when the flow patterns of FIGS. 6 and 7 are combined.

FIG. 9 is an enlarged detail, sectional view, in perspective, showing the preferred form of the rotor blades of the dual rotors.

FIG. 10 is a graph showing the standards of pulping efficiency used herein.

FIG. 11 is a graph comparing the rotation of the inner rotor only with the opposite rotation of the dual rotors in terms of the time required to reach the desired defibering standard, and

FIG. 12 is a graph comparing the rotation of the inner rotor only with the opposite rotation of the dual rotors in terms of horsepower per day, per ton required to reach the desired defibering standard.

A preferred embodiment of the invention is shown in the drawing in which **20** designates a pulp disintegrator, or pulper, having a pulp container **21** with a flat horizontal, central, bottom portion **22**, an upwardly sloping outer bottom portion **19** and an upstanding cylindrical wall **23**. The pulp container **21** is adapted to receive a charge of water and paper stock material such as paper pulp, used paper, waste or the like. An arcuate sump **24** extends around the outer periphery of the container with a screen **25** in the bottom **21** and a drain pipe **26** all in a manner well known in the trade for discharging the pulped stock. The container **21** is mounted on suitable frame supports **27** and the height of the wall **23**, from the unobstructed top opening **28** to the circular bottom **22** is preferably slightly greater than the diameter of the bottom. It should be noted that there are no lobes or baffles within container **21** and no rim cover plates for dampening surges or preventing spillage, the interior of the container permitting free circulation of the stock or pulp therein.

A pulp circulating disc, or rotor, **31** is mounted in the bottom portion **32** of container **21** just above the container bottom **22** to rotate in a horizontal plane on a vertical axis by means of the central drive shaft **33**. Drive shaft **33** is suitably journalled in bearings **34** within a concentric outer shaft **35** and outer shaft **35** is suitably journalled in bearings **36** mounted in a bearing housing **37** fixed below the central aperture **38** of the container bottom **22**. Commercially available O rings and closure seals, indicated at **39**, are provided to prevent leakage around the concentric shafts or through the aperture **38** all in a manner well known and unnecessary for description in detail herein. Impeller **31** includes a plurality of vanes **42**, curved away from the direction of rotation shown by the arrow, each vane having an outer upstanding edge **43**, a horizontal top edge portion **44**, a downwardly beveled top edge portion **45** and an inner upstanding edge **46**, the inner edge **46** being proximate the lower periphery of a central tapered impeller cap **47**. The vanes **42** may be conveniently welded to an annular plate **48**, the plate **48** being affixed to the rotor hub **49** by machine screws such as **51** for ready removal or replacement. Upon rotation of impeller disc **31** alone a vortex with a central vertical axis is created in container **21**, the material being drawn downwardly toward cap **47** and then delivered outwardly, in the form of a horizontal disc of stock, toward the bottom portion **32** of the wall **23** by the vanes **42**. The stock after striking the inclined bottom portion **19** is urged upwardly along the wall **23** by the vortical action of impeller disc **31** for repeated vortical circulation.

A pulp disintegrating disc, or rotor, **52** is mounted for independent rotation in a horizontal plane on the bottom **22**, coaxially with impeller disc **31**, with the disc **31** preferably encircled within a recess **53** in disc **52**. The impeller disc **52** is carried by the outer drive shaft **35** and includes a plurality of upstanding defibering blades **54** spaced therearound. The defibering blades **54** are mounted on a ring **55** which forms recess **53**, the ring **55** being fixed by machine screws **56** to the disc so that the bladed ring may be easily replaced. It should be noted that the blades **54** and the vanes **42** rotate substantially entirely in the same horizontal plane and that the blades **54** travel within the horizontal disc of pulp being thrown outwardly toward the bottom portion **19** of wall **23** by the impeller vanes. In other words, the blades **54** rotate in a horizontal annular path and the vanes **42** rotate in a horizontal circular path entirely within the annular path of the blades. Similarly the path of the blades **54** is outside the path of the vanes, and at the same level, to counter the circulatory effect of the vanes while disintegrating the material being discharged therefrom into the annular, disco-planate, material discharge zone.

The circulating disc **31** corresponds to a pitcher throwing a ball, or lump, outwardly to be impacted by the defibering disc **52** with a disintegrating, but not a cutting effect. Both discs, therefore, share in the disintegration action and both discs share in the pumping and circulating action, although the outer disc **52** reduces the circulatory effect of the inner disc **31** and might well be termed a defibering and counter circulating disc. The inner rotor, or disc, **31** serves to deliver the stock to the outer rotor, or disc, **52** at a high velocity in the direction opposed to the direction of rotation of the outer rotor. Then the outer rotor **52**, upon impact of the stock, leaves only enough energy to slowly circulate the stock. This then results in a flat, vertical planar movement or at the most a slight spiralling movement of the stock either with the outer rotor **52** or in the opposite direction and this slow but straight line movement results in a more positive transport of the floating materials through the center of the rotor than any fast spinning motion causing a deep vortex. In other words, the word vortex usually has the connotation as being formed by a fast spinning mass of liquid, causing the liquid to rise at the outer wall and causing a deep opening in the center. Along this vortex the liquid travels downward in a fast spiralling motion and this is different from the straight line radial inward motion accomplished by the pulper of this invention. It is a simple matter by speeding up the outer rotor to obtain a true vortex but it has been found in laboratory tests that both pulping efficiency and submergence are better with the non spinning, vertical planar, circulation.

As best shown in FIG. 9 each upstanding blade **54** includes the outer inclined edge **57**, a rounded top edge **58** in the same plane as the top edge portion **44** of the vanes **42** and an upstanding, or vertically extending, inner edge **59**. Preferably the outer edge **57** is cut away, or inclined, to reduce circulatory effect and reduce power consumption, this streamlined construction having been found to give improved defibering results. The inner edges **59** of the blades and the outer edges **43** of the vanes have very small clearance in the order of about one-sixteenth ($\frac{1}{16}$) inch clearance diameter whereby a knot or fiber bundle caught therebetween will be broken up. Preferably the bases **60** of the blades **54** are each adjustably fixed to the ring **55** by a machine screw **61** so that they may be turned on a vertical axis for varying their defibering action and their counter circulatory effect. However, it has been found that the particular tangent to the inner rotor at which they are illustrated in FIG. 7 gives the most consistently good results, this being an angle of about 15° to 20° when the inner edge **59** and the screw **61** are both on a radial line while the outer edge **57** is correspondingly at a distance from the radial line. The inclined outer edges **57** of the blades **54** diverge away from the upstanding inner edges **59**, from top to bottom, to form a substantially triangular leading, or forward, wall, the triangular wall extending vertically but being angularly offset from a radial direction to present an obliqued, substantially triangular face to the pulp discharged from the vanes. The bases **60** of blades **54** are beveled, as shown in FIG. 9 to further streamline the blades.

Drive means **62**, of the bottom drive type, is provided for counter rotating the disintegrating disc **52** and the circulating disc **31** in the direction of the arrows. Drive means **62** includes the inner shaft **33** and the outer shaft **35**, each having a drive pulley **63** or **64** thereon. Pulley **63** on shaft **33** is connected to a pulley **65** by a belt **66**, the pulley **65** being driven by the electric motor **67** mounted on the disintegrator 20. Pulley 64 on shaft 35 is driven in the opposite angular direction by the belt 68, pulley 69 and electric motor 71, similarly mounted on the disintegrator 20 since the power trains are identical. The circulatory disc 31 and disintegrating disc 52 rotate oppositely at such speeds as may be desired depending on tub size, vane size, etc. At equal speeds, the preferred speed has been found to be about 3,000 feet per minute, the clearance diameter being about one-sixteenth inch for a consequent gap between the interfaces of the vanes and blades of about one thirty-second inch. This gives a differential speed of 6,000 feet per minute which defibers the pulp in the least time, with the least power and with very little visible agitation, spinning or surging of the stock. Control mechanism such as a rheostat 72 and 73 is provided for each motor making it possible to vary the speeds of the rotors in any amount desired.

If the impeller disc, or rotor, 31 alone as in a conventional single rotor pulper is rotated at a peripheral speed such as 3,400 feet per minute, as in test run 244 shown in FIGURES 11 and 12, and with the outer disc, or rotor 52 stationary, a vigorous vortical circulation takes place with a circumferential spinning of the contents of the pulper and a hollow vortex on the vertical axis of the pulper. Pulping of the contents takes place but defibering is quite slow while consuming considerable horsepower per ton per day, much of which is wasted in violent, but relatively useless circulation.

For comparison purposes the graph of FIG. 10 has been developed to indicate pulping efficiency. The graph visually illustrates the energy requirement, measured in horsepower per ton per day, to convert waste paper and the like from the lumps and bundles shown at the bottom of the graph to the finely defibered condition shown at the top of the graph, the defibered rating ranging from zero to 100.

Graphs 11 and 12 illustrate the fact that mere rotation of the inner rotor, as in test run 244, with the outer rotor held stationary and serving mainly as a baffle to avoid spillage, results in a pulping time of ninety minutes and an expenditure of about 42.5 horsepower per ton per day to reach the desired defibering standard of 100.

In the method and apparatus of this invention, however, with an identical charge, but with the outer rotor counter rotating to give a differential speed of approximately 6,000 feet per minute, the results are unusually improved. As shown in test run 224 the defibering standard of 100 is reached in about twenty-two minutes with an expenditure of only about sixteen horsepower per ton per day.

The flow pattern of the stock in the pulper, with the dual rotors in use, results in the elimination of any hollow vortex and the elimination of all spinning of the mass around the vertical axis of the pulper, as illustrated in FIG. 4. As shown by the arrows, the pulp discharged from the inner rotor travels outwardly and radially across the tank bottom, up the walls, back to the central axis (as shown in FIG. 5) and then down the central axis all in a vertical plane which remains substantially fixed rather than twisting into helical form or spinning continuously around the tub. This is for the reason that the stock discharged in the direction of the arrows from the inner rotor 31 (FIG. 6) is intermittently impacted, and intermittently intercepted, by the vanes of the outer rotor 52 (FIG. 7) traveling in the opposite angular direction, the latter vanes tending to discharge stock in the direction of the arrows shown in FIG. 7. The resulting composite path of the stock, as shown in FIG. 8, is substantially radial for each particle with the speed of the stock reduced to a slow, smooth, non spinning, non vortical flow and with the particles each following a closed path in a single vertical plane. The absence of a hollow vortex is illustrated in FIG. 5 wherein all the stock at the top of the pulper moves radially inwardly to the

central axis before submergence takes place thus eliminating the surging and air hammering of certain types of vortical pulpers.

I claim:

1. A pulp disintegrator comprising a pulp container having a bottom and an upstanding side wall; a pulp disintegrating rotor, having upstanding defibering blades spaced therearound, mounted for rotation in a horizontal annular path on a vertical axis proximate the bottom of said container; a rotary pulp circulating impeller, mounted for independent rotation coaxially with said disintegrating rotor proximate the bottom of said container; upstanding pumping vanes spaced around said impeller and mounted for rotation in a horizontal circular path encircled by the horizontal annular path of said blades, the paths of said vanes and blades being entirely in a common horizontal plane of rotation; drive means, mounted under said container bottom, rotating said disintegrating rotor and said circulating impeller in opposite angular directions and means for controlling the relative speeds of said rotor and impeller for securing smooth circulation of pulp in said container.

2. A combination as specified in claim 1 wherein said circulating impeller is recessed within said defibering rotor and the upper and lower extremities of said vanes and blades are rotatable in common horizontal planes whereby pulp discharged outwardly from said vanes is delivered directly into said blades.

3. A combination as specified in claim 1 wherein the outer edges of said vanes and the inner edges of said blades are vertical and uniformly spaced apart to create a narrow gap therebetween about one thirty-second inch in width.

4. A combination as specified in claim 1 wherein said vanes and blades are of substantially the same height and said blades are stream-lined and adjustable to control their counter circulatory effect and substantially eliminate vortical agitation in said container.

5. A combination as specified in claim 1 wherein the outer edges of said upstanding blades diverge from top to bottom and said blades are angularly offset from a radial direction to present an obliqued, substantially triangular face to pulp discharged from said vanes.

6. A pulp disintegrator comprising a pulp container having a bottom and an upstanding cylindrical wall; a pulp disintegrating rotor, having upstanding defibering blades thereon, rotatable on a vertical axis in a horizontal annular path at a level just above the bottom of said container; a pulp circulating impeller mounted for independent rotation coaxially with said rotor, said impeller having upstanding pumping vanes entirely at the level of the blades of said rotor and inside the annular path of said blades for discharging pulp outwardly directly into, and between, said blades and means for independently rotating said rotor and said impeller in opposite angular directions at predetermined relative speeds.

7. A combination as specified in claim 6 wherein said rotor blades have a triangular forward face and are mounted at an angle from the radial on said rotor for defibering and counter circulating said pulp without spinning the same around said pulp container.

8. In a pulper the combination of a pulp container; a circulation impeller having vanes rotating in a horizontal plane on a vertical axis in one angular direction in the bottom of said container and a defibration and counter circulation rotor rotating coaxially with said impeller but in the opposite angular direction in the bottom of said container, said rotor having blades entirely in the same horizontal plane with said vanes and encircling said vanes.

9. A combination as specified in claim 8 wherein said impeller vanes and said rotor blades are of equal height and the outer faces of said impeller vanes form a narrow relatively high passage of uniform width with the

inner faces of said rotor blades for disintegrating lumps of material in said container.

10. The method of disintegrating the contents of a material container rapidly with low consumption of energy which comprises the steps of imparting a vigorous, vortical, spinning circulation to said contents while continuously discharging a stream thereof horizontally at the bottom of said container and intermittently impacting the material in said stream, and intermittently barring the advance of said stream, while imparting a vigorous counter vortical, counter spinning circulation to said stream for disintegrating said contents with a smooth, generally radial flow in fixed vertical planes.

11. In a pulper of the type having a rotary impeller in the centre of the bottom of a pulp container, the method of pulping which comprises the steps of imparting a high peripheral speed in one angular direction to the horizontal, annular, disco-planate stream of stock emitted from the outer face of said impeller to vortically circulate said stock, then impacting said stock within said disco-planate stream proximate said outer face for disintegrating the same and simultaneously imparting a peripheral speed to said disintegrated stock in the opposite angular direction proximate said outer face to reduce the vortical circulation imparted by said impeller to a smooth, non spinning, slow circulation pattern.

12. A method of pulping with a relatively low consumption of energy which comprises the steps of imparting a predetermined amount of kinetic energy to paper stock to vortically circulate the same at relatively high speed, repeatedly impacting said stock in a selected zone of the vortical circulation pattern so created and simultaneously imparting a predetermined amount of kinetic energy to said paper stock to counter the vortical circulation of the same in said zone thereby reducing the kinetic energy of said stock to a predetermined amount just sufficient to non vortically circulate the same at relatively low speed back to said zone.

13. A pulp disintegrator comprising a pulp container, a rotary disintegrating impeller mounted in said container at the bottom thereof to rotate in a horizontal plane, said disintegrating impeller having vertically extending blades spaced therearound in an annular pattern, a rotary circulating impeller independently rotatable, and coaxially recessed within said disintegrating impeller to rotate in a horizontal plane, said circulating impeller having vertically extending vanes spaced therearound inside said annular pattern of blades, said vanes and blades being substantially coextensive in height and at equal distances above the bottom of said container for rotating entirely in a common horizontal plane and means for driving said impellers in opposite angular directions.

14. A material disintegrator comprising a material container having a bottom and an upstanding cylindrical

wall; a disintegrating rotor, having upstanding disintegrating blades thereon, rotatable on a vertical axis on the bottom of said container, said rotor blades each having a triangular forward face and being mounted at an angle from the radial on said rotor; a circulating impeller mounted for independent rotation co-axially with said rotor, said impeller having upstanding pumping vanes in a common plane of rotation with, and encircled by the blades of said rotor for discharging material outwardly into the path of said blades and means for independently rotating said rotor and said impeller in opposite angular directions at variable, predetermined differential speeds, said rotor blades disintegrating and counter circulating said material without spinning the same around said container.

15. In a pulper the combination of a pulp container; a circulation impeller rotating in a horizontal plane on a vertical axis in one angular direction in the bottom of said container; and a defibration and counter circulation rotor rotating co-axially with, and outside, said impeller in the same horizontal plane but in the opposite angular direction in the bottom of said container; the outer faces of said impeller and the inner faces of said rotor being opposed and of equal height to form a narrow, relatively high passage of uniform width therebetween for disintegrating lumps of material in said container, and means on said rotor for selectively positioning said inner faces relative to the outer faces of said impeller.

16. In a disintegrator of the pulper type the combination of a container for material to be disintegrated; a circulation impeller rotating in a horizontal plane on a vertical axis in one angular direction in the bottom of said container for forming an annular, disco-planate material discharge zone, and a disintegration and counter circulation rotor mounted in said disco-planate material discharge zone, said rotor rotating co-axially with, and outside, said impeller substantially entirely in the same horizontal plane therewith, but in the opposite angular direction, in the bottom of said container for disintegrating said material and imparting a counter circulatory force to said material within said disco-planate zone.

References Cited in the file of this patent

UNITED STATES PATENTS

1,992,447	Savy	Feb. 26, 1935
2,265,936	Cowles	Dec. 9, 1941
2,682,810	Jones	July 6, 1954
2,706,621	Laird	Apr. 19, 1955
2,853,280	Cusi	Sept. 23, 1958

FOREIGN PATENTS

822,143	Great Britain	Oct. 21, 1959