

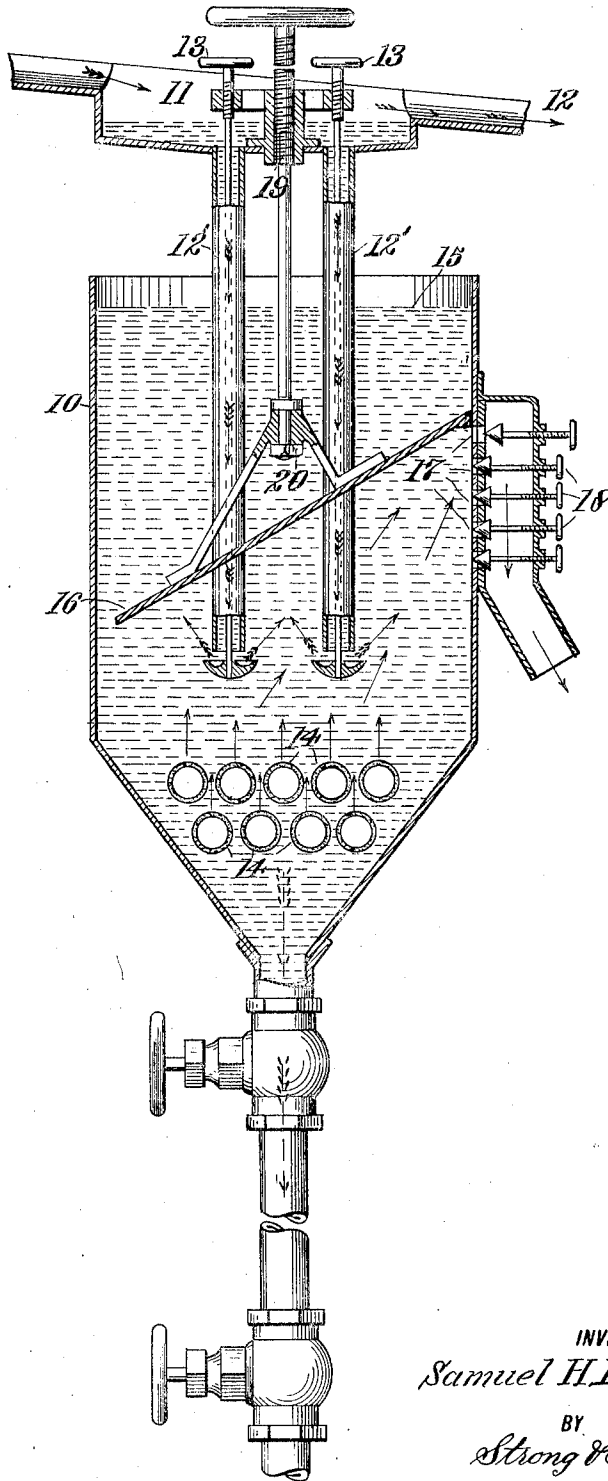
S. H. DOLBEAR.

PROCESS AND APPARATUS FOR CONCENTRATING ORES OR OTHER MATERIALS.

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1,343,313.

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INVENTOR

Samuel H. Dolbear

BY

Strong & Townsend
ATTORNEYS

UNITED STATES PATENT OFFICE.

SAMUEL H. DOLBEAR, OF SAN FRANCISCO, CALIFORNIA, ASSIGNOR TO MINERALS SEPARATION NORTH AMERICAN CORPORATION, A CORPORATION OF MARYLAND.

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Specification of Letters Patent.

Patented June 15, 1920.

Application filed November 14, 1918. Serial No. 262,446.

To all whom it may concern:

Be it known that I, SAMUEL H. DOLBEAR, a citizen of the United States, residing in the city and county of San Francisco and State of California, have invented new and useful Improvements in Processes and Apparatus for Concentrating Ores or other Materials, of which the following is a specification.

This invention relates to a process and apparatus for concentrating ores or other materials, and particularly pertains to a process involving the utilization of the well-known preference of certain substances called flotative agents in wetting or adhering to metallic and some metalliferous and other substances.

The object of this invention is to effect economically the concentration and separation of the valuable mineral or metalliferous contents of ore or other materials, from the gangue or other portion that it is desired to reject. A particular object is to accomplish this concentration and separation by a sub-surface process as distinguished from the usual froth flotation process.

In the so-called flotation process, as now practised, it is common to form a pulp of the ore or other material undergoing treatment, a suitable quantity of water being added for that purpose. To this pulp is then introduced air, dispersed by any convenient means, together with suitable flotative agents, such as oil. When air is suitably introduced into the water air bubbles are produced which travel upward and upon reaching the surface, a froth is formed within which the metalliferous particles are suspended. The bubbles formed below the surface of the solution or pulp as they rise toward the top of the water column are enlarged to some extent and form above the surface a coherent froth.

In the present invention no utilization is made of froth floating on the normal atmospheric surface of the liquid medium or pulp. On the contrary the bubbles which are formed within the body of the liquid medium or pulp by the proper introduction of the air are drawn off before they reach the normal atmospheric surface of the liquid medium or pulp, and thus do not produce a floating froth on said normal atmospheric surface. The primary conception of the in-

vention, therefore, is to draw off the bubbles at a point within the liquid column and at some distance below the normal atmospheric surface of the liquid.

With this idea in view, it has been the prime object of my invention to produce bubbles within the liquid column into which the pulp has been introduced and to carry off the resultant bubbles, retaining the desired mineral or metallic particles at a critical point in their upward course of travel and below the normal atmospheric surface of the liquid where the segregation of the mineral or metalliferous particles from the gangue is at a maximum.

In the embodiment of my invention I preferably employ a column of water, or other suitable liquid, with means for introducing air or gas therein, together with means for introducing the pulp and flotative agent and for diverting into a gaseous medium the resultant mineral-bearing bubbles from such liquid column at a point below the normal atmospheric surface thereof where the desired segregation is at a maximum. The point in the column at which this segregation takes place may be varied by controlling the rapidity with which the air or gas is introduced, the speed of the inflowing pulp, and the height of the column by which the head of water is made to vary.

The separated mineral or metalliferous concentrate thus drawn off may then be filtered, dried, or delivered to points for storage or further treatment as desired.

Below the point or zone at which the effective segregation takes place the gangue or undesired portion of the solids is permitted to settle, and suitable means are provided for conducting this portion away.

The nature of this invention will be more fully understood by the following description, with reference to the accompanying drawing in which—

The figure illustrates schematically an apparatus suitable for practising the invention.

It will be manifest that the invention may be practised by a variety of means, all of which, however, will embody the idea of sub-surface separation by drawing off the bubbles carrying the values at the effective point of segregation from the gangue and

below the normal atmospheric surface of the liquid undergoing treatment.

In the drawing, 10 represents a container of suitable description which, for convenience, may be termed the liquid column container. The pulp to be treated enters a launder 11 provided with an overflow 12; the feed from the launder into the lower strata of the column being through one or more delivery pipes 12' having a suitable feed control 13. The air for producing the air bubbles within the column is delivered from any suitable source by any appropriate means.

As here shown I employ a series of porous tubes 14 discharging into the lower end of the column and beneath the outlet from the feed pipes 12'; the pulp outlet and the porous pipe 14 being arranged a substantial distance below the normal atmospheric surface or water level represented at 15. Porous tubes are preferable for producing the air bubbles because the porosity of the tubes so controls the air flow that minute air bubbles in large volume are produced as distinguished from bubbles that might flow from an open nozzle simply discharging below the surface of the water. By having a vast number of these small air bubbles they provide much better carriers for the values.

It is a well established fact that under conditions such as these, bubbles are formed with a film having a peculiar affinity for metalliferous particles which have been treated with a flotative agent, such particles being retained by the bubbles and caused to rise while the gangue material settles.

The air thus released into the column in my system is not allowed to come to the surface and form a floating froth for the reasons heretofore stated. Suitable means must, therefore, be provided to arrest the up-current of value-carrying bubbles and lead it off from the column into a gaseous medium which in practice is usually the atmosphere. To this end there is disposed an adjustable deflector 16, arranged in the path of the ascending bubble stream. This deflector 16 is so arranged that it may be raised or lowered as desired and is inclined at such an angle that the rising bubbles are carried to the side of the apparatus where concentrate-outlet openings 17 permit their escape into a gaseous medium which in practice is usually the atmosphere. The concentrate-outlet openings 17 are arranged in horizontal series at different levels, depending at what point in the height of the column the bubbles shall be drawn off; it being understood that usually only one horizontal series of concentrate-outlet openings 17 will be open at one time, the others being temporarily plugged with stoppers 18.

A convenient form of vertical adjustment for the deflector 16 is by the hand-screw

19 having a suitable swivel connection 20 with the deflector 16 and the deflector being adjustable up and down with respect to the concentrate-outlet openings 17. The deflector 16 usually is set so that when the concentrate-outlet openings of the horizontal series just below the upper edge of the deflector are opened, there will be produced the most effective practical separation of the values from the gangue.

This point of maximum effective separation is termed the critical point and is generally that point or level at which the mineral-bearing bubbles continue to rise and substantially all of the gangue or waste material tends to settle toward the bottom. The head of water above this critical point may be great enough so that its weight is sufficient to preserve the spherical or spheroidal shape of the bubbles.

The operation of this process and apparatus is as follows: An ore-containing sulfid, or other minerals or metalliferous particles amenable to separation through the medium of treatment with flotative agents, is crushed, ground or pulverized to the desired degree of fineness. A pulp is then made with water or other liquid with this finely divided product, to which is added a suitable volume of any satisfactory well-known flotative agent. When oil is used as the flotative agent the amount used in this process would depend more or less on the ores undergoing treatment. As a rule, good practice dictates from one to two pounds of oil per ton of dry ore.

When the mixture above described is properly introduced into such a column or body of water or other suitable liquid, the resultant air bubbles carrying up the metallic particles will continue in their course of travel to some point in the column where substantial segregation from the gangue is effected. In my invention it is necessary, to determine the most effective point of segregation of the gangue from the metalliferous particles, to set the deflector 16 accordingly and to draw off the bubbles at such a point through the proper set of concentrate-outlet openings 17.

In the so-called flotation processes now in use, it is common to use open tanks filled with a liquid, and upon the top of which liquid the froth collects. If this froth be very evanescent it will break down upon reaching the surface, thereby releasing the metalliferous particles before the froth can be removed. This results in the precipitation of such metalliferous particles which may sink into the gangue and be lost. If the resultant froth is moderately persistent there is a tendency to hold entangled gangue. If the resultant froth is highly persistent then there is the same tendency to hold entangled gangue and difficulty is experienced

in breaking down such froth after it has been removed, thus making difficult the recovery of the concentrate.

I am able to use the very evanescent bubble for the reason that in my method the bubble does not reach the normal atmospheric surface of the liquid medium, but is preserved during its entire function and is not ruptured until it passes from the liquid column and into a gaseous medium. Evanescence is, therefore, desirable. The bubble, when conducted away from the column, is easily ruptured and readily surrenders its metalliferous load, thereby rendering subsequent treatment and handling less difficult. The advantages of using an evanescent sub-surface bubble instead of a persistent surface froth are readily apparent.

I am able to adjust my apparatus so as to effect the removal of the bubbles bearing the metalliferous particles from the liquid column at a point of maximum efficiency, and I arrange that the vertical distance traveled by the segregated material may be increased or decreased at will with desirable results. In other words, I effect the withdrawal of the metalliferous particles at the critical point of segregation and at a point sufficiently below the normal atmospheric surface of such column that the head of liquid above such bubbles is great enough to preserve the bubbles from rupture or such enlargement as would result in loss of mineral burden up to the point of their escape, or such point as would result in the escape of their mineral burden, out of the body of the pulp and into a gaseous medium.

It will thus be observed that the essential characteristic of the present method is the creation of a value-bearing stream of bubbles within the body of the pulp undergoing treatment and the withdrawal of these bubbles into a gaseous medium and before they reach the surface and before they pass into the condition of floating froth at the normal atmospheric surface.

The foregoing process results in the bodily removal of the bubbles with their mineral burdens from the water column and without passing a water-filled chamber, the bubbles being in such volume and under such static pressure that no substantial amount of free water is allowed to escape.

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

1. A process of concentration consisting in subjecting a column of liquid having therein a mixture of floatable and unfloatable material in a suitably divided condition to gasification in such manner that gas in the form of bubbles will rise upward in the liquid and become attached to the floatable material, and diverting such bubbles from

the column into a gaseous medium at a point where the pressure in said column is greater than in such gaseous medium.

2. A process of concentration consisting in subjecting a column of liquid having therein a mixture of floatable and unfloatable material in a suitably divided condition to gasification in such manner that gas in the form of bubbles will rise upward in the liquid and become attached to the floatable material, and diverting such bubbles from the column into a gaseous medium at a point in the liquid column where the liquid is subjected to hydrostatic pressure.

3. A process of concentration consisting in subjecting a column of liquid having therein a mixture of floatable and unfloatable material in a suitably divided condition to gasification in such manner that gas in the form of bubbles will rise upward in the liquid and become attached to the floatable material, and diverting such bubbles from the column into a gaseous medium at the side of the liquid column.

4. A process of concentration consisting in introducing finely ground pulp containing the material to be concentrated, together with a flotative agent, into a column of suitable liquid through which bubbles of gas are rising, and withdrawing the bubbles bearing the concentrate into a gaseous medium at a point substantially below the normal atmospheric surface of such column and in proximity to the point in such column where the segregation of such concentrate is substantially complete.

5. A process of concentration consisting in introducing finely ground pulp containing the material to be concentrated, together with a flotative agent, into a column of suitable liquid through which bubbles of gas are rising, and withdrawing the bubbles bearing the concentrate into a gaseous medium at a point below the normal atmospheric surface of such column and in proximity to the point in such column where the segregation of such concentrate is substantially complete.

6. Concentration apparatus comprising a vessel adapted to contain a column of liquid having therein a mixture of floatable and unfloatable material in suitably divided condition, means for introducing a gas therein in such manner that gas in the form of bubbles will rise upward in the liquid and become attached to the floatable material, and means for diverting such bubbles from such column to a gaseous medium at a point where the pressure in the liquid is greater than the pressure in such gaseous medium.

7. Concentration apparatus comprising a vessel adapted to contain a column of liquid having therein a mixture of floatable and unfloatable material in suitably divided condition, means for introducing a gas therein

in such manner that gas in the form of bubbles will rise upward in the liquid and become attached to the floatable material, and means for diverting such bubbles from such column to a gaseous medium at a point in the liquid column where the liquid is under a hydrostatic pressure.

8. Concentration apparatus comprising a vessel adapted to contain a column of liquid having therein a mixture of floatable and unfloatable material in suitably divided condition, means for introducing a gas therein in such manner that gas in the form of bubbles will rise upward in the liquid and become attached to the floatable material, and means for diverting such bubbles from such column to a gaseous medium at the side of the liquid column.

9. Concentration apparatus comprising a vessel adapted to contain a column of liquid having therein a mixture of floatable and unfloatable material in suitably divided condition, means for introducing such mixture therein, porous medium gas-introducing means arranged below the point at which such mixture is introduced, and means for diverting gas-bubbles from the liquid column into a gaseous medium at a point substantially below the normal atmospheric surface of such column.

10. Concentration apparatus comprising a vessel adapted to contain a column of liquid having therein a mixture of floatable and unfloatable material in suitably divided condition, means for introducing such mixture therein, porous medium gas-introducing means arranged below the point at which such mixture is introduced, and means for diverting gas-bubbles from the liquid column into a gaseous medium at a point below the normal atmospheric surface of such column.

11. An apparatus for concentration by flotation comprising a vessel adapted to contain a column of suitable liquid, means for introducing therein finely ground ore or pulp, a porous medium adjacent to the bottom thereof through which gas may be admitted into the column, and means for diverting and removing resultant bubbles from such liquid column into a gaseous medium at a point substantially below the normal atmospheric surface of such column of liquid.

12. An apparatus for concentration by flotation comprising a vessel adapted to contain a column of suitable liquid, means for introducing therein finely ground ore or pulp, a porous medium adjacent to the bottom thereof through which gas may be admitted into the column, and means for re-

moving resultant bubbles from such liquid column into a gaseous medium at a point below the normal atmospheric surface of such column of liquid.

13. An apparatus for concentration by flotation comprising a suitable receptacle having means for delivering the material to undergo separation at a point substantially below the normal water level therein, means for gasifying the contents of the receptacle to create bubbles within the body of liquid, and means for arresting the upward progress of the bubbles through the body of liquid and withdrawing them therefrom into a gaseous medium before they pass into the stage of froth floating on the normal atmospheric surface of the liquid.

14. A process of concentration consisting in introducing finely ground pulp containing the material to be concentrated, together with a flotative agent, into a column of suitable liquid through which gas bubbles are rising, and withdrawing the bubbles bearing the concentrate into a gaseous medium at a point sufficiently below the normal atmospheric surface of such column that the head of liquid above such bubbles is great enough to preserve the bubbles from depositing their load within the pulp.

15. A process of concentration consisting in introducing finely ground pulp containing the material to be concentrated, together with a flotative agent, into a column of suitable liquid through which gas bubbles are rising, and withdrawing the bubbles bearing the concentrate into a gaseous medium at a point sufficiently below the normal atmospheric surface of such column that the head of liquid above such bubbles is great enough to preserve the spherical or spheroidal shape of the bubbles while within the liquid column.

16. A process of concentration consisting in introducing finely ground pulp containing the material to be concentrated, together with a flotative agent, into a column of suitable liquid, through which gas bubbles are rising, and withdrawing the bubbles bearing the concentrate into a gaseous medium at a point sufficiently below the normal atmospheric surface of such column that the pressure on the bubbles is great enough to prevent such enlargement as will result in loss of their burden.

In testimony whereof I have hereunto set my hand in the presence of two subscribing witnesses.

SAMUEL H. DOLBEAR.

Witnesses:

R. B. AYRES,
ESTHER M. PEARSON.