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2,718,178

MACHINE FOR EFFECTING A REFINING TREATMENT OF FIBROUS MATERIAL

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4 Sheets-Sheet 1

Fig. 1.

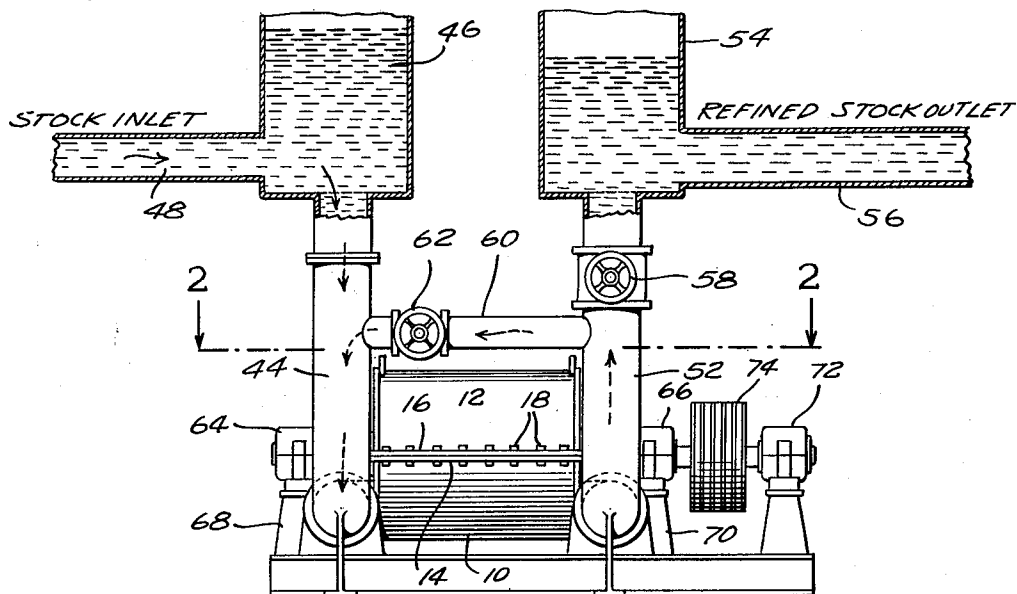
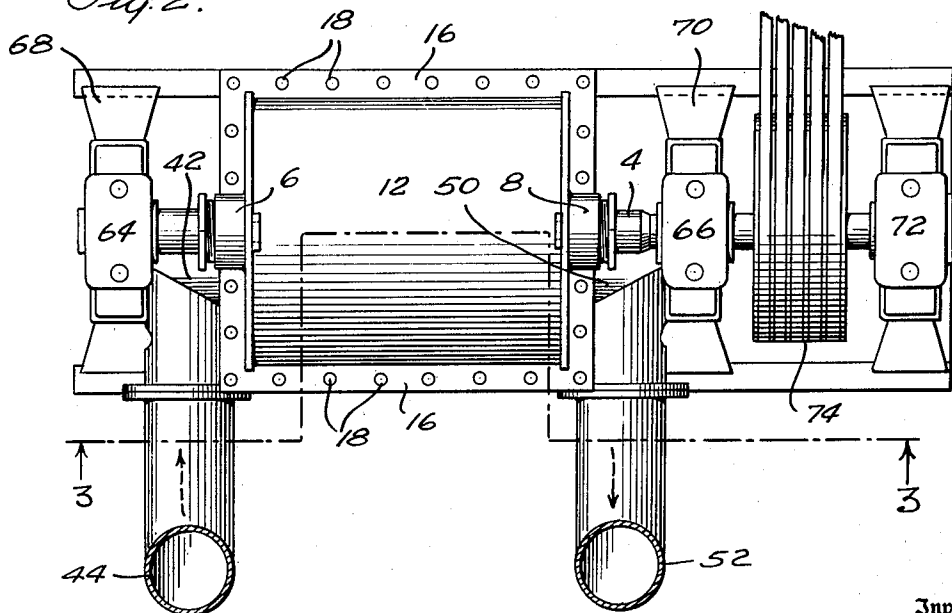


Fig. 2.



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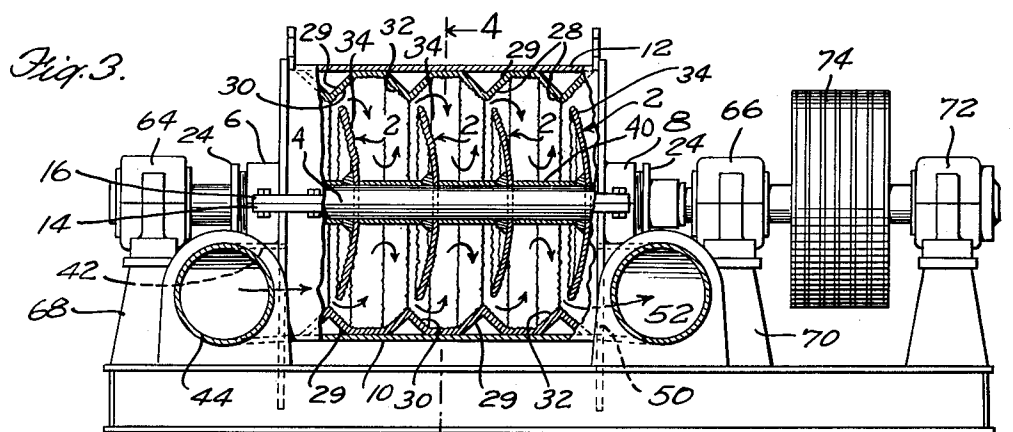
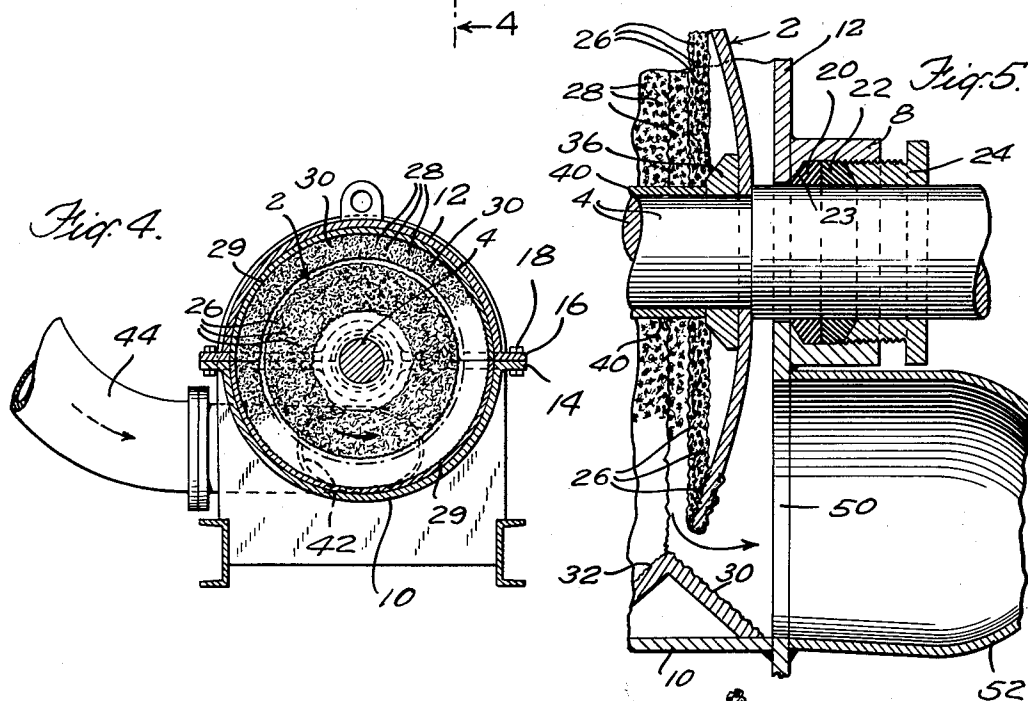
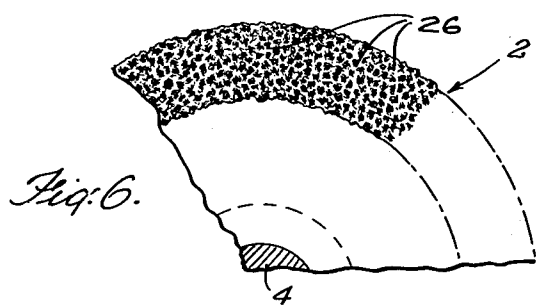
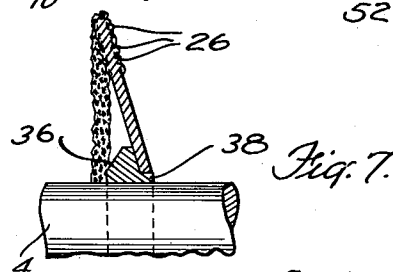
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4 Sheets-Sheet 2



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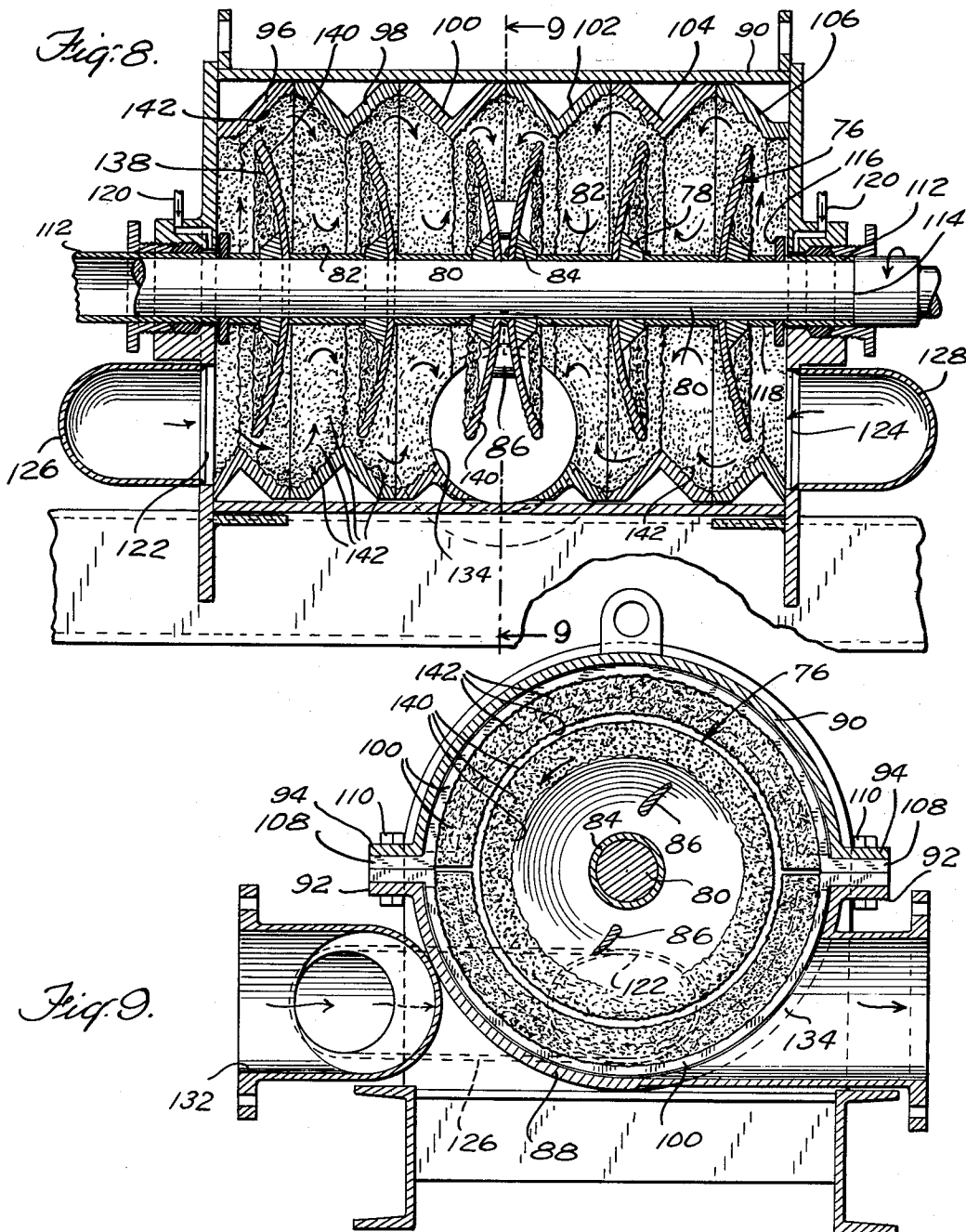
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4 Sheets-Sheet 3



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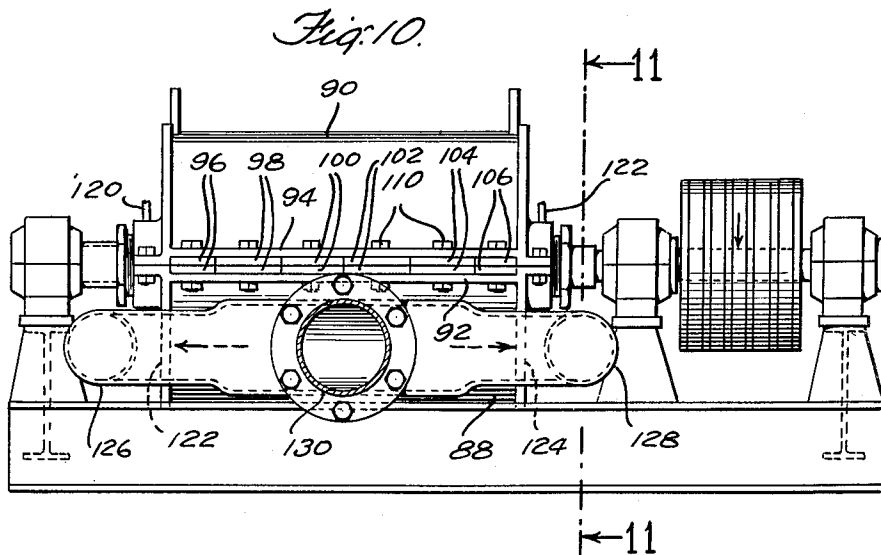
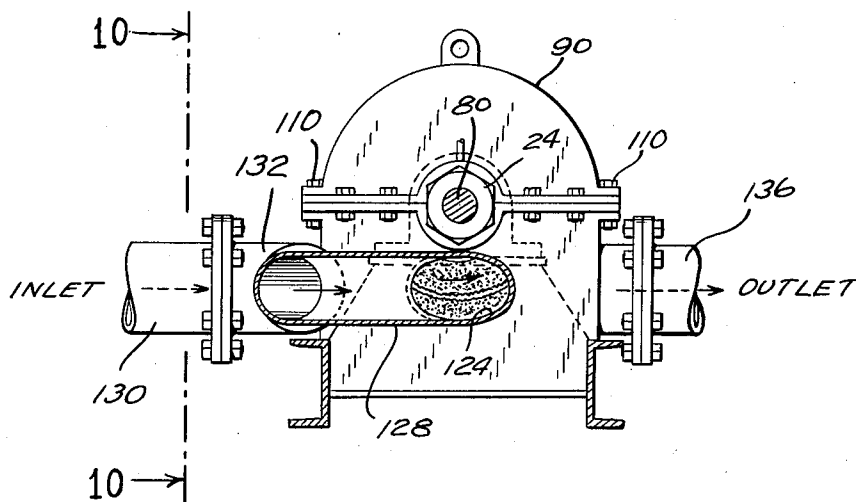


Fig. 11.

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2,718,178

MACHINE FOR EFFECTING A REFINING TREATMENT OF FIBROUS MATERIAL

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Application February 4, 1948, Serial No. 6,254

10 Claims. (Cl. 92—20)

This invention relates to machines for effecting a refining treatment of materials, particularly fibrous materials which may be floated, suspended or dispersed in a liquid medium, such as water, and is herein shown and described more particularly in its application to the preparation of paper stock. It will be understood, however, that the machine has wide possibilities of use in other fields where disintegration, dispersion or commingling of materials in a liquid carrier is desirable.

In my copending application Serial No. 603,181, filed July 4, 1945, now Patent No. 2,592,215, I have shown and described a disintegrating or pulping machine which has gone into extensive use in the preparation of paper stock and which operates to effect the disintegration, defiberization, decortication, and/or shredding of various fibrous materials useful in the making of paper and which effects the pulping of such materials and the carding, combing, separation and dispersion of the fibres in the water carrier so thoroughly that, for the manufacture of the coarser grades of paper, particularly from waste paper, broke, etc., further treatment of this nature is usually not necessary. When, however, an even more complete separation of the fibres from each other and a more thorough dispersion of the fibres in the water carrier are desirable, particularly in the production of finer grades of paper, there is practical need for a machine such as that which constitutes the subject matter of the present invention.

Present methods of refining paper stock, as it comes from the beaters, digesters or other pulping machines, involve usually passing the stock between relatively closely spaced abrading surfaces, as in Jordans, which further break up the fibrous materials and effect some further separation of the fibres but usually at the expense of considerable breakages and consequent shortening of the fibres, thus reducing the average fibre length of the resultant stock. Such treatment is particularly objectionable where the stock to be treated has been prepared from waste paper, broke, etc., since the fibres do not require hydrating, which is one of the operations usually performed in the Jordan, and since the fibres are already of suitable lengths for paper making.

The excessive production of so-called "fines," or too short fibres, incidental to present paper stock refining procedures results in shrinkage of the paper during the sheet forming operations and slow release of the water. The slow water release characteristic of paper stock refined by present methods obviously makes it unsuitable for use with modern high speed paper making machinery.

An important object of the present invention is to provide a machine for refining paper stock and for similar operations on other materials which will effect a further separation and carding or combing of the fibres of the stock and a more complete dispersion of the fibres in the liquid carrier, without any substantial breaking of the fibres or shortening thereof.

An important feature of the invention is the utilization in a refining machine of the principles of operation of the material disintegrating mechanism of my copending appli-

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cation hereinabove identified. As herein embodied, I provide a series of coaxially turning, axially spaced dished discs, the discs being of a construction similar to that disclosed in my copending application, that is, each has at least a substantial marginal portion of its concave face provided with a material disintegrating surface. To make certain that the stock to be refined will be operated upon in succession by each of the disintegrating discs of the series, I preferably provide annular deflectors, which overhang the peripheral discharge edges of the respective discs and which are shaped to direct the stock discharged from each disc into the field of operation of the succeeding disc, and I mount the whole mechanism in a tank, on the inner wall of which the deflectors are located and through which the stock to be treated is forced to flow by the cooperative action of the discs and the deflectors of a given series, all of the discs of the cooperating series just described facing in the same direction.

Although it is important, in the present invention, that the stock to be subjected to the refining action be operated upon in succession by each of the disintegrating discs of a series of discs facing in the same direction, it will be understood that the invention is not limited to a structure in which all of the discs enclosed within the tank or vat face in the same direction. In fact, in the preferred embodiment of the invention superior results are obtained by providing two series of disintegrating discs within the same enclosure so arranged that each series tends to move the stock to be treated through the enclosing tank or vat in a direction opposed to that in which the other series tends to move it.

It will be seen that in such a structure, provided with an intermediate discharge common to the two series of discs, an even more complete separation of the fibres and dispersion thereof in a liquid carrier can be brought about. In fact, with either of the foregoing arrangements of the novel disintegrating discs or impellers of my prior application, hereinabove identified, it is possible to obtain exceptional refining results with a moderate consumption of power, that is, with a consumption of power very much less than that required in the operation of existing machines that even approximate the results obtained with the machine of the present invention. By the expression "exceptional refining results" I mean not only a more complete separation of the fibres and a more complete dispersion thereof in the liquid carrier, but also an almost complete absence of breaking or shortening of the fibres.

Further to insure separation of the fibres and to prevent excessive wear on the surfaces over which the stock passes in its travel through the refining apparatus of the present invention, the invention contemplates providing disintegrating surfaces, of hard abrasive material, not only on the marginal portions of the concave faces of the disintegrating discs but also upon the faces of the deflectors over which the stock travels as it is discharged from the edges of the disintegrating discs and on a substantial marginal portion of the convex surface of each disintegrating disc. By thus providing additional hard abrasive material in the path of travel of the stock as it moves from one disintegrating disc of a series to the next, I have found not only that I prevent too rapid wear of such surfaces but also increase the carding, combing and fibre separating action of the apparatus as a whole.

Although, with the arrangement of a series of coaxially turning, axially spaced dished discs, such as herein shown and described, it is usually possible to effect the desired refinement of the paper stock or other water borne material to be treated by a single passage through the machine, there may be occasions when recycling of the material is desirable and to this end the invention

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further contemplates simple means for quickly and easily effecting such recycling.

Other important features, advantages and objects of the invention to which reference has not hereinabove specifically 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 front elevation, partly in section, of a refining machine embodying the present invention;

Figure 2 is a plan view, with the intake and discharge elements sectioned on the line 2—2 of Figure 1;

Figure 3 is a vertical section on the line 3—3 of Figure 2;

Figure 4 is a transverse section on the line 4—4 of Figure 3;

Figure 5 is an enlarged sectional detail of one of the impellers or disintegrating discs and the parts, including the shaft bearing and stuffing box, associated therewith;

Figure 6 is a detail view looking from the front of one of the discs showing the appearance of a preferred type of abrasive coating covering a marginal portion of the concave face of the disc;

Figure 7 is a sectional view of a modified disc construction in which the disc, instead of being formed as a segment of a hollow sphere, is formed as the segment of a hollow cone;

Figure 8 is a longitudinal section of a modified form of the invention in which two series of disintegrating discs are mounted on a common shaft in a common vat or tank;

Figure 9 is a section on the line 9—9 of Fig. 8;

Figure 10 is a side elevation of the modified form of the invention shown in Fig. 8, the inlet pipe being sectioned on the line 10—10 of Figure 11, and

Figure 11 is an end elevation of the modified embodiment of the invention shown in Fig. 10, parts being sectioned on the line 11—11 of Fig. 10.

In the illustrative embodiment of the invention which is shown in Figs. 1 to 6, inclusive, the disintegrating impellers 2, of which four of identical construction are shown in this embodiment, are carried upon a horizontal shaft 4 which has bearings 6 and 8 carried by the end walls of a cylindrical vat or tank made up of two half shells 10 and 12 provided on their sides and ends with horizontal flanges 14 and 16, respectively, adapted to be connected together by bolts 18. The division of the tank or vat into upper and lower sections or half shells 10 and 12 includes also the bearings 6 and 8 for the shaft 4 so that the lifting of the upper movable section 12 away from the lower stationary section 10 of the vat or tank uncovers not only the disintegrating discs 2 but also the lower part of the stuffing box in each bearing. This stuffing box comprises packing rings 20 and 22 in a recess 23 in each bearing 6 and 8 and a gland 24 adapted to be screwed into each of the bearings to press the packing rings 20 and 22 into water sealing relation to the shaft 4.

As shown more particularly in Figures 3, 5 and 6, each of the disintegrating discs 2 is provided upon a substantial marginal portion of its concave face with a disintegrating surface which may be made up of any suitable abrasive material. The surface herein specifically illustrated and which has proved highly efficient in actual practice is formed of particles of tungsten carbide distributed over that part of the surface of the disintegrating disc which is to perform the disintegrating action and bonded thereto in any suitable manner.

I have found in practice that an exceptionally efficient surface for the purposes of the present invention, as well as for the purposes of the disintegrating disc of my copending application, may be formed by causing a hollow rod of mild steel, in which the particles of tungsten carbide are confined, to be melted at the points on the surface of the disc, for example, on a marginal portion of the concave face of the disc which is to be provided with

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disintegrating material. When this is done the tungsten carbide particles on the inside of the steel tube do not melt but are flowed over the surface of the metal of the disc together with the molten mild steel sheath. When the deposit thus made upon the disc surface solidifies, the tungsten carbide particles are quite evenly distributed in the deposit, as shown in the drawings, are well bonded to the disc and form an extremely hard surface which is heterogeneous in structure, that is, it has projecting points which act to effect the disintegration, carding and combing of the fibres, as the water in which they are suspended carries them over the treated surface.

I have found a very satisfactory material for this purpose to be that sold under the trade name of "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, is stated to have an analysis which shows the nonferrous ingredients of the steel to be as follows:

Phosphorous	0.03
Carbon	0.06
Silicon	0.15
Sulphur	0.03
Manganese	0.30

From an inspection of Figures 3, 5, 6 it will be seen that the disintegrating surface 26 is provided upon a substantial marginal portion of the concave face of each disc, the width of the disintegrating surface on the concave face of each disc being substantially the same. It will also be seen that a disintegrating surface 28 is provided upon the faces of the deflector rings 29, both upon the inclined face 30 of each ring which overhangs the outer edge or perimeter of the disintegrating disc 2 and upon the other inclined face 32 of each deflector ring which assists in directing the stock into the concavity of the succeeding disc 2.

It has been found in practice that, as the stock is deflected into the field of operation of each succeeding disc 2, that is, toward the center of the concave face thereof, it tends to travel closely over the marginal portion of the convex face of the disc from which it has just been discharged. It has, therefore, been found to be important to provide a hard disintegrating surface on the marginal portion of the convex face of each disc, not only to prevent wear of this face but to insure further disintegration, combing and carding of the fibres as they pass over this marginal portion of the convex face into the field of action of the succeeding disc. I have found that this disintegrating surface 34 upon the marginal portion of the convex face of each disintegrating disc 2 needs to be somewhat wider on the first disc which acts upon the stock than it needs to be on the succeeding discs and that it can be gradually narrowed on each succeeding disc so that this disintegrating surface 34 on the marginal portion of the convex face of the last disc of the series may be considerably narrower than that upon the first disc of the series and still perform its two functions of protecting this face against excessive wear and effecting such disintegration, combing and carding of the fibres as needs still to be performed as the stock passes over the last disc of the series.

From an inspection of Figures 5 and 7 of the drawings, it will be seen that each disintegrating disc 2 is preferably provided with a hub 36 shaped to fit within the concavity of the disc near its center and having a reduced part 38 that fits within a central opening in the disc, the thus shouldered hub being secured to the disc in any suitable manner, as, for example, by welding it thereto. The exposed face of the hub is preferably frusto-conical in shape to facilitate directing the stock toward the disintegrating surfaces of the disc.

Suitable spacing sleeves 40 may be provided for spacing the successive discs of any series from each other and also for spacing the hub at the end of each series from

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the shaft bearings. The hubs 36, and with them the discs 2, may be secured to the shaft in any suitable manner to turn therewith, as for example by being keyed thereto by keys not shown.

In the form of the invention shown in Figures 1 to 5 inclusive, the stock to be treated is introduced into the tank or vat through an intake opening 42, in the left hand end of the tank in Figures 1 and 3, this intake opening 42 being connected by a pipe 44 with a box 46 into which the stock is pumped or otherwise introduced under pressure through a stock inlet pipe 48, the stock being preferably maintained at a level in said box 46 somewhat above the inlet. After passing through the refining tank and being subjected to the action of the disintegrating discs 2, the stock is discharged through a discharge opening 50, in the right hand end of the tank, which communicates with a pipe 52 connected to a box 54 having an outlet near its lower end into a stock outlet pipe 56. To provide for maintaining the desired back pressure on the discs 2 and the desired stock head in the box 46, a valve 58 is provided in the pipe 52 by which the flow of stock through the pipe 52 into the box 54 can be controlled. Provision is also made for recycling the stock, where it is desired to subject it to more than one pass over the refining discs. As shown in Figure 1, a by-pass pipe 60 connects pipe 52, at a point below the valve 58, with pipe 44, this by-pass being provided with a controlling valve 62 by which flow therethrough can be completely cut off or permitted to any desired extent.

As shown in Figures 1 and 3, the shaft 4 is also supported in outside bearings 64 and 66 carried on columns 68 and 70 of concrete or other suitable material. When the shaft, and with it the disintegrating discs 2, is to be driven from a separately mounted motor, the shaft 4 is preferably extended into a third bearing 72 and carries between these bearings a multiple V-belt pulley 74. It will be understood, of course, that, if desired, direct-connected motors can be mounted at one or both ends of the shaft 4 for direct drive of the refining apparatus.

In the modified form of the invention shown in Figures 8 to 11 inclusive, two series of disintegrating discs are provided, the discs of one series facing in a direction opposite to that in which the discs of the other series face. As shown particularly in Figure 8 of the drawings, each series comprises three disintegrating discs 76, each of substantially the same construction as the discs 2 shown in Figures 3 and 5. These discs have hubs 78 mounted upon a driving shaft 80 and are separated by spacing sleeves 82 upon said shaft, the endmost discs of each series, that is, the discs from which the final discharge of the stock takes place, being separated by a short sleeve 84, whereby these last-mentioned two discs are almost in abutting relation to each other. To prevent the formation of a dead spot in the stock to be treated between the last-mentioned two discs, blades 86 shaped to effect a centrifugal movement of the stock between the end discs extend between said discs.

In the form of the invention shown in Figs. 1 to 5 inclusive, the deflectors are formed as integral parts of two one-piece linings for the upper and lower half shells 10 and 12, respectively, so that the deflectors are readily removable for replacement. In the form of the invention shown in Figs. 8 to 11 inclusive, the deflectors, instead of being formed together as two half-shell linings, are formed in segments as shown, there being six half annular segments in each half shell.

As shown particularly in Figs. 8 and 9, the cylindrical tank or vat is formed of a lower stationary half shell 88 and a removable upper half shell 90, the lower half shell having a flange 92 and the upper half shell having a flange 94 by means of which the two half shells may be secured together. The removable deflectors comprise six half annular segments 96, 98, 100, 102, 104 and 106 for each half shell, each of these half rings or segments being provided at each end with

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a flange 108 adapted to extend between the flanges 92 and 94 of the lower and upper half shells of the tank or vat.

It will be noted that the foregoing arrangement of the parts is such that each half shell 88 and 90 of the vat or tank is slightly less than a half cylinder, the cylinder being completed by the flanges of the deflector lining members or segments. Bolts 110 extending both through the flanges 92 and 94 on the tank or vat half shells 88 and 90 and through the flanges 108 on the half annular deflector segments secure the parts in their assembled relation.

In the structure shown in Figs. 8 to 11 inclusive the bearings for the shaft 80 in the tank or vat ends differ somewhat from the bearings shown in the form of the invention illustrated in Figs. 1 to 5 inclusive, the bearings shown particularly in Fig. 8 being designed to prevent wear due to leakage of the stock into the inner end of the tank end bearings and abrasion of the surfaces thereof. To prevent this, the bearings shown in Fig. 8 are each provided with a bushing 112 which extends through the stuffing box and is confined between a shoulder 114 on the shaft, one of which may be provided by a removable collar, not shown, and a guard ring 116 within the tank or vat, the ring 116 being confined between the end disc spacing sleeve 118 and the bushing. Further to prevent the entrance of any of the liquid in the tank or vat into the bearing, outside water is constantly forced under pressure into the bearing between the stuffing box and the ring 116 through a conduit 120.

In the form of the invention shown in Figs. 8 to 11 inclusive, the inlets into the tank or vat are at the ends and the outlet is at the middle with its bottom substantially flush with the bottom part of the tank, the bottoms of the inlets also being substantially flush with the bottom of the tank. As shown particularly in Figs. 8 to 10, the inlet openings 122 and 124 in the ends of the tank or vat are connected by pipes 126 and 128 to a common inlet feed pipe 130 through a T 132 that may be bolted thereto and to which the pipes 126 and 128 are joined. The inlet pipe 130 may be connected to a stock inlet box (not shown) similar to that shown in Fig. 1 in connection with the other embodiment of the invention.

As above pointed out, the outlet 134 for the refined stock is preferably at the middle of the tank or vat with its bottom flush with the tank bottom and may be connected by an outlet pipe 136 to a stock outlet box, not shown, similar to the stock outlet box 54 shown in Fig. 1 in connection with the first described embodiment of the invention. Likewise, if desired, any suitable means, similar to that shown in Fig. 1, may be provided for recycling the stock to be treated where this is found to be either necessary or desirable.

It will be seen that each set of three disintegrating discs 76 is made up of discs similar to those shown in Fig. 3, that is, each has a substantial marginal portion of its concave face provided with a disintegrating surface 138, which may be of the same character as that hereinabove described in connection with the discs 2 shown in Fig. 3, and that, on a substantial marginal portion of its convex face, each disc is also provided with a similar disintegrating surface 140. As in the case of the form of the invention shown in Fig. 3, the width of the margin of the convex face to be covered by the disintegrating surface 140 will be greatest in the disc over which the stock first passes in its passage through the refiner, the succeeding discs of the series having increasingly narrow margins of their convex faces covered with the disintegrating material 140.

As in the form of the invention shown in Fig. 3, the faces of the deflectors in Fig. 8 are also covered with a disintegrating surfacing 142 so that, not only are they protected from erosion and wear by any of the material

in suspension in the stock to be treated, but they also act further to card, comb and separate the fibres of the fibrous material in suspension.

From the foregoing description, the operation of the stock refining machine shown in Figs. 8 to 11 will readily be understood. The stock to be treated is introduced into the openings 122, 124 in the two ends of the treating tank or vat under the desired head and immediately comes into the field of action of the first disc of the series of three discs at each end of the tank and, as it moves toward the center of this first disc and then is thrown outwardly by centrifugal action, it passes over the disintegrating surface 138 on the concave face of the disc and is discharged against the disintegrating surface 142 on the first deflector, thus travelling over this deflecting surface and against the oppositely inclined deflector face, a part of the stock being thrown directly back over the convex face of the first disc and thus over the disintegrating surface 140 on the margin of said convex face.

The stock, as it is thus deflected toward the center of the next disc of the series, enters the concavity of this second disc and travels out over the disintegrating surface 138 thereof, in the same manner that it did over the corresponding surface of the first disc, and, as it strikes the second deflector, its travel is similar to that which follows its discharge from the first disc until it comes into the field of action of the third disc of the series. As it is discharged from the third or last disc of each series, it strikes the deflectors common to the inner end discs of the two series of discs, there being some turbulence from the meeting of the two discharges due to the fact that these two end discs are discharging against oppositely inclined and partly facing deflectors. To prevent any stagnation in the stock flow or dead spot between the innermost two discs of the two series of discs, as hereinabove pointed out, blades 86 are provided to insure centrifugal movement of the stock outward from the space between the back-to-back end discs and through the discharge opening 134 into the pipe 136. As above pointed out, at the point where the outlet 134 intersects the tank it is substantially flush with the bottom of the tank and thus interrupts the junction of the opposed deflectors at this point. The surfacing 142 on the deflectors is, however, preferably carried over these deflector faces substantially to the point of intersection of the discharge therewith.

Although the disintegrator discs here shown are preferably formed substantially as segments of hollow spheres, slight modifications of this shape may be desirable under some circumstances. For example, as shown in Figure 7, the disc may be formed as a section of a hollow cone. Attention has been called to the fact that, in the illustrative embodiments, the disintegrating surfacing on the succeeding discs from the intake toward the outlet may be reduced in marginal width. It may be found, however, as a matter of convenient practice and to facilitate replacement of discs, that advantage need not be taken of this possibility of saving surfacing but that all of the discs may be provided with disintegrating surfacing of uniform widths.

It will be understood that the invention is not restricted to the illustrated embodiments thereof and that many modifications of the disclosures herein made are possible without departing from the invention, the scope of which is defined in the appended claims.

What is claimed as new is:

1. A machine of the class described, in combination, a tank, a shaft supported for rotation therein, a series of disks having abrading surfaces supported on said shaft

in an axially extending row with spaces between the adjacent disks, said tank having axially spaced inlet and outlet ports, annular deflectors on the inner wall of said tank surrounding said respective disks, said deflectors comprising surfaces at an angle to the axis of rotation with the edges of smaller diameter at the inlet sides of the perimeters of the disks and the edges of larger diameter at the outlet side of said perimeters and wall sections connecting said deflectors, each of said wall sections including an annular portion adjacent the next succeeding deflector and reversely inclined with respect thereto.

2. A machine according to claim 1 in which the abrasive surface is formed of projecting particles of a hard abrasive material.

3. A machine according to claim 1 in which the abrasive surface comprises a multiplicity of sharp projections of a hard abrasive material projecting slightly above the surface of the disc.

4. A machine according to claim 1 in which the deflectors are also provided with abrasive surfaces.

5. A machine according to claim 1 in which the coaxially turning axially spaced discs are concave on the surface facing the inlet and turn about a horizontal axis.

6. A machine according to claim 5 in which each concave disc has a marginal portion of its convex face provided with an abrasive surface.

7. A machine according to claim 5 in which the concave discs of a series of cooperating discs have their concavities all facing in the same direction.

8. A machine according to claim 1 in which two series of concave discs are arranged to turn coaxially but the concave faces of one series face in one direction and the concave faces of the other series face in the opposite direction, the tank having a stock intake opening at each end thereof and a stock discharge opening intermediate its ends.

9. A machine according to claim 1 in which two series of coaxially turning axially spaced concave discs are located in a common tank, one series having its concave faces facing in one direction and the other series having its concave faces facing in the opposite direction, the convex face of the innermost disc of each series approximately abutting the corresponding face of the corresponding disc of the other series and impeller blades being provided between said back-to-back discs.

10. A machine according to claim 5 in which the convex faces of the discs of a series are provided with material disintegrating surfaces on marginal portions thereof that progressively diminish in width on successive discs in the direction of stock flow.

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