F. GROCH.

ORE CONCENTRATION.

APPLICATION FILED JULY 3, 1916.

1,413,723. Patented Apr. 25, 1922.

4 SHEETS—SHEET 1.

FIG. 1.

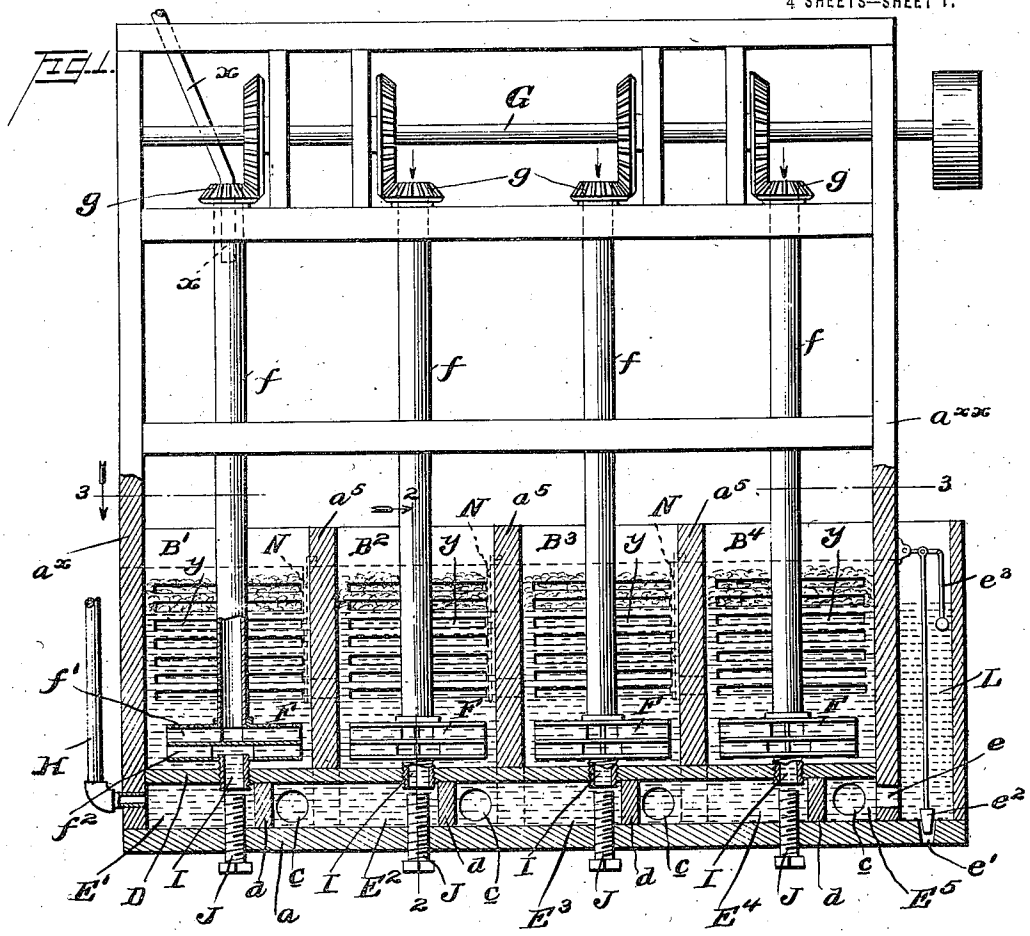
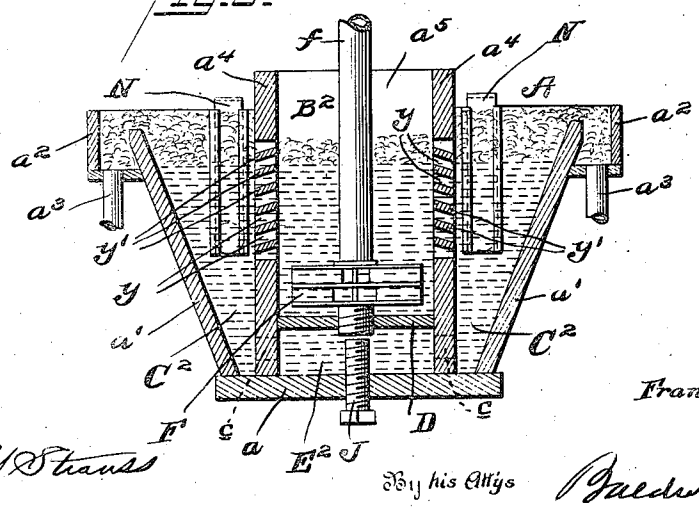


FIG. 2.



Witness

Harold Strauss

Inventor

Frank Groch

By his Attys

Baldwin & Wight

F. GROCH.

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4 SHEETS—SHEET 2.

FIG. 3.

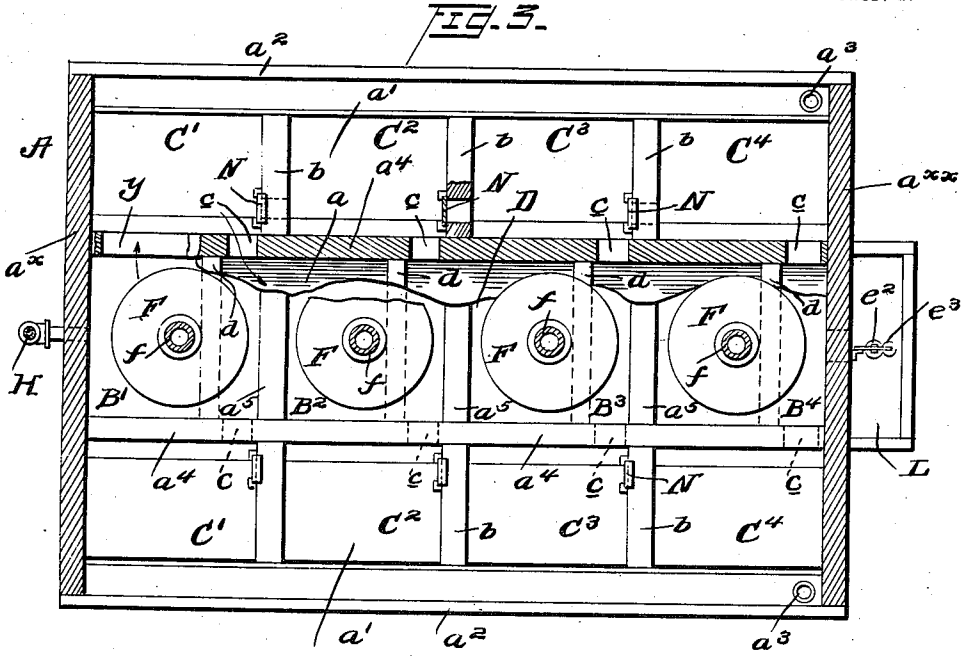


FIG. 4.

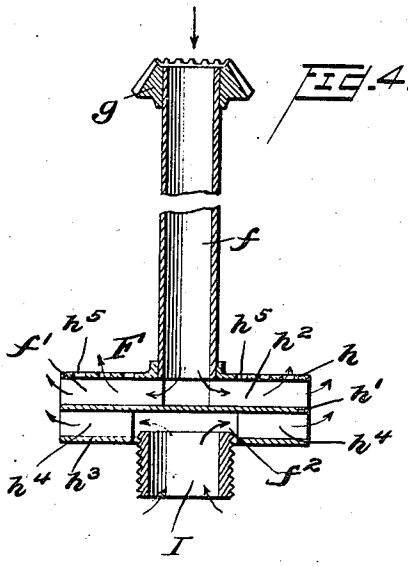
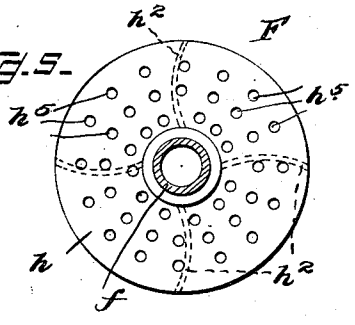


FIG. 5.



Witness

Harold Staus

Inventor

Frank Groch

By his Attys Baldwin & Wright

F. GROCH.

ORE CONCENTRATION.

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4 SHEETS—SHEET 3.

FIG. 6.

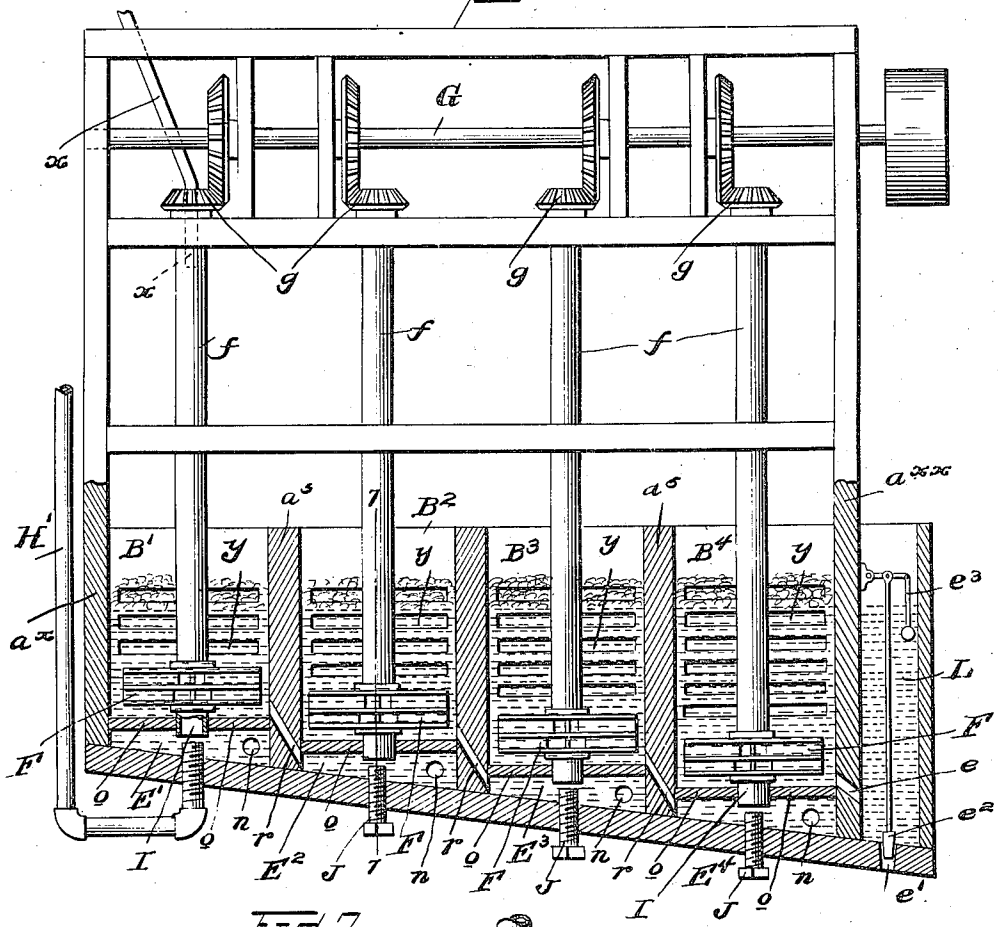
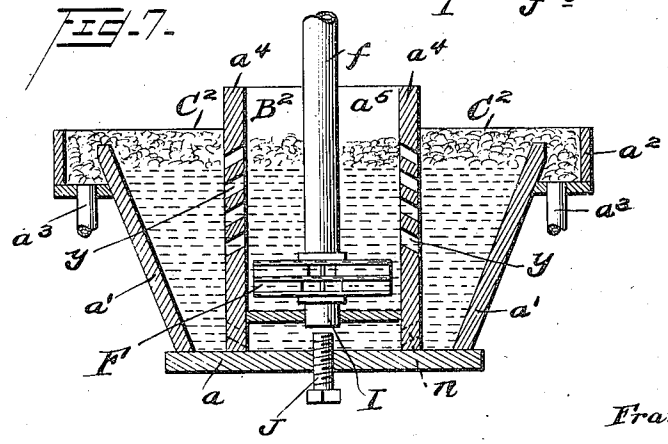


FIG. 7.



Witness

Harold Strauss

Inventor

Frank Groch

By his Attys

Baldwin & Wight

F. GROCH.

ORE CONCENTRATION.

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1,413,723.

Patented Apr. 25, 1922.

4 SHEETS—SHEET 4.

FIG. 8.

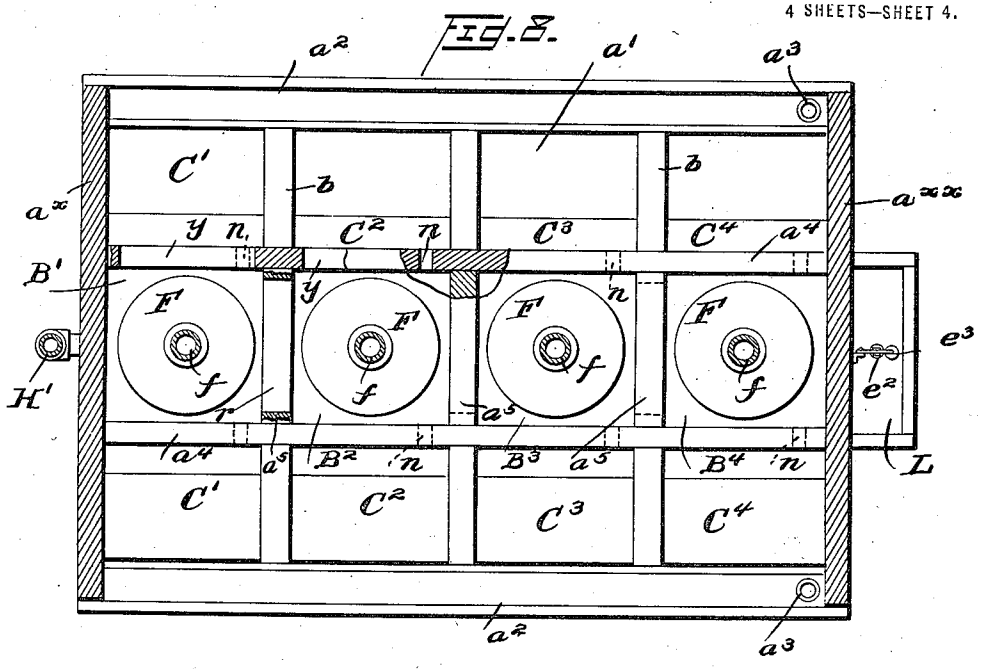
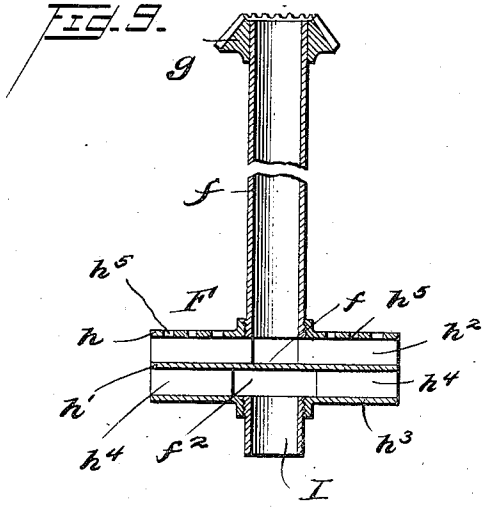


FIG. 9.



Inventor

Frank Groch

Witness

Harold Strauss

By his Attys

Baldwin & Wright

UNITED STATES PATENT OFFICE.

FRANK GROCH, OF COBALT, ONTARIO, CANADA.

ORE CONCENTRATION.

1,413,723. Specification of Letters Patent. Patented Apr. 25, 1922.

Application filed July 3, 1916. Serial No. 107,434.

To all whom it may concern:

Be it known that I, FRANK GROCH, a citizen of the United States, residing in Cobalt, in the Province of Ontario and Dominion of Canada, have invented certain new and useful Improvements in Ore Concentration, of which the following is a specification.

This invention relates to ore concentration in which the metals and metalloids in an ore-pulp containing them are separated from the gangue by the selective action of a froth or foam producing agent, such as oil, which carries the metallic particles to the surface of a bath while the particles of gangue are allowed to settle. By thus separating the values from the gangue the two products may be separately removed and further treated.

The object of my invention is to provide improved apparatus for practicing a method of concentration of the kind referred to.

In such processes it is important that the metalliferous particles should be detached or separated from the particles of gangue as thoroughly as possible in order that the buoyant oil or other froth producing substance and the upward currents of air may cause them to rise while the gangue is settling and it is also important that, where possible, the process of separation should be continuous in a single apparatus and should reduce to a minimum the metallic content of the tailings.

According to my invention I provide an apparatus wherein a pulp containing the material to be separated is thoroughly aerated and wherein the bath is so agitated that substantially all the metallic particles are caused to rise to the surface of the bath while the particles of gangue are allowed to settle. The apparatus is so constructed that the foam or froth containing the values is continuously removed while the settled gangue is also continuously withdrawn and contains a minimum quantity of values. The apparatus is so constructed that the gangue is retreated, being taken from one compartment to the next and when finally discharged it has been separated from practically all of the metallic values contained in the pulp.

In one form of the apparatus a series of agitation compartments is provided which communicate with a series of settling compartments and below each agitation compartment there is a chamber to which the pulp is delivered before passing upwards to the agitation compartment. Each agitation compartment contains means for distributing air within it and it also contains a distributer for the pulp which is closely associated with the air distributer. The agitated pulp passes from each agitation compartment to a settling compartment and a communication is provided between the lower part of each settling compartment and a chamber below the next succeeding agitation compartment whereby the settled material may pass successively through the agitation and settling compartments of the apparatus. At the delivery end of the apparatus a chamber is provided to receive the tailings and this chamber may be equipped with a float valve for regulating the discharge. The details of construction of this form of the apparatus will be hereinafter more fully described.

In another form of the apparatus some of the settled gangue is taken from each settling compartment and returned to the same agitation compartment from which it came, the gangue from each agitation compartment which does not pass to the settling compartment being conveyed through a port to a chamber below the next agitation compartment from which it passes to a settling compartment. Other features of this form of the apparatus will be described later on.

In the accompanying drawings,

Figure 1 is a view in side elevation and partly in section showing one form of apparatus constructed in accordance with my invention.

Fig. 2 shows a transverse section thereof on the line 2—2 of Fig. 1.

Fig. 3 shows a horizontal section on the line 3—3 of Fig. 1, some parts being broken away in order to better illustrate other parts.

Fig. 4 shows in vertical section the combined agitator and air and pulp distributers.

Fig. 5 is a plan view of the combined agitator and distributers with the air supply tube in section.

Fig. 6 is a view similar to Fig. 1 of a modified form of the apparatus.

Fig. 7 shows a transverse section on the line 7—7 of Fig. 6.

The vessel A is divided into a series of agitation compartments and a series of settling compartments. As shown in Figs. 1 and 2 the vessel has a flat horizontal bottom

a with sides a' which incline upwardly and outwardly and on each side of the vessel there is an overflow launder a^2 provided with a discharge pipe a^3. The ends of the vessel are closed by end-pieces a^x and a^{xx} as shown. Upright longitudinal partitions a^4 divide the vessel into three sections, the middle section being subdivided by transverse partitions a^5 into agitation compartments B', B², B³, B⁴. The two outer sections are divided by transverse partitions b into a series of settling compartments C', C², C³, C⁴. I preferably employ two sets of settling compartments as shown but only one set need be used.

The agitation compartments are all arranged above a false bottom D and the space between this false bottom and the bottom a of the vessel is divided by transverse partitions d into a series of chambers E', E², E³, E⁴, E⁵. The several compartments and chambers communicate with each other in the manner hereinafter described.

In each agitation compartment there is a combined agitator and distributer F, each of which comprises a vertically arranged tube f connected at its lower end with an air distributer f' which communicates with the tube and which is arranged above a pulp distributer f^2. The tubes and the distributers are rotated by gearing g operated by a power shaft G.

Various forms of distributers and agitators may be employed, but in Figs. 4 and 5 I have shown the preferred construction. As there illustrated two circular plates or discs h, h' carry between them blades h^2 disposed as shown in Fig. 5, and the construction is such that as the distributers are rotated air will be discharged by centrifugal force from the periphery of the distributer. The tubes f are all open, air enters at their upper ends and passes down to the air distributers f' and is thrown centrifugally outwards into the agitation compartments. The pulp distributers f^2 are formed in a similar way, blades h^4 being mounted between the plates h' and h^3. These blades may be disposed in various ways, but the construction should be such that the pulp which enters the center of the distributer shall be thrown outwards by centrifugal force. Preferably the upper disc h is perforated as shown so that air will not only pass outward from the periphery of the distributer but will also pass upwardly therefrom and thus increase the distribution of the air for agitation and flotation purposes.

The distributers of course operate to draw air and pulp to their centers as well as to discharge air and pulp from their peripheries.

The pulp is mixed with oil or other froth-producing agent preferably before it is fed to the apparatus but it may be supplied in any suitable way.

The pulp may be fed to the tube f of the first agitator through a supply conveyer x as indicated in Fig. 1. When the pulp is thus supplied it enters with the air and becomes, to some degree, mixed therewith before it passes out from the agitator or distributer F. Pulp may also be delivered through a supply pipe H which enters the first chamber E' in the series. Each chamber E', E², E³, E⁴ communicates with the agitation compartment above it through a tube I which, as shown in Fig. 1, has a threaded connection with the partition D and which enters the pulp distributer in said agitation compartment. The capacity of each of said tubes may be regulated by an adjustable bolt J in an obvious manner. Each agitation compartment communicates with a corresponding settling compartment on each side of it through openings y disposed between slats or baffles y'. As the pulp rises in the agitation compartments it passes through the openings between the slats and these slats or baffles serve to retard the upward air currents so that when the pulp passes to the settling chambers quiet settling may be more efficiently accomplished. Each settling compartment or each pair of settling compartments communicates with a chamber below the next agitation compartment in the series as indicated at c in Figs. 1, 2 and 3 of the drawings. The last chamber E⁵ of the series communicates by means of an opening e with a chamber L for the tailings or gangue after the metallic values have been separated. This chamber L is provided with a discharge opening e' provided with a valve e^2 controlled by a float e^3 in well known ways.

If it be necessary to maintain an even fluid level in all the settling compartments, it can be accomplished by providing openings or communications between said compartments controlled by slides or valves N.

As before stated, the pulp may be fed to the first tube f by means of a supply pipe x, or it may be fed to the first chamber E' by a pipe H. In fact pulp may be supplied simultaneously to the first agitation compartment from both of these sources. The several agitators and distributers are rotated simultaneously and continuously. In the first compartment the pulp is distributed and thoroughly mixed with the air thrown out by the agitator. The agitated pulp passes through the openings y into the settling chambers C'. The froth with the metallic values passes over into the launders a^2 while the settled material passes through the opening c to the chamber E² below the second agitation compartment B². In this compartment the settled pulp from the first compartment, deprived of some of its values, is thoroughly agitated and aerated and passes to the settling compartments on each side of it, the froth rising and overflowing into the launders a^2 and the settled material passing through the openings c to the cham-

ber E^3 below the third agitation compartment. The material in like manner passes through the other compartments in the series, the froth overflowing into the launders and the gangue passing to the chamber L. The froth may be conveyed away for further treatment. Preferably but not necessarily, the troughs or launders are continuous and preferably each agitation compartment is provided with a settling compartment on each side of it, although obviously it is only necessary to provide each agitation compartment with a single settling compartment.

By this apparatus a thorough commingling of the pulp with the air is accomplished in all of the compartments. Much of the metallic values is removed from the pulp in the first compartment and as the material passes through the several compartments the remaining metallic values are gradually separated so that the gangue which reaches the chamber L is practically free from all materials of value which it is desired to recover.

In Figs. 6 to 9 of the drawings I have shown some modifications. Much of the apparatus is similar to that before described and the parts are similarly lettered. In this case, however, the bottom *a* of the vessel is preferably inclined. The agitators and distributers are of the same construction as those previously described but in this case the tubes I are shown as being rigidly connected with the distributers and rotating with them. Instead of employing a continuous partition D, as shown in Fig. 1, a series of false bottoms *o* are used and the tubes I extend through said false bottoms and are free to rotate therein. The settling compartments are similar to those before described and communicate with the agitation compartments in a similar way except that each chamber below an agitation compartment communicates with the settling compartments associated therewith through openings *n*, that is to say, the settling compartments C′ communicate with the chamber E′ below the agitation compartment B′. The compartments C^2 communicate with the chamber E^2 below the agitation compartment B^2 and so on, so that in this way material which has passed from each agitation compartment is returned thereto for re-treatment but each agitation compartment communicates with the chamber below the next agitation compartment through an opening *r* and it is through these openings that the settled material passes through the apparatus to the discharge chamber L. The pulp may be fed to the tube *f* of the first agitator and it may be also fed to the first agitation compartment by a pipe H′ which communicates with the chamber E′ in the manner indicated. The agitated pulp passes from the first agitation compartment B′ to the settling compartments on each side of it and is returned in the manner before described. Settled material in the first compartment B′ passes through the port or opening *r* to the chamber E^2 below the second agitation compartment and in like manner the material passes from an agitation compartment to a settling compartment throughout the series and from the several agitation compartments to chambers below the succeeding agitation compartments and so on until the gangue or tailings finally reaches the chamber L from which it is discharged, while the froth containing values is received by the troughs or launders a^2 and conveyed away for further treatment.

It will, of course, be understood that any desired number of compartments may be employed for agitation, settling, etc. The specific number shown is not essential. The apparatus is self contained requiring no auxiliary apparatus to supply air under pressure, the rotary agitators serving to induce or draw in air which is forcibly discharged into the agitation compartments where it mingles thoroughly with pulp which is induced and distributed by the rotary pulp distributers associated with the rotary air distributers.

While I prefer to employ the chambers E′, etc. below the agitation compartments it is obvious that such chambers constitute part of the means for conveying the settled pulp from a settling compartment to the next agitation compartment in the series and that a more direct connection might be employed.

In case the pulp is fed to the first agitation compartment by way of the tube *f* only, as indicated at *x* in Fig. 1, it will not be necessary to provide a pulp distributer in the first compartment as the pulp is distributed by the same apparatus which distributes the air.

In my application for patent filed July 29, 1918, No. 247,155, I have shown an apparatus for concentrating ores comprising a tank and a rotary member which is provided with a set of passages extending from its central portion towards its periphery and a hollow member through which said passages are in communication with the atmosphere above the liquid which the tank is adapted to contain and another set of similar passages having both ends in communication with the liquid in the tank. Said application also shows a rotary head having a set of passages for gas or air extending outwardly from the center towards the periphery of the head and a set of liquid passages also extending towards the periphery, all said passages being open at both ends. The rotary head consists of an impeller somewhat similar to that herein shown and

described having axial inlet ports in its opposite walls and a discharge opening, a partition within the impeller in spaced relation to the opposite walls thereof and impeller blades on opposite sides of the partition. I do not herein claim such subject matter, it being claimed in my application for patent above mentioned which is a division of the present application.

I claim as my invention:

1. An apparatus for concentrating ores, comprising an agitation compartment, a settling compartment laterally disposed relatively to the agitation compartment and having an opening into said agitation compartment, a vertical series of horizontally disposed slats arranged across said opening for directing the rising air currents in the agitation compartment into the settling compartment, and means in the agitation compartment for distributing air and pulp therein.

2. An apparatus for concentrating ores, comprising a series of agitation compartments each provided with means for distributing pulp and air therein, a series of settling compartments communicating with the agitation compartments, a pulp-receiving chamber below each agitation compartment, means for conveying settling material from the lower portion of one settling compartment to the chamber below the next agitation compartment in the series, and means for separately removing the floating and settling material.

3. An apparatus for concentrating ores, comprising a series of agitation compartments, a series of chambers below said compartments, a series of settling compartments having communication with the agitation compartments to receive the agitated pulp therefrom, means in each agitation compartment for distributing air and pulp therein, and means for conveying settling material from each settling compartment to the chamber below the next agitation compartment in the series, and a communication between each of said chambers and the agitation compartment above it.

4. In flotation apparatus, an agitating compartment and a separating compartment, the upper portion of the agitating compartment having communication with the separating compartment, the bottom of the agitating compartment having an aperture therein, the lower portion of the separating compartment being in communication with said aperture, and a hollow agitator in said agitating compartment having its interior in communication with the separating compartment through said aperture whereby pulp passes through the agitator before entering the agitating compartment.

5. In flotation apparatus an agitating compartment and a separating compartment, the agitating compartment having an overflow into the separating compartment, the bottom of the agitating compartment having an aperture therein, the bottom portion of the separating compartment being in communication with said aperture, and a hollow agitator in the agitating compartment having a hollow extension fitting into said aperture and communicating with the interior of the agitator, whereby the interior of the agitator is in communication with the bottom portion of the separating compartment, and the pulp must pass through said extension and agitator before entering the agitating compartment.

In testimony whereof, I have hereunto subscribed my name.

FRANK GROCH.