Jan. 17, 1961 D. E. JONES 2,968,444

REFINING DISCS

Filed Nov. 7, 1956 2 Sheets-Sheet 1

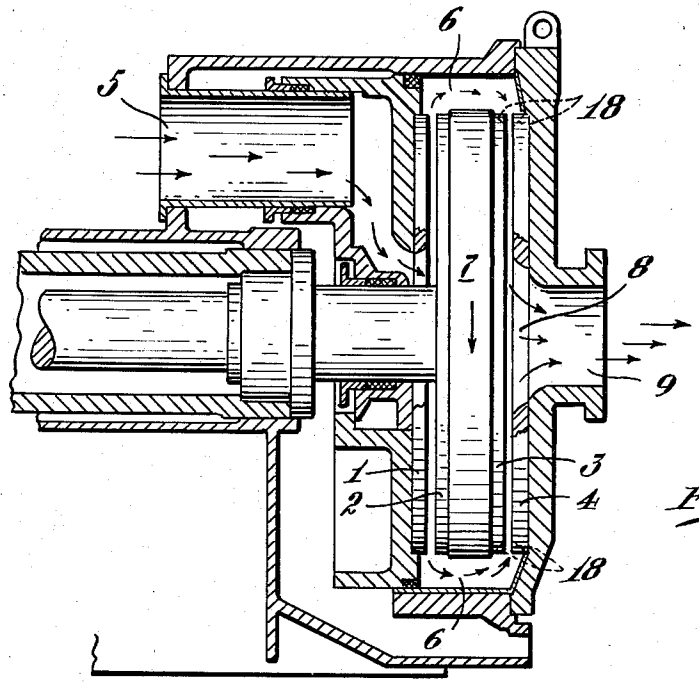


Fig. 1

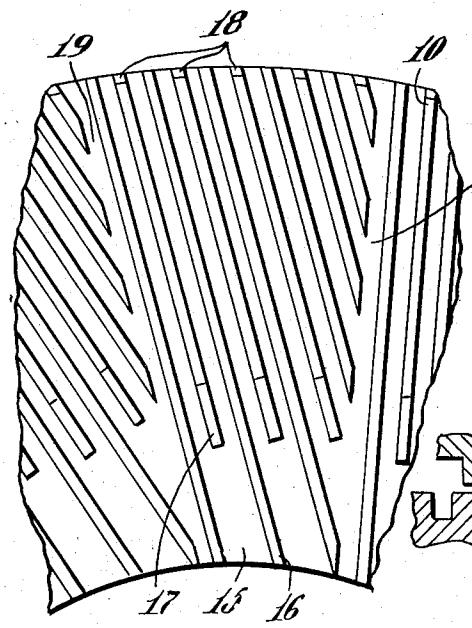


Fig. 2

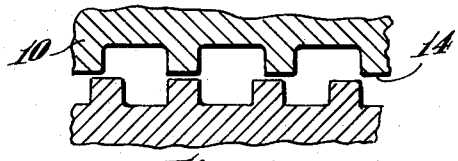


Fig. 3

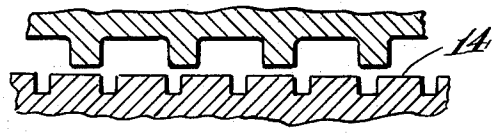


Fig. 4

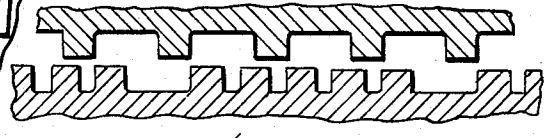


Fig. 5

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REFINING DISCS

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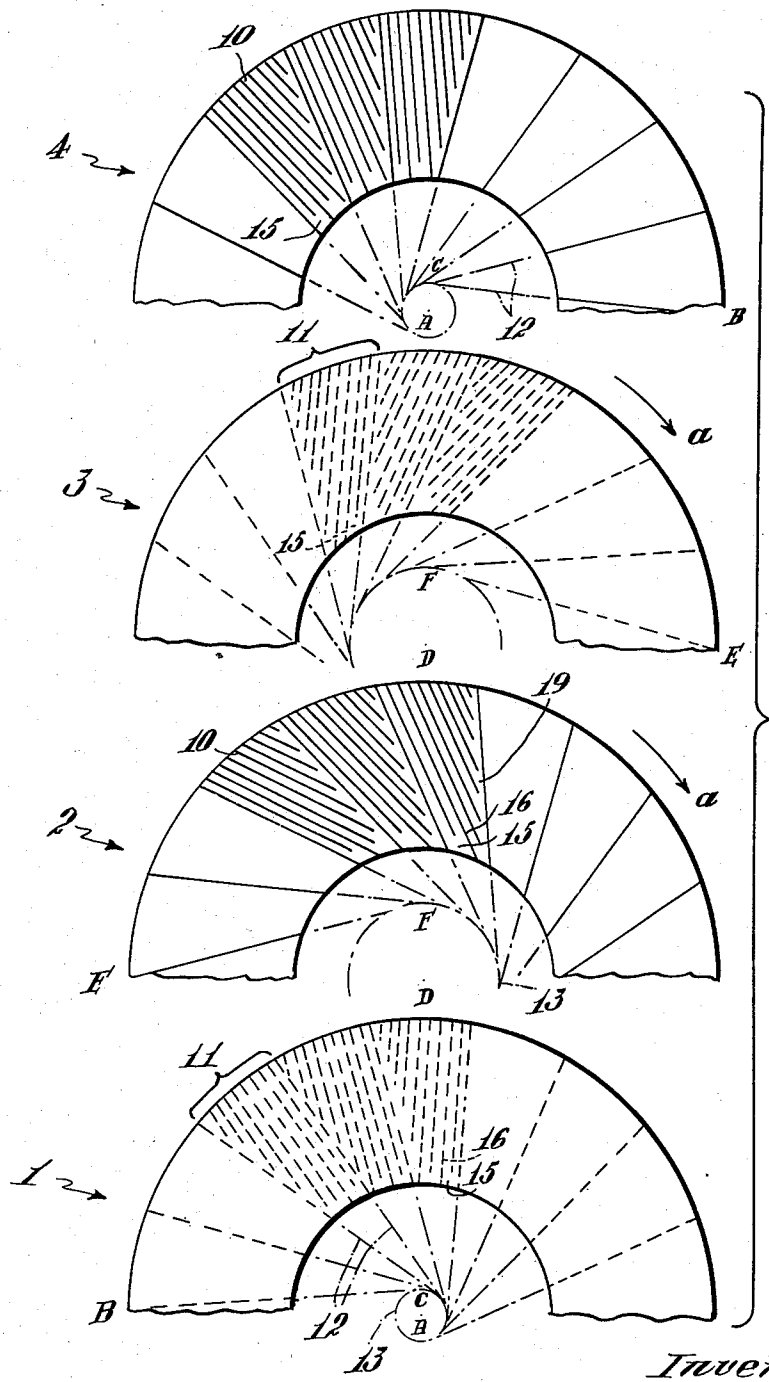


Fig. 6

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REFINING DISCS

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Filed Nov. 7, 1956, Ser. No. 620,967

3 Claims. (Cl. 241—163)

This invention relates to improvements in the art of refining fibrous materials and the like and more particularly to improved discs for use in refiners of the attrition mill type. This invention is related to and will be described in connection with my refining apparatus disclosed in U.S. Letters Patent No. 2,690,098 issued to me on September 28, 1954.

In the refining of fibers and the like it is the usual practice to suspend the material to be reduced or defibered in a liquid, usually water, and then to pass the resulting suspension into refining apparatus. One type of such apparatus is illustrated by my Patent No. 2,690,098 and involves generally the passing of the suspension between parallel, relatively revolving discs provided with closely spaced, cooperating working faces having blades or raised projections over which the suspension passes and which reduces the fibers by abrasion or cutting to the desired form. One defect in such apparatus has been with the design of the discs. Discs heretofore in use have either permitted too much raw fiber to pass between the discs without adequate reduction or permitted excessive reduction of a portion of the fibers. Such discs have embodied an excessive pressure loss in the fluid suspension with the resultant high power requirement and unnecessary wear. A further difficulty has been that fibers have occasionally accumulated in the grooves between the blades filling and blocking them and causing defective refining.

It is accordingly one object of the present invention to provide improved discs for use in such refiners whereby better refining can be obtained. It is a further object to provide refining discs requiring less power and embodying a smaller loss in pressure than discs currently in use. Other objects are to reduce the wear on such discs and to minimize groove blocking with compressed fibers. Further objects and advantages will be apparent from the following disclosure.

In accordance with this invention these objects are obtained by providing at least two cooperating sets of improved discs, each set comprising two substantially parallel coaxial discs one of which rotates relative to the other and having blades or raised projections extending generally radially on their adjacent, cooperating faces, said blades being arranged in circumferential segments defined by tangents on a circle of lesser diameter concentric with the disc. The fiber stock flow between the cooperating discs of one set is outward from center to periphery and between the discs of the other set, inward from periphery to center. The blades on the rotating, pumping or propelling disc of the disc set having outward flow are offset from radial such that inner ends of the blades lead the outer ends in the direction of rotation while the blades of the rotating propelling disc of the other disc set are offset in the opposite direction, that is, the outer ends lead the inner ends in the direction of rotation. The segments of said other discs may be radial or offset from radial in the same direction as the propelling disc sections in the same disc set. For improved refining

the blades on the said other disc in each disc set may have greater width and be more closely spaced than the rotating, propelling disc in the same disc set.

In another aspect this invention comprises an improved circular disc having a working face formed by relatively spaced blades, said blades being arranged in groups providing circumferentially arranged, segments or sections wherein the blades of each section are substantially parallel to one edge of the said section. For improved flow, alternate or some of the blades in each blade section have inner ends which terminate outwardly of adjacent, full length blades. In discs having inward flow across their working faces, alternate or at least some of the blades in each section have outer ends which are bevelled inwardly providing transport spaces at the outer portions of each section.

In another aspect this invention comprises a pair of circular, coaxial discs one of which rotates relative to the other and having adjacent, cooperating working faces formed by relatively spaced blades, the blades being arranged in groups providing circumferentially arranged sections with the blades of each section being parallel to one edge of said section. The blades of each section on both discs terminate outwardly from the edges of adjacent sections on each disc providing transport spaces across the face of the disc at the section boundaries and the blades of the two discs intersect at an angle not exceeding 45°.

In still another aspect the present invention comprises the method of refining fiber stock and the like, said method comprising feeding the stock outwardly from center to periphery between one set of two coaxial discs one of which rotates relative to the other, said discs having adjacent cooperating working faces provided with blades, and inwardly from periphery to center between another set of two such coaxial discs. The stock is introduced between the discs of the disc set having outward flow by feeding into transport spaces provided by blades which terminate outwardly from adjacent full length blades and is propelled outwardly under pressure between the discs by means of the rotating disc which is provided with blades offset from radial such that inner ends thereof lead outer ends in the direction of rotation. The stock is propelled inwardly between the discs of the said inward flow disc set by means of the rotating disc in said set, said disc being provided with blades offset from radial such that outer ends thereof lead inner ends in the direction of rotation.

For the purpose of illustration a typical embodiment of the invention is shown in the accompanying drawings in which

Fig. 1 is a vertical cross section of a refining machine with the discs mounted in place;

Fig. 2 is a plan view of a portion of disc 4;

Fig. 3 is a cross section at right angles to a radius of portions of two cooperating refining discs showing one disposition of the blades on the two discs;

Fig. 4 is a cross section at right angles to a radius of portions of two cooperating refining discs showing a second alternative disposition of the blades on the two discs;

Fig. 5 is a cross section at right angles to a radius of portions of two cooperating refining discs showing a third alternative disposition of the blades on the two discs; and

Fig. 6 is an exploded axial layout of the four refining discs of Fig. 1 looking from inlet to discharge.

The embodiment of the present discs construction shown for illustration is shown in Fig. 1 mounted in the refining machine disclosed in my U.S. Letters Patent No. 2,690,098. Fig. 1 herein is substantially the refining end of the machine therein shown in Fig. 3 and the discs herein indicated by the numerals 1, 2, 3, and 4 are therein

indicated by the numerals **102, 106, 104** and **100**, respectively.

The fiber stock and the like to be refined, generally consisting of fibers or the like suspended in water and usually under pressure, is fed into an inlet **5** and conveyed thence to the center of the first set of two cooperating discs **1** and **2**. One of said discs rotates relative to the other. While this relative rotation can be accomplished by rotating the discs in opposite directions or by rotating them at different speeds in the same direction and such are included in the term as herein used, No. **1** disc as shown is stationary while No. **2** disc is rotated in the direction indicated by the arrow *a*. The stock is propelled outwardly between discs **1** and **2** into the peripherial casing chamber **6** by the pressure of the fluid and by the action of disc **2**, hereinafter to be described. From the casing chamber **6** the stock passes between the cooperating refining discs **3** and **4**, disc **4** being herein shown as stationary while disc **3** is mounted to and rotates with the same rotor **7** as disc **2**. In flowing from periphery to center the stock again is propelled by fluid pressure and by the action of disc **3** hereinafter to be set forth. From the center **8** of disc **4** the refined stock passes to the discharge **9**.

The adjacent working faces of discs **1** and **2** and of discs **3** and **4** are provided with blades **10** over which and between which the desired refining occurs. These blades are arranged in circumferential segments or sections **11**, the edges of which and extensions **12** thereof converging tangential to a circle **13** having the center of the disc as its center. As will be subsequently explained, the blade sections of discs **1** and **4** may converge radially to the center of the disc which will herein be considered as a circle of zero radius. Due to the rotation of the rotating discs **2** and **3**, the fiber stock is propelled in a spiral path moving in the direction of rotation of said discs, spiralling outwardly between discs **1** and **2** and inwardly between discs **3** and **4**. To materially enhance this movement of stock, the blades on discs **2** and **3** are disposed to propel the stock in the desired direction, disc **2** having blades the sections of which are offset from radial such that inner ends of the blades lead outer ends in the direction of rotation while disc **3** has blades the sections of which are offset in the opposite direction, that is, such that outer ends of the blades lead inner ends in the direction of rotation. Since it is the rotating discs **2** and **3** which give both the radial and the circular components of movement (with the probable assistance of the stock fluid pressure) to the stock, these discs are herein called propelling discs.

It is apparent that without a countering force, the fiber stock in the groove of the rotating discs would merely move outwardly in the grooves between the blades without being subjected to refining action. This countering force is supplied by the disposition of the cooperating blades on said other or stationary discs **1** and **4** which operate to cause the fibers to move out of grooves and across the blades where they are refined. For this purpose I have found that the blades on the stationary disc should be disposed substantially perpendicular to the path of the fiber stock as it moves spirally between the discs. This is accomplished by offsetting the blade sections from radial in the same direction as the cooperating rotating disc in the same disc set; that is, disc **1** has sections offset such that inner ends of the section edges lead outer ends in the direction of rotation of disc **2** and disc **4** has section edges offset such that outer ends lead inner ends in the direction of rotation of disc **3**. This disposition is obtained by offsetting the blade sections of discs **1** and **4** from 0° to 10° in the indicated directions while the rotating blade sections are offset tangentially from 5° to 25°. In other terms, referring to Fig. 6, angles ABC may vary from 0° to 10° while angles DEF may vary from 5° to 25°. The imaginary lines AB and DE define a radius of the disc circle while lines BC and EF are edges of segments **11** tangent to the circle **13**. Further, the blades in the blade sections **11** of disc **2** are arranged parallel to the trailing edge of said sections while the blades of disc **1** are arranged parallel to the leading section edges in the direction of rotation of disc **2** and the blades of the blade sections **11** of disc **3** are arranged parallel to the leading edge of the sections while the blades of disc **4** are arranged parallel to the trailing section edges in the direction of rotation of disc **3**. With the blades thus disposed on the cooperating working faces of the discs, the blades of cooperating discs always intersect at an angle thus avoiding parallelism which would result in a loss in refining action. In addition the noise level of the machine is substantially reduced.

The operation of the cooperating disc faces is believed to be substantially as follows: The pulp stock enters the groove spaces between the discs under the force of the fluid pressure and the blade disposition above described and assisted by transport spaces to be hereafter set forth. The stock is put into spiral motion by the rotation and blade disposition of the propelling disc **2** or **3**. This motion is resisted by the blades of the stationary disc **1** or **4** respectively which resisting force causes the fibers to be forced out of the grooves not only by direct action but also by a pressure distribution set up in the grooves, and to be forced between and across the interacting and intersecting blade surfaces or lands **14** of the two co-acting discs where refining by abrasion ("beating") or cutting takes place. For refining the blades of the two co-acting discs should not intersect at an angle greater than 45°.

The number of blade sections **11** herein shown disposed circumferentially of the discs are eighteen. The number has been found to be a satisfactory compromise between the desire to have as many as possible to keep the angle of blade intersection between the rotating and the stationary discs are nearly constant as possible and ease of manufacture.

To facilitate entry of the fiber stock between discs **1** and **2** and to facilitate central discharge from discs **3** and **4** transport spaces **15** at the inner portions of each blade section are provided by terminating certain blades in each such blade section inwardly of adjacent, full length blades **16**. The inner ends of these outwardly terminating blades may be tapered as shown at **17**. Entry of fiber stock between the discs **3** and **4** at the peripheries thereof is materially aided by bevelling inwardly the outer ends of certain blades in each blade section on each disc, herein illustrated with alternate blades bevelled. The bevelled edges providing entry passages are indicated at **18**. Further stock passages **19** are provided across the faces of all discs by terminating the blades of each circumferential section **11** short of the first blade of the adjacent section.

I have also discovered that improved refining results are obtained if the spacing between the blades of the rotating disc differs from the blade spacing on the cooperating stationary disc. Specifically, the spacing on the stationary disc need not be as large since the most important turbulence occurs over and between the blades of the rotating disc and increased refining area is provided by having more blades and blade surface on the stationary disc. The blade surface or width of the blade land **14** on the stationary disc may also be beneficially greater than that of the rotating disc. Three such arrangements are illustrated in Figs. 3, 4, and 5 respectively wherein the upper disc in each figure is the rotating disc.

Additionally it has been discovered that for cutting the lands **14** should be as narrow as possible while for abrading or "beating" the lands on the rotating propelling discs should be approximately equal in width to three times the average fiber length. While the normal tendency is to pump from center to circumference, no difficulty has been encountered in pumping from circum-

ference to center in discs 3 and 4 due to the action of discs 3 which must be rotating and due to the fluid pressure at the circumference which has increased in passing between discs 1 and 2 until it exceeds the centrifugal force of the rotating disc. Units of this type have been constructed to give greatly improved refining with a very small pressure drop through the refiners, some having been constructed with no pressure loss at all through the unit.

A final practical advantage of construction is to be noted. Except for the bevelled edges 18, discs 3 and 4 are identical to discs 1 and 2 except that they are reversed with respect to rotation thus requiring the manufacture of only one set of discs.

As disclosed in the aforesaid patent the spaces between the stationary and rotating discs are adjustable by self-centering means which maintains the space between discs 1 and 2 substantially equal to the space between discs 3 and 4, with yielding means to permit the rotating discs to move off-center in response to excessive pressure in one of the spaces, produced for example by the passage of a solid object.

It should be understood that the present disclosure is for the purpose of illustration only and that this invention includes all modifications and equivalents falling within the scope of the appended claims. It will be apparent from the foregoing disclosure that a greater or lesser number of circumferential segments may be employed, that one or more sets of such discs may be utilized, and that this invention can be utilized in refining apparatus other than that disclosed in my U.S. Letters Patent, No. 2,690,098.

I claim:

1. In a refining machine, two sets of cooperating refining discs, each set comprising a pair of coaxial discs, one of which rotates relatively to the other, one of said disc sets having stock flow between the two discs outwardly from center to periphery and the other set having stock flow inwardly from periphery to center, said discs having working faces provided with blades arranged in groups providing circumferential segments, opposite edges of the segments and extensions thereof inwardly converging tangential to a circle having the disc center at its center, the blades in each segment being arranged substantially parallel to one edge of said segment, the segment edges of the disc set having outward stock flow being tangential to said circle such that the inner ends of said edges lead the outer ends in the direction of rotation of the more rapidly rotating propelling disc, the blades of the rotating disc in this disc set being substantially parallel to the trailing edge of the segments while the blades of the other disc in the same disc set are substantially parallel to the leading edge of its segments in the direction of rotation of said propelling disc, and the segment edges of the disc set having inward flow converging tangentially such that the outer ends of said edges lead inner ends thereof in the direction of rotation of the more rapidly rotating propelling disc, the blades of the rotating disc of this inward flow set being substantially parallel to the leading edge of the segments while the blades of the other disc of this disc set are substantially parallel to the trailing edge of the segments in the direction of rotation of the more rapidly moving propelling disc, all of the blades on the discs of each set intersecting at an angle greater than zero degrees at all rotational positions, the outer ends of alternate blades of the discs having inward flow from periphery to center being beveled inwardly at their outer ends to assist in entry of the pulp stock, certain blades of each segment of each disc having inner ends terminating outwardly of the inner ends of blades on opposite sides thereof providing transporting spaces at inner portions of said segments, whereby fiber stock is propelled in the desired direction and refined between the blades.

2. In a refining machine, two sets of cooperating refining discs, each set comprising a pair of coaxial discs, one of which rotates relatively to the other, one of said disc sets having stock flow between the two discs outwardly from center to periphery and the other set having stock flow inwardly from periphery to center, said discs having working faces provided with blades arranged in groups providing circumferential segments, opposite edges of the segments and extensions thereof inwardly converging tangential to a circle having the disc center at its center, the blades in each segment being arranged substantially parallel to one edge of said segment, the segment edges of the disc set having outward stock flow being tangential to said circle such that the inner ends of said edges lead the outer ends in the direction of rotation of the more rapidly rotating propelling disc, the blades of the rotating disc in this disc set being substantially parallel to the trailing edge of the segments while the blades of the other disc in the same disc set are substantially parallel to the leading edge of its segments in the direction of rotation of said propelling disc, and the segment edges of the disc set having inward flow converging tangentially such that the outer ends of said edges lead inner ends thereof in the direction of rotation of the more rapidly rotating propelling disc, the blades of the rotating disc of this inward flow set being substantially parallel to the leading edge of the segments while the blades of the other disc of this disc set are substantially parallel to the trailing edge of the segments in the direction of rotation of the more rapidly moving propelling disc, all of the blades on the discs of each set intersecting at an angle greater than zero degrees at all rotational positions, the outer ends of alternate blades of the discs having inward flow from periphery to center being beveled inwardly at their outer ends to assist in entry of the pulp stock, whereby fiber stock is propelled in the desired direction and refined between the blades.

3. In a refining machine, two sets of cooperating refining discs, each set comprising a pair of coaxial discs, one of which rotates relatively to the other, one of said disc sets having stock flow between the two discs outwardly from center to periphery and the other set having stock flow inwardly from periphery to center, said discs having working faces provided with blades arranged in groups providing circumferential segments, opposite edges of the segments and extensions thereof inwardly converging tangential to a circle having the disc center at its center, the blades in each segment being arranged substantially parallel to one edge of said segment, the segment edges of the disc set having outward stock flow being tangential to said circle such that the inner ends of said edges lead the outer ends in the direction of rotation of the more rapidly rotating propelling disc, the blades of the rotating disc in this disc set being substantially parallel to the trailing edge of the segments while the blades of the other disc in the same disc set are substantially parallel to the leading edge of its segments in the direction of rotation of said propelling disc, and the segment edges of the disc set having inward flow converging tangentially such that the outer ends of said edges lead inner ends thereof in the direction of rotation of the more rapidly rotating propelling disc, the blades of the rotating disc of this inward flow set being substantially parallel to the leading edge of the segments while the blades of the other disc of this disc set are substantially parallel to the trailing edge of the segments in the direction of rotation of the more rapidly moving propelling disc, all of the blades on the discs of each set intersecting at an angle greater than zero degrees at all rotational positions, certain blades of each segment of each disc having inner ends terminating outwardly of the inner ends of blades on opposite sides thereof providing transporting spaces at inner portions of said segments, whereby fiber stock is propelled in the desired direction and refined between the blades.

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