

April 6, 1926.

W. E. GREENAWALT

1,579,355

APPARATUS FOR TREATING LIQUIDS WITH GASES

Filed June 11, 1923

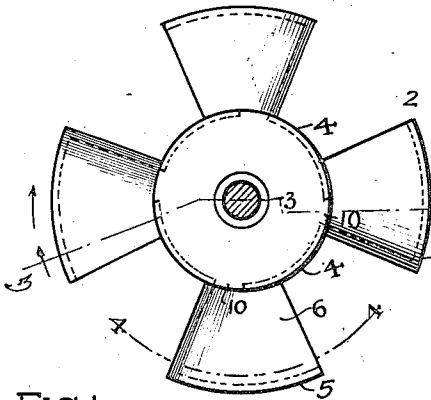


FIG 1

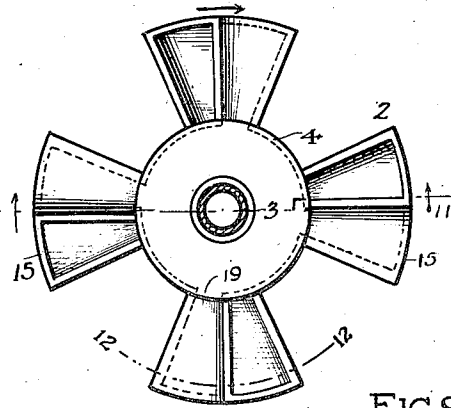


FIG 9

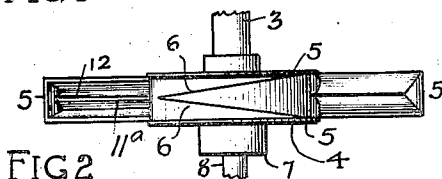


FIG 2

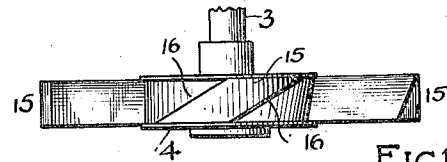


FIG 10

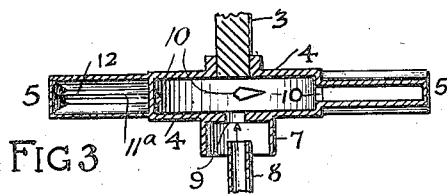


FIG 3

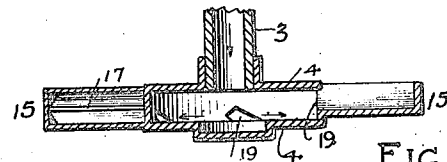


FIG 11

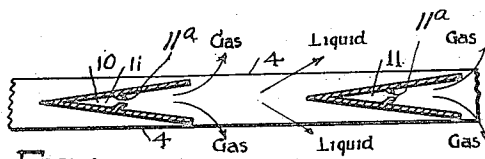


FIG 4

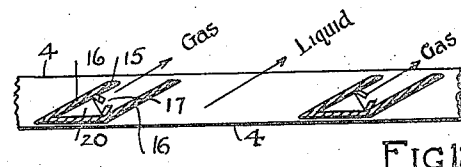


FIG 12

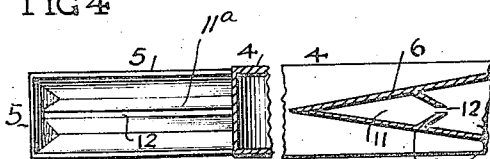


FIG 5

FIG 6

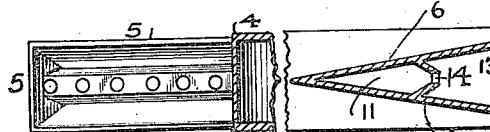


FIG 7

FIG 8

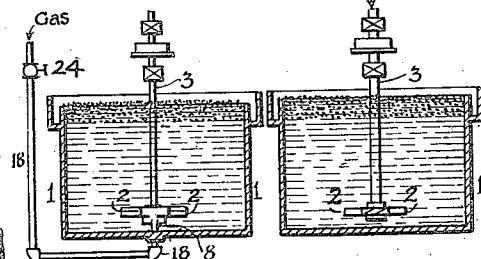


FIG 13

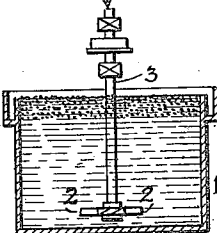


FIG 14

INVENTOR
William E. Greenawalt.

UNITED STATES PATENT OFFICE.

WILLIAM E. GREENAWALT, OF DENVER, COLORADO.

APPARATUS FOR TREATING LIQUIDS WITH GASES.

Application filed June 11, 1923. Serial No. 644,711.

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 effective atomization, or fine subdivision, of gas in liquid, to accomplish certain results, as for example, the application of gas to liquids to facilitate desired chemical reactions, and in the flotation treatment of ores.

This invention may be considered as an improvement, or modification, of that described in Patents No. 1,374,500, April 12, 1921: No. 1,374,446, April 12, 1921: and No. 1,374,445, April 12, 1921; and my pending application, Serial No. 571,819, filed June 29, 1922, discloses the form of invention shown in Figures 9 and 10 of the present application.

In the operation of the apparatus described in the above mentioned patents it has been observed that excellent results were obtained under some conditions and for some purposes by emphasizing the suction action of the stream of liquid in proximity to the gas outlets of the hollow rotary member. It has also been observed that while the suction action of the rotary member is dependent on the vacuum produced by displacing liquid in proximity to the outlets of the discharge passages of the rotary member, both the amount of suction and the degree of atomization of the gas in the liquid are very largely dependent on the form of the gas discharge passages. The distribution of the atomized gas in the liquid is also largely dependent on the form of the rotary member and the method of ejecting the gas of liquid. The power consumed is also largely dependent on the form of the rotary member and the design of the discharge passages. The object of the present invention is to embody these observations in an apparatus so that they can be given full practical application.

The invention can best be described by referring to the accompanying drawings in which Fig. 1 shows a plan of the preferred design of the rotary member or gas atomizer, Fig. 2 the corresponding elevation,

Fig. 3 the corresponding vertical section, Fig. 4 a developed section on the line 4—4 of Fig. 1, Fig. 5 a rear view of one form of discharge passage with a slot arrangement for distributing the gas, Fig. 6 the corresponding section, Fig. 7 a rear view of another form of discharge passage provided with holes for the distribution of the gas, and Fig. 8 the corresponding section.

Fig. 9 shows a modified form of rotary member or gas atomizer, Fig. 10 the corresponding elevation, Fig. 11 the corresponding vertical section, Fig. 12 a developed section on the line 12—12 of Fig. 9.

Fig. 13 shows the complete apparatus, in vertical section, when the gas is introduced through a stationary pipe. Fig. 14 shows the complete apparatus when the gas is introduced through a hollow shaft.

Referring to the drawings, 1 shows a tank adapted to contain liquid and the material to be treated, 2 the rotary member or atomizer journaled on a vertical axis 3 and suspended within the tank. 4 is a hollow central portion, or hub, of the rotary member from which radiate or project hollow members 5 forming discharge passages 5'. The sides 6 of the hollow discharge passages are inclined so as to form a hollow wedge, with the edge of the wedge facing the direction of rotation. The hollow of the wedge is positioned away from the direction of rotation. At the lower end of the hub 4 is a collar 7, adapted to receive gas from a stationary gas inlet pipe 8 and conduct it into the interior of the hollow hub 4 through the opening 9. From the interior of the hub 4 the gas flows, either by suction or plenum or both combined, through the perforations 10, in the side walls of the hub, and which communicate with the wedge shaped hollow discharge passages 5'. In order to distribute the gas evenly through the length of the outlet of the discharge passages and quite evenly through the liquid in the tank, a duct 11 is formed in the point of each member 5 by ribs 11^a which are arranged on the inner walls of the members 5 so that the discharge passage is reduced to a narrow slot 12 between the edges of the ribs. The gas distributing duct 11 corresponds to the perforation 10 and communicates with it. When the rotary member is rotated at the proper speed, a vacuum will be formed in

the interior of the wedge and surrounding the outlet, and in the intimate mixing of the gas and liquid, due to this vacuum, the gas is extremely finely subdivided or atomized. It will be understood that the gas may be sucked into the interior of the rotary member 2 through the stationary nipple 8 and pipe 18, or it may be delivered into the interior of the rotary member by pressure from without, or by a combination of pressure and suction. The flow may be regulated by the valve 24 in the pipe 18. Or, the gas can be sucked into the interior of the rotary member through a hollow shaft. The choice will depend on the operator and the conditions of operation.

If the liquid to be treated contains coarse material in suspension, a narrow slot 12 might get clogged, in which case it would be desirable to have holes 14, as shown in Figs. 7 and 8, communicating with the gas duct 11.

It has been observed, in the operation of the apparatus described by the patents referred to, that where gas is introduced into the hollow rotary member through a stationary pipe in the bottom, liquid necessarily enters with the gas, and while this is usually desirable, the amount of liquid should be limited or subject to regulation. If liquid is allowed to enter the rotary member in unrestricted amounts, the rotary member will act as a liquid pump and circulate large quantities of liquid. This is not usually desirable, and it is sometimes highly injurious. It will usually be best and practically always desirable to restrict the amount of liquid flowing into the rotary member, so that only small amounts of liquid will be introduced into the rotary member with the gas. The gas, in any event, will escape with the liquid, and will flow through the rotary member to the exclusion or restriction of the liquid, even if the liquid is given a free flow. It is very desirable, within certain limits, to control the flow of both the gas and the liquid, and usually to restrict the flow of the liquid to a small maximum flow. This may be done by restricting the size of the gas opening 9 into the rotary member. It may also be done by restricting the size of the perforations 10 between the hub 4 and the discharge passages 5. It may also be done by restricting the size of the slots 12, in the discharge passages. Ordinarily the restriction will be made in the gas opening into the rotary member. In this way the amount of liquid pumped and circulated will be relatively small and the power required to rotate the rotary member will be relatively small also.

The speed of rotation will depend somewhat on the material to be treated and the results desired. A peripheral speed of from 1000 to 2000 feet per minute will ordinarily

give good results. The rotary speed will, of course, depend largely on the size of the rotary member: for a rotary member 15 inches in diameter, 350 R. P. M. has been found to give good results, both for agitation and flotation, as also for aeration.

Figures 9, 10, 11, and 12, show a modification of the apparatus described, the principal difference being in the form of the discharge passages. In this modification the shaft 3 may be made hollow, and the discharge passages 15 are adapted to project the gas upwardly from the outlets into the liquid in the tank. When the rotary member is rotated at a proper speed, gas is sucked down through the hollow shaft and enters the central gas chamber 4, then flows through the ports or perforations 19 into the distributing ducts 20 and out through the slots 17 and into the tank through the unrestricted outlet of the discharge passage. The flow of gas is induced by the vacuum formed by the gas discharge passages.

In both types of rotary members, it will be noted that the form is such as to induce currents of liquid between the gas discharge passages, and the inclined sides of the discharge passages, at an angle to the plane of rotation, which tend to cause an upward movement of the liquid in the tank within the area of the peripheral circle. This upward movement of the liquid is less pronounced in the type of atomizer shown in Figures 1 to 8, than in the type shown in Figures 9 to 12.

The flow of gas through the rotary member, by suction, is dependent on the degree of vacuum produced by the hollow discharge passages, and that is dependent largely or mostly on the outlets of the discharge passages. Unrestricted outlets with divergent sides, or walls, in the form of a hollow wedge or funnel, with the outlets positioned away from the direction of rotation appear to give the best results.

I claim:

1. In apparatus for treating liquid with gas, a tank adapted to contain liquid, a hollow rotary member having a gas chamber at its central portion journaled on a vertical axis within the tank and submerged in the liquid, said rotary member having hollow members forming discharge passages projecting outwardly from the periphery of the gas chamber with open spaces between them within the area of the peripheral circle of the rotary member and having top walls disposed so as to form acute angles with the plane of rotation and adapted to create upward currents of liquid in the tank through the spaces between the discharge passages on the rotation of the rotary member, and means for supplying gas and liquid to the interior of said rotary member, said interior of the hollow rotary member being arranged

so that the gas and liquid will be ejected together through the discharge passages into the surrounding liquid in the tank.

2. In apparatus for treating liquid with gas, a tank adapted to contain liquid, a hollow rotary member having a gas chamber at its central portion journaled on a vertical axis within the tank and submerged in the liquid, said rotary member having wedge shaped radial hollow members forming discharge passages extending from the periphery of the central gas chamber to the peripheral circle of the rotary member with open spaces between them within the area of the peripheral circle of the rotary member and adapted to create upward currents of liquid in the tank through the spaces between the discharge passages within the area of the peripheral circle, and means for supplying gas to the interior of said rotary member.

3. In apparatus for treating liquid with gas, a tank adapted to contain liquid, a hollow rotary member having a gas chamber at its central portion journaled on a vertical axis within the tank and submerged in the liquid, a series of outwardly projecting wedge shaped hollow members forming discharge passages arranged about the periphery of the central gas chamber with open spaces between them within the area of the peripheral circle of the rotary member and positioned so that the acute angle of one discharge passage is adjacent to the outlet of the adjacent discharge passage, said members being adapted to create upward currents of liquid in the tank in the spaces between them, and means for delivering gas and liquid to the gas chamber of said rotary member.

4. In apparatus for treating liquid with gas, a tank adapted to contain liquid, a hollow rotary member having a gas chamber at its central portion journaled on a vertical axis within the tank and submerged in the liquid, a series of outwardly projecting hollow members forming discharge passages with divergent top and bottom walls arranged about the periphery of the central gas chamber with open spaces between them within the area of the peripheral circle of the rotary member and positioned so that the exterior angle of one of said members is adjacent to the outlet of the adjacent member, said members being adapted to create upward currents of liquid in the tank within the space between the discharge passages and within the area of the peripheral circle of the rotary member, and means for supply-

ing gas to the interior of said rotary member.

5. In apparatus for treating liquid with gas, a tank adapted to contain liquid, a hollow rotary member having a gas chamber at its central portion journaled within the tank and submerged in the liquid, outwardly projecting hollow members forming discharge passages arranged about the periphery of the gas chamber, said members having ribs arranged on their inner walls to form a slot between the edges of the ribs, and means for supplying gas to the interior of said rotary member.

6. In apparatus for treating liquid with gas, a tank adapted to contain liquid, a hollow rotary member having a gas chamber at its central portion journaled on a vertical axis within the tank and submerged in the liquid, said rotary member having hollow members forming discharge passages projecting outwardly from the periphery of the gas chamber with open spaces between them within the area of the peripheral circle of the rotary member and having walls adapted to create upward currents of liquid in the tank through the spaces between the discharge passages, and a stationary gas inlet in the lower portion of the tank adapted to deliver gas to the interior of said rotary member.

7. In apparatus for treating liquid with gas, a tank adapted to contain liquid, a hollow rotary member journaled in the tank and submerged in the liquid, said hollow rotary member having hollow members forming discharge passages communicating with the tank and having a collar at its lower portion and a partition with an opening of restricted area between the gas chamber and the collar, and means for delivering gas to said collar through a stationary gas inlet.

8. In apparatus for treating liquid with gas, a tank adapted to contain liquid, a hollow rotary member having a gas chamber at its central portion and elongated hollow members forming discharge passages projecting outwardly from the gas chamber to the peripheral circle of the rotary member with open spaces between them within the area of the peripheral circle, said members having inclined upper walls adapted to create upward currents of liquid in the tank within the area of the peripheral circle, and means for delivering gas to said rotary member through a stationary gas inlet.

WILLIAM E. GREENAWALT.