L. T. EDWARDS.

METHOD AND APPARATUS FOR LIFTING WATER.

APPLICATION FILED APR. 1, 1915.

1,213,170.

Patented Jan. 23, 1917.

2 SHEETS—SHEET 1.

FIG. 2.

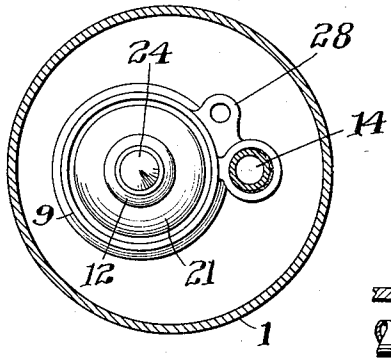


FIG. 1.

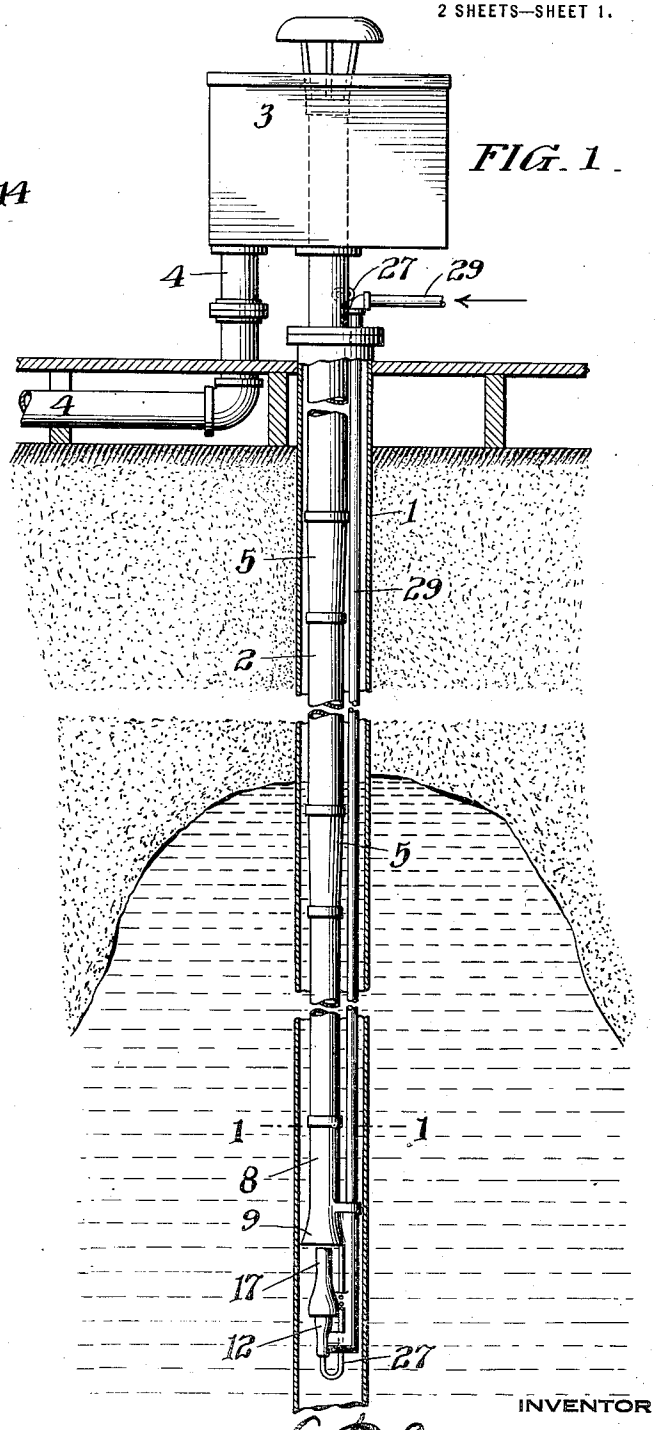
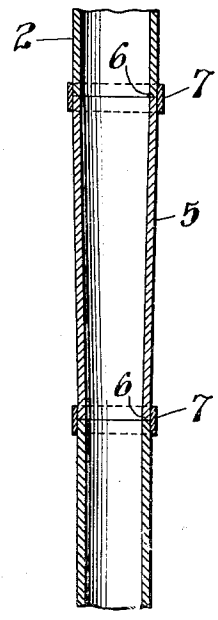


FIG. 3.



WITNESSES

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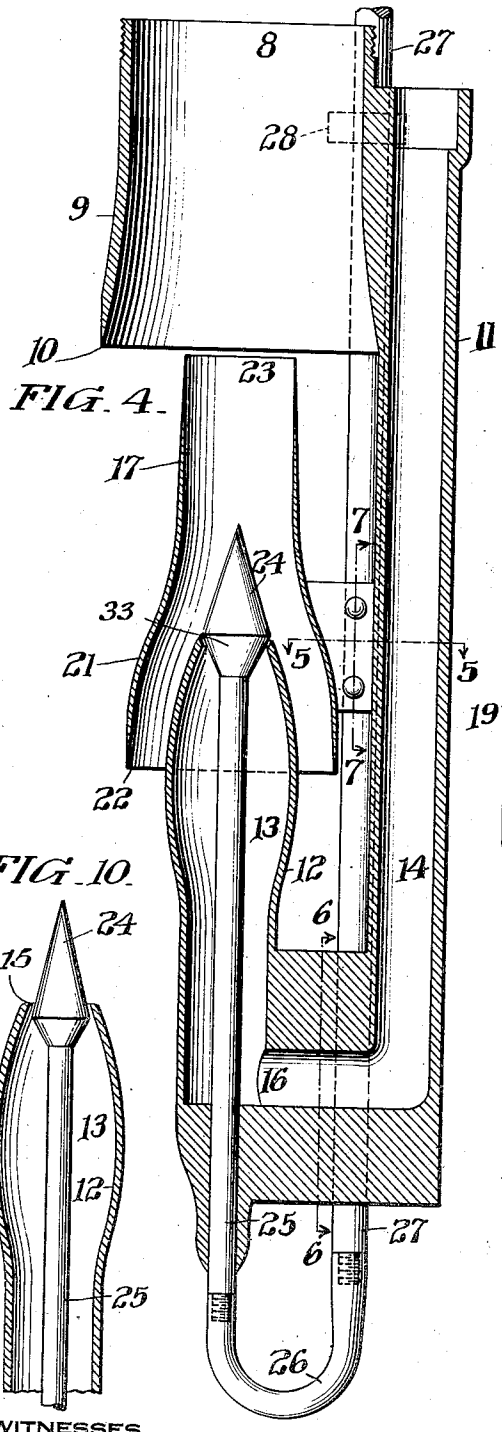


FIG. 4.

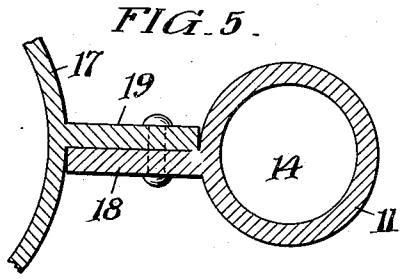


FIG. 5.

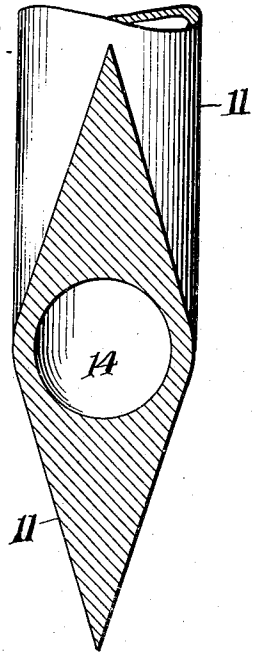


FIG. 6.

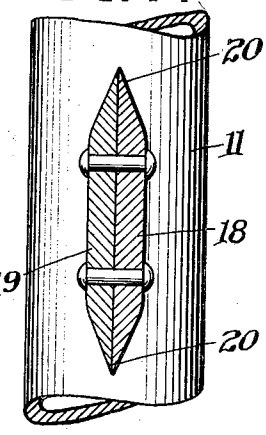


FIG. 7.

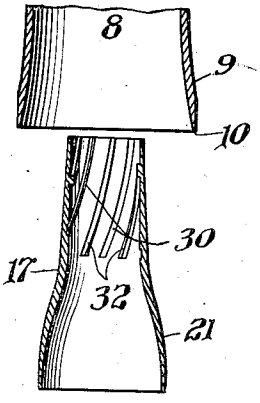


FIG. 8.

FIG. 10.

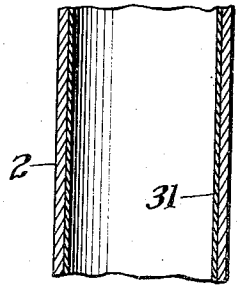


FIG. 9.

WITNESSES

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UNITED STATES PATENT OFFICE.

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METHOD AND APPARATUS FOR LIFTING WATER.

1,213,170. Specification of Letters Patent. Patented Jan. 23, 1917.

Application filed April 1, 1915. Serial No. 18,444.

To all whom it may concern:

Be it known that I, LEVI T. EDWARDS, a citizen of the United States, residing in Philadelphia, Pennsylvania, have invented certain new and useful Improvements in Methods and Apparatus for Lifting Water, of which the following is a specification.

My invention relates to a method of and apparatus for lifting and delivering water from a low level to a higher one in a substantially continuous, economical and efficient manner.

An object of the invention is to provide, in such a method and apparatus, a series of steps or operations carried out by certain novel mechanism whereby the friction of a moving column of water is reduced to a minimum, and the losses due to such cause are in a great measure eliminated.

A further object is to provide an air lift mechanism wherein the column of water moving to the point of discharge or reservoir has a free, unobstructed passage throughout its travel under the action of air under pressure.

Another object of the invention is to provide for staged reduction of the acceleration of the moving column of water through the conducting medium whereby friction is materially reduced.

A still further object is to provide an air discharge nozzle located at a predetermined submerged point within the well and below the inlet of the water delivery pipe or conduit whereby the moving column of water, induced by the action of the discharge air, is out of the zone of the air mechanism and its adjuncts and therefore has a free flow by way of the unobstructed delivery conduit.

In air lifts as heretofore constructed it has been found in practice that the frictional losses due to obstructing pipes or other parts of the air controlling means increases the frictional loss of the moving column of water and impairs the efficiency of the lift to a serious degree. Furthermore, such lifts suffer a reduction in efficiency in accordance with the depth of submersion so that lifts in use at the present time give a minimum efficiency with a minimum submersion. By my present invention I have provided a construction wherein the friction of the moving water is relatively exceedingly small, and in practice of the invention I have found the efficiency of the device has been increased to approximately sixty per cent. greater pumping capacity per cubic foot of air used than has heretofore been possible. This increase in efficiency prevails irrespective of the depth of submersion in comparison with other types of air lifts, with the result that the quantity of water discharged per cubic foot of air is a maximum for the particular location of the air jet with respect to the water level.

It further consists of other novel features of construction, all as will be hereinafter fully set forth.

For the purpose of illustrating my invention, I have shown in the accompanying drawings one form thereof which is at present preferred by me, since the same has been found in practice to give satisfactory and reliable results, although it is to be understood that the various instrumentalities of which my invention consists can be variously arranged and organized and that my invention is not limited to the precise arrangement and organization of these instrumentalities as herein shown and described.

Referring to the drawings: Figure 1 represents a sectional elevation of an air lift for water, embodying my invention; Fig. 2 represents a section on line 1—1 of Fig. 1; Fig. 3 represent a sectional elevation of a portion of the delivery pipe showing more particularly the connector between adjacent sections of the delivery pipe; Fig. 4 represents a longitudinal section of the air discharge nozzle and its adjuncts in operative position adjacent the inlet to the delivery pipe; Fig. 5 represents a section on line 5—5 of Fig. 4; Fig. 6 represents a section on line 6—6 of Fig. 4; Fig. 7 represents a section on line 7—7 of Fig. 4; Fig. 8 represents a section of a modified form of the mixing tube or nozzle; Fig. 9 represents a section of a portion of one of the conduits for water showing a modification of the invention; Fig. 10 represents another embodiment of the air discharge nozzle.

Similar numerals of reference indicate corresponding parts.

1 designates the well proper, having the delivery pipe or conduit 2 extending downwardly therein with its inlet end submerged to a suitable depth below the level of the water in the well and its outlet end arranged to discharge into the reservoir or tank 3 as will be readily understood. The

well 1 is here shown as a pipe or casing terminating within the water bearing strata, but it is to be understood that I do not wish to be restricted to the use of such a piping as obviously the bounding walls of the well may be variously constructed without departing from my invention. The tank 3 is provided with an outlet pipe 4 leading to a suitable reservoir or point of use located at any convenient point according to requirements. In connection with the delivery pipe or conduit 2 it will be noted that in the preferred embodiment of my invention the same increases in diameter from the bottom toward the top, such increase taking place at suitable stages and the respective pipes of different cross sectional dimensions being connected by the connectors 5. These connectors 5 are preferably of frusto-conical form having upwardly tapered walls diverging toward the top of the discharge or delivery pipe, thereby lowering the acceleration of the moving column of water and consequently reducing the friction. In connection with the delivery pipe 2, attention is directed to the fact that the several sections thereof have their end portions arranged in abutting relation in order to form a continuous uninterrupted discharge channel with no lost energy due to the water impacting against shoulders, projections or the like. The type of joint above referred to is illustrated in Fig. 3 by the reference numeral 6 and the abutting portions of the joint are retained in place by a suitable coupling ring 7.

8 designates the inlet section or foot piece of the delivery pipe, the same being of suitable length and having the inlet end thereof outwardly flared as shown at 9 and terminating in a knife edge 10 directed toward the incoming water in order to cut or divide the water entering the pipe from the main body in the well. Such a construction not only provides a relatively wide inlet mouth but also forms easy curves for the flow of the water and consequently results in less friction. In the present instance the inlet section 8 is cast as a part of the casing 11 which has as an integral part thereof the air jet or nozzle 12. It will be understood, however, that I do not wish to be limited to these parts as a single casting, as this is only the preferred form shown by way of example, and it will be obvious that the construction may be readily changed to suit requirements. The nozzle 12 is preferably of tubular form to provide a chamber 13 into which the air under pressure is admitted from the channel 14 formed within the casing 11. That portion of the casing joining the nozzle structure is preferably substantially of diamond shape in cross section as shown in Fig. 6, the longitudinal axis of the diamond being arranged parallel to the axial flow of the column of water so that there is a minimum amount of resistance offered to the free flow of the water.

Referring more particularly to the nozzle 12, it will be seen that the walls thereof approaching the outlet opening 15 are of curved contour, being outwardly flared from a point adjacent the air inlet 16 and then converging and terminating in the nozzle opening 15.

17 designates a mixing tube located in alinement with the inlet section 8 and the nozzle 12, having a portion encircling the end of the air nozzle for the purpose of causing an initial movement of a portion of the liquid and mixing it with the incoming air prior to impacting with the column of water in the delivery pipe. The attaching means for this mixing tube consists preferably of a lug 18, shown as cast integrally with the casing and adapted to seat against a similar lug 19 of the tube 17 and be clamped or riveted together, as will be understood. It will be noted in cross section that these lugs have correspondingly tapered end portions 20 forming relatively sharp edges in the path of the moving water to reduce the resistance to the flow. The mixing tube 17 is open at both ends, having the lower end outwardly flared as shown at 21 to encircle the discharge end of the nozzle and provide a suitable circumferential passage for the water. The flaring side walls of this tube are also tapered to provide the knife edge 22 which is opposed to the direction of flow of the water and performs the same function of reducing friction as heretofore explained. The opposite end of the tube 17 forms a discharge opening 23 located below, even with or within the inlet of the section 8 as conditions indicate, the said parts being, as previously described, substantially axially alined so that the mixed air and water are projected directly into the inlet section and mingle with the main body of water drawn or forced directly into the delivery pipe. The walls of the tube 17 bounding the outlet 23 are tapered toward the said outlet to a relatively sharp edge so that the two masses of moving water become effectively merged without producing eddy currents or the like. In connection with the flared inlet end of the tube 17 it will be noted that the curvature of this part is substantially concentric with the curve of the outer wall of the nozzle, thereby providing an easy path of flow for the water.

24 designates a valve piece, preferably of conical form, which is adapted to operate exterior of the discharge opening 15 of the nozzle to regulate and adjust the quantity of air delivered from the nozzle according to requirements. The valve piece 24, as here shown, is connected to a stem 25 which passes

exterior of the casing 11 and has connection, by way of a return bend pipe 26, with the operating rod 27 which extends upwardly through the well to a suitable point above ground where it may be manually or otherwise controlled. The delivery pipe is provided with guide lugs 28 arranged as necessary to support and permit proper movement of the rod 27 as will be understood. It will also be evident that the air supply pipe 29 extends from the casing 11 up through the well and has suitable connection with a source of compressed air.

In the modification shown in Fig. 8, I have provided the mixing tube 17 with internal spiral grooves 30, giving the effect of a rifled surface and adjacent which I preferably provide spirally arranged vanes 32 so that the mixed air and water passing through the tube are given a spiral or swirling movement which causes a thorough inter mixing with the main body of water and prevents the formation of air pockets in the delivery pipe with a consequent loss of efficiency.

As a further modification I have indicated in Fig. 9 a portion of one of the water conduits provided with an anti-friction lining 31, preferably of vitreous materials such as enamel or the like which presents a hard, polished surface for contact with the moving water, in order to still further reduce the frictional losses. While I have in this instance shown this lining as applied to a section of the delivery pipe, it will be understood that the inlet section 8, mixing tube 17 and other parts of the mechanism exposed to the flow of the water may be similarly coated without departing from the spirit of my invention.

In Fig. 10 I have shown another embodiment of the valve for controlling the air nozzle, wherein the valve piece 24 is located within the nozzle and provided with a conical portion which is arranged to seat against the interior wall of the nozzle and thus operates in the reverse manner from that described for the construction shown in Fig. 4.

In the operation of the device the delivery pipe is positioned within the well proper and arranged to terminate at a suitable depth below the level of the water in the well so that the inlet section 8 and the nozzle adjuncts operating in conjunction therewith are located at the most effective depth for efficient lifting of the water. The gravity flow of the water naturally causes it to rise within the well casing 1 to the level of the surrounding body of water, and the admission of compressed air through the nozzle structure and beneath the column of water contained within the delivery tube causes the said column to be set in motion upwardly and discharged into the tank 3. The action of the device is substantially continuous, the water being lifted by way of the delivery pipe under the action of the air, and owing to the elimination of a large part of the frictional losses the quantity of water discharged by the apparatus is a maximum as compared to the quantity of air supply. It will further be noted that the valve rod 27 may be manually or otherwise operated from a point exterior of the well so that the valve piece may be adjusted to suit requirements and supply the proper quantity of air for the purpose intended. A disadvantage inherent in previous air lifts is that frequently the air nozzle becomes clogged with mud, sediment or other debris, thereby rendering the apparatus temporarily inoperative and necessitating the removal of the parts before the apparatus is again in condition for use. By my present construction, however, this disadvantage is eliminated since the valve rod 27 may be shifted to entirely open the nozzle, thereby permitting the air pressure to blow out the collected sediment or debris clogging the outlet.

The novel method which I have devised, and of which the foregoing apparatus illustrates one means of carrying it out in practice, consists in introducing air under pressure to a submerged point in a well, there discharging the air and mixing it with a body of water below a column of water to be lifted, and discharging the moving mixture of air and water into the column of water. By this method a certain quantity of water becomes intimately mixed with the compressed air and is given an initial velocity which combines with the column of water to be lifted so that air pockets are eliminated and the air more effectively acts in the capacity of a discharging medium for the water. The method further consists in reducing the acceleration of the moving column of water as it approaches the delivery point, such reduction of acceleration being accomplished by expansion of the conducting medium at different levels or stages according to the depth of the well and other requirements.

It will now be apparent that I have devised a method and apparatus for lifting and discharging water in a continuous manner, with a maximum degree of efficiency, and wherein frictional resistance is either eliminated or reduced to a minimum. In this connection attention is directed to the construction of nozzle, the casing, the mixing tube, and the inlet section, wherein the parts thereof which are opposed to the direction of flow of the water are provided with relatively sharp edges formed by converging or tapered surfaces, so that that portion of the moving water having these parts in its path passes along lines offering the least resistance to the flow and reaches the inlet to the delivery pipe with comparatively small fric-

tional losses. It will further be noted that the air discharge nozzle and its adjuncts are located both below the inlet to the delivery pipe and the main column of water to be lifted, so that this latter in its passage to the discharge point does not contact with any parts of the nozzle mechanism, and therefore has a free, unobstructed flow throughout the length of the said delivery pipe.

The mixing tube which partially encircles the air nozzle is preferably constructed so that its cross sectional area decreases from the inlet end for the water to a point substantially opposite the end of the valve piece, and consequently, in view of the fact also that the flaring end is concentric with the curve of the nozzle, there is a water space provided about the nozzle which gradually decreases so that the water flows along free easy curves within the said tube. This line of flow is further effectually aided by the conical projecting end of the valve piece which serves to prevent the formation of a pocket at the end of the nozzle which might otherwise cause reverse or eddy currents. The entire construction, therefore, of the nozzle, the valve and the mixing tube, is such as to provide long curved surfaces and knife edges in order that the least possible resistance may be offered to the water moving over such surfaces. Furthermore, by providing for the adjustment of the air valve at the end of the air nozzle it is possible to directly throttle the air at the discharge opening, and secure a higher velocity of the air jet and expansion of the air at this point.

While I have, in the foregoing description, referred to the device as used as an air lift for water, I wish it understood that I do not wish to be limited to this specific use, since obviously it is equally applicable for use in connection with other liquids, and the term "water" is therefore employed only by way of example. It will also be understood that I have used the term "delivery pipe" in its broad sense as a conduit for conveying water, and therefore I do not wish to be restricted as to its scope.

Having now described my invention, what I claim as new and desire to protect by Letters Patent is:

1. In an apparatus for lifting water, the combination of a well, a delivery pipe extending into said well, a foot piece secured to said pipe and having a flaring unobstructed inlet end submerged in the body of water, a nozzle located below said foot-piece and arranged to discharge air under pressure into said foot piece and means to supply compressed air to said nozzle.

2. In apparatus for lifting water, the combination of a well, a delivery pipe extending into said well and having a foot piece terminating in a submerged unobstructed inlet, a nozzle located below said foot piece and arranged to discharge air under pressure into said delivery pipe and means to supply compressed air to said nozzle.

3. In apparatus for lifting water, the combination of a well, a delivery pipe extending into said well and having a foot piece terminating in a submerged unobstructed inlet, a nozzle located below said foot piece and arranged to discharge air under pressure into said delivery pipe and means exterior of said delivery pipe to supply compressed air to said nozzle.

4. In an apparatus for lifting water, the combination of a delivery pipe extending into a body of water, an inlet section secured to the lower end of said pipe having a flaring unobstructed inlet end, a nozzle provided with an outlet located below said inlet section and arranged to discharge air under pressure into said inlet section, and means to vary the size of said outlet, said means being operable above the level of the body of water.

5. In an apparatus for lifting water, the combination of a well, a delivery pipe extending into said well, an inlet section secured to the lower end of said pipe, a nozzle located below said inlet section and arranged to discharge air under pressure into said inlet section, and a mixing tube having a portion encircling said nozzle and having its discharge end located in alinement with said delivery pipe and in close proximity to the inlet of said inlet section.

6. In an apparatus for lifting water, the combination of a well, a delivery pipe extending into said well and having a foot piece terminating in a submerged inlet, a nozzle located below said inlet and arranged to discharge air under pressure into said delivery pipe, and a mixing tube arranged to project mixed air and water into said delivery tube and having a gradually decreasing cross sectional area for a portion of its length whereby a water space is provided between said tube and nozzle having relatively long curved bounding walls offering minimum resistance to the flow of water.

7. In an apparatus for lifting water, the combination of a delivery pipe extending into a body of water and having a submerged inlet, a nozzle located below said inlet and having its outlet arranged to discharge air under pressure into said delivery pipe, and a valve piece for said outlet having a substantially conical part extending exterior of said nozzle, the converging surface of which forms substantially a continuation of the outer walls of said nozzle.

8. In an apparatus for lifting water, the combination of a delivery pipe extending into a body of water and having a submerged inlet, a nozzle located below said inlet and having its outlet arranged to dis-

charge air under pressure into said delivery pipe, a valve piece for said outlet having a substantially conical part extending exterior of said nozzle, the converging surface of which forms substantially a continuation of the outer walls of said nozzle, and means operable above the level of the body of water for adjusting the position of said valve piece.

9. In an apparatus for lifting water, the combination of a well, a delivery pipe extending into said well and increasing in cross sectional area at intervals from the inlet end of said pipe, frusto-conical connectors respectively joining adjacent sections of different cross sectional dimension, an inlet section secured to the bottom of said pipe having an unobstructed inlet, and a nozzle located below said inlet section and in alinement therewith whereby air under pressure is discharged beneath the column of water contained within said delivery pipe.

10. In an apparatus for lifting water, the combination of a well, a delivery pipe extending into said well, an inlet section secured to the bottom of said pipe having outwardly flared tapered walls forming a relatively sharp edge disposed in the path of movement of the water, a nozzle positioned below said inlet section and arranged to discharge air under pressure into said inlet section, and a mixing tube partially encircling said nozzle and having the side walls thereof forming the discharge opening concentrically arranged with respect to the flaring walls of the inlet section.

11. In an apparatus for lifting water, the combination of a delivery pipe extending into a body of water, an inlet section secured to the bottom of said pipe having outwardly flared, tapered walls forming a relatively sharp edge disposed in the path of movement of the water, a nozzle positioned below said inlet section and arranged to discharge air under pressure into said inlet section, and a mixing tube partially encircling said nozzle and having the side walls forming the discharge opening concentrically arranged with respect to the flaring walls of the inlet section, and the opposite end of said mixing tube having tapering walls forming a relatively sharp edge disposed in the path of the moving water whereby frictional losses are reduced.

12. In an apparatus for lifting water, the combination of a delivery pipe extending into a body of water, a casing supported adjacent the inlet end of said pipe, a nozzle positioned below the inlet end of said pipe for discharging air into said delivery pipe, and means for connecting said nozzle to said casing, said means embodying tapering surfaces forming a relatively sharp edge disposed in the path of movement of the water, whereby friction is reduced.

13. In an apparatus for lifting water, the combination of a delivery pipe extending into a body of water, a casing supported adjacent the inlet end of said pipe, a nozzle located below the inlet end of said pipe and arranged to discharge air into said delivery pipe, a mixing tube for air and water arranged about said nozzle, said tube and casing being provided with means for reducing the friction of the moving water.

14. In an apparatus for lifting water, a delivery pipe extending into a body of water and having a submerged unobstructed inlet, a foot piece secured to said pipe and terminating in an inlet, and a nozzle located below said inlet and arranged to discharge air under pressure into said inlet section, said delivery pipe having a lining of anti-friction material.

15. In an apparatus for lifting water, a delivery pipe extending into a body of water a foot piece secured to said pipe and terminating in an unobstructed inlet and a nozzle located below said inlet and arranged to discharge air under pressure into said inlet section, said delivery pipe having a lining of anti-friction material.

In testimony that I claim the foregoing invention, I hereunto set my hand this 31st day of March, 1915.

L. T. EDWARDS.

In the presence of—
C. H. WISSMANN,
FLORENCE DEACON.