

Oct. 30, 1962

W. H. GRUBER
ORE HANDLING MACHINE AND APPARATUS FOR
REMOVING MINERALS FROM ORE

3,061,536

Filed Nov. 17, 1958

2 Sheets-Sheet 1

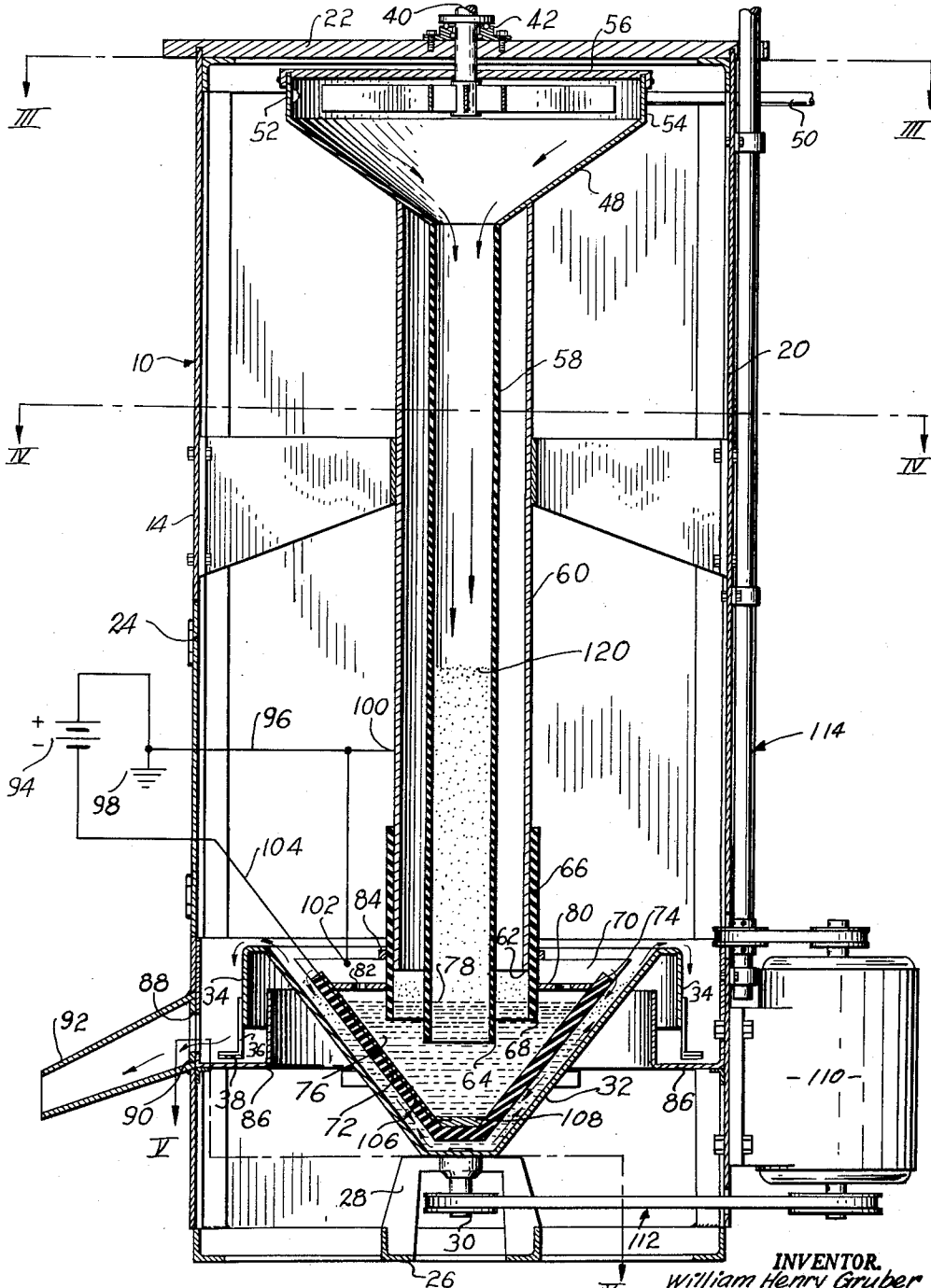


Fig. 1.

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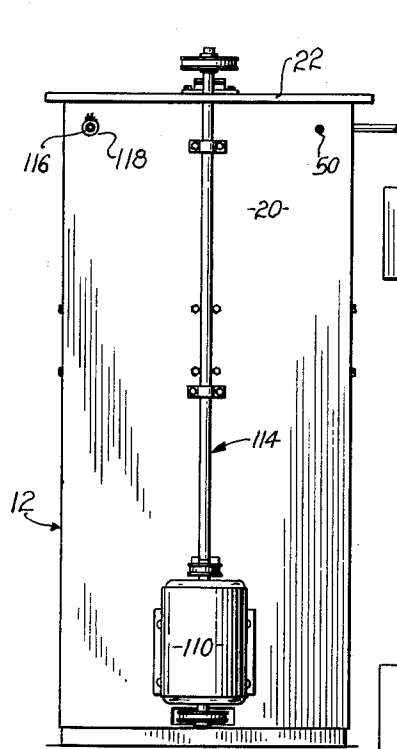


Fig. 2.

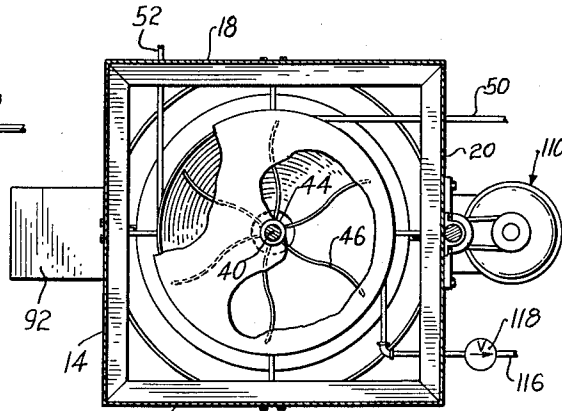


Fig. 3.

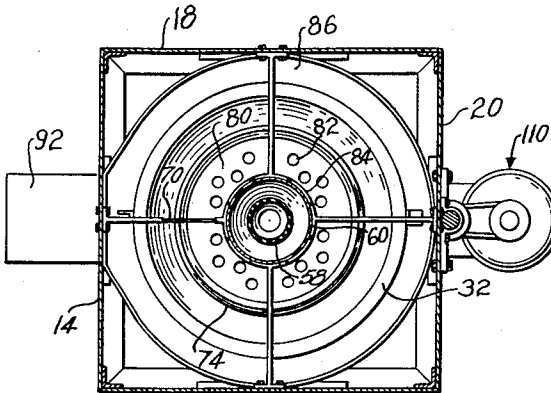


Fig. 4.

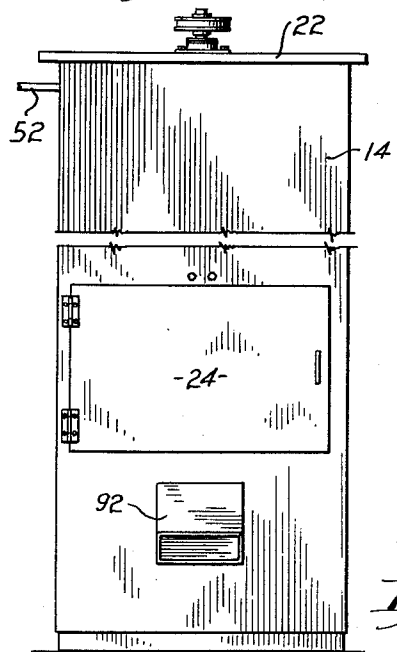


Fig. 6.

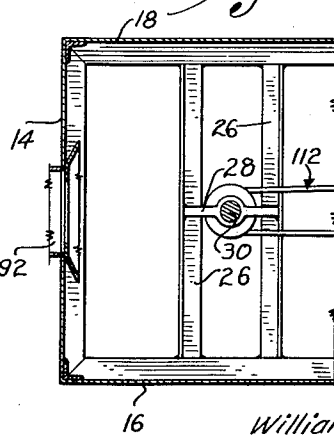


Fig. 5.

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3,061,536
ORE HANDLING MACHINE AND APPARATUS
FOR REMOVING MINERALS FROM ORE

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This invention relates generally to the field of mining and, more particularly, to a unique method of removing minerals from ore slurries as well as a novel ore handling machine for expeditiously carrying out the removal operation.

The primary object of this invention is to provide a machine for handling ores wherein novel structure is utilized to cause the minerals contained in the ore to amalgamate with a quantity of mercury contained in a basin therefor provided in the machine, whereby a much higher concentration of minerals may be removed from a particular ore slurry than heretofore possible.

An equally important object of this invention is to provide an ore handling machine wherein the slurry is introduced into the body of mercury below the free surface thereof so that the minerals are exposed to a maximum area of the mercury and amalgamation of the minerals with the mercury is thereby assured.

Also an important object of this invention is to provide a machine for removing minerals from an ore slurry wherein a substantially vertical delivery tube is disposed with its lowermost end thereof below the free surface of the body of mercury so that as the slurry is delivered to the tube and gravitates to the lowermost end thereof, the slurry must pass through a considerable portion of the mercury and thereby expose the minerals to a much greater surface area of the mercury.

An additional important object of this invention is to provide such an ore handling machine as hereinabove described wherein there is provided means surrounding the mercury basin in a position to receive the slurry overflowing from the basin so as to trap all amalgamated minerals and mercury which escape from the basin.

A further important object can be seen to be the provision of an ore handling machine as alluded to above wherein there is provided a negatively charged electrode within the mercury of the basin and a positively charged electrode disposed in the overflow of slurry from the basin, so as to increase the degree of separation of minerals from the ore by electrolysis.

Another important object of this invention is to provide an ore handling machine wherein there is a rotatable cone surrounding the mercury basin for trapping the amalgam and mercury which overflows with the slurry from the mercury basin, and also to effect separation of the amalgam and mercury from the rest of the ore in the slurry by flotation.

Other important objects relate to the provision of an agitator at the uppermost end of the delivery tube for dislodgment of the minerals from the slurry and to produce somewhat of a vacuum on the material gravitating through the tube; to the provision of another annular container surrounding the rotatable cone in a position so as to trap amalgam and mercury which escape from the cone during rotation of the latter; to the provision of a method of expeditiously removing minerals from ore by utilization of the principles of electrolysis, centrifugal force, gravitation, flotation, and amalgamation; and other less important objects and details of construction which will become obvious or be explained more fully hereinafter as the following specification progresses.

In the drawings:

FIGURE 1 is a fragmentary, central, vertical, cross-sectional view illustrating an ore handling machine em-

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bodying the concepts of the instant invention and showing a schematic electrical diagram therefor;

FIG. 2 is a rear elevational view thereof on a reduced scale;

FIGS. 3, 4 and 5 are cross-sectional views taken on the lines III—III, IV—IV, and V—V respectively of FIG. 1; and

FIG. 6 is a fragmentary, front elevational view thereof.

An ore handling machine designated generally by the numeral 10 comprises a rectangular box structure 12 having a front wall 14, side walls 16 and 18, a rear wall 20, and a top wall 22. Front wall 14 preferably has a door 24 therein which is hingedly mounted thereon for reasons to be hereinafter outlined. Manifestly, other constructions may be employed rather than the wall structure illustrated, and members forming a parallelepipedon may be employed although, in some instances, the solid wall structure is desirable because it tends to prevent contamination of the body of mercury contained within structure 12.

Mounted on lower cross member 26 is a bracket 28 which is adapted to rotatably receive a shaft 30. Secured to the uppermost end of shaft 30 in a manner so as to be rotatable therewith is a relatively large, centrifugal cone 32 which has an annular, downwardly extending flange 34 integrally attached to the uppermost circular edge of cone 32. Secured to the lowermost edge of annular flange 34 is a circular band 36 which is substantially L-shaped in cross-sectional configuration so as to present a horizontal leg 38, the function of which will be hereinafter set forth.

Another rotatable shaft 40 is provided extending through the uppermost top wall 22 and mounted in suitable bearing means 42 so as to be rotatable on an axis coincident with the axis of shaft 30. Mounted on the lowermost end of shaft 40 is a hub 44 having a number of radially extending vanes 46 thereon, it being apparent from FIG. 3 of the drawings that each of the vanes 46 is of substantially S-shaped configuration. Also mounted on structure 12 adjacent the top wall 22 is a substantially conical hopper 48 adapted to receive the ore slurry from a designated supply source. As shown clearly in FIGS. 1 and 3, a pair of supply conduits 50 and 52 communicate with the hopper 48 by virtue of openings provided therefor in the vertical annular wall 54 of hopper 48. The conduits 50 and 52 are disposed in a position so as to direct the ore slurry into the hopper 48 on a line substantially tangential to the annular wall 54, and it can be seen that the linear path of travel of the ore material as it emerges from each of the conduits 50 and 52 is transformed into substantially circular motion by the vanes 46 cooperating with the annular wall 54. As illustrated in FIG. 3, the vanes 46 are adapted to be rotated in a substantially counterclockwise direction so that the bowed surface on the outermost end of each vane 46 tends to throw the ore slurry against the upright surface of annular wall 54.

The top of hopper 48 is closed by a circular plate 56 secured thereto by suitable means and thus, it can be seen that the vanes 46 thoroughly agitate the ore slurry before the same gravitates into an elongated, vertical tube 58 secured to the lowermost open end of hopper 48. By virtue of the fact that the outermost ends of each of the vanes 46 are in relatively close proximity to annular wall 54, it is most usually necessary to direct the ore slurry into the hopper 48 via conduits 52 under a pressure of several pounds per square inch.

From FIG. 1, it can be seen that tube 58 extends downwardly from hopper 48 to a point substantially midway between the upper edge of cone 32 and the apex thereof, and it can also be ascertained that it usually is preferable to provide another tubular member 60 in surrounding

relationship to tube 58. The lowermost end 62 of member 60 terminates at a point somewhat above the lowermost end 64 of tube 58. Also provided over member 60 in telescoping relationship thereto is a relatively short tubular element 66 preferably constructed of suitable, long wearing, electrically non-conductive material. As shown in FIG. 1, the lowermost end 68 of element 66 is located intermediate end 64 of tube 58 and end 62 of member 60. Secured to the members 60 and 66 and extending outwardly therefrom are a number of trapezoidally-shaped metallic brackets 70 which extend outwardly from the member 60 and element 66 in substantially radial relationship thereto, the outermost end of each of the brackets 70 being spaced from but proximal to the upper edge of cone 32.

Secured to the brackets 70 and depending therefrom is a frusto-conical mercury basin 72, the axis of which is in substantial alignment with the axes of shaft 30 and tube 58. It is notable that the uppermost circular edge 74 of mercury basin 72 is somewhat lower than the uppermost peripheral edge of cone 32. For reasons to be hereinafter made clear, mercury basin 72 is preferably constructed of suitable, electrically non-conductive material but is of relatively rugged construction and capable of withstanding a considerable amount of stress when filled with mercury. As shown in FIG. 1, in order to carry out the concepts of this invention, it is contemplated that mercury basin 72 will contain a body of mercury 76 having a level 78 which is above the lower edges 64 and 68 of tube 58 and member 60 respectively, but below the uppermost circular edge 74 of basin 72.

It is also desirable to provide a number of arcuate, segmental, metallic plates 80, each of which has a number of openings 82 therein and which are adapted to be disposed in a position bridging the space between element 66 and the innermost curved surface of basin 72. As is shown in FIG. 4, it is usually desirable to provide four of the plates 80, each of which is disposed between a pair of brackets 70 in contacting relationship therewith.

Also disposed around element 66 is a relatively small, metallic ring 84 which engages each of the brackets 70.

An annular trough 86 is provided in surrounding relationship to the flange 34 of cone 32 and it can be seen from FIG. 1 that trough 86 is preferably substantially U-shaped in cross-section in a manner so that flange 34 and band 36 are disposed between the legs thereof. Furthermore, the trough 86 located in a position so that the leg 38 is in close proximity to the lowermost face portion of trough 86 but spaced therefrom a distance sufficient to permit rotation of cone 32 with respect to the trough 86.

A rectangular opening 88 is provided in the front wall 24 of structure 12 and it is seen that opening 88 also extends through and communicates with the outermost wall of trough 86, but opening 88 is disposed in a position so that there is presented a small, upstanding flange 90 at the outermost portion of trough 86. Located over the opening 88 in a position to direct material outwardly from structure 12 is an elongated, downwardly inclined trough 92 for removing ore slurry from the machine.

Electrical means for effecting electrolysis during the recovery operation may conveniently take the form of a battery 94, a conduit 96 connected to the positive terminal of battery 94 and grounded at 98, connected to tubular member 60 at 100, and electrically connected to one of the brackets 70 at 102. Another conduit 104 is connected to the negative terminal of battery 94 and passes through a suitable passage 106 in the side wall of mercury basin 72, and is connected to an iron plate 108 disposed at the lowermost end of basin 72 in a position to contact mercury 76.

Means for driving shafts 30 and 40 at suitable speeds may conveniently include a prime mover 110 which is connected to shafts 30 and 40 respectively by suitable pulley and belt means 112, and pulley, belt and shaft

means 114. It is manifest that the r.p.m.'s of shafts 30 and 40 may be varied at will by the use of pulleys of suitable diameters.

Also communicating with hopper 48 is an outlet conduit 116 having a valve 118 therein whereby the material passing from conduits 50 and 52 into hopper 48 may be tested at suitable intervals by opening of valve 118 and allowing the slurry to flow out through conduit 116.

In operation, upon energization of prime mover 110 to rotate cone 32 and vanes 46, an ore slurry consisting of finely particulated ore in a water medium is directed into hopper 48 through each of the supply conduits 50 and 52 respectively.

Inasmuch as the action of vanes 46 tends to force the slurry contained in hopper 48 outwardly against annular wall 54, it is necessary to direct the slurry into hopper 48 through conduits 50 and 52 under a pressure and thus, the slurry containing the minerals to be separated is thoroughly agitated within hopper 48 and thereby cleansing of the surfaces of the minerals is effected. In other words, because of the extreme agitation of the ore slurry in hopper 48, all foreign materials and substances are removed from the surfaces of the native minerals and other compounds which are to be subjected to the separating operation.

From hopper 48 the ore slurry gravitates into tube 58 and passes downwardly therein into the body of mercury 76. Because of the differential in specific gravity between the mercury 76 and the ore slurry introduced into hopper 48, the mercury 76 supports the ore slurry in tube 68 to a height of approximately fourteen inches as indicated at 120. The exact height to which the ore slurry is supported above the surface of mercury 76 will be somewhat variable because of the action of vanes 46, which tend to establish a vacuum in tube 58 above line 120 and, therefore, the gravitation of ore slurry downwardly in tube 58 is somewhat retarded. This retardation of the gravitation of the ore slurry in tube 58 is very important because it causes the minerals contained in the ore slurry to be subjected to the mercury 76 in basin 72 for a longer period of time.

It can be seen that as more slurry is introduced into hopper 48 and gravitates downwardly through tube 58, the slurry is forced into the body of mercury 76 through the opening 64 of tube 58. Because of the fact that the outermost end 64 of tube 58 is disposed below the level 78 of mercury 76, the ore slurry must pass through the mercury instead of traveling across the uppermost surface of the mercury. Also, because of the provision of tubular member 60 in surrounding relationship to tube 58, the ore slurry first travels up into the space between tube 58 and member 60 before it can pass to the uppermost surface of mercury 76. Since the member 60 is substantially airtight, the ore slurry cannot pass upwardly within member 60 for any substantial distance and is forced downwardly through the mercury again and under the outermost end 68 of member 60. The slurry then passes upwardly through the openings 82 in the plates 80 and overflows the uppermost edge 74 of basin 72 in the cone 32 which is caused to rotate by prime mover 110.

Because of the rotation of cone 32, the particles of ore contained in the liquid of the ore slurry are caused to rotate with the cone 32 and thus, are directed over the uppermost edge of cone 32 by the action of centrifugal force.

As the ore slurry overflows the uppermost edge of cone 32, the same is allowed to gravitate into trough 86 where the lower leg 38 of band 36 again agitates the slurry before the same finally overflows flange 90 and is directed outwardly of the machine via trough 92.

It is manifest that as the ore slurry is forced through the body of mercury 76, the native minerals in the ore, such as gold and silver, readily amalgamate with the mercury to form an amalgam in the body of mercury 76. By virtue of the provision of cone 32 in surround-

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ing relationship to basin 72, any amalgam which passes over the uppermost edge 74 of basin 72 gravitates to the lowermost portion of cone 32 where the same may be recovered. It is contemplated that cone 32 is to be rotated at a speed sufficient only to cause the particles of ore to be flowed over the edge of cone 32 with the liquid medium, but if the centrifugal force of the cone 32 is sufficient to cause some amalgam to pass over the edge of cone 32, the same will be retained in the lowermost portion of trough 86. This retention of amalgam in trough 86 is assured by virtue of upstanding flange 90, inasmuch as the ore slurry will overflow flange 90 but the amalgam will remain in the lower portion of trough 86. Also, the leg 38 of band 36 prevents the formation of a relatively hard deposit of particles of ore on the lowermost face of trough 86 which would build up to a point where any trapped amalgam would pass over flange 90.

Effective separation of all of the minerals contained in the ore slurry is assured by an electrolysis process wherein an electric current through the system is effected by virtue of the connection of conduit 96 to brackets 70 and conduit 104 to iron plate 108. It can be seen that the current flow passes through brackets 70 to which conduit 96 is connected and thence through ring 84 to the remaining brackets 70 and the plates 82. Although the provision of ring 84 is not absolutely essential it has been found that the flow of current is maintained more uniform throughout the system if such ring is provided. The negative side of the circuit is provided by virtue of the conduit 104 being connected to iron plate 108 and it can thus be ascertained that the brackets 70 and plates 82 are, in effect, positive electrodes in the electrolysis process and the body of mercury 76 is the negative electrode. The minerals in the ore slurry contained in cone 32 and basin 72 are ionized by virtue of the current between the positive and negative electrodes, and the positive ions migrate to the negative mercury electrode and are deposited thereon. In this manner, complete removal from the ore slurry of all free metal ions, as well as those which are present in a combined state, is assured.

From the foregoing it can be seen that a method is provided for removing minerals from ore wherein the principles of electrolysis, centrifugal force, gravitation, flotation, and amalgamation are all utilized to completely and effectively remove the valuable minerals from the ore slurry.

When it is desired to remove the amalgam and the mercury from the basin 72, cone 32 and trough 86, it is but necessary to open the door 24, remove at least one of the plates 80, and direct a suction pump conduit into the bath of mercury to the lowermost end of basin 72 into a suitable container. If any amalgam is observed in the bottom of cone 32, the same may also be removed by passing the suction pump conduit down to the bottom of cone 32 between the wall of the latter and basin 72 to pull the amalgam out of cone 32. Likewise, any amalgam contained in trough 86 may be removed in a like manner. The minerals may be readily removed from the mercury with which they are amalgamated by distilling of the mercury in any of the well known methods in the art.

The basin 72 is again filled to the level 78 with a fresh charge of mercury, plate or plates 82 are again placed in position, and the machine is ready for use again. Although the process is particularly advantageous when the electrolysis phase thereof is utilized, it is mani-

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fest that this may be eliminated if desired, and removal of native minerals will be completed without the electrolytic process being necessary.

Having thus described the invention what is claimed as new and desired to be secured by Letters Patent is:

1. In a machine for removing minerals from a slurry, an open top, stationary mercury basin; an open top receptacle surrounding said basin and disposed to receive the slurry after the minerals have been separated from the latter; an upright tube extending at its lowermost end into said basin below the upper level of the mercury for introducing the slurry thereinto; means operably coupled with said receptacle for rotating the latter about a vertical axis, whereby the minerals amalgamate with the mercury and the remainder of the slurry overflows the basin and the receptacle as the latter collects any mercury and amalgam which overflows the basin.

2. In a machine as set forth in claim 1 wherein is provided a base supporting said receptacle and provided with an outlet opening therein spaced from the latter, and means within the path of travel of the overflow from the receptacle to said outlet opening for trapping amalgam and mercury in said overflow.

3. In a machine as set forth in claim 1 wherein is provided a positively charged electrode in the overflow from said basin and a negatively charged electrode within the said basin for electrolytic separation of said minerals.

4. In a machine for removing minerals from a slurry, an open top cone having a lowermost apex end; an open top, stationary mercury basin of conical configuration within the cone with the apex end of said basin being disposed adjacent the lowermost end of said cone and spaced therefrom; an upright tube above said basin and extending at its lowermost end into the basin below the upper level of the mercury for introducing the slurry thereinto, whereby the minerals amalgamate with the mercury and the remainder of the slurry overflows the basin into the cone; and means mounting the cone for rotation about a vertical axis whereby said remainder of the slurry is caused to overflow the cone as the cone collects any mercury and amalgam which overflows the basin.

5. In a machine as set forth in claim 4 wherein is provided a base supporting said cone and provided with an outlet opening spaced from the latter, and structure within the path of travel of the overflow from said cone to said outlet opening for trapping amalgam and mercury contained in said overflow.

6. In a machine as set forth in claim 5 wherein said structure includes an annular, open-top trough having a flange extending upwardly into said outlet opening and surrounding the cone, said trough having its open top disposed to receive the overflow from the basin.

7. In a machine as set forth in claim 6 wherein said cone is provided with agitator means rotatable therewith and extending into the trough.

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