E. M. ROGERS.

AIR LIFT APPARATUS.

APPLICATION FILED AUG. 29, 1919.

1,339,137. Patented May 4, 1920.

Fig. 1.

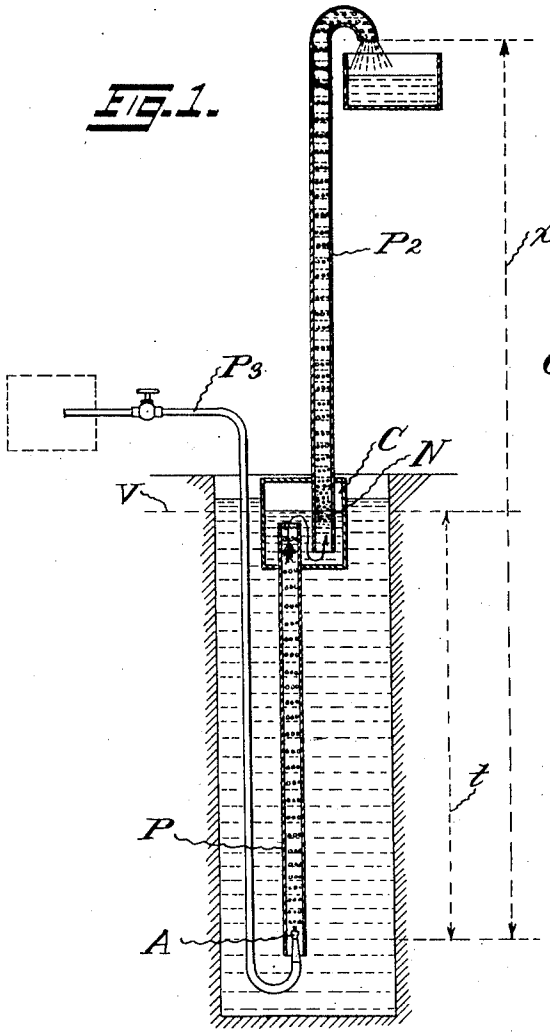


Fig. 2.

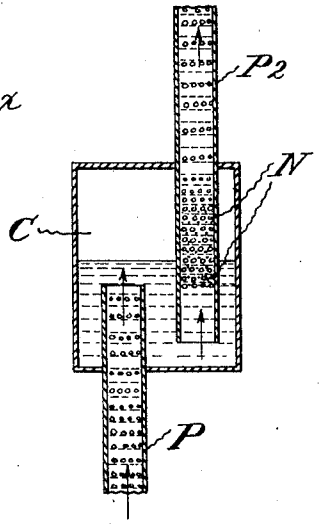


Fig. 3.

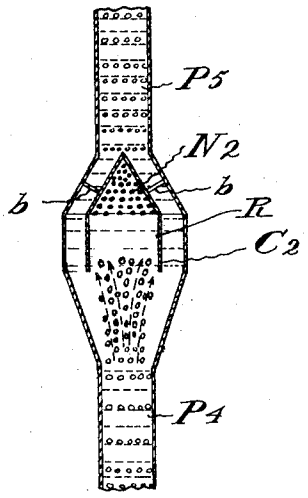
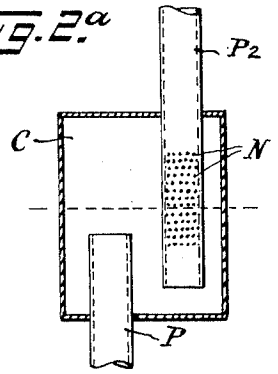


Fig. 2a.



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UNITED STATES PATENT OFFICE.

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AIR-LIFT APPARATUS.

1,339,137. Specification of Letters Patent. Patented May 4, 1920.

Application filed August 29, 1919. Serial No. 320,652.

To all whom it may concern:

Be it known that I, EDWIN M. ROGERS, a citizen of the United States, residing in New York, in the county of New York and State of New York, have invented certain new and useful Improvements in Air-Lift Apparatus, of which the following is a specification.

This invention relates to the class of fluid-elevating apparatus which is usually designated as air-lifts. A principal object of the present improvements is to organize and equip an air-lift apparatus in such a manner as to improve the efficiency and range of commercial applicability of this class of fluid elevating means; and to furnish an air-lift adapted to operate by an improved method or system.

In the accompanying drawings forming a part of this specification, Figure 1, is a side elevation of an air-lift apparatus organized in accordance with my present invention.

Fig. 2, is a sectional and partly diagrammatic side view (drawn on a relatively larger scale than Fig. 1,) of a mid-length portion of the apparatus illustrated in Fig. 1.

Fig. 2^a is a sectional and partly diagrammatic side view (on a relatively larger scale than Fig. 1,) of said mid-length portion of the apparatus showing the perforations or apertures in the upper pipe or uptake, and without liquid in said mid-length portion.

Fig. 3, is a sectional and partly diagrammatic side view of a modified form of the mid-length portion of the apparatus illustrated in Figs. 1 and 2.

Similar characters designate like parts in all the figures.

In the form of apparatus shown in Fig. 1, the total submergence effect should correspond, substantially as in ordinary practice, to the total height to which the fluid is to be elevated and the quantity of air used for aerating the uptake column to sufficiently reduce the weight thereof as compared with the weight, or gravity effect, of the submergence column. In some instances, if desired, the total submergence effect may be obtained by a relatively short height of the submergence column combined with a mechanically operated fluid-impelling means; this arrangement is not herein illustrated, but one form thereof is described in Letters Patent of the United States Number 1,319,797, granted to me October 28th, 1919, on my copending application Serial No. 242,363.

In the arrangement of apparatus herein shown (Fig. 1) for the purposes of illustration, the uptake line or column, comprises a lower air-lift pipe, or uptake, as P, and an upper air-lift pipe, or uptake, as P^2, each to be made of a size and proportions suitable to the requirements as to the capacity of plant, in any particular instance. These two air-lift pipes P and P^2 are to be provided each with, or have appurtenant thereto,—a suitable or well known fluid-aerating means or device, whereby the air supplied thereto may be so incorporated into, or mixed with the fluid, as to aerate properly the ascending fluid column. In practice I prefer to employ as such aerating means, an ordinary perforated air-lift nozzle,—preferably with the usual surrounding "hood" (not herein shown) whereby to subdivide finely or comminute the air into small masses or "bubbles."

In Fig. 1, the aerating device is indicated at A, (but only in a diagrammatic manner) in a position for aerating the fluid column at a point at or near to the lower end of said pipe P; in this instance the effective head, or height of the submergence column is shown by the distance line *t*.

The first, or lower air-lift comprising the pipe P, and the second or upper air-lift comprising the pipe P^2, are in coacting relation through a de-aerating chamber or tank, as C, which is a closed chamber, and is arranged for air and liquid separation; that is said chamber is closed as to the atmosphere, and closed excepting as to the inlet and outlet pipes or passage-ways, while the apparatus is in use. In practice, however, where the apparatuses are of large size, said chamber should be provided with suitable hand-holds, or with man-holes (not herein shown) for access to the interior, in accordance with a well known practice as regards boilers and tanks. Also, said chamber C, may be provided interiorly with baffle plates or other well known means (not herein shown) for accelerating or otherwise controlling the separating of the air from the aerated liquid. In the present instance, said aerated liquid is discharged into the chamber C from said lower air-lift pipe P, and the upper end of this pipe is indicated as being in a position for establishing in the chamber (while the apparatus is in normal

or full operation) a normal fluid end or level, at about the height indicated by the dotted line v, below which the liquid in the chamber C becomes, or may be designated, as "de-aerated," since it will then retain only a small proportion of the air contained therein at the time of maximum aeration.

The mode of action of said lower air-lift is in accordance with the usual practice in this art, except that, as already indicated,—the total submergence effect should be sufficient for the entire height to which the fluid is to be elevated, which in this instance is the distance shown by the line x, Fig. 1, from the aerator at A to the discharge end of the upper pipe P^2; the air being supplied from a compressor (not shown) through an air pipe P^3, is introduced into the liquid column through the nozzle or aerator A in the form of small bubbles which thus aerate and lighten the fluid.

When the air bubbles ascend from the aerator A in said lower pipe P, they are of small size, but constantly increase in size as they move upward, since the fluid itself constantly decreases in pressure as it moves upwardly. Now, in practice, it is known that the air bubbles not only displace fluid, (and so lighten the fluid column), but they have a tendency to float upwardly in the fluid and with relation to the column and thereby, through this "slippage" and the friction involved,—cause a very material loss of power and efficiency. Also, it appears the slippage of air bubbles increases during the expansion thereof, which may be due to the circumstance that the surface of the bubble increases less rapidly than the volume during such expansion, *i. e.*, as the square and as the cube, respectively, of the diameters.

Said expansion of the air bubbles results in a constantly increasing velocity and pipe-surface friction of the fluid column at successive points upwardly from the aerator, and also correspondingly increases the volume of a given weight of the aerated fluid, as this approaches the discharge end of the air-lift pipe; these phenomena are understood to occur in each of the air-lift pipes P and P^2. Under these conditions, and for the reasons above briefly explained, it has been found in practice, undesirable because of waste and loss, to employ the air lift system in many situations to which otherwise, this system would be well adapted.

In applying my present invention, it is contemplated to limit said lower air-lift line or uptake, as pipe P, to such moderate distance or height as will avoid any considerable loss of power by reason of increasing slippage, and to discharge the associated air and liquid directly into the aforesaid chamber C, for separation. From this chamber C, the second or upper air-lift pipe P^2, extends upwardly to the height required; or if this total height is deemed too great for economy of operation, two or more of the de-aerating chambers may be used in some instances.

For the purpose of restoring or regenerating the air bubbles when introduced into the upper pipe or uptake P^2 after loss of power and efficiency, I have devised a novel and peculiar means, Figs. 1, 2 and 2^a, comprising perforations or apertures N in the lower end of the upper pipe or uptake P^2, above the intake end thereof, said perforations or apertures N being adapted and arranged for aerating the liquid in said upper pipe or uptake P^2 by air supplied from the chamber C after separation from aerated liquid discharged from said lower pipe P into said chamber, the air in passing into said pipe P^2 through said perforations or apertures N being comminuted or sub-divided into small bubbles with the power and efficiency incident thereto. Thus the fluid after being once aerated and de-aerated is re-aerated in the upper pipe or uptake P^2, by a re-use of the same air supplied to the fluid at the lower end of said air-lift pipe P. By the perforations or apertures N, the air may be subdivided or comminuted in a regular and uniform manner, and I provide for converting into bubbles of the desired small size the whole quantity of separated air.

A modified form of the means for re-aerating is illustrated in Fig. 3, in which the lower pipe or uptake P^4 is provided with an enlargement which affords an air and liquid separation chamber C^2. The chamber C^2 is provided with a re-aerating member R, supported in the chamber C^2 by suitable means, such as the bars or rods b. The member R is somewhat like an inverted cup, the lower portion of which is arranged as a receiving portion for the segregated air, and the upper portion of which is provided with perforations or apertures N^2, for regenerating or comminuting the air received in the lower portion of the member R. The upper pipe or up-take P^5 is arranged as a continuation of, or in the line of the lower pipe or up-take P^4.

This modified form, Fig. 3, is not specifically claimed herein, but is the subject of a separate application Serial No. 371,392.

If necessary to provide for an increased number of air-bubbles in the upper pipe P^2, P^5, due to such re-aeration, the cross-sectional area of the upper pipes P^2, P^5, may be made proportionately larger than that of the lower pipes P, P^4, this arrangement providing for the same, or nearly the same, upward velocity of the aerated fluid in the lower part of the pipes P, P^4, and P^2, P^5.

Since, as well known, the function of the air bubbles is to lighten the specific gravity of a given mass of the content of the column, it is obvious that any available gases

may be used in place of atmospheric air, and hence it is to be understood that the term "air" is herein employed as a generic term for designating the air or other gases which may in any given instance be available for use in effecting the necessary reduction in the weight of the fluid contained within a given length of the up-take pipe.

Having thus described my invention, I claim—

1. In an air-lift, in combination, an air segregating chamber; an air-lift column connected for delivering by an upward stream, aerated liquid into said chamber; a second air-lift column leading upwardly from said chamber; and means within said chamber for comminuting the segregated air and delivering this comminuted air into said second air-lift column.

2. In an air-lift, in combination, two air-lift columns positioned at successive elevations, respectively, and a columns-connecting receptacle in position and arranged for receiving aerated liquid from a lower said column, and for de-aerating said aerated liquid and delivering this de-aerated liquid to an upper said column, said receptacle being provided with means in position and adapted for comminuting the air received from said lower column and delivering this comminuted air into said upper column.

3. In an air-lift, in combination, a first air-lift column provided with means for aerating therein an up-flowing stream of liquid; a laterally closed chamber arranged for receiving a stream of aerated liquid from said first air-lift column; a second air-lift column leading out of said chamber and extending upwardly therefrom; and, means appurtenant to said chamber and second air-lift column for de-aerating the liquid received from said first column and comminuting the air thereof, and delivering this comminuted air into said second column at a position above the level of the de-aerated liquid in said chamber.

4. In an air-lift, in combination, a first air-lift column provided with means for aerating therein an up-flowing stream of liquid; a laterally closed chamber arranged for receiving a stream of aerated liquid from said first air-lift column; a second air-lift column leading out of said chamber and extending upwardly therefrom, and having an inlet in position for receiving from said chamber a stream of de-aerated liquid; and means appurtenant to said second air-lift column for re-aerating the liquid received from said first column, said means comprising an air-comminuting device in position for delivering the comminuted air into said second column.

5. In an air-lift, in combination, a first air-lift column provided with means for aerating therein an up-flowing stream of liquid; a laterally closed chamber arranged for receiving a stream of aerated liquid from said first air-lift column; a second air-lift column leading out of said chamber and extending upwardly therefrom, and having an inlet in position for receiving from said chamber a stream of de-aerated liquid; and means appurtenant to said chamber and second air-lift column for de-aerating the liquid received from said first column, and comminuting the air thereof, said means comprising an air-comminuting device in position and arranged for delivering the comminuted air into said second column at a position above the level of the de-aerated liquid in said column.

6. That improvement in the art of air-lifting liquids, which consists in aerating by comminuted aeration-air, a column of liquid in a first uptake conduit which is subject to submergence-effect; next, at a height where the aeration-air has expanded and partially coalesced segregating said air and delivering the liquid into a second uptake conduit; and, then, subjecting the segregated air to recomminution and subjecting the liquid, after entering said second conduit, to re-aeration by said re-comminuted air.

7. That improvement in the art of air-lifting liquids, which consists in subjecting a column of liquid in an uptake conduit and under a submergence-effect to two successive aerations and at a point where the aeration-air has expanded and partially coalesced segregating and comminuting the aeration-air and then returning this comminuted air into the liquid for the re-aeration thereof.

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Witnesses:
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GEORGE J. BARTELS.