L. E. JONES.

ORE CONCENTRATOR.

APPLICATION FILED APR. 10, 1912.

1,029,933.

Patented June 18, 1912.

3 SHEETS—SHEET 1.

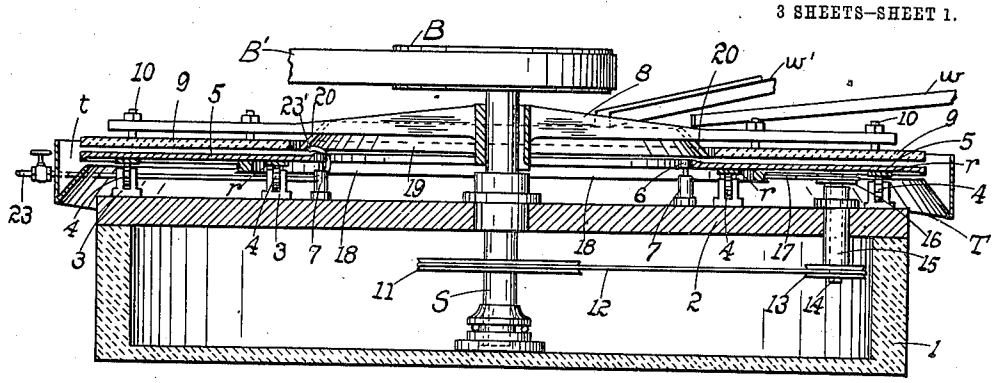

FIG. 1.

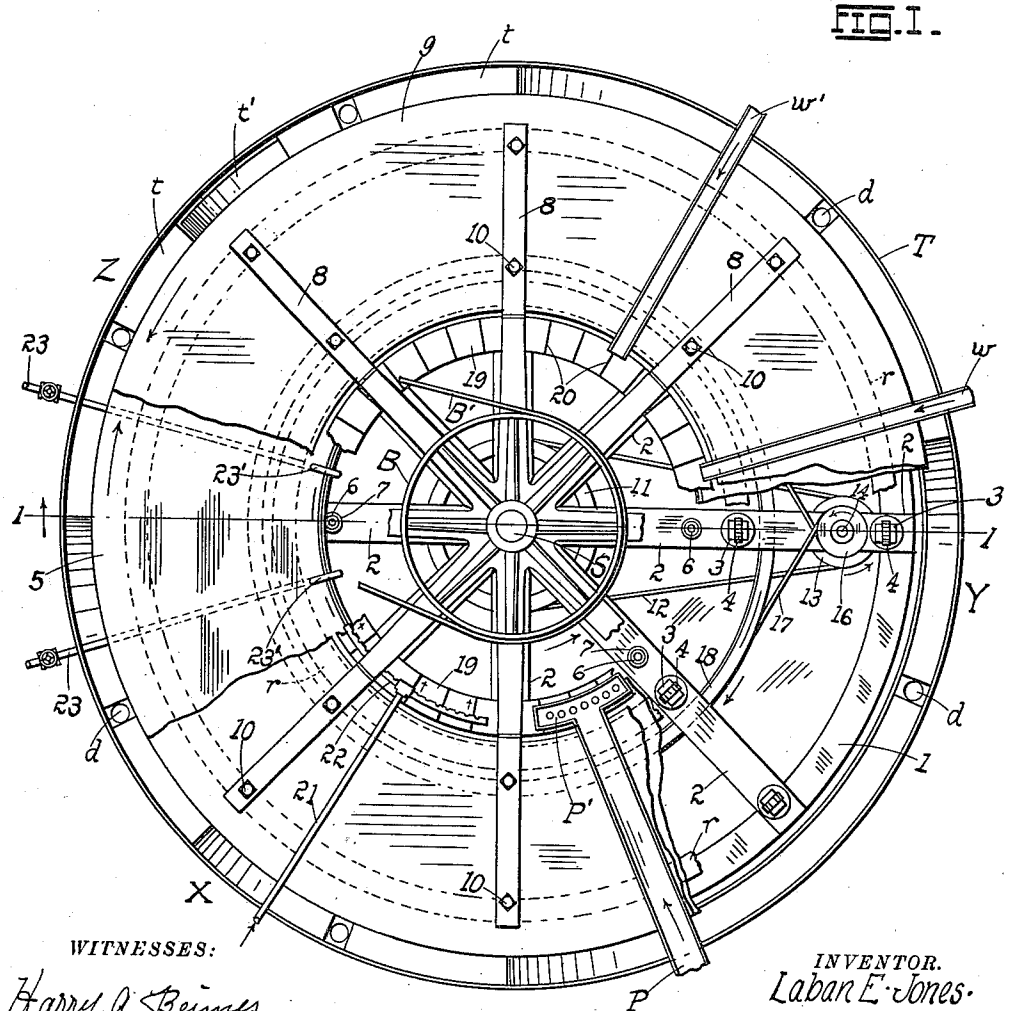

FIG. 2.

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3 SHEETS-SHEET 2.

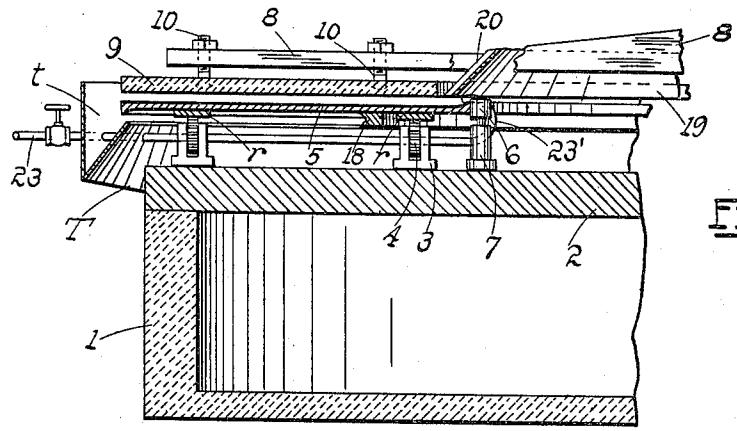

FIG. 3.

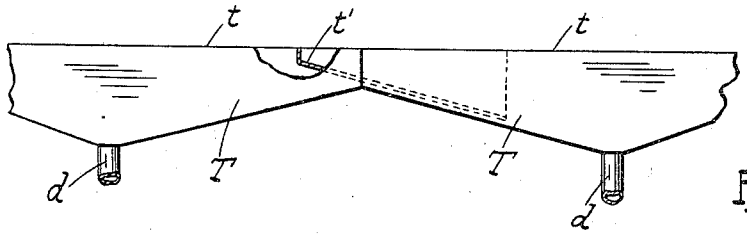

FIG. 4.

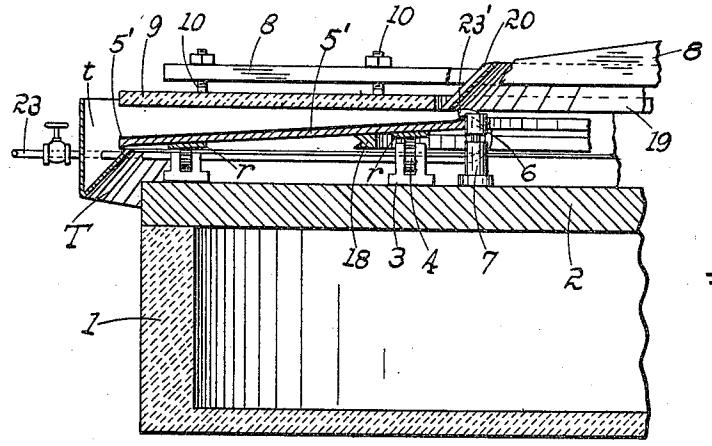

FIG. 5.

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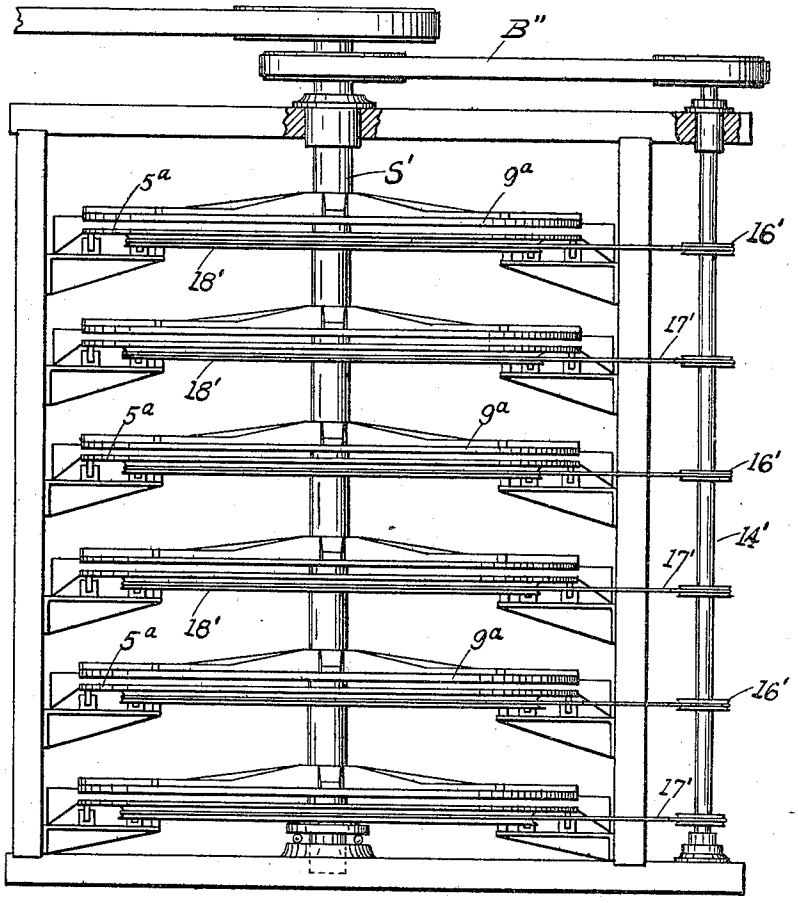
3 SHEETS—SHEET 3.

FIG. 6.



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ORE-CONCENTRATOR.

1,029,933. Specification of Letters Patent. Patented June 18, 1912.

Application filed April 10, 1912. Serial No. 689,845.

To all whom it may concern:

Be it known that I, LABAN E. JONES, citizen of the United States, residing at Anaconda, in the county of Deerlodge and State of Montana, have invented certain new and useful Improvements in Ore-Concentrators, of which the following is a full, clear, and exact description, reference being had to the accompanying drawings, forming a part hereof.

My invention has relation to improvements in ore concentrators; and it consists in the novel details of construction more fully set forth in the specification and pointed out in the claims.

In the drawings, Figure 1 is a vertical diametrical section taken on the line 1—1 of Fig. 2; Fig. 2 is a top plan of the concentrator, parts being broken away; Fig. 3 is an enlarged vertical section of one-half of the machine, said section corresponding to that shown in Fig. 1; Fig. 4 is an elevational view of a portion of the outer trough by which the various classified materials are caught; Fig. 5 is a section similar to Fig. 3 showing a modified form of the lower depositing or concentrating disk; and Fig. 6 is an elevation of a machine showing a number of concentrators operated from a single shaft.

The present apparatus is designed to take the place of the usual vanner or slanting surfaces on which fine ore pulp is generally treated for purposes of concentration, the capacity of such machines being more or less limited on account of the tendency to form minute furrows or channels and small ripples when worked rapidly, such formations interfering with the concentrating process.

The object of my present invention is to provide a machine of maximum capacity; one in which the operation shall be uniform, and certain; one which permits of a thorough washing and scouring of the pulp while the concentrates are given a chance to settle and separate from the sands and lighter colloids under a rapid quiver or vibration of the concentrating surface; one assuring a uniform thickness of film or layer of concentrates; one preventing the formation of ripples which tend to disturb the settling action; and one presenting further and other advantages to be more clearly apparent from the detailed description of the invention which follows.

Generally stated, the concentrator contemplates the use of two superposed rotating disks or surfaces between which a differential in velocity is maintained preferably by rotating the disks simultaneously in opposite directions about a common axis, although by way of modification one of the disks (the lower) may remain stationary while the other is allowed to rotate. The disks are maintained in close relation, the pulp being allowed to flow in sheet form in the space between the disks. Within this space the pulp components are separated or classified, and the concentration effected in a manner which, so far as I am aware, is new in the art.

In detail the apparatus may be described as follows:—

Referring to the drawings, and for the present to Figs. 1 to 4 inclusive, 1 represents a preferably concrete base surmounted by the timbers 2 forming a skeleton platform or frame, through the center of which is suitably supported a drive-shaft S to which rotation may be imparted from a point above the frame by a pulley B, and belt B′, leading to any suitable source of power (not shown). Disposed in concentric circles on the platform 2 are series of brackets 3 in which are mounted fluted rollers 4, said rollers supporting the bottom rotatable depositing or concentrating disk 5 preferably built of iron and covered with rubber, canvas, linoleum, or equivalent material known to the art, to which the pulp concentrates may adhere. The rollers traverse the circular rails *r* disposed along the under surface of the disk 5 as shown. The inner edge of the disk 5 is slightly raised to prevent the pulp from running over (Figs. 1, 3). Engaging the walls of the opening of the bottom disk are guide rollers 6 the spindles of which are mounted in bearings 7 disposed about a common circle on the platform frame 2. Keyed, or otherwise secured to the shaft S between the frame 2 and the pulley B, is a spider 8 to the arms of which is secured the upper disk 9 preferably built of reinforced concrete. The same is secured by means of bolts 10 whereby its distance from the disk 5 may be carefully adjusted; and being coupled to the spider 8 obviously rotates in the same direction with the shaft S to which the spider is keyed. The disk 5 on the other hand preferably rotates in the opposite direction or clockwise (though it may be stationary), and in the present illustration has

rotation imparted thereto by means of a sheave or grooved pulley 11 secured to the shaft S below the platform 2, a belt or band 12 passing from said sheave over a sheave 13 at the lower end of a spindle 14 mounted in a tubular bearing 15 on the platform 2, the upper end of the spindle carrying a sheave or pulley 16 over which wraps a cross-belt 17, the latter passing over a grooved sheave ring 18 fastened to the disk.

The disk 5 is somewhat wider than the disk 9, the inner edge of the former projecting beyond that of the latter, said projecting or overlapping portion receiving the pulp from the annular conical deflecting flange or apron 19 secured in any mechanical manner to the spider 8, the upper surface of the apron being provided with projecting radial fins 20 whereby a forward rotating motion is imparted to the pulp. The pulp and water are properly deflected by the apron 19 so as to pass down between the disks 9 and 5.

P, represents the pulp-trough, the same terminating above the apron in a perforated distributing head P′ as shown. Disposed radially above the machine are wash-water troughs w, w'. At the proper position is disposed a water pipe 21 terminating in a distributing head 22 (above the apron 19), by which the heavy foreign materials are removed from the concentrates deposited on the surface of the disk 5, the said concentrates being finally dislodged and washed away by jets issuing from the valve-controlled jet-pipes 23, 23, whose terminal upturned goose-necks 23′ play against the concentrating surface of the disk 5 below and behind the apron 19, the jets being projected radially outward (Figs. 1, 2, 3).

Surrounding the disks 5, 9, and forming the outer boundary of the machine, is a trough T, characterized by a series of contiguous sections or compartments t, t, to catch the different grades of materials into which the pulp is separated, the bottoms of the sections ranging upwardly and intersecting or meeting in lines defining the shallowest portions of the trough, the lowest portions of the respective compartments having connected thereto the discharge pipes d for conducting away the contents of the respective compartments. Any compartment may be enlarged or contracted by an adjustable or movable section t' which is closed at its narrow end. It is apparent that by depositing the member t' on the inclined bottom of any compartment t, and moving the same up or down along said bottom, the length of such compartment may be increased or reduced at pleasure. This lengthening or shortening of a section may be desirable according to the volume of the particular product discharging into any section. It may be stated in passing that the jet pipes 23, 23, are preferably passed through the walls of the trough T as shown to secure their proper disposition for the service they are intended to perform. To facilitate the outward washing of the concentrates on the disk 5, under the action of the jets 23, the disk may be given a slight drop or dip outwardly as shown at 5′ in the modification illustrated in Fig. 5, in which the remaining features of the machine are not changed. This dip provides more room for the pulp sheet and at the same time a slant in the proper direction to facilitate its flow toward the trough T.

In Fig. 6 are illustrated a series of pairs of disks 5^a, 9^a, driven from a common shaft S′, the contrary rotation partaken of by the disks 5^a being imparted from a common shaft 14′ driven by the belt B″ and equipped with pulleys 16′ from which lead the cross-belts 17′ over grooved ring-sheaves 18′. This figure is more or less diagrammatic in character, to illustrate the plan of combining several concentrators or elements in compact form for the purpose of economizing space, each element being designed to treat a particular kind of material.

The operation of the concentrator may be conveniently described by a reference to Figs. 1 to 4 inclusive and is substantially as follows:—The pulp (fine ore mixed with water) is fed from the trough P and through the perforated distributing head P′ thereof onto the apron 19, which as already described is secured to the spider 8 keyed to the drive-shaft S, and which spider likewise carries the upper disk 9. Rotation is imparted to the shaft S (and consequently to the apron 19 and disk 9) during the pulp flow, said rotation being counter clockwise as shown by the arrow in Fig. 2. This naturally imparts a contrary or clockwise rotation to the bottom concentrating disk 5 as also indicated by the arrow in said figure. The radial projecting fins 20 on the apron or deflector 19 serve to impart a rotating forward motion to the pulp, the pulp flowing radially outward over the disk 5 and at the same time advancing in a rotary direction under the driving action of the fins. The pulp thus distributes itself between the two disks 9, 5, the degree of separation between them being such as to exert a definite amount of friction against the opposite surfaces of the pulp sheet. By virtue of this friction the upper disk or member 9 which rotates contrary to the disk 5, will advance the pulp around counter clockwise, the lighter particles going faster and farther around than the comparatively heavier particles, and finally leaving at about the point Z, and flowing into the trough T (Fig. 2). The heavier portions lag behind being retarded more or less by the opposed direction of rotation participated in by the lower disk

5, such lagging heavier particles receiving the washing effect from the lighter portions of succeeding streams of pulp admitted from the trough P and from the water discharged by the troughs w, w', and being pressed forward and outward until they finally leave at approximately the point Y. Still other and yet heavier portions will lag behind even more, being carried around (on the disk 5) out of the path of the fresh pulp, and are washed and scoured at the point X by the jets from the distributing head 22 of the wash-water pipe 21. Finally, the particles which still remain on the lower or concentrating disk 5 after all the scouring referred to, are the heavy ore concentrates desired and these are washed off and dislodged by the jets issuing from the pipes 23 or their equivalents.

It will be seen from the foregoing that the pulp is resolved into a number of separable and classifiable components, from the very lightest colloids or tailings through the various grades of heavier sandy components or gangue up to the heavy ore values or concentrates, the number of these components depending on the nature of the pulp, the speed of the disks, the degree of separation between them and the intensity of flow of the feed and wash waters. In practice the speeds of the disks, their precise separation or spacing, and the flow of pulp are adjusted to bring about the most desirable results, always with a view of entailing a minimum loss of concentrates. The character of the machine permits of very accurate adjustments. The several classified and separated components of the pulp as they leave the disk 5 flow into their respective sections t of the outer trough T whence they escape through the discharge pipes d to any desired point. It is obvious that should it be desirable to lengthen or shorten any trough section to accommodate more or less of the product flowing thereinto, this may be done by a proper adjustment of the movable member t'. As the disk 5 is carried around, the fluted rollers 4 on which it rests impart a quiver or shaking motion or tremor thereto, thus facilitating the settling and separation of the concentrates thereon.

The initial direction of flow of the pulp over the disk 5 is both radially outward and likewise circular, the circular component depending on the relative speeds of the disks 9 and 5. Whether one of the disks (5) be stationary or whether it rotate in a direction opposite to the disk 9, the differential between the angular velocities of the two disks is what determines the degree of deflection of the original pulp stream from its radial course. By reason of the differential however, the sheet of pulp between the disks is subjected to a horizontal shearing stress, that is to say, a shear in a plane parallel to the planes of the opposite faces of the pulp sheet. In the present example the backward (or clockwise) rotation of the bottom disk 5 is much slower than the forward (or counter-clockwise) rotation of the upper disk 9, the latter tending to constantly advance forward what the bottom disk tends to carry backward. In this action the lighter particles which naturally approach the upper disk will follow that disk with the greatest facility, the heavier particles progressively lagging behind according to their relative weight, the heaviest component or concentrates favoring the lower disk on which they settle without material disturbance from the upper disk 9. At what points successive grades of material shall be dropped will depend much on the relative speeds of the disks, but these are adjusted to bring about the results substantially as here indicated. The terms "backward" and "forward" as used here are merely for convenience, and the reverse would be as applicable.

It may be stated in passing that the rotation of the disks is not supposed to be rapid, as it is desirable to keep down the centrifugal stress as much as possible. The pulp being free to flow outwardly between the disks, a high velocity would generate an undesirable centrifugal force which would tend to expel the material from the peripheries of the disks. This of course, is not intended, only that degree of rotary speed being maintained as will insure the gradual working off of the materials from the disks in conjunction with the wash waters, the lightest particles or colloids not requiring to be washed, being carried off by the water of the pulp. The degree of separation between the disks or members 9, 5, should be such as to maintain a sheet flow of pulp between them, that is to say, a liquid film whose opposite faces shall be at all times in frictional engagement with the adjacent surfaces of the respective disks. This frictional engagement causes the layers of pulp in contact with the upper disk to participate in the movement of that disk, carrying the lighter particles with them, while the bottom pulp layers toward which the concentrates gravitate, partake in the main of the movement of the bottom disk.

It may be stated in conclusion that the disks might even rotate in the same direction so long as a differential in velocity was maintained between them to secure the "scouring" effects here pointed out.

Having described my invention, what I claim is:—

1. In a concentrator, a pair of members provided with pulp distributing surfaces spaced vertically apart and permitting a free flow of the pulp over the lower mem-

ber through said space, and means for advancing one of the members relatively over the other member and causing certain portions of the pulp to participate in such movement.

2. In a concentrator, a pair of members provided with pulp distributing surfaces spaced vertically apart, and permitting a free flow of the pulp over the lower member through said space, and means for advancing one member relatively over the other member and causing portions of the pulp adjacent to the moving member to participate in said movement.

3. In a concentrator, a pair of disks disposed about a common vertical axis and spaced apart, the pulp flowing freely through said space over the lower disk, and means for rotating one of the disks about the opposite disk whereby the layers of the pulp adjacent the rotating disk participate in such rotation.

4. In a concentrator, a pair of disks disposed about a common vertical axis and spaced apart, means for imparting simultaneous rotation to the disks about said axis in opposite directions, and means disposed about said axis for feeding pulp into the space between the disks and directing the same outwardly toward the peripheries of the disks, the layers of pulp in contact with the disks participating in the respective directions of rotation of the disks and the concentrates depositing on the lower disk.

5. In a concentrator, a pair of annular disks disposed about a common vertical axis and superposed over one another and spaced apart, the bottom disk overlapping the upper disk on the side toward the axis, means for imparting to the disks a simultaneous rotation about said axis, in opposite directions, means for feeding pulp, an apron disposed above the inner overlapping portion of the bottom disk for directing the pulp into the space between the disks, means for washing the separated materials, and circumferentially spaced means for collecting the separated components of the pulp.

6. In a concentrator, a pair of annular disks disposed about a common vertical axis and superposed over one another and spaced apart, the bottom disk overlapping the upper disk on the side toward the axis, means for simultaneously rotating the disks in opposite directions about said axis, an annular apron disposed above the overlapping portion of the lower disk, an outer circumferential trough composed of independent sections disposed about the peripheries of the disks, means for feeding pulp against the apron at a given point, means for directing the liquids into the space between the disks, and means for dislodging the concentrates from the lower disk and directing them into the trough.

7. In a concentrator, a pair of superposed members provided with opposed surfaces spaced apart for the flow and distribution of a pulp-sheet, means for rotating one of the members and causing the pulp sheet to participate in said rotation the concentrates depositing on the lower member during such rotation.

8. In a concentrator, a pair of disks disposed about a vertical axis and provided with opposed substantially horizontal surfaces spaced apart for the flow and distribution of a pulp-sheet between them, means for rotating one of the disks relatively over the other, and means for adjusting the degree of separation between the disks.

9. In a concentrator, a pair of substantially horizontal disks disposed about a common vertical axis and rotatable simultaneously in opposite directions about said axis, means for maintaining the disks a suitable distance apart to accord a free flow and distribution of a pulp-sheet between them, the pulp flowing between the disks radially outward from the axis of rotation thereof.

10. A concentrator comprising a central vertical rotatable drive-shaft, an annular disk supported from said shaft, a suitable platform, a second annular disk supported by said platform and spaced a suitable distance below the first disk and forming a passage therewith for the free flow and distribution of pulp between the disks, means secured to the lower disk, intermediate connections between said means and the drive-shaft for imparting to the lower disk a rotation contrary to the rotation of the shaft and of the upper disk, an annular conical apron coupled to the shaft and provided with fins for directing the pulp and wash-water radially outward into the space between the disks, means for directing a pulp flow and wash-water against the finned surface of the apron, means for directing jets of water against the lower disk at points below the apron and directing said jets toward the periphery of the lower disk for the dislodgment of the concentrates, and a compartment trough surrounding the disks for catching the various classified constituents of the original pulp.

11. In a concentrator, a trough provided with a series of compartments, and a movable member or section closed at one end for lengthening or shortening any compartment, for the purpose set forth.

12. In a concentrator, a pair of members spaced a suitable distance apart for the flow of a pulp-sheet between them, and in contact therewith, and means for imparting to the members a differential of movement between them in a horizontal plane, whereby the pulp sheet is subjected to a shearing stress or strain and a portion of the molecules thereof constrained to follow one of the members,

another portion adhering to the opposing member, for the purpose set forth.

13. In a concentrator, a pair of oppositely rotating substantially horizontal surfaces confining between them a pulp-sheet, as set forth.

14. In a concentrator, a pair of disks having opposing substantially horizontal faces confining a pulp-sheet between them, one of the disks having a horizontal rotary movement imparted thereto, whereby the sheet is constrained to participate in such rotation, for the purpose set forth.

15. In a concentrator, a pair of disks having opposing substantially horizontal faces confining a pulp-sheet between them, means for rotating the disks about a vertical axis and maintaining a differential of speed between them, and means for imparting a vertically vibratory motion or tremor to the lower disk.

In testimony whereof I affix my signature, in presence of two witnesses.

LABAN E. JONES.

Witnesses:
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