F. LAIST.

CENTRIFUGAL CONCENTRATOR AND CLASSIFIER.

APPLICATION FILED DEC. 4, 1908.

935,311.

Patented Sept. 28, 1909.

2 SHEETS—SHEET 1.

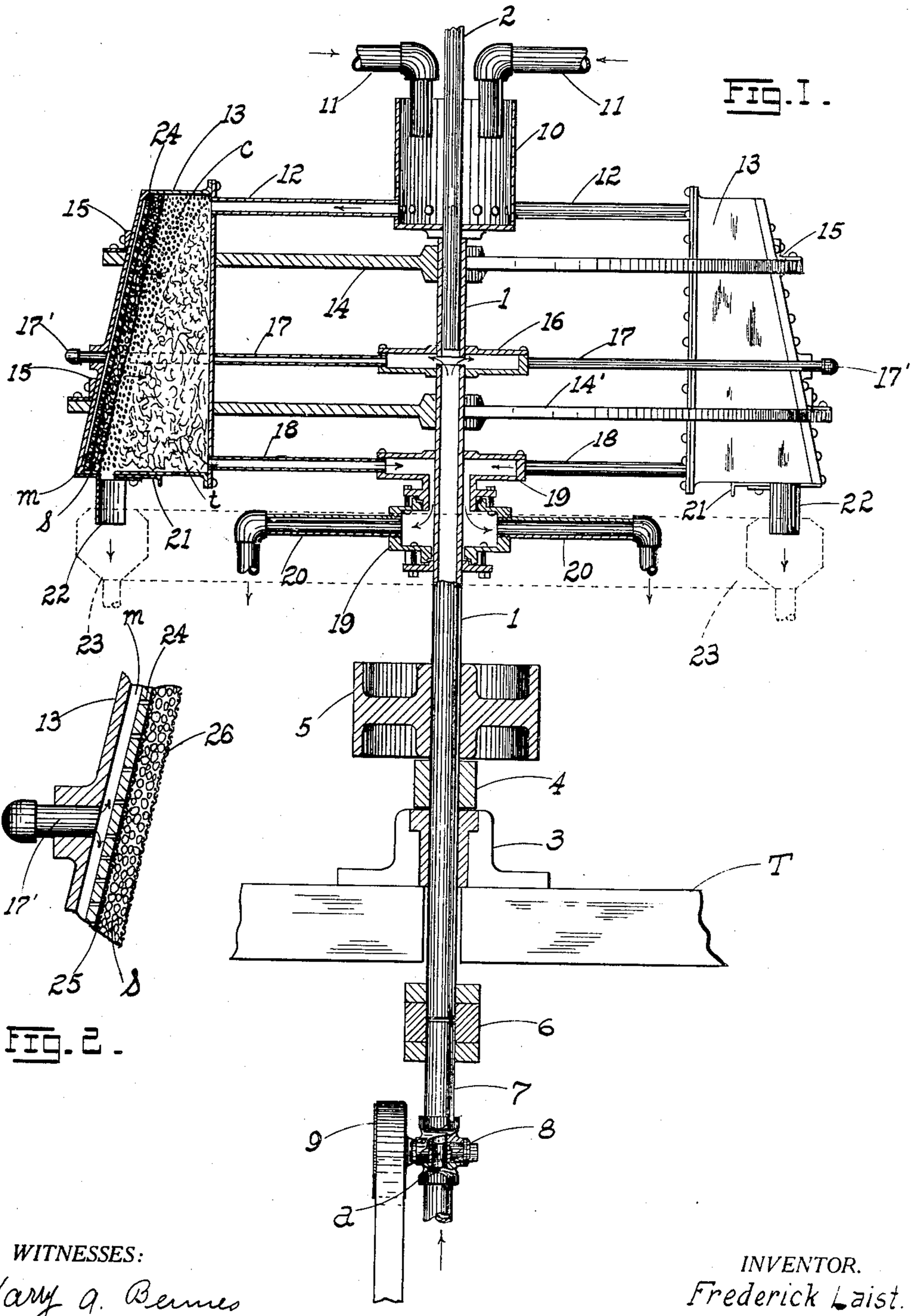

FIG. 1.

FIG. 2.

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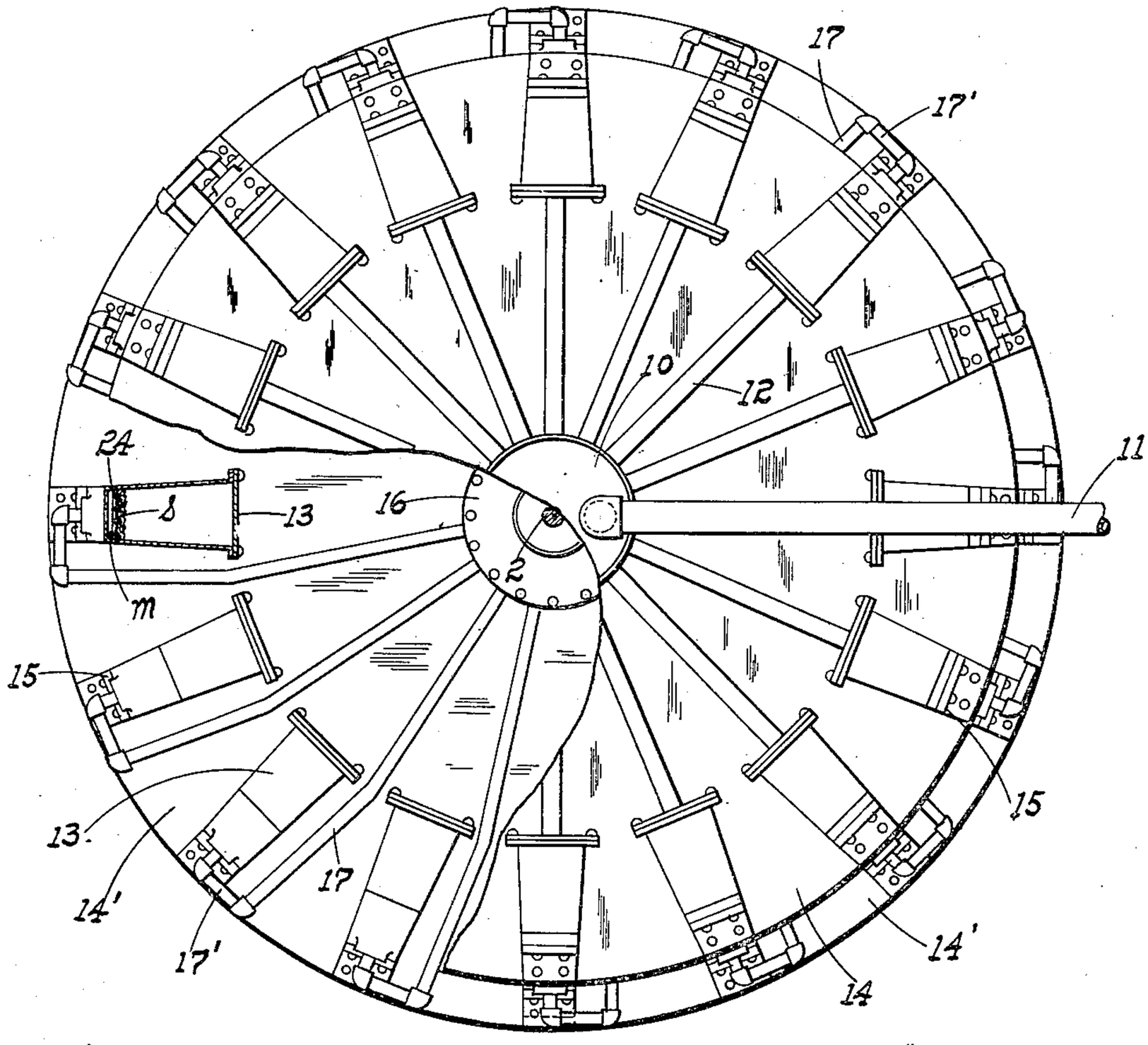
2 SHEETS—SHEET 2.

FIG. 3.



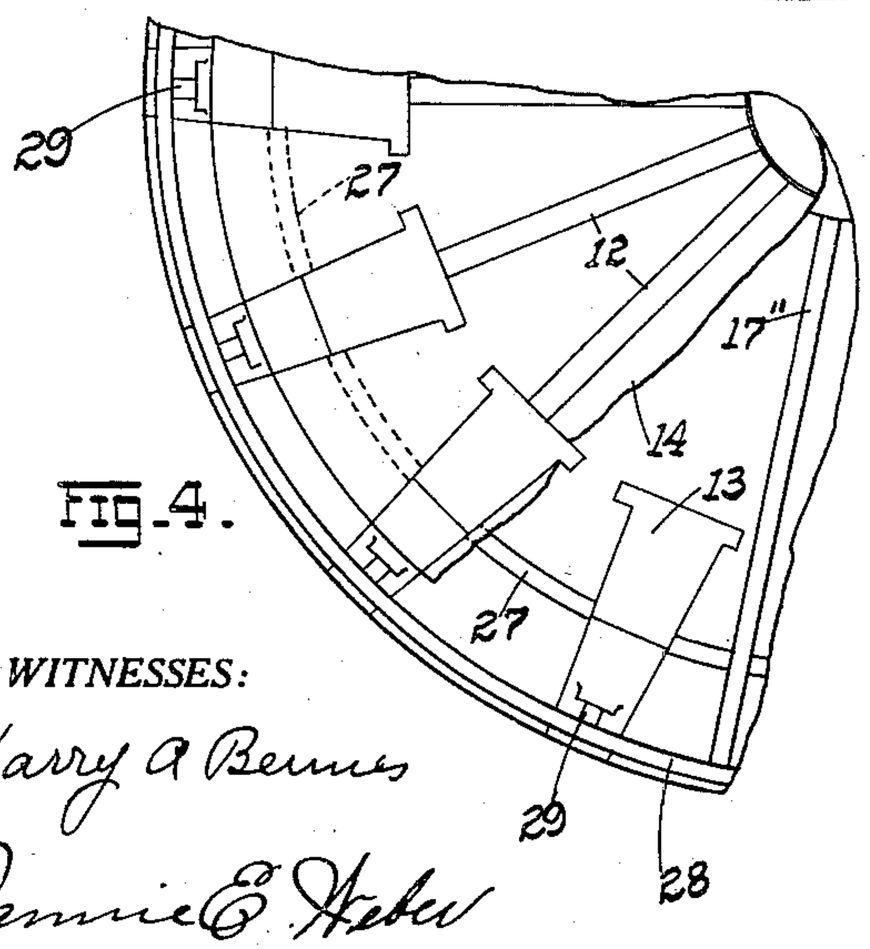


FIG. 4.

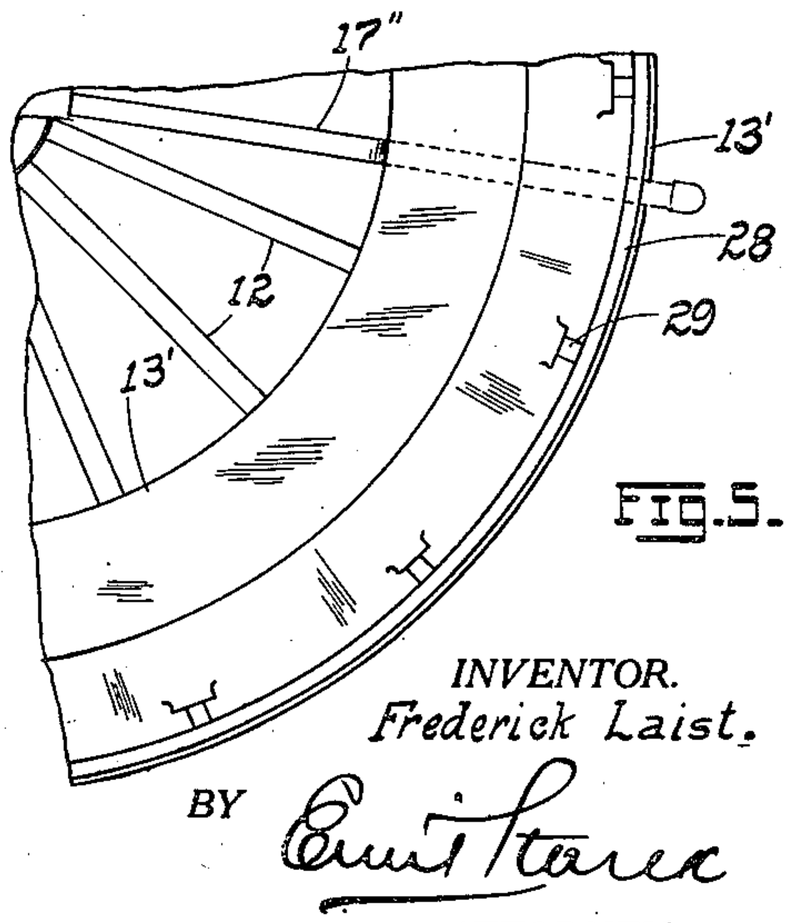


FIG. 5.

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CENTRIFUGAL CONCENTRATOR AND CLASSIFIER.

935,311. Specification of Letters Patent. Patented Sept. 28, 1909.

Application filed December 4, 1908. Serial No. 465,959.

To all whom it may concern:

Be it known that I, FREDERICK LAIST, 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 Centrifugal Concentrators and Classifiers, 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 centrifugal ore-concentrators and classifiers; and it consists in the novel construction and arrangement of parts more fully set forth in the specification and pointed out in the claims.

In the drawings, Figure 1 is a combined vertical middle section and elevation of one form of my invention; Fig. 2 is an enlarged vertical sectional detail showing manner of constructing the outer wall of the concentrating chamber; Fig. 3 is a top plan of the apparatus with parts broken away, one of the concentrating chambers being shown in transverse section; Fig. 4 is a top plan of a section of a modified form of apparatus; and Fig. 5 is a top plan of a section of another modification.

The object of the present invention is to construct an apparatus for subjecting fine ore or slime to the action of centrifugal force for the purposes of concentration and classification. Centrifugal force is hereby substituted for gravity when used in conjunction with rising water currents (a process generally availed of in ore classifiers), the advantages of centrifugal action being (1) that by virtue thereof the settling rate of the particles is considerably increased, making it possible to work very much finer material than can be treated in a gravity machine; (2) the centrifugal force itself assists very materially in the concentration and classification; (3) it permits the accurate proportioning to the centrifugal force of the counter or opposing currents of water by which not only the discharge of the concentrates from the vessel in which the pulp is treated is facilitated, but which exercise an influence in effecting the necessary separation of the concentrates from the tailings; (4) it permits an accurate distribution and apportionment of the counter or opposing currents to the intensity of the centrifugal force developed in the vessel in which the pulp is undergoing treatment; and finally it presents further and other advantages better apparent from a detailed description of the invention which is as follows:

Referring to the drawings, and for the present to Figs. 1 to 3 inclusive, 1, represents a vertical hollow shaft provided with an upper cylindrical bearing 2 and a bottom journal 3, the shaft having secured thereto a collar 4 resting on the journal, above which collar there is secured to the shaft a belt-pulley 5 to which rotation may be imparted from any suitable source of power (not shown). The rotatable shaft 1 projects a suitable distance below the timber T to which the journal 3 is bolted, a suitable stuffing box 6 serving to bring together the adjacent ends of the shaft and of the stationary feed pipe 7, the latter leading to any source of hydraulic water supply (not shown). Adjacent to the stuffing-box 6 there is mounted in the feed-pipe 7 a rotatable cock or valve 8 having a passage-way *a*, said valve or cock being of well known and ordinary construction. To the stem of the valve is secured a belt pulley 9 to which rotation may be imparted from any available source of power (not shown). As the valve rotates, the water which enters the pipe 7 under a head will flow intermittently into the hollow-shaft, being that with every rotation of the valve the passage-way *a* will have been turned so as to temporarily cut off the flow of the water to the shaft, the result being a pulsating or intermittent flow into the shaft. Mounted above the shaft and disposed symmetrically about the guide-bearing 2 is a tank or pulp distributer 10 into which discharge one or more pipes 11, 11, conveying pulp thereinto from the usual sources of supply (not shown). This pulp is conducted from the distributer through a series of radially disposed pipes 12, 12, each pipe discharging into a suitable concentrating chamber or container 13 through the top of the rear vertical wall thereof as shown. These chambers are coupled to the central shaft 1 by means of supporting castings 14, 14′, embracing the chambers near the top and bottom and secured to the outer or front inclined walls thereof by means of angle-pieces 15. The castings have respectively formed therein suitable openings conforming to the cross section of the chamber at the plane where the casting envelops the

chamber, at which point the parts are riveted together as shown.

At the top of the hollow shaft 1, and between the supporting castings 14, 14′, is disposed a hollow disk or head 16 from which radiate a series of water-conducting or distributing pipes 17 bent slightly to readily pass around the sides of their corresponding concentrating chambers 13, and terminating in an elbow 17′ which taps the front or inclined wall of the chamber at a point somewhat below the middle of the chamber. From the bottom of the rear wall of each concentrating chamber leads a return pipe 18 (for the tailings) the inner ends of the pipes discharging into the upper head of a hollow stuffing-box 19, from the bottom head of which lead a series of tailings-discharge pipes 20 conducting the tailings *t* and water to any convenient point of disposition (not shown). At the outer end of the bottom wall of the chamber 13 is a slide or valve 21 for the discharge of the concentrates *c* (or sandy component of the slime) the discharge opening being protected by a plate or guard 22 which in the rotation of the chambers about the axis of the shaft 1 traverses the intake mouth of an annular launder 23 (shown dotted in Fig. 1) placed in proper position to receive the concentrates which are being constantly and automatically discharged from the series of chambers when the slides 21 are open. The launder is well known and a bare reference thereto is sufficient.

The construction of the concentrating chamber or container 13 is substantially as shown in the drawings and while I do not wish to limit myself to the form shown it is one which will probably prevail in practice meeting as it does, the majority of conditions imposed on an apparatus of this character. Spaced a suitable distance *m* from the outer inclined wall of the chamber is a perforated partition 24, the perforations being closer together at the bottom than at the top. Against the partition is placed a screen 25 and about a half inch removed therefrom is a second screen 26, the space between the screens being filled with sand or small shot *s*. This filling forms a distributer or equalizer for the jets projected through the perforations, from the space *m* into which the water is initially discharged by the pipe 17, said filling breaking up and diffusing the individual force of the jets and producing a uniform and evenly distributed current which thus enters the chamber in opposition or counter to, the centrifugal force exerted against the outer wall thereof. Of course, centrifugal force affects more strongly the particles of a body farthest removed from the axis of rotation, and since the outer wall of the chamber 13 is inclined inwardly and upwardly, the force at the bottom will be stronger than at the top, and to offset this excess the perforations in the partition 24 are closer together, thereby discharging a greater quantity of water. The purpose of the opposed current produced by the passage of the water through the perforated wall 24 and the diffusing layer *s* is identical with, and is a substitute for, the rising current availed of in gravity classifiers, centrifugal force in the present instance being substituted for gravity for reasons previously set forth. This counter or opposed current may be continuous or intermittent (pulsating), and when intermittent, the apparatus becomes virtually a pulsion jig. The current is steady or continuous for a permanently open position of the valve 8, and pulsating for a continuous rotation of said valve, and the choice of current would depend on practical considerations, depending an the composition of the pulp treated, and, in the treatment of "slimes", depending on the tenacity with which the flocculent component of the slime clings to the sandy constituent thereof. The outer wall of the concentrating chamber 13 is given the slope as shown so as to assist the movement of the sand or concentrates down it toward the discharge opening. Theoretically it might be possible to slope this wall to such an extent that no opposed water current would be required to secure a continuous discharge of sand or concentrates (it being remembered that this current assists in the washing down of the concentrates crowded against this wall). In practice such theoretical slope of the outer wall would probably not work out well. An examination of the cross section of the chamber 13 shows that the front inclined wall is somewhat narrower than the rear vertical wall, the chamber thus tapering or converging outwardly. This is done in order to proportion the opposed or counter water currents to the centrifugal force at all points throughout the chamber. With the widening of the cross section from front to rear the counter current necessarily dissipates, but in the same proportion does the centrifugal force decrease, that is, it becomes less effective as the axis of rotation (shaft 1) is approached. By thus making the counter current proportionately commensurate with the centrifugal force at all points, an ore of given behavior and composition may be successfully treated. But special conditions may arise which would necessitate a change in the relation of the counter current and centrifugal force, and it might become necessary for some purposes to have a greater counter current along the outer inclined wall than at the rear wall, or vice versa, in which event the cross section of the chamber would be modified to bring about such results.

The operation of the concentrator is obvious from the drawings, but may be re-

viewed briefly at this point. Rotation being imparted to the hollow shaft, and hydraulic water being admitted thereto either in the form of a steady or a pulsating current, circulates through the several pipes and discharges into each chamber 13 through the outer inclined wall thereof and the distributing layer *s* in a direction substantially opposed or counter to that exerted against such outer wall by the centrifugal force (arrows Fig. 1). At the same time the pulp runs from the pulp distributer 10 into the several chambers 13, where it is subjected to two opposing forces, viz. centrifugal force on the one hand, and the force of the opposed or counter water current on the other hand, the two forces jointly separating the constituents of the ore, the coarse component or concentrates *c* settling against the outer inclined wall down which they run to the discharge opening controlled by the valve 21, discharging continuously behind the guard 22 into the launder 23, and the fine materials or tailings *t* (flocculent component in the case of slimes) running back through the return pipes 18 into the hollow stuffing box 19 and out through the pipes 20. Thus the action of the machine is continuous and the operation may be carried on for an indefinite period. The feature of the separate chambers 13 mounted around a central shaft is important since with the use of such separate chambers the pulp is in a more quiet condition than when the cylinder or bell form of machine is used.

The above machine is eminently adapted for washing and dewatering gold slimes (that is, slime from cyanid plants). Instead of filtering the slime the material may be fed into my machine, the centrifugal force throwing the fine material against the outer walls of the several chambers 13, the clear water running out of the tailings discharge, while the thick pulp will run out through the concentrate discharge opening. In this case the water introduced through the walls acts as wash water, removing the cyanid and gold solutions from the slime, the thick pulp being removed from the concentrating chambers in as thick condition as possible.

It is apparent that my machine may be changed in minor details without changing either its principle or mode of operation, and in Figs. 4 and 5 I show modified forms that will answer in practice. In Fig. 4 I show the series of concentrating chambers 13 connected by intercommunicating pipe sections 27. Again in lieu of having an individual pipe 17 for conducting the clear water into each chamber, I may substitute a single pipe 17″ which discharges into a single pipe 28 encircling the entire series of chambers, the latter receiving the water through branches 29 leading from the encircling pipe 28 opposite each chamber. Again, in lieu of a series of chambers, I may substitute a single annular (or cylindrical) chamber 13′ (Fig. 5) likewise encircled by a feed pipe 28 having branches 29 tapping the outer inclined wall of such single chamber at points along the periphery thereof, such pipe 28 receiving its supply from a pipe 17″ passed under the chamber and then bent up to meet such encircling pipe. Other modifications will suggest themselves to the skilled mechanic as must be obvious from the specific forms here presented.

When treating slimes, the term "classifier" technically would perhaps not be strictly appropriate, since "classification" has for its object to separate grains of gangue and mineral into two or more products according to their relative size and specific gravities, the individual particles of which will have as nearly as possible the same settling rate under free settling conditions, and all of which products can be concentrated by prevailing methods such as by jigs, tables, and vanners. In the case of slimes, these will split up under centrifugal action into a sandy component susceptible of concentration in the usual way, and a flocculent component which is light and can not be treated by ordinary methods. So that so far as the sandy component only is concerned the term "classifier" as used in designating the present invention would be applicable; and as it is a concentrator as well, the invention may be termed as a concentrator and classifier. The rapidity of rotation may of course be regulated according to the size of material treated and thus has a decided advantage over gravity classifiers which can only avail themselves of gravity as a constant force that can not be varied while centrifugal force may be varied at pleasure.

Reverting momentarily again to the matter of proportioning the currents projected through the outer inclined wall of the chamber 13, to the centrifugal force developed within said chamber, it may be stated that these currents have their maximum velocity at this wall not only because at this wall the centrifugal force is greatest, but a higher velocity is here necessary to prevent the sand or concentrates packing against said outer wall. The opposing currents decrease in velocity as they approach the rear wall of the chamber since the centrifugal force likewise decreases but, as before stated, the cross section of the chamber may be varied so as to secure almost any relation between the centrifugal force and the opposing or counter currents flowing from the outer wall. The chamber formed between the screens 25, 26, for holding the sand or shot *s* is not absolutely necessary, and may be dispensed with in cases where the perfo-

rations in the partition 24 are of a character as not to give rise to too forcible or penetrating individual jets. The pulsations in the water current need not necessarily be effected through a valve or cock such as 8, but may be brought about by any means known in the art.

Having described my invention, what I claim is:—

1. In a centrifugal concentrator, a suitable container, means for rotating the same about an axis located exterior thereto, means for diffusing water currents over the outer wall of the container and projecting such currents toward said axis, the cross-section of the container tapering outwardly or away from said axis in order to proportion the force of said currents throughout the container to the opposing centrifugal force developed by the rotation of the container.

2. In a centrifugal concentrator, a container, means for subjecting the same to rotation about a fixed exterior axis, means for projecting toward said axis water currents co-extensive with the area of the outer wall of the container in substantially direct opposition to the centrifugal force developed by the rotation of the container, the cross-section of the container tapering outwardly or away from said axis in order to proportion the force of said currents throughout the container to the opposing centrifugal force developed by the rotation of the container.

3. In a centrifugal concentrator, one or more containers, means for rotating the same about a common axis exterior to the container, means for introducing thereinto throughout the area of the outside wall of each container individual streams of water and projecting the same toward and substantially at right angles to, such common axis, the cross-section of the container tapering outwardly or away from said axis in order to proportion the force of said streams throughout the container to the opposing centrifugal force developed by the rotation of the container.

4. In a centrifugal concentrator, a container rotating about a fixed vertical axis located exteriorly thereto, said container having side walls converging outwardly or away from said axis, whereby there is formed a narrow outer wall and a wide rear wall, and means for forcing a current of water diffused over the outer wall toward the rear wall whereby said current is proportioned at all points to the centrifugal force developed in the rotation of the container.

5. In a centrifugal concentrator, a container, means for rotating the same about a fixed vertical axis located exteriorly thereto, said container being provided with an upwardly and inwardly inclined outer wall, outwardly converging side walls and an inner vertical wall, and having a discharge opening at the base of the inclined wall.

6. In a centrifugal concentrator, a container rotating about a fixed vertical axis located exteriorly thereto, and having an upwardly and inwardly inclined outer wall, outwardly converging side walls and an inner vertical wall terminating at said side walls, and means for projecting counter currents in individual jets from the outer wall toward the inner vertical wall.

7. In a centrifugal concentrator, a container rotating about a fixed vertical axis located exteriorly thereto, means rotating with the container for introducing currents of water in jets disposed throughout the area of the outer wall of the container, and means for maintaining a maximum velocity in said currents at points adjacent to the outer wall whereby the sand accumulating at said outer wall is prevented from packing against it.

8. In a centrifugal concentrator, a container provided with an outer inclined wall, a partition located adjacent and substantially parallel thereto and spaced therefrom, said partition having perforations distributed over substantially its full area, side walls converging toward the outer wall, and a rear or inner wall for the container, and means for rotating the container about an axis located adjacent to the inner wall.

9. In a centrifugal concentrator, a container having an outer upwardly and inwardly inclined wall, a perforated partition spaced a suitable distance therefrom, the perforations increasing in number toward the bottom, means for delivering counter currents through the perforations in opposition to the centrifugally impelled material acting against the partition, and means for rotating the container.

10. In combination with a vertical hollow water circulating shaft, a container having an outer upwardly and inwardly inclined wall, a rear vertical wall, and outwardly converging side walls, rotating about the axis of the shaft, a pulp-distributer disposed about the axis of the shaft, a pulp-conducting pipe conveying pulp from the distributer to a point adjacent the rear wall of the container, a pipe leading from the shaft and discharging water into the container in a direction opposed to the centrifugally impelled material acting against the outer wall, means for diffusing such opposing current over the outer wall, and means for discharging the concentrates at a point at the base of the outer wall of the container.

11. In combination with a vertical hollow water-circulating shaft, a container rotating about the axis of the shaft and provided with an upwardly and inwardly inclined outer wall, a pulp distributer disposed about the axis of the shaft, a pipe for conducting

the pulp to the container, a pipe leading from the hollow shaft and tapping the outer wall of the container and discharging thereinto in a direction substantially in opposition or counter to, the centrifugal force acting against said wall, means co-extensive with the area of said wall for splitting up the counter currents into jets, the container having openings for the discharge respectively of the concentrates at the bottom of the outer wall, and of the tailings at the bottom of the inner or rear wall.

12. In combination with a vertical hollow shaft, means for circulating therethrough a pulsating water current, a container rotating about the axis of the shaft and provided with an upwardly and inwardly inclined outer wall, a pulp distributer disposed about the axis of shaft, means for conducting pulp from the distributer to the container, a pipe leading from the hollow shaft and discharging water thereinto in pulsating currents in opposition to the centrifugal force acting against the walls of said contain[illegible].

13. In combination with a vertical hollow water circulating shaft, a container rotating about the axis of the shaft and provided with an upwardly and inwardly inclined outer wall, a pulp distributer disposed about the shaft axis, a pipe for conducting the pulp to the container, a pipe leading from the hollow shaft and tapping the outer wall of the container and discharging thereinto in a direction opposed to the centrifugal force acting against said wall, means for diffusing the opposing current over the entire area of said outer wall, the container having a bottom opening adjacent to the outer wall for the escape of concentrates, and a pipe for conducting the tailings from the rear of the container toward a point adjacent to the shaft.

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

FREDERICK LAIST.

Witnesses:

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HENRY N. THOMSON.