W. E. GREENAWALT.

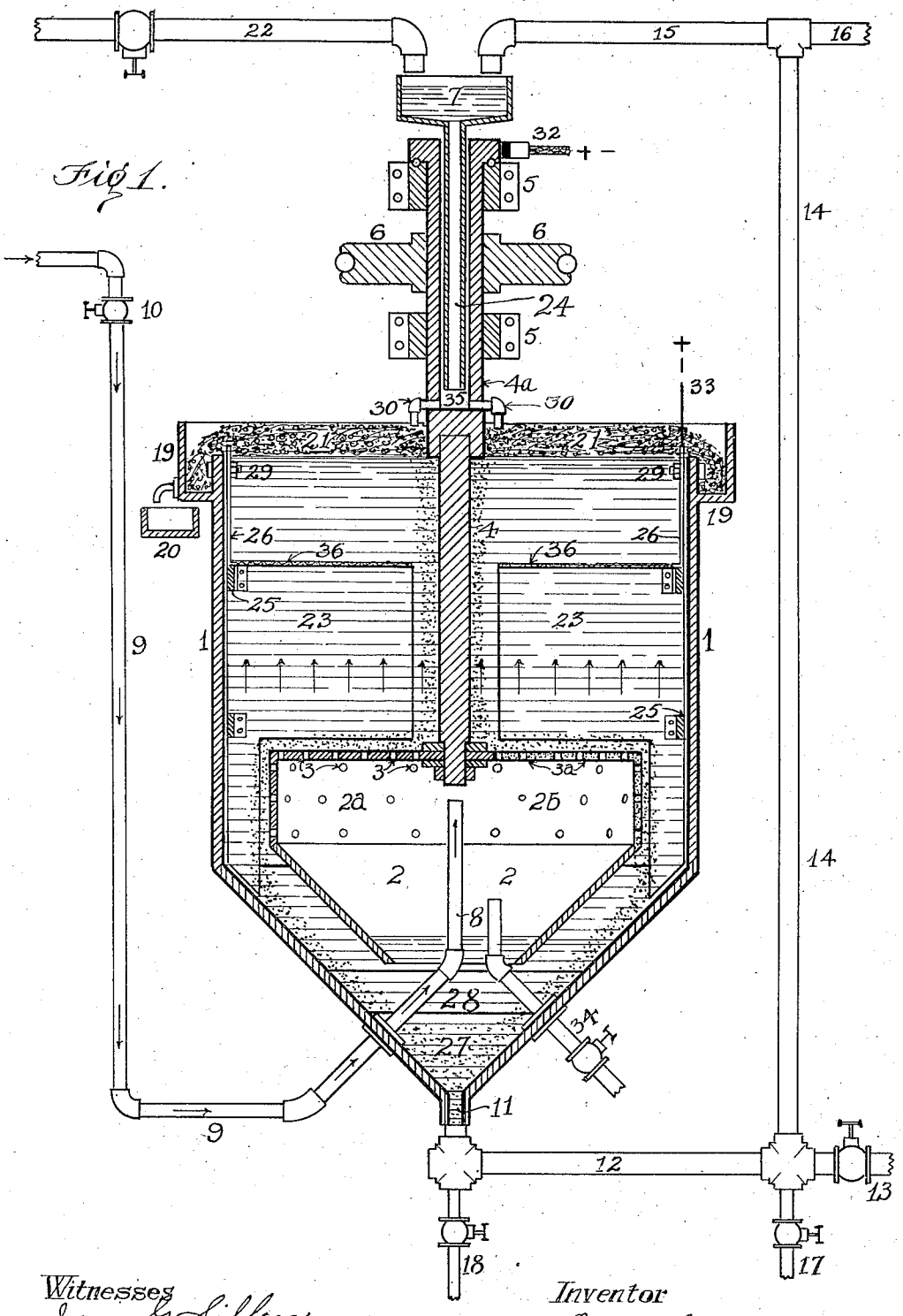
FLOTATION APPARATUS.

APPLICATION FILED DEC. 27, 1915.

1,374,499. **Patented Apr. 12, 1921.**

2 SHEETS—SHEET 1.

Fig 1.



Witnesses
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2 SHEETS—SHEET 2.

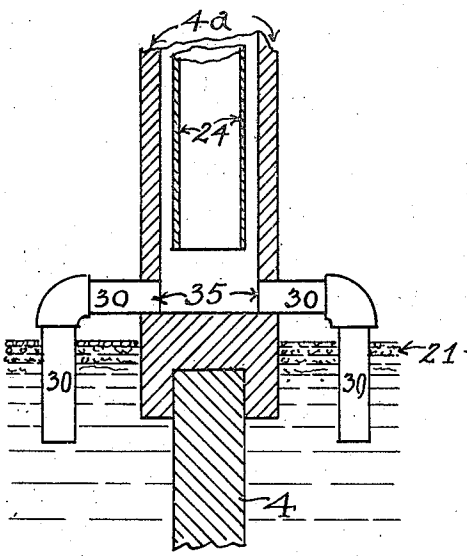


FIG. 2

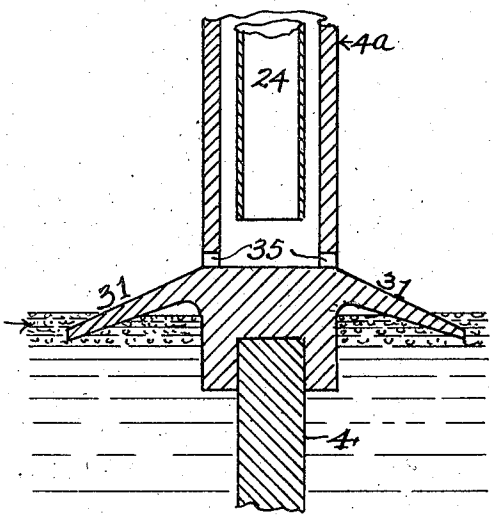


FIG 3

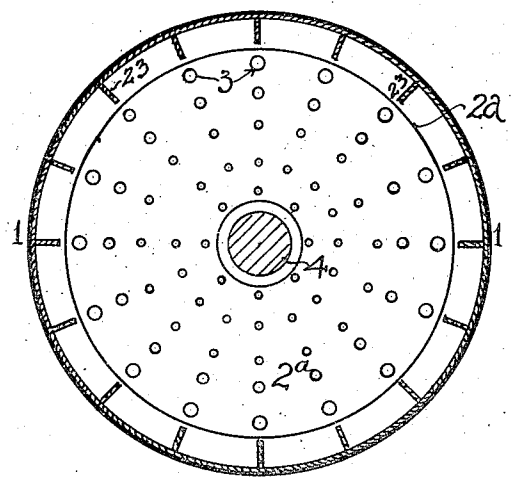


FIG 4

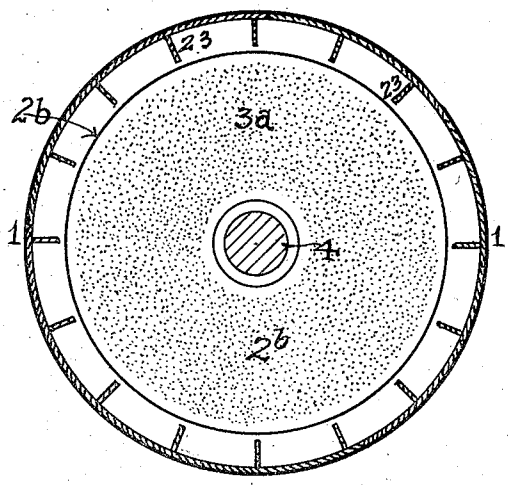


FIG 5

Witnesses

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UNITED STATES PATENT OFFICE.

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FLOTATION APPARATUS.

1,374,499. Specification of Letters Patent. Patented Apr. 12, 1921.

Application filed December 27, 1915. Serial No. 68,718.

To all whom it may concern:

Be it known that I, WILLIAM E. GREENAWALT, a citizen of the United States, residing in the city and county of Denver and State of Colorado, have invented certain new and useful Improvements in Flotation Apparatus, of which the following is a specification.

My invention relates to apparatus for the separation of mineral values from their gangue by flotation, and has for its object the cheap, effective, and economical recovery of the mineral values by flotation in an apparatus which is cheaply installed and which is simple in operation.

This application is a continuation in part of my pending application. Serial No. 58,748, filed October 30, 1915, and also a continuation in part of my pending applications, Serial No. 812,951, filed January 19, 1914 and Serial No. 845,011, filed June 13, 1914.

In the accompanying drawing Figure 1 is a vertical section through the apparatus; Fig. 2, a detail section showing the method of introducing the material to be treated into the liquid in the tank; Fig. 3, an alternative method for introducing and distributing the material to be treated into the liquid in the tank; Fig. 4, a horizontal section showing a perforated hood or surface, and Fig. 5, a horizontal section showing a porous hood.

Referring to the drawings, 1 is a tank adapted to contain a liquid and the material to be treated. 2 is a hood suspended within the tank and submerged in the liquid, and having perforations 3 (or porous material 3^a see Fig. 5) through which gases pass from the inside of the hood to the liquid in the tank. 4 is a shaft, a portion of which 4^a is hollow, rotating in bearings 5, by means of which the hood 2 is suspended and rotated within the tank when driven by the pulley 6. 7 is a feed hopper by means of which the material to be treated is fed into the tank through the stationary tube 24 within the hollow shaft 4^a, and passing through the holes 35, enters the liquid in the tank either through the distributing pipes 30 or over the distributing surface 31. See Figs. 4 and 5. If it is desired to feed the material close to the shaft 4^a, it is preferably fed through the pipes 30, and if it is desired to spread it in a thin sheet over the top of the liquid, it is preferably spread over the rotating surface 31. 8 is a pipe, preferably stationary, through which air or other gas may be delivered to the submerged hood, communicating with the source of gas supply through the pipe 9, having a gas regulating valve 10. The pipe 8 enters the mouth of the hood, and preferably delivers the gas above the liquid in the hood, although if the liquid enters the pipe 8, as it frequently may, no particular harm will be done, as it would again be expelled by the air or gas. 11 is an opening in the bottom of the tank through which the gangue may be removed by passing it through the pipe 12 and the regulating valve 13. If desired, the material may be returned to the tank for re-treatment through the pipes 14 and 15, or passed on to another similar apparatus, in series with it, for further treatment through the pipe 16. Air or other gas is introduced into the pipe 14 through the pipe 17, thus making an air-lift of the pipe 14. Clogging in the opening 11, in the bottom of the tank 1, is removed or prevented by an air or water jet introduced through the pipe 18. 19 is a launder into which the liquid may overflow and from which the floated products may be delivered into the trough 20. 22 is the feed pipe for the fresh ore delivered to the hopper 7 to be introduced into the tank for treatment. 23 are baffles arranged to retard the circulatory motion of the liquid in the tank. Any number of these baffles may be fastened to the hoops 25, and the baffles suspended in the liquid by the suspenders 26. The depth of the baffles in the liquid may be regulated by the bolts 29, arranged with the suspenders 26. Similarly, it may be desirable to have baffles 28 in the lower part of the tank to facilitate the settling down of the waste material, or gangue, into the bottom of the cone hopper 27. Samples from the hood may be taken through the pipe 34, and this pipe will also serve to determine the height of the liquid, or may be used to introduce another gas into the liquid.

The hood may be constructed in various ways. The two preferred arrangements are shown by 2^a which represents a perforated hood, and by 2^b which represents a porous hood. If perforations are used, the hood is rotated more rapidly than when a porous hood is used, for the porous material itself will help to finely subdivide, or atomize, the air in its passage through the hood into the liquid in the tank. The speed of rotation

may vary greatly, depending on whether a perforated or a porous hood is used: the nature of the material and the results desired. For small machines it may vary from several hundred to several thousand revolutions per minute: for large machines it will be considerably less. Perforated hoods will be rotated much more rapidly than porous hoods.

The height of the hood or depth in the liquid may also vary greatly, and the pressure of the gas will be determined by the hydrostatic head of the liquid in the tank above the hood. Rapid rotation of the hood will tend to generate a more positive electrostatic action, through frictional electricity, and thus assist in getting leaner tailings. It is preferred to have the surface of the hood quite smooth so that rapid rotation of the hood in the liquid will not consume excessive power.

In addition to the static electricity which is inevitably generated by the rapid rotation of the hood through the liquid, it may at times be desirable to pass an electric current through the liquid. This is readily accomplished by having one of the electric brushes acting on the shaft, designated by 32, and the other at the suspender bolts 29. The current will then pass through the shaft and hood, across the liquid, to the baffle plates 23, and out through the terminal 33.

The operation of the apparatus will now be described when used in the treatment of suitable ores. The tank 1 is filled with water or ore sludge. The hood 2 is rapidly rotated by the pulley 6. The valve 10 is then opened and air or other gas under pressure forced into the hood through the pipe 8, supplied by the pipe 9, and regulated by the valve 10. The gas so forced into the hood will displace a certain amount of liquid in the hood and escape through the perforations 3 or the porous material 3^a, but in escaping through the hood into the liquid in the tank, the gas is atomized, or finely subdivided, in contact with the liquid. The speed at which the hood is rotated will vary according to its size and the material treated: for small hoods it will usually be greater than for large ones. The idea in operating the apparatus, is to get the gas in a fine state of subdivision. The finer the subdivision, the more effective the application of the gas becomes, but this again may vary according to the material treated.

The hood may vary in details of construction, but for the purpose of the present description the idea is to have the surface of the hood quite smooth, so as not to agitate the liquid any more than is unavoidable, and to use as little power as possible. The hood, primarily, is not intended as an agitator but rather as an atomizer, as the preferred method of operation. The result will be that while the liquid in the vicinity of the hood has a tendency to circulate quite rapidly, this is obviated by the baffles 23, so that the liquid in the upper part of the tank will not be greatly disturbed and gives excellent conditions for the flotation froth to separate from the gangue and rise to the surface of the liquid.

The ore, crushed to a suitable degree of fineness, usually from 60 to 80 mesh, and treated with suitable frothing agents to facilitate flotation, such as oil, and possibly acid, is then introduced into the apparatus through the hopper 7, and, passing down through the stationary tube 24 in the hollow shaft 4^a is delivered to the openings 35 and passes into the liquid in the tank through the rotating pipe 30 or over the rotating surface 31. The more easily floatable particles will at once float, while the bulk of the ore will pass downwardly through the ascending bubbles, which will cause more particles to float. The liquid in the immediate vicinity of the shaft is not so much disturbed as that nearer the periphery of the hood, or of the tank, and there is less air. The ore working its way downwardly, lands on the surface of the hood near the shaft and then, due to the rotation of the hood, is gradually worked toward the periphery, where the action of the rotation and the action of the air is more violent and floats the remaining floatable particles. The gangue passes down between the hood and the tank and finally lands in the hopper 27, where it is removed through the opening 11 and the pipe 12, regulated by the valve 13; or, it may be returned for retreatment to the tank through the pipes 14 and 15, or passed on to another similar apparatus in series with it, through the pipe 16. The froth rises to the surface of the liquid in the tank, and is worked toward the launder 19, partly by the overflow of the water, and partly by the rotating shaft. Its rate of travel toward the launder is expedited and facilitated and regulated by the rotating pipe 30, or by the projecting surface 31, either by their action on the liquid itself, or indirectly, by air currents induced by the rotating shaft and accessory pipe, or surface which also acts as vanes.

The liquid in the upper part of the tank 1 may be made more quiescent by placing a coarse wire screen 36 on top of the baffles 23, but this will not ordinarily be necessary or desirable.

The gas in the hood is to a large extent self-regulating. The hood acts to a greater or less extent as a gas storage, or reservoir: if the hood becomes pretty well filled so that there is danger of the gas escaping at the bottom, the increased hydrostatic pressure will tend to force the gas out more rapidly

so that once the conditions are established for a certain depth of hood and the size of openings, those conditions are easily maintained. If the hood is very shallow, as may frequently be the case, the escape of air is regulated by the number and size of the openings, perforations, or pores. With a shallow hood some of the liquid may be forced with the gas through the perforations: this will do no harm, although in such cases the perforations should be large enough to prevent clogging by the material being treated. It is desirable to have the perforations near the shaft fewer in number, as well as smaller, than those nearer the periphery.

It will be observed that there is no mechanical connection between the rotating hood and the pipe 8 through which the gas is introduced into the hood. This is the preferred arrangement, for with a high rotary speed moving connections, such for example as when the gas is introduced through a hollow shaft, are exceedingly troublesome. The gas, introduced through the mouth of the hood, offers no mechanical trouble of any kind, no matter what the speed of rotation may be.

With high rotary speeds the tube 24 in the hollow shaft 4^a appears to be necessary: with slow rotary speeds the tube 24 may be omitted.

The size of the perforations in the hood is preferably varied, from small holes, say $\frac{1}{16}$ inch, near the shaft, to, say $\frac{1}{8}$ inch near the periphery, but the best conditions can only be obtained by actual experimenting. The holes are preferably made larger than the material to be treated so as to prevent the material from clogging the holes, if the gas is passed through perforations.

In operating the apparatus probably the best results are obtained by having several of them in series, and passing the gangue from one apparatus into the next. In such cases it is desirable to vary the conditions of operation, especially the speed of rotation and the submergence of the hood in the liquid.

It is not likely that any floatable mineral will get into the hood and cause trouble after the intense action the material has been subjected to in the upper part of the tank, but if any floatable mineral gets into the hood, it may be removed through the pipe 34. If a perforated hood is used, the idea would be to have the perforations large enough so that any floatable mineral, or even gangue, that got into the hood would pass through the perforations without obstructing them. If a certain amount of liquid is passed through the perforations with the gas that will do no harm. The apparatus is not sensitive in that respect.

In the preferred arrangement, as shown in the drawings, there is no mechanical connection between the gas pipe and the hood, and the gas escapes through the gas passages in the hood into the liquid in the tank by means of its own buoyancy, and the gas, once having been delivered into the tank, is no longer under the direct pressure from the source of gas supply.

I claim:

1. In apparatus for treating liquids with gases, a tank adapted to contain the liquid, a rotary member journaled on a substantially vertical axis submerged in the liquid, stationary members in proximity to the rotary member, and means for passing an electric current from the rotary member to the stationary members.

2. In apparatus for treating liquids with gases, a tank adapted to contain the liquid, a rotary member journaled on a substantially vertical axis submerged in the liquid, stationary members in proximity to the rotary member, means for passing an electric current from the rotary member to the stationary members, and means for introducing the material to be treated in the upper portion of the tank and allowing it to descend through the zone of electrification.

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Witnesses:
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IVA L. MYERS.