

Oct. 21, 1924.

1,512,469

L. M. KELLOGG

CENTRIFUGAL CONCENTRATOR

Filed June 5, 1923

2 Sheets-Sheet 1

Fig. 1.

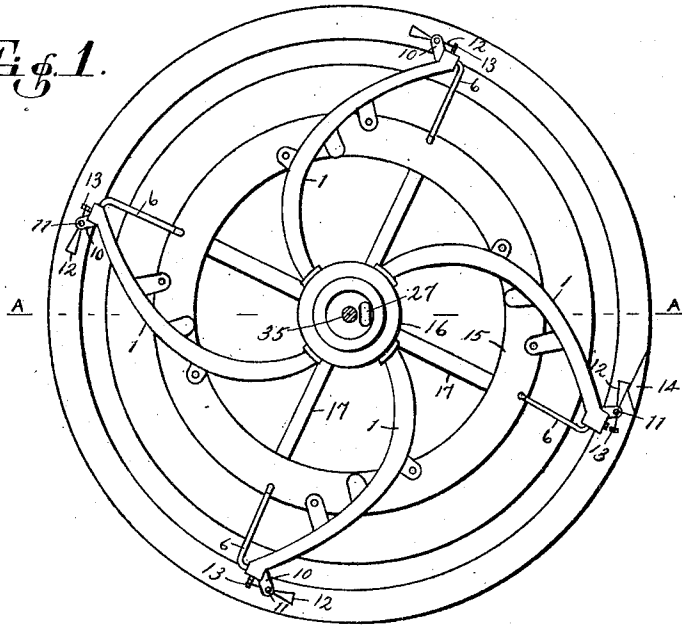
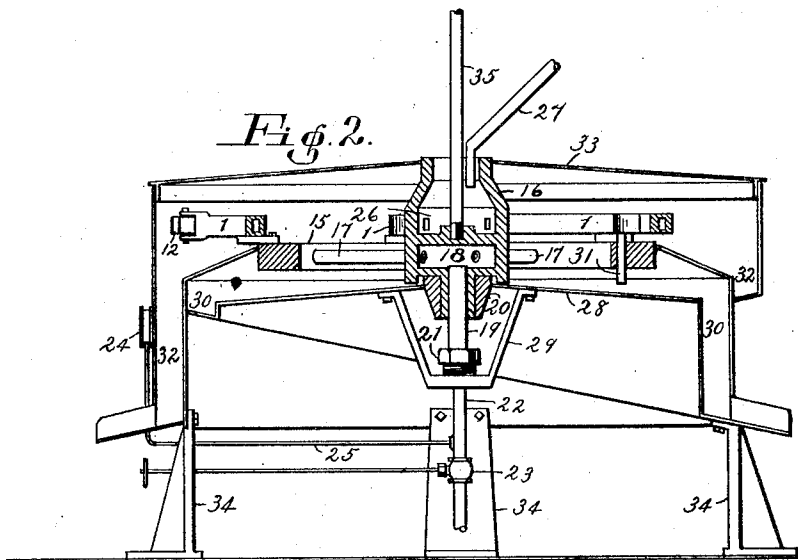


Fig. 2.



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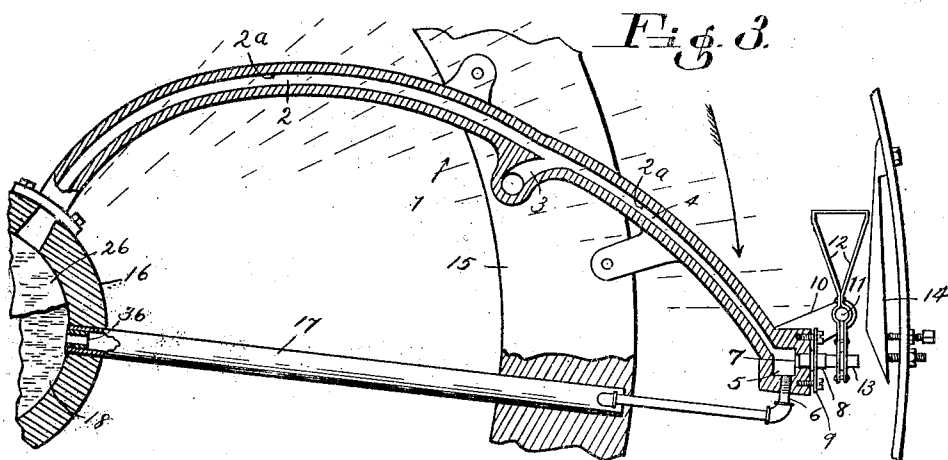


Fig. 4.

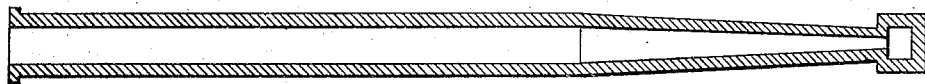


Fig. 5.

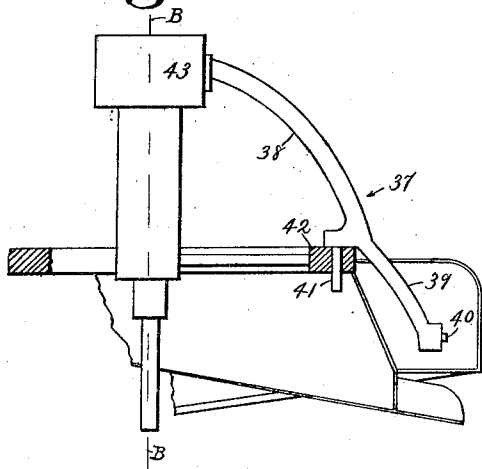


Fig. 6.

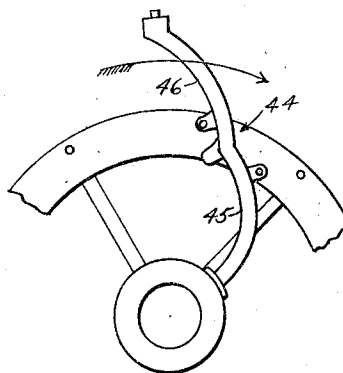


Fig. 7.

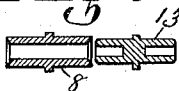


Fig. 8.

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## UNITED STATES PATENT OFFICE.

LEWIS M. KELLOGG, OF LOS ANGELES, CALIFORNIA.

## CENTRIFUGAL CONCENTRATOR.

Application filed June 5, 1923. Serial No. 642,587.

*To all whom it may concern:*

Be it known that I, LEWIS M. KELLOGG, a citizen of the United States, residing at Los Angeles, in the county of Los Angeles and State of California, have invented new and useful Improvements in Centrifugal Concentrators, of which the following is a specification.

My invention relates to improvements in centrifugal concentrators, adapted to effect a recovery of valuable minerals from their ores. In the successful operation of concentrators of this class, three essential actions must be set up; first, the valuable mineral and the worthless gangue must be definitely stratified; second, the stratum of valuable mineral must be separated from the stratum of gangue; and, third, the separated mineral stratum must be discharged from the device, and the objects of the present invention are to provide means for properly carrying on the three above mentioned actions.

With reference to the drawings:

Fig. 1 is a top view of the entire device.

Fig. 2 is a sectional elevation of the device taken on line A. A. Fig. 1.

Fig. 3 is an enlarged view of a vein in horizontal longitudinal section and its concentrate discharge means.

Fig. 4 is a sectional view in elevation of the vein shown in Fig. 3, and shown as it would appear if straightened out.

Fig. 5 is a view in elevation of a fragment of a runner and housing, and showing a vein disposed longitudinally of the axis of rotation.

Fig. 6 shows a fragment of a runner upon which is mounted a vein curved backwardly or away from the direction of rotation.

Fig. 7 shows in longitudinal section a replaceable valve seat and a replaceable valve—the view being greatly enlarged.

Fig. 8 is an enlarged fragment of a vein in horizontal section showing a modification of the outer wall thereof.

More specifically, the present invention comprises a plurality of veins 1, each having a stratifying chamber 2, a tailings discharge port 3 (see Fig. 3), at the outer end of the stratifying chamber, a classifying chamber 4 extending beyond and in communication with the stratifying chamber and terminating in a pocket 5 at its outer end. The pocket 5 carries a water inlet con-

duit 6, and a concentrate discharge orifice 7, into which is fitted a replaceable bushing 8, the bushing being held by a plate 9 screwed to the outer face of the vein. The vein is provided with two ears 10, extending outwardly and carrying a pin 11. Upon the pin 11 is mounted rotatably a reversible blade 12, carrying at one end a valve 13 adapted to effect a closure with an orifice in the bushing 8. The other end of the blade 12 forms a trailing end adapted to engage a cam member 14, whereby the valves 13 are lifted from their seats or bushings 8.

The veins 1 are mounted upon a runner comprising a ring 15, and a hub 16 connected by tubular spokes 17. The hub 16 is provided with a chamber 18 in the bottom in open communication with the tubular spokes 17, and each spoke is connected to an inlet conduit 6 of the pockets 5. Extending downwardly from the hub 16 is a tubular shaft 19, carried in a bearing 20 and a packing gland 21, the shaft opening into the chamber 18 at the top end. A water supply conduit 22 is connected with the gland 21, and is provided with a regulating valve 23, and above the valve with a pressure gauge 24 mounted on a conduit 25. In the top of the hub 16 is formed a chamber 26, adapted to receive a pulp flow from a launder 27, the chamber 26 being in open communication with each of the veins 1 through restricted orifices.

The runner and veins are provided with a housing composed of a diaphragm 28 which carries the bearing 20 and a bracket 29 in which is mounted the gland 21. Surrounding the diaphragm an inclined channel 30 is formed, adapted to carry away tailing issuing from the ports 3 of the veins through conduits 31. Outside the channel 30 a second inclined channel 32 is formed adapted to carry away concentrates discharged from the pockets 5, the whole having a cover 33, and being supported by legs 34.

In the operation of the device, the valve 23 is opened, thus admitting a flow of classifying water to the chamber 18, thence to the pockets 5, and inwardly through the chambers 4. The runner may be conveniently rotated, at a proper speed, by means of a vertical shaft 35, pocketed in the chamber 26. The direction of rotation is as the arrows in Figs. 1 and 3, the veins being curved forwardly or towards the direction

of rotation. Ore pulp carried in a flow of water is then admitted to the chamber 26 by the launder 27, the pulp flow passing out of the chamber into the stratifying chambers 2 of the veins 1. The action of centrifugal force on the pulp flow in the chambers 2 stratifies the heavier minerals against the outer wall 2<sup>A</sup>. In Fig. 3 the dotted radial lines will be noted, and that the line of the chambers cross these lines at an extremely advanced angle. The pulp in moving outwardly through the chamber moves within its own body—that is, one particle of the pulp relative to the particles next to it—and the heavy mineral particles down to the finest slime crowd back radially to the wall 2<sup>A</sup> along which it moves as a concentrate stratum to the end of the chamber together with the lighter portion of the pulp lying against it. At the end of the chamber 2, the pulp flow is met by the inwardly flowing water from the classifying chamber 4, and the lighter gangue is here turned backwardly into the port 3, discharging by the conduit 31 and channel 30. The flow in the classifying chamber is regulated by the valve 23, the amount of the flow being indicated by the gauge 24.

The classifying flow in the chamber 4 is carried at a velocity sufficient to throw back the worthless gangue, but allows the valuable mineral lying upon the wall 2<sup>A</sup> to pass on through the classifying chamber and into the pocket 5. The classifying chamber is formed smaller in cross sectional area at the outer end than at the inner end in order to allow for the difference in centrifugal of the two different circles of movement, and also in order that classification will take place in a considerable length of the inner end of the chamber. The stratifying and classifying chambers are curved forwardly ahead of rotation in order that the concentrate will form a definite stratum on the wall 2<sup>A</sup> and move along that wall and be able to resist any force set up in the chamber that would tend to throw it away from the wall and out into the chambers.

By the rotation of the runner the blades 12 engage the cam 14, thus opening the valves 13. By this valve opening, two actions are set up. First, a small portion of water is discharged from the pockets 5 and with it the concentrate which has issued from the chambers 4 during the revolution. And, second, the flow into the pockets 5 from the conduits 6 is diverted into the chambers 4, for about nine tenths of each revolution, and then out by the valves 13 for the remaining tenth of the revolution.

This rapid diversion of the classifying flow causes a pulsation to be set up in the classifying chambers which is a great aid in working the concentrate away from the gangue and out into pocket 5. A closure

of the valve 13 is effected by centrifugal force, the trailing end of the blades 12 weighing more than the valve end.

The valves 13 and blades 12 are made reversible so that when one side is worn they can be turned over. The valves are formed hollow ended in order that they will wear properly, see Fig. 7. The valve seats or bushings 8 may also be reversed when worn off on one end by removing the plates 9.

It will be noticed that the classifying chamber 4 is curved forwardly at a lesser degree than the stratifying chamber. The reason for this is that the flow is moving with the concentrate in the stratifying chamber and against the concentrate in the classifying chamber; therefore, the wall 2<sup>A</sup> in the classifying chamber must be disposed closer to the radii. It has been found that the stratifying chamber will operate successfully when inclined forwardly as much as 70 degrees from a radius while the classifying chamber to operate well should be less than 60 degrees for circumferential speeds under 5000 feet per minute.

With some pulps the mass tends to slide out through the stratifying chamber without sufficient internal movement to allow all the concentrate to pass back to the wall 2<sup>A</sup> and with such pulps a chamber having a corrugated wall such as that shown in Fig. 8 may be adapted. At the inner end of each tubular spoke 17 (see Fig. 3), is a restriction 36 having an orifice of a size to properly retard the classifying flow, thus causing each vein to receive an equal amount of cleaning water.

In Fig. 5 is shown a modification of the present invention comprising a vein 37 disposed longitudinally of the axis of rotation B. B. and curved outwardly, the vein having a stratifying chamber 38, a classifying chamber 39, a concentrates discharge orifice 40, and tailings conduit 41, the chamber being carried by a ring 42 and a pulp feed chamber 43. In a vein so arranged, a result approaching that given by the structure shown in Figs. 1, 2 and 3 may be had.

In Fig. 6 is shown, as a modification of the present invention, a vein 44 like the veins 1 shown in Figs. 1, 2 and 3, but curved backwardly or away from the direction of rotation as indicated by the arrow, and in which 45 represents the stratifying chamber and 46 the classifying chamber. With such an arrangement of the vein a rough concentrate can be made.

In the operation of the present invention with some slight modification of the several essential parts, the ore pulp might be entered into the stratifying chambers in a dry pulverulent state and air might be used as a classifying flow in the chambers 4 in place of water.

It is to be understood that the number 130

and the exact degree of curvature of the veins 1 forms no part of the present invention and that various changes may be made in the invention as herein set forth without departing from the spirit thereof as claimed.

Having thus described my invention, I claim:

1. In a centrifugal concentrator in combination, a curved stratifying chamber, a curved classifying chamber extending outwardly from and connecting into the stratifying chamber, a tailings discharge port at the juncture of the two chambers, a pocket formed at the outer end of the classifying chamber, a restricted classifying water conduit connecting into the pocket, a concentrate discharge valve for the pocket, means for pulsating a classifying flow set up in the classifying chambers, and means for feeding ore pulp to the stratifying chamber.

2. In combination in a centrifugal concentrator, a stratifying chamber, a classifying chamber extending outwardly from and connecting into the stratifying chamber, a tailings discharge port for the chambers, means for passing a flow of water inwardly through the classifying chamber, means for discharging concentrate from the classifying chamber, and means for feeding ore pulp to the stratifying chamber.

3. In combination in a centrifugal concentrator, a curved stratifying chamber, means for feeding ore pulp to the chamber, a curved classifying chamber extending outwardly from and connecting into the stratifying chamber, means for discharging tailings from the chambers, means for establishing a centripetal flow of water in the classifying chamber, and means for discharging concentrate from the classifying chamber.

4. In a centrifugal concentrator, in combination, a chamber adapted to stratify the mineral content from the gangue content of an ore pulp and a second chamber extending outwardly from and connecting into the first mentioned chamber and adapted to separate the mineral stratum from the gangue stratum developed by the first mentioned chamber.

5. In a classifying chamber, the chamber rotatably mounted, a concentrate discharge orifice for the chamber and a valve for the orifice adapted to form a closure therewith by centrifugal force.

6. In combination in a centrifugal concentrator, a curved radiating classifying chamber, means for admitting an ore pulp flow to the inner end of the chamber, means for establishing a classifying flow of water inwardly through the chamber, a tailings discharge port for the chamber, means for pulsating the classifying flow in the chamber and means for discharging mineral concentrate from the chamber.

7. In a centrifugal concentrator in combination, a radiating classifying chamber, means for admitting an ore pulp flow to the inner end of the chamber, means for establishing a classifying flow inwardly through the chamber, a tailings discharge port for the chamber, a concentrate discharge means for the chamber and means for pulsating the classifying flow within the chamber.

8. In combination in a centrifugal concentrator, a classifying chamber, means for admitting an ore pulp flow to the inner end of the chamber, means for establishing a classifying flow inwardly through the chamber, a tailings discharge port for the chamber, and means for discharging mineral concentrate from the chamber.

9. In a centrifugal concentrator in combination, a chamber rotatably mounted and curved athwart the radial lines of the path of rotation and adapted to classify the gangue content from the mineral concentrate of an ore pulp, means for admitting and discharging the gangue at the inner end of the chamber and means for discharging the mineral from the chamber.

10. In combination in a centrifugal concentrator, a chamber rotatably mounted and adapted to classify a gangue content from a mineral content of an ore pulp, means for admitting a pulp flow to the chamber, a tailings discharge port for the chamber, a concentrate discharge orifice for the chamber, a conduit connecting with the outer end of the chamber and adapted to supply a classifying flow thereto, and means for diverting the classifying flow alternately inwardly through the chamber and outwardly through the concentrate discharge orifice.

11. In a centrifugal concentrator in combination, a plurality of chambers rotatably mounted and adapted to classify the gangue content from the mineral content of an ore pulp, means for admitting a pulp flow in like quantity to each chamber, a tailings discharge port for each chamber, a concentrate discharge means for each chamber, an individual classifying water conduit connecting with the outer end of each chamber, a water supply chamber common to all the classifying water conduits, and a stricture in each of the classifying water conduits adapted to maintain a flow of classifying water in like quantity to each of the chambers.

12. In combination in a centrifugal concentrator, a plurality of chambers rotatably mounted and adapted to stratify the gangue content from the mineral content of an ore pulp, means for feeding a pulp flow in like quantity to each chamber, a tailings discharge port for each chamber, classifying chambers extending beyond and connecting one with each stratifying chamber, an individual water inlet conduit connecting with the outer end of each classifying chamber,

a water supply chamber common to all the water inlet conduits, and means for maintaining a classifying flow of like intensity in each of the classifying chambers.

13. In a centrifugal concentrator in combination, a plurality of stratifying chambers rotatably mounted, means for feeding a pulp flow in like quantity to each of the chambers, classifying chambers—one extending beyond and connecting with each of the stratifying chambers, a tailings discharge port at the inner end of each classifying chamber, water inlet conduits connecting one with the outer end of each classifying chamber, means for supplying the inlet conduits with water, means for maintaining a classifying flow of water of like velocity in each of the classifying chambers, a concentrate discharge means for each classifying chamber, and means for pulsating the classifying flow in each of the classifying chambers.

14. In combination in a centrifugal concentrator, a plurality of stratifying chambers rotatably mounted, means for feeding ore pulp in like quantity to each of the chambers, classifying chambers positioned one at the outer end of each stratifying chamber and communicating therewith, a tailings discharge port at the inner end of each classifying chamber, means for maintaining a classifying flow of like velocity inwardly in each classifying chamber, a concentrate discharge orifice at the outer end of each classifying chamber, and means for alternately directing the classifying flow inwardly through the classifying chambers and outwardly through the concentrate discharge orifices.

15. In a centrifugal concentrator in combination, a plurality of stratifying chambers rotatably mounted and curved athwart the radial lines of the path of rotation, means for feeding ore pulp in like volume to each of the chambers, classifying chambers connecting with and extending outwardly from the stratifying chambers and being curved in the same direction as the stratifying chambers, a tailings discharge port at the inner end of each classifying chamber, means for maintaining a classifying flow of like velocity inwardly in each of the classifying chambers, means for discharging concentrate from the classifying chambers, and means for pulsating the classifying flow in the classifying chambers.

16. In combination in a centrifugal concentrator, a stratifying chamber rotatably mounted and curved athwart the radial lines of the path of rotation, means for feeding ore pulp to the chamber, a classifying chamber extending outward from and connecting with and curved in the same direction as the stratifying chamber, means for discharging tailings from the chambers, means for discharging concentrate from the classifying

chamber and means for establishing a classifying flow inwardly through the classifying chambers.

17. In a centrifugal concentrator in combination, a chamber rotatably mounted and curved athwart the radial lines of the path of rotation and adapted to stratify the gangue content and the mineral content of an ore pulp, and a classifying chamber forming an outward extension of the first mentioned chamber and adapted to separate the mineral stratum from the gangue stratum built up by the stratifying chamber.

18. In combination in a centrifugal concentrator, a curved chamber adapted to stratify the gangue content and the mineral content of an ore pulp, and a classifying chamber formed integral with and extending outwardly from the stratifying chamber and adapted to separate the gangue stratum from the mineral stratum developed by the stratifying chamber.

19. In a centrifugal concentrator in combination, a chamber adapted to stratify the gangue content from the mineral content of an ore pulp, and a curved classifying chamber formed integral with and extending outwardly from the stratifying chamber and adapted to separate the mineral stratum from the gangue stratum developed by the stratifying chamber.

20. In a centrifugal concentrator in combination, a rotatable carrier, a stratifying chamber mounted upon the carrier and inclined forward in the direction of rotation, a classifying chamber forming an outward extension of the stratifying chamber and inclined forward in the direction of rotation, means for admitting ore pulp to the stratifying chamber, means for discharging tailings from the chambers, and means for discharging concentrate from the classifying chamber.

21. In a classifying chamber, a radially disposed chamber, means for admitting ore pulp to the chamber, means for establishing a classifying flow of water in the chamber adapted to oppose the movement of the ore pulp therein, and means for pulsating the classifying flow within the chamber.

22. In a classifying chamber, the chamber rotatably mounted, means for admitting a pulp flow to the chamber, means for discharging tailings from the chamber, a concentrate discharge orifice for the chamber, a removable valve seat for the orifice, a blade rotatably mounted and having a valve at one end adapted to form a closure with the valve seat and having a trailing end heavier than the end upon which the valve is mounted whereby a closure of the valve is effected by centrifugal force, and a cam adapted to engage the trailing end of the blade to effect an opening of the valve.

23. A method of stratifying a heavy min-

eral content from an ore pulp consisting of passing the mineral carrying pulp through radiating veins inclined athwart the radial lines of a path of rotation and of rotating the veins in the direction of their outward inclination.

24. A method of classifying the heavy mineral content away from a lighter gangue consisting of passing the mineral and gangue into radiating chambers inclined athwart the radial lines of a path of rotation and advanced into the direction of rotation, of rotating the veins and of passing the centripetal flow of water through the veins in opposition to the centrifugal movement of the mineral and gangue therein.

25. A method of concentrating heavy mineral out of an ore pulp consisting of strati-

fying the mineral content from the lighter gangue by passing the pulp through radiating veins inclined athwart the radial lines of a path of rotation and forwardly in the direction of rotation, of then classifying the mineral stratum from the gangue stratum by passing the stratified material into a classifying chamber forming an outward extension of and inclined in the same direction as the stratifying chamber, of rotating the chambers in the direction of their outward inclination and of passing a classifying flow inwardly through the classifying chamber in opposition to the centrifugal movement of the stratified pulp therein.

In testimony whereof, I have signed my name to this specification.

LEWIS M. KELLOGG.