W. E. GREENAWALT.

APPARATUS FOR TREATING LIQUIDS WITH GASES.

APPLICATION FILED OCT. 16, 1918. RENEWED MAY 25, 1920.

1,374,446. Patented Apr. 12, 1921.

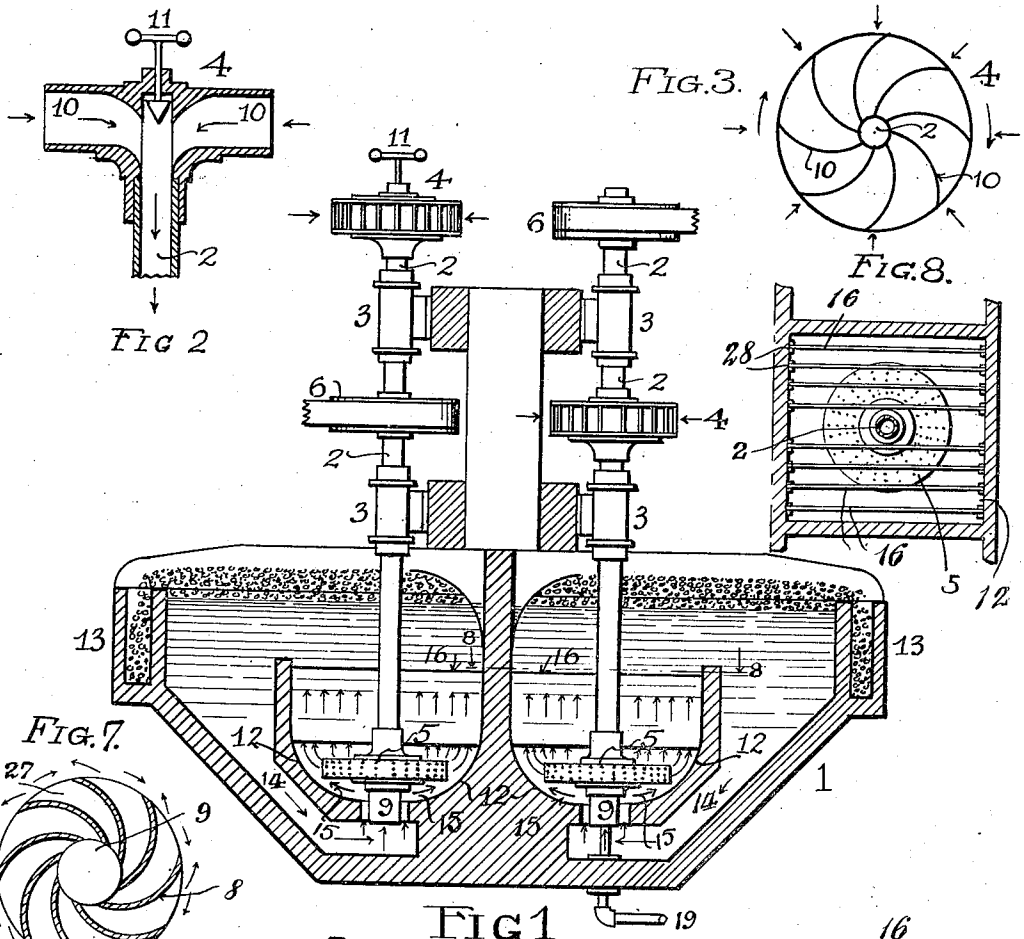

FIG. 1

FIG. 3.

FIG. 8.

FIG. 7.

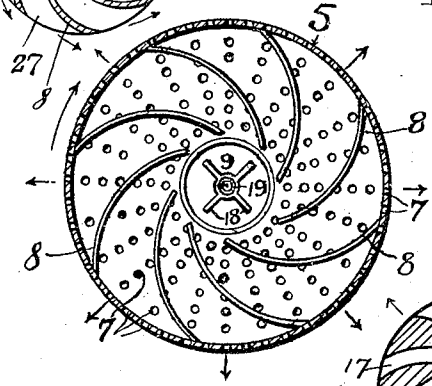

FIG. 4

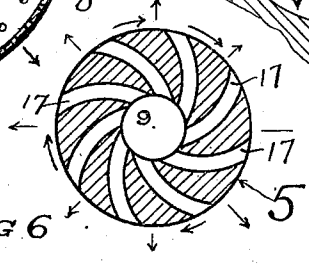

FIG 6

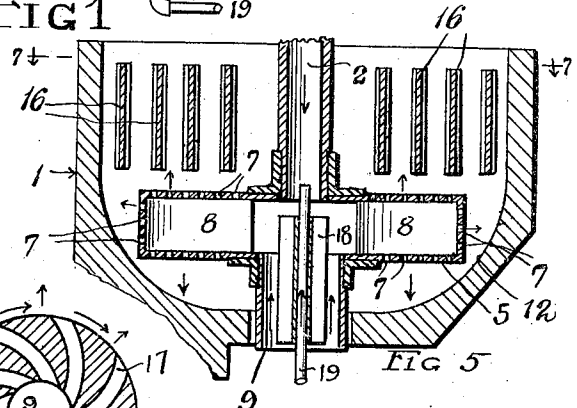

FIG 5

INVENTOR

William E. Greenawalt

UNITED STATES PATENT OFFICE.

WILLIAM E. GREENAWALT, OF DENVER, COLORADO.

APPARATUS FOR TREATING LIQUIDS WITH GASES.

1,374,446. Specification of Letters Patent. Patented Apr. 12, 1921.

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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 Apparatus for Treating Liquids with Gases, of which the following is a specification.

The invention has for its object the more effective application of gases to liquids to accomplish certain results, as, for example, the precipitation of metals from their solutions by a gas such as hydrogen sulfid, or in the flotation treatment of certain ores. It is not, however intended to limit it to any particular use, although in describing the apparatus, its use in the flotation of ores will be kept more or less in mind.

This apparatus may be regarded as a modification or improvement of that described in my co-pending applications, Serial No. 58,748, filed October 30, 1915, and Serial No. 91,675, filed April 17, 1916.

The best results in the flotation of ores of metals, under assumed conditions, are obtained when the air, or other gas, is finely sub-divided, or atomized, in the liquid. It may be said that the results are more or less proportional to the extent to which the gas is atomized. In sub-aerated machines in which the air is broken up by rapidly rotating paddles, the atomization is not effectively accomplished, either as to the fineness of the sub-division, or as to the power consumption. In consequence, also, there is not obtainable either the highest grade concentrate, or the highest possible extraction of the minerals from the gangue.

In the present invention, as in my co-pending applications referred to, extremely effective sub-division of the gas is accomplished by passing the gas through gas passages in an atomizer submerged in the liquid and revolving the atomizer at a high rotary speed. This is made practicable by the form of the atomizer, and is, more particularly, due to the fact that there is no mechanical connection between the atomizer and the stationary source of gas supply. It is not probable that with high rotary speeds a practicable connection can be made between gas passages of a gas atomizer in a liquid and a pipe supplying the gas from a stationary compressor of any kind. It would appear quite hopeless to maintain an air tight connection between a pipe line of a stationary air compressor of any sort and an atomizer mounted, say, on a hollow shaft rotating at a speed of, say, 500 R. P. M. Such connections have been tried in connection with flotation apparatus, but have never come into practical use, evidently on account of the inherent mechanical difficulties.

In my co-pending applications referred to, the gas is preferably introduced into the liquid from a stationary gas outlet and forced through the gas passages of the atomizer by the pressure of the liquid in the tank on the gas. This method is preferred in most instances because it admits of easy regulation of the gas within wide limits, and this regulation, in some types of machines, is quite essential for obtaining both a high grade concentrate and a high percentage of extraction. It may not always be convenient however, to supply the gas in this way, and in some types of machines close regulation of air is not necessary.

In the present apparatus the air, or gas, is supplied to the atomizer through a hollow shaft, and to get positive results an air impeller is mounted on the hollow shaft to force the air through the hollow shaft and through the gas passages in the atomizer. The impeller, at one end of the shaft, acts as a blower, while the atomizer at the other end of the shaft may act as an exhauster while expelling the air into the liquid.

The apparatus will now be described by referring to the accompanying drawings, in which Figure 1 shows a cross section; Fig. 2 a detail section of the impeller for forcing air through the hollow shaft; Fig. 3, a horizontal section of the impeller; Fig. 4 a horizontal section of the atomizer; Fig. 5, a vertical section of the atomizer, and Figs. 6 and 7, horizontal sections, respectively, of modified atomizers. The section in Fig. 5, is taken at right angles to that in Fig. 1. Fig. 8 is a small scale horizontal section on the line 8—8 of Fig. 1.

In the drawings 1 is a tank adapted to contain a liquid and the material to be treated, 2 is a hollow shaft vertically mounted in the bearings 3, 4 is an impeller for forcing gas into the hollow shaft when rotating at a proper speed, 5 is an atomizer, suspended within the tank and submerged in the liquid, which when revolved at a high rotary speed, atomizes the air, or gas, in the liquid.

The shaft may be belt driven by means of the pulley 6. The speed at which the shaft is rotated will ordinarily vary from 300 to 800 R. P. M. to get the best results.

The impeller 4, has curved blades 10 arranged so as to catch the air and force it into the hollow shaft, much the same as in an ordinary blower. The impeller rotates with the shaft. The amount of air forced by the impeller through the hollow shaft and to the atomizer, will depend somewhat on the shape of the impeller and the atomizer, but with a proper impeller and a proper atomizer it will depend almost entirely on the speed of rotation. The atomizing effect, under the same conditions, is also almost entirely dependent upon the speed of rotation; the higher speed giving the finer atomization of the air in the liquid. A little experimenting may be necessary in some cases to determine the most desirable speed for the best results for both the atomizer and the impeller. Some regulation may be had, without changing the speed, by means of the valve 11, attached to the impeller. In many instances the volume of air is immaterial; in such cases the rotary speed will be regulated for the best atomizing effect of the air in the liquid.

The atomizer, shown in detail in Figs. 4 and 5, is preferably made with a circular periphery and continuity of surface so as to admit of high rotary speeds with the smallest amount of agitation of the liquid and the smallest consumption of power. The gas passages, which extend from the interior to the exterior, or from the central portion of the atomizer toward its periphery, communicate with the hollow shaft; these gas passages may take the form of perforations as shown by 7, Figs. 4 and 5; of ducts of uniform cross section as shown by 17, Fig. 6, of ducts of variable cross sections as shown by 27, Fig. 7; or of both combined as shown in Figs. 4 and 5, where blades 8 are used in connection with the perforations 7. Blades 8, are arranged to assist in forcing the air, or, preferably, a mixture of air and liquid, toward the periphery, thus giving it a higher velocity impact in the liquid and consequent greater atomization, with a high rotary speed. The blades will also act to create a suction and assist the impeller in creating a flow of air through the shaft. The atomizer is preferably open to the liquid at the bottom, through the extension 9: in this way some of the liquid will be drawn into the atomizer, and, due to the blades 8, will be thoroughly mixed with the gas, and the mixture of gas and liquid expelled together through the gas passages 7 (or 17 and 27 Figs. 6 and 7, respectively). This will usually give the best atomization of the gas, and usually the best results are obtained in this way in the treatment of ores by flotation. However, if it is desired to expel the gas without mixing the liquid with it, the bottom opening of the extension 9, may be plugged. Various forms of atomizers may be used; the ones shown in the drawings will be found to give good results.

A positive upward flow of the liquid in the vicinity of the atomizer is produced by the gas acting as an air lift. It is also greatly assisted, or entirely accomplished, by having curved deflectors 12, which deflect both the gas and the liquid into a vertical stream, and this vertical stream creates a flow of liquid through the channels 14 and 15 upwardly past the atomizer, so that all the liquid is thoroughly treated. The forcible injection of the gas from the atomizer, into the vertical stream, further assists in sub-dividing the gas, as also the baffles 16 located above the atomizers. The baffles 16, as shown in Figs. 1 and 5, are placed above the atomizer to break up the circulatory motion of the liquid induced by the rapidly rotating atomizer and to prevent undue agitation of the surface of the liquid. In Fig. 5, which is supposed to be taken at right angles to the plane of section in Fig. 1, the baffles 16 are shown in cross-section. They are held in place by the grooves 28, and are loosely fitted, so that they can be inserted and removed as desired. The curved deflectors 12 will ordinarily simply be pieces of wood or metal, of the shape shown, inserted longitudinally between the sides of the tank.

In the flotation treatment of ores the froth rises to the top of the liquid and overflows into the froth launder 13.

A flow of gas may be obtained through the hollow shaft without the use of an impeller to force the gas through it, with a properly designed atomizer. The impeller, however, gives a more positive action, so that lower rotary speeds may be used, more gas caused to flow at the same rotary speed, and an atomizer may be used, if desired, which does not produce any suction in the shaft to cause a flow of gas. It will, ordinarily, be preferable to expel the gas from the atomizer with considerable violence, and this can better be obtained by expelling the gas with a positive pressure behind it, than when expelled entirely by suction and the centrifugal force producing the suction.

The location of the impeller on the shaft, above the liquid, is immaterial. Ordinarily the impeller for the gas will be at the upper end of the shaft and the atomizer at the lower end. The length of the shaft is of little consequence in the operation of the apparatus, for, with the positive gas current produced by the impeller, the resistance to the gas through the hollow shaft is easily overcome.

In Fig. 1, two cells are shown, back to back, with modified arrangement in each. This is purely a matter of convenience.

In order to insure a more thorough mixture of gas and liquid than that accomplished by the blades 8 alone, it is desirable to insert baffles 18, Figs. 4 and 5, in the interior of the atomizer. These baffles may be attached to a stationary pipe 19, if desired, and air may be introduced into the atomizer through the pipe 19 if desired. The gas and the liquid is thoroughly mixed before it enters the gas passages.

When gas and liquid are introduced into a common interior of a rotary atomizer, as in the present apparatus, it will be necessary to so proportion the liquid inlet and the gas inlet that both liquid and gas will be sucked into the interior. The proportion of the liquid inlet to the gas inlet can readily be determined experimentally for any particular speed of rotation and depth of liquid in the tank.

I claim—

1. In apparatus for treating liquids with gases, a tank adapted to contain a liquid, a rotatably mounted hollow shaft, means attached to the shaft above the liquid for causing a flow of gas through the hollow shaft, means submerged in the liquid attached to the shaft and rotating with it for atomizing the gas in the liquid, and means for rotating the shaft.

2. In apparatus for treating liquids with gases, a tank adapted to contain a liquid, an impeller rotating in a gas, an atomizer rotating in the liquid, a hollow shaft communicating with the impeller and the atomizer, and means for rotating the impeller the shaft and the atomizer with sufficient speed to cause a flow of gas through the hollow shaft and to atomize the gas in the liquid.

3. In apparatus for treating liquids with gases, a tank adapted to contain a liquid, a rotatably mounted hollow shaft, an atomizer having gas passages communicating with the hollow shaft suspended within the tank and submerged in the liquid, an impeller attached to the shaft above the liquid and arranged to force a gas through the hollow shaft to the atomizer in the liquid, and means for rotating the shaft.

4. In apparatus for treating liquids with gases, a tank adapted to contain a liquid, a rotatably mounted hollow shaft, means attached to the shaft above the liquid for causing a flow of gas through the hollow shaft working by pressure, means attached to the shaft and submerged in the liquid for causing a flow of gas through the hollow shaft working by suction, and means for rotating the shaft.

5. In apparatus for treating liquids with gases, a rotary atomizer arranged with gas passages from its interior to its exterior for atomizing a gas in the liquid, stationary means for mixing the gas with a portion of the liquid before ejecting the gas through the gas passages, and means for rotating the atomizer.

6. In apparatus for treating liquids with gases, a rotary atomizer arranged with gas passages extending from its interior to its exterior for atomizing a gas in the liquid, means for mixing the gas with a portion of the liquid before it passes into the gas passages, means for passing the mixture of gas and liquid through the gas passages, and means for rotating the atomizer about its vertical axis.

7. In apparatus for treating liquids with gases, a tank adapted to contain a liquid and the material to be treated, a rotary atomizer suspended within the tank and submerged in the liquid and having gas passages extending from its interior central portion toward its periphery, means arranged for ejecting a mixture of gas and liquid through the gas passages from the interior central portion of the atomizer toward its periphery and into the liquid in the tank, and means for rotating the atomizer about its vertical axis.

8. In apparatus for treating liquids with gases, a tank adapted to contain a liquid and the material to be treated, a rotary atomizer suspended within the tank and submerged in the liquid and having gas passages communicating with the liquid in the tank and extending from the central portion of the atomizer toward its periphery, means arranged for ejecting a mixture of gas and liquid through the gas passages from the interior central portion of the atomizer toward its periphery and into the liquid in the tank, and means for rotating the atomizer about its vertical axis.

9. In apparatus for treating liquids with gases, a tank adapted to contain a liquid, a gas impregnator within the tank having a hollow interior in communication with the liquid in the tank, means for causing a flow of liquid in the tank into the interior of the impregnator, means for causing a flow of gas into the interior of the impregnator, means in the interior of the impregnator for mixing the liquid and the gas, and means for ejecting the mixture of gas and liquid into the surrounding liquid in the tank.

10. In apparatus for treating liquids with gases, a tank adapted to contain a liquid, a rotary atomizer having passages extending from its interior central portion toward its periphery suspended within the tank and submerged in the liquid, a liquid inlet to the interior of the atomizer communicating with the passages and with the liquid in the tank, a hollow shaft gas inlet communicating with the interior of the atomizer

and with the atmosphere above the liquid, said liquid inlet and gas inlet being proportioned and arranged so as to cause a flow of both gas and liquid into the interior of the rotary atomizer and eject both gas and liquid through the passages of the rotary atomizer into the surrounding liquid in the tank.

11. In apparatus for treating liquids with gases, a tank adapted to contain a liquid, a rotary atomizer having gas passages extending from its interior toward its exterior suspended within the tank and submerged in the liquid, means for causing a flow of gas through a hollow shaft to the interior of the atomizer, means for causing a flow of liquid from the tank to the interior of the atomizer through a constricted opening, means for rotating the atomizer about its vertical axis, stationary means at the upper extremity of the hollow shaft for regulating the flow of gas through the hollow shaft, and means arranged for ejecting a mixture of gas and liquid through the gas passages from the interior toward the exterior and into the liquid in the tank.

WILLIAM E. GREENAWALT.