Jan. 4, 1938. H. J. MacCAMY 2,104,349

ORE SEPARATOR

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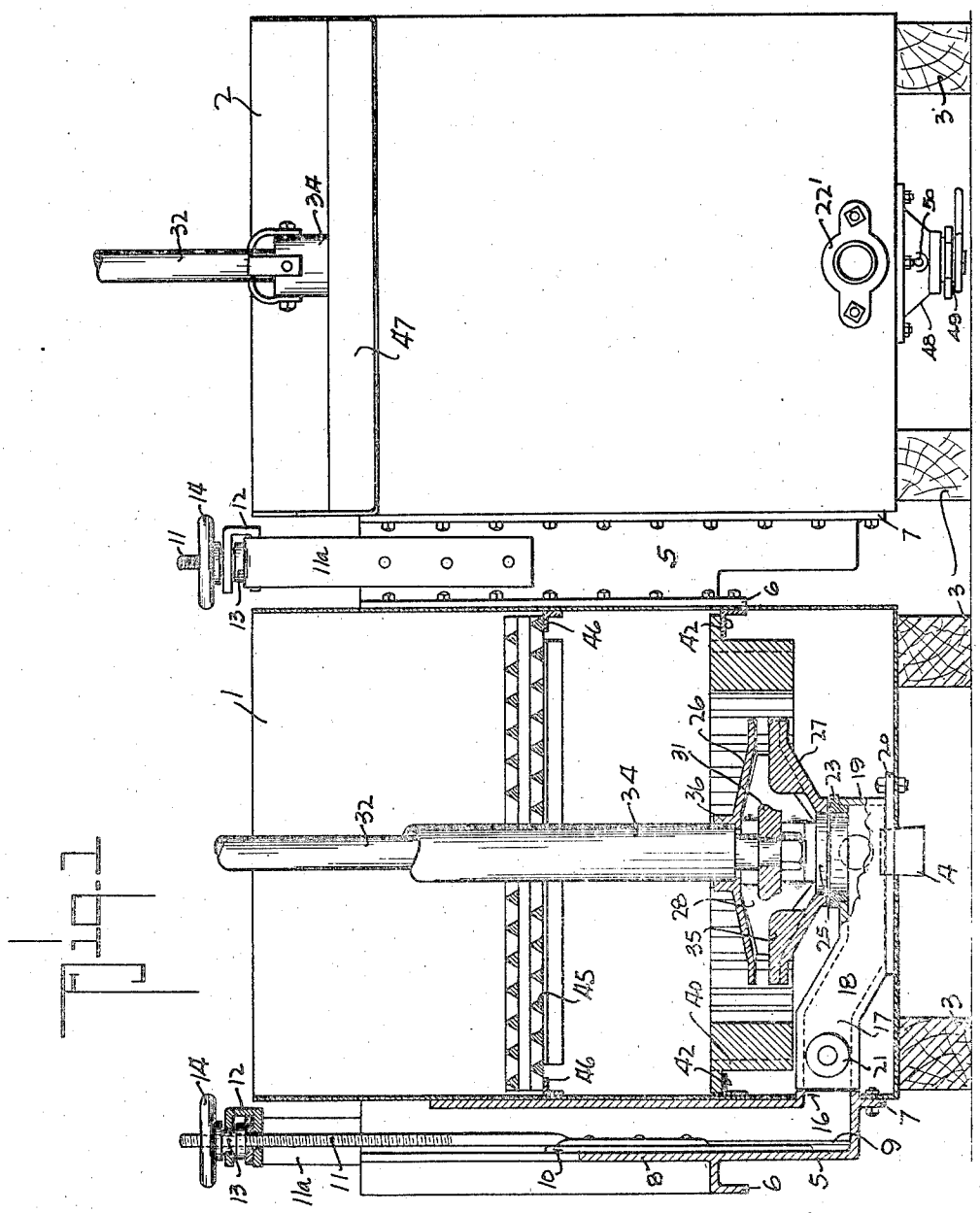

Fig. 1.

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Fig. 2

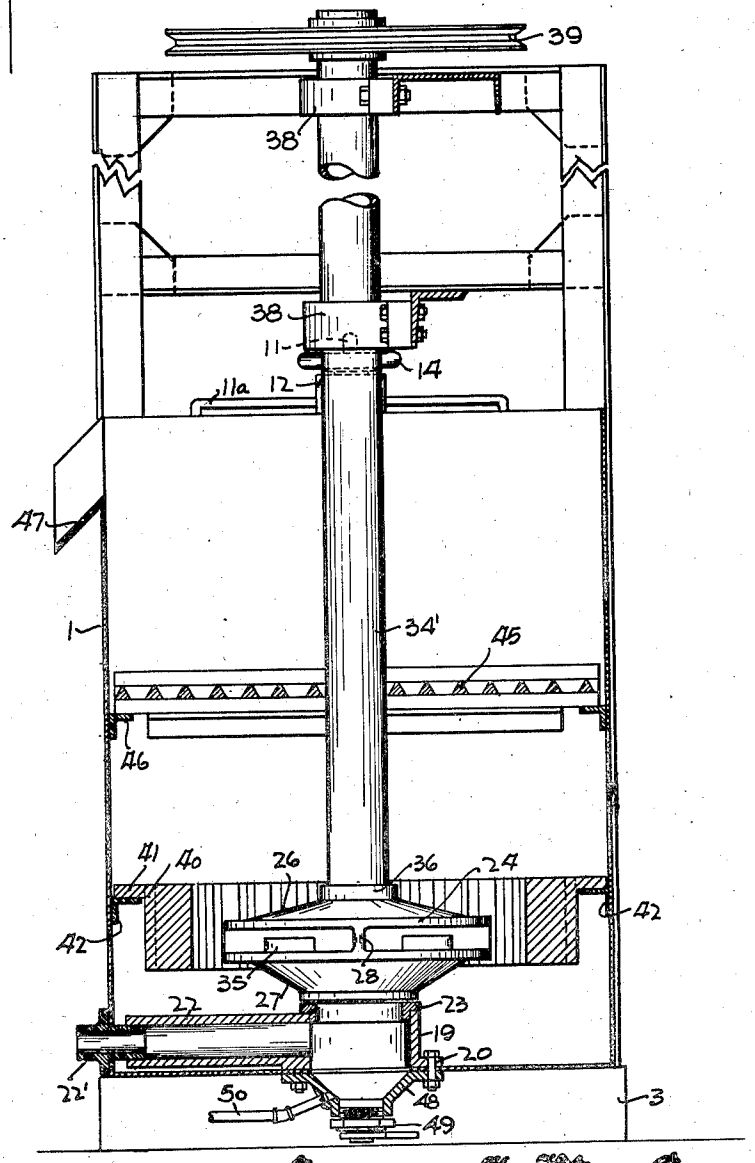

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Fig. 3

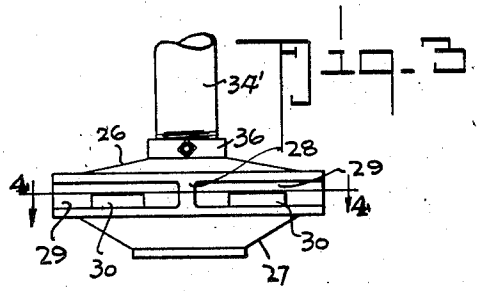
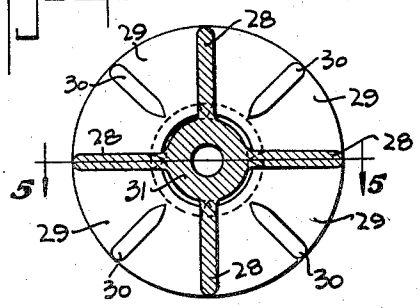


Fig. 4



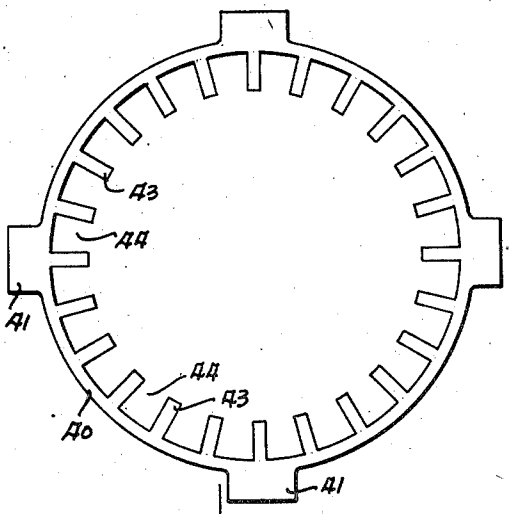
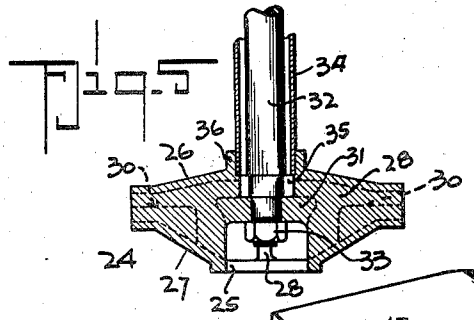


Fig. 6

Fig. 5



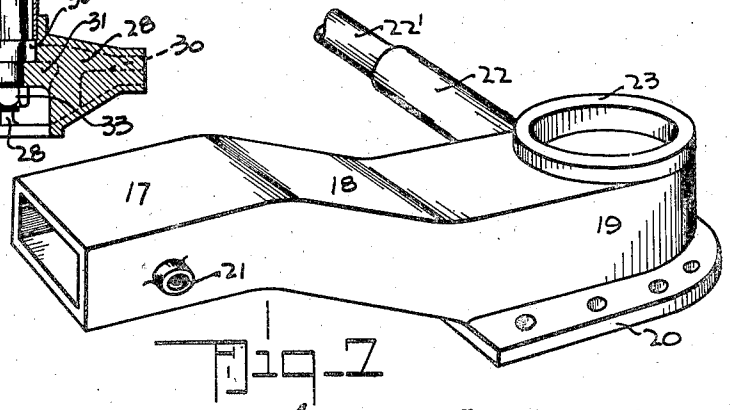


Fig. 7

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UNITED STATES PATENT OFFICE

2,104,349

ORE SEPARATOR

Harry J. MacCamy, Spokane, Wash., assignor to Union Iron Works, Spokane, Wash.

Application April 15, 1935, Serial No. 16,378

2 Claims. (Cl. 209—169)

My present invention relates to improvements in ore separators of the flotation type, and contemplates the use of separate tanks or cells, preferably arranged in pairs that communicate, and in which the ore pulp is successively treated to insure the extraction and recovery of a maximum quantity of the values. As here illustrated, I have indicated a pair of cells as forming a unit through which the ore pulp is circulated, but it will be understood that a single cell may be employed as a unit, or more than two cells may operatively be connected together for separation of the minerals or metals from their ores.

The ore is first thoroughly comminuted, mixed with the necessary quantity of water and agencies to form the required pulp, and then the pulp is fed to or introduced into the cell at its bottom portion to provide for an upward flow of the material during the separating process. When a second cell is employed in the unit, a portion of the pulp flows from the first cell, through a fixed coupling or connection, to the second cell, and from both cells the separated values are floated with foam or froth to the discharge trough for laundering, or disposed of in other suitable manner.

Means are provided for insuring a continuous movement or circulation of the pulp or gangue, for aerating and agitating the material to provide the froth or foam for the flotation process, for distributing the aerated and agitated material uniformly about the bottom portion of the cell or tank, and for initiating and maintaining an equalized upward flow of the aerated material toward the outlet from the cell or tank.

The invention consists in certain novel combinations and arrangements of parts as will hereinafter be more specifically set forth and claimed. In the accompanying drawings I have illustrated a complete example of the physical embodiment of my invention, wherein the parts are combined and arranged according to one mode I have thus far devised for the practical application of the principles of my invention, but it will be understood that various changes and alterations may be made and are contemplated in the exemplifying structures, within the scope of my appended claims, without departing from the spirit of my invention.

Figure 1 is a view in elevation showing a separating unit comprising two cells or tanks, one of which is illustrated in section, parts being omitted for convenience of illustration.

Figure 2 is a transverse vertical sectional view of one of the cells or tanks, with the upper portion of the operating shaft and frame broken away, and showing the drive pulley for the rotary head.

Figure 3 is a detail view of the rotary or centrifugal head that performs the functions of aerating, mixing, separating, and distributing the pulp in the lower portion of the tank or cell.

Figure 4 is a horizontal sectional view at line 4—4 of Figure 3, and Figure 5 is a vertical section at line 5—5 of Figure 4.

Figure 6 is a plan view of the swirl ring, removed from the agitating chamber of the cell, which quiets the turbulency of the agitated pulp preparatory to flotation of the values with the froth or foam.

Figure 7 is a perspective view of the combined feed-trough and feed-head for introducing the pulp to the bottom portion of the tank or cell.

In Figure 1, I have illustrated two tanks or cells, 1 and 2, of similar construction, and similar interior arrangement, which are supported on sills 3, and provided with clean-out plugs 4 that are used to close drain openings in the bottoms of the cells. These two cells or metallic tanks 1 and 2 are joined together by a fixed coupling or connection 5 for passage or flow of grangue or pulp from tank 1 to tank 2, and a similar connection or coupling is attached at the feed or front end of the first tank 1, for feeding the pulp to the tank. The coupling is fashioned with attaching flanges 6 and 7 that are bolted to the tanks 1 and 2 when the coupling is employed between two tanks. At the left in Figure 1 the connection or fixture is bolted by means of flange 7, only, to the tank, to form an inlet chute to the tank for the pulp fed thereto in suitable manner.

The connection or chute is fashioned with an interior partition 8, forming an outer wall for the chute in Figure 1 at the left, over which the material or pulp is fed. Within the chute, and at opposite sides thereof are provided ribs and guide grooves 9 in which is located a vertically adjustable gate 10 that is adapted to co-act with the partition to vary the height of the upper edge of the outlet opening for pulp between two cells or tanks. The gate is vertically adjusted through the use of a screw bar 11, having its lower end attached to the gate, and its upper end supported in a cross head 12 secured at the top of a frame 11a that is attached to the sides of the chute 5 and supports the cross head 12 above the chute. A non-traveling nut 13, having a hand wheel 14, is mounted on the upper end of the screw bar, and the nut is mounted at 15 in a seat of the cross-head and retained against

longitudinal movement on the screw-bar. Thus, by turning the hand wheel, the gate may be raised above the upper edge of the partition 8, to elevate the overflow or outlet from one tank to the other, and thus determine the level of the pulp in the first tank.

At its lower end the feed chute 5 is fashioned with an elbow or bend that terminates in a port 16 opening to the interior of the tank, just above the bottom of the tank, and this port is joined in suitable manner to the open end of a closed feed trough 17 located within the tank. The entrance end of the feed trough is located just above the bottom of the tank, and a bend 18 is provided in the trough which declines to the feed-head 19, to insure gravity flow of the pulp to the head. The feed head is hollow, located at the approximate center of the cell or tank, and it is bolted, as by flange 20 to the bottom of the tank. The hollow feed head has an opening in its bottom registering with the similar opening in the bottom of the tank and these openings are closed by the clean-out plug 4.

The chute or feed trough 17, as indicated in Figures 1 and 7 is provided with a lateral intake port 21 to assist in circulation of the pulp, and the hollow head 19 is fashioned with an outlet tube 22 which is connected with a nipple 22' mounted in a wall of the tank, to which nipple a return feed pipe is attached to return excess gangue or pulp to the source of supply in appropriate manner.

By means of the upright chute and the horizontally disposed trough, the pulp or gangue is delivered to the feed-head 19 at the center of the bottom portion of the tank, and the pulp ascends through the head, and through a flanged bushing 23 which performs the functions of a filler and wear ring at the upper face of the feed-head, in which face the wear ring is seated.

Directly above the feed-head is located a rotary, centrifugally operating, hollow head 24, adapted to receive the material from the feed-head, and to perform the functions of agitating, separating, aerating, and distributing the material, preparatory to the flotation of the values together with the froth or foam and ascent of the froth and values to the surface level of the contents of the tank.

At its underside the head is fashioned with an intake chamber 25 located directly over the outlet from the feed-head 19, and the agitator-head 24 is fashioned with upper and lower conical face-plates 26 and 27 respectively, which impart a double-cone shape to the head. Between the two face plates are located four upright, diametrically extending partitions 28 with their inner ends terminating at the entrance chamber 25 and their outer ends or edges terminating at the annular or circular periphery of the rotary head, and between these diametrically extending partitions, four outwardly flaring ports 29 are fashioned, through which the pulp is distributed into the agitation chamber formed in the bottom of the tank.

The rotary head forms an impeller, which receives the pulp from the feed-head, and discharges the pulp through its four outwardly flaring ports into the agitating chamber. As a means for guiding the material as it is discharged under centrifugal action through the ports, I may use a set of diagonally arranged guide-ribs 30, integral with the upper face of the lower face plate, and approximately one-half the height of the ports.

The impeller is supported from above and is suspended in the tank, and for this purpose it is fashioned with a central, interior, perforated boss 31 in which the lower, reduced end of the operating shaft 32 is secured by means of a nut 33.

In Figures 1 and 5 an air pipe 34 is mounted on the operating shaft to form an annular air space for introduction of air to the impeller. The lower end of the air pipe is fixed in the upper part of the impeller and opens into a port 35 that communicates with the discharge ports 29 of the impeller, and an annular flange 36 on the impeller is provided to receive the lower end of the pipe and insure a liquid-tight joint. The operating shaft and the air pipe depend through the pulp contained in the tank or cell, and the upper, open end of the air pipe is located above the liquid level of the tank for intake of air. The air pipe is supported at its upper end by suitable means, as spring fingers, or clamp lugs 37 secured to the pipe and bearing against the shaft. Air is induced to flow down through the air pipe to the interior of the impeller by suction due to the rotary motion of the impeller.

In Figure 2, the impeller is secured at the lower end of a tubular operating shaft 34' that supplies air to the impeller, and in both types of shaft, suitable bearings as 38 are provided and a drive pulley 39 is illustrated for revolving the operating shaft.

From this description it will be apparent that the rotating impeller receives the pulp from the feed-head, and that the pulp is thoroughly aerated within the impeller by air mixing with the pulp, and that the aerated material is discharged from the impeller through its flaring ports. The material is also agitated and the values are separated, as the aerated pulp is whirled around by centrifugal action of the impeller and discharged laterally into the tank, together with the froth and foam thus formed.

To quiet the turbulency of the swirling discharges from the impeller I provide a baffle-ring 40 that surrounds the impeller at a suitable distance therefrom, and this baffle ring is supported in stationary position by a number of lugs 41 that rest upon an annular flange 42 fixed within the tank.

The inner periphery of the baffle ring is fashioned with integral, vertical, circumferentially spaced baffle plates 43, which form vertical spaces 44 between adjoining plates. Thus it will be apparent that as the material is laterally discharged from the impeller, it is thrown into contact with the baffle ring, against the plates, and into the spaces between the plates, and the turbulency or swirling movement of the material imparted thereto by the impeller is broken up. The separated values, together with foam and froth, thus begin their ascent from the spaces between the baffle plates, and the plates form channels that direct the flotation of the material, upwardly, after it has been evenly distributed by the impeller.

To aid in quieting the turbulency within the tank or cell, and especially to prevent surging of the agitated pulp, I provide a horizontally disposed screen or reticulated mat 45 supported on flanges 46 that are secured to the inner face of the tank-wall above the impeller and the baffle-ring, and the froth or foam, carrying the values, passes through this screen, ascending to the discharge opening or overflow lip 47 in Figure 2, to a launder, or to another receptacle for further treatment.

The gates 10 in the feed chute of the first cell, and between adjoining cells, regulate the height of the pulp levels and maintain or control the levels, under adjustment through the instrumentality of the hand wheels 14 of the gates.

The gravity feed of material or pulp through the feed chute to the feed trough, and thence to the feed head, supplies the separator with material, and the suction caused by the rotation of the centrifugal impeller pulls air down through the air supply pipe to the agitator head or impeller. Any material falling below the impeller ports may be returned to the feed trough through the inlet 21, and any excess material is conveyed from the feed head through the return connection 22, 22' to the source of supply.

In Figure 1 it will be seen that the upwardly flowing pulp and the downwardly flowing air currents meet and commingle in the interior of the impeller or agitator head to insure thorough aeration of the pulp, and the action of the impeller in agitating the material separates the fines or values from the gross, and at the same time forms the froth or foam for the flotation of the values. The separated and aerated pulp is discharged through the ports of the impeller into the pockets or spaces 44 of the baffle ring, and at this point begins the ascension of the foam or froth. The pockets or spaces 44 are of sufficient area and depth as to receive and separate the discharged material into divided portions, and thereby the swirling movement of the discharged material is arrested, and the pulp is then permitted to ascend in currents for the formation of the flotation process.

As thus constructed and arranged the separator is comparatively simple in its operation and highly efficient in the separation of the values, and where the cells are coupled together and used in pairs, as a unit, a maximum extraction of values is assured from the pulp, and any excess feed of pulp is returned to the source of supply and again fed to the separator. In this manner a continuous circulation of the closed type is afforded for the pulp without waste and under regulated control.

When operating with pulp carrying a precious metal content, as gold, I provide a catch basin or receptacle disposed on the underside of the bottom of the cell and located directly below the feed-head 19 and in communication therewith. This basin will permit the heavier metals and mineral content of the pulp to settle and be concentrated in a small area at the extreme bottom of the basin.

In the illustration, Figure 1, on the right hand cell, and in Figure 2, I have illustrated one form of a catch basin 48 which is formed with slanting sides terminating in a restricted area at the bottom thereof and provided with a valve 49 through which the collected material may be removed from the cell.

The valve may be of any suitable form to open and permit passage of the material from the basin. A water pipe 50 is utilized to inject a stream of water under a desired pressure into the basin and provide a lifting action for the pulp or material that settles into this area.

The heavy, precious metals will not be affected by this lifting action and are allowed to settle to the bottom of the basin along with such coarser mineral in the pulp as will not be affected by the lift of the impeller.

Having thus fully described my invention, what I claim as new and desire to secure by Letters Patent is:—

1. In a mineral separator, the combination of an enclosing tank, an interior feed-head having an outlet port in its upper face, a centrifugal impeller having an intake port in its lower face directly over said outlet port, means for supplying air to the impeller, said impeller having lateral discharge ports above its intake port, a baffle ring elevated above the bottom of the tank and supported therein, said ring forming a solid wall and surrounding the impeller, and spaced vertically arranged radially projecting plates on the inner side of said ring forming guide grooves adjacent the lateral discharge ports.

2. In a mineral separator, the combination of an enclosing tank and means for feeding pulp thereto including a head having an outlet port in its upper face, a centrifugal impeller comprising a hollow head having a closed upper face and an intake port in its lower face directly over said outlet port, a series of interior partitions radiating from the open center of said impeller head and forming lateral discharge ports, a baffle ring elevated above the bottom of the tank and supported therein, said ring forming a solid wall surrounding the impeller and spaced from its lateral discharge ports, and vertically arranged integral spaced plates projecting radially from the interior face of the ring and forming guide grooves adjacent the lateral discharge ports.

HARRY J. MacCAMY.