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A. M. LOCKETT.

APPARATUS FOR ELEVATING WATER BY MEANS OF COMPRESSED AIR.

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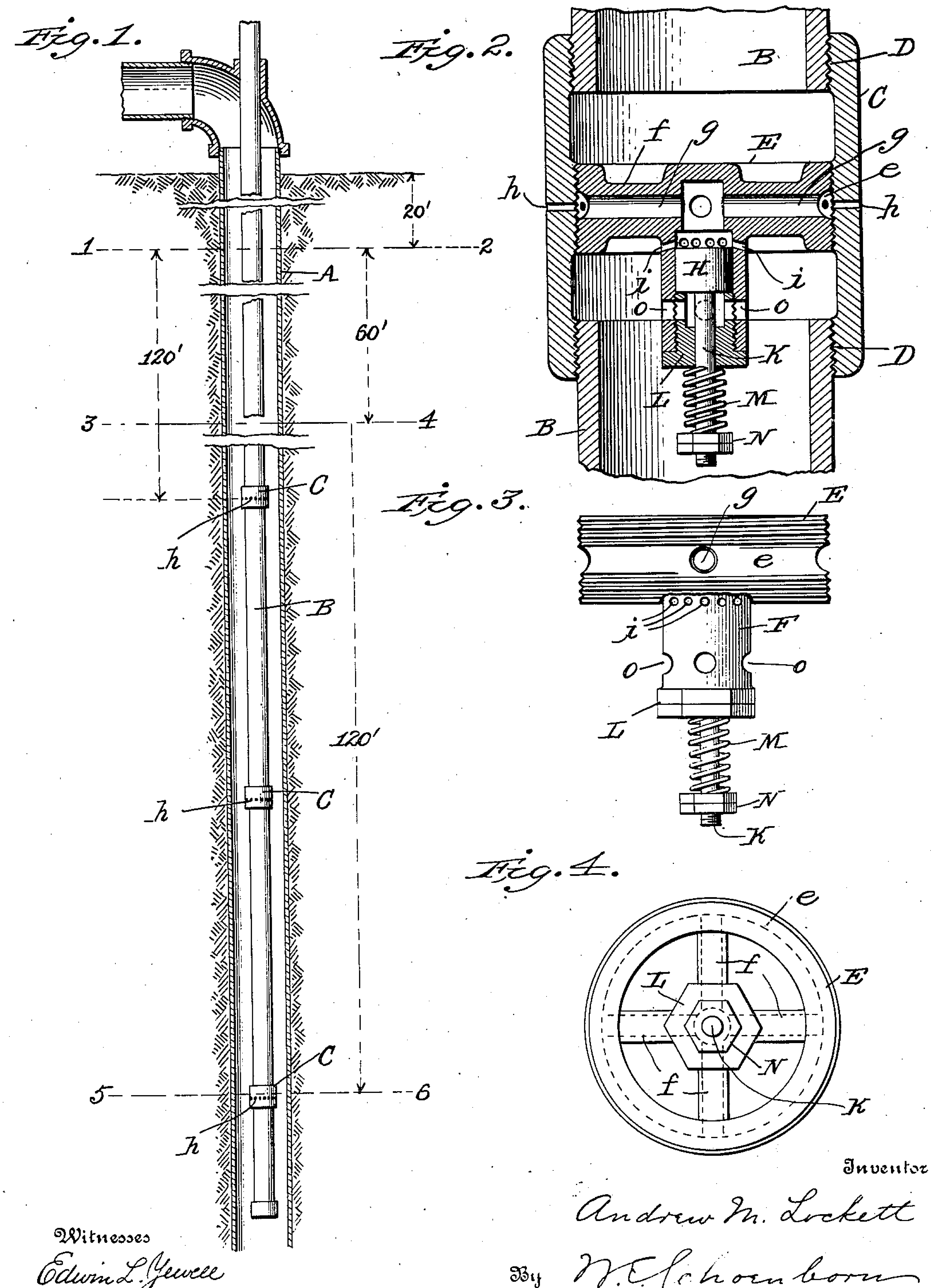

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APPARATUS FOR ELEVATING WATER BY MEANS OF COMPRESSED AIR.

No. 855,518. Specification of Letters Patent. Patented June 4, 1907.

Application filed June 25, 1906. Serial No. 323,253.

To all whom it may concern:

Be it known that I, ANDREW M. LOCKETT, a citizen of the United States, residing at New Orleans, in the parish of Orleans and State of Louisiana, have invented certain new and useful Improvements in Apparatus for Elevating Water by Means of Compressed Air, of which the following is a specification.

My invention relates to the art of elevating water from wells or other sources of supply through tubes or casings sunk into the water or water bearing strata, by means of compressed air injected into the column of water within the tube or casing, which column thereby becomes less dense or lighter than when unmixed with air, and is caused to rise to the surface of the ground by the pressure due to the head of the shorter but more dense column of water outside the well tubing. Such devices are commonly called air lift pumps. In such devices it is found that the pressure of air necessary to start the flow of water is materially greater than that necessary to continue the discharge from the well after it has been once established.

The object of my invention is to provide means whereby such a water elevating device may be started with air under the same pressure as that which will be necessary to afterward continue the action thereof, said means being automatic in its action, so that no manipulation of any mechanical device will be necessary, and no excess of air pressure over the normal working pressure will be required to place the well in operation.

A further object of my invention is to provide an improved air discharge nozzle through which the compressed air is injected into the column of water in the well tubing.

In the accompanying drawings, in which like reference characters indicate like elements in the various views, Figure 1, is a vertical sectional view of a well tube or casing with an air supply pipe containing a series of nozzles shown in elevation therein, said figure having certain dimensions indicated thereon which serve to illustrate the operation of my invention; Fig. 2, is a vertical central section of one of a series of valve controlled air discharge nozzles located in the air supply pipe; Fig. 3, is an elevation of a valve supporting member for supporting the valve which controls the discharge of air through said nozzle, and Fig. 4, is a plan view of said valve supporting member.

A represents the tubing or casing of the well, which tubing forms the water discharge pipe from the well. This tubing extends a considerable distance below the normal water level as is necessary in devices of the kind to which my invention relates.

B is an air supply pipe designed to supply compressed air to the column of water within the casing. This air supply pipe is provided with a series of nozzles C, C, C, through which the compressed air escapes. As shown in Figs. 2, 3, and 4, each nozzle comprises a coupling member D into which sections of the air pipe B are screwed, and said coupling member is interiorly threaded to form a support for the threaded valve support E. Said valve support is provided with a groove *e*, and with arms *f* through which extend passages *g*. The coupling member D is provided with a series of holes shown at *h* through which compressed air passing through passages *g* and grooves *e* escapes into the water in the well tubing.

F is a cylinder supported by and formed in one piece with the valve supporter E, and H is a valve fitting closely in the said cylinder. This valve when in a closed position closes a series of openings *i* in the cylinder F, and when in an open position permits compressed air to flow from the supply pipe B through said openings, passages *g*, groove *e* and holes *h* into the column of water in the tubing or casing A. The valve H is provided with a stem K which passes through an opening in the gland L.

M is a spring surrounding the valve stem and held between the gland and nuts N upon the valve stem, and acting to normally hold the valve H in its lower or open position.

O, O, are passages leading into the cylinder F below the valve H, and through which the compressed air in the pipe B acts upon the lower surface of the valve H, tending to force it upward. The downward movement of the valve is stopped by the gland L as shown.

Referring to Fig. 1, as illustrative of the operation of air lift pumps in wells in which the water normally rises to within a comparatively short distance of the surface, of the ground, the line 1—2 indicates the level to which the water will rise when no water is being pumped from the well, assuming in this instance to be 20 ft. below the surface of the ground. When water is being pumped from the well the level at which the water stands will be depressed a distance depending upon the rapidity of withdrawal and the rate of in-flow from the surrounding water bearing strata, and in this case it is assumed that the level will be depressed a distance of 60 ft. when the well is yielding its greatest possible amount of water, that is when water is being withdrawn therefrom at the same rate per unit of time as it flows thereinto. The level when the well is in operation is indicated by the line 3—4. It has been demonstrated by experiment that the maximum efficiency of air lift pumps is obtained when the distance from the water level, when water is being pumped from the well to the point of discharge, is approximately 40% of the distance from said level to the air discharge nozzle. Applying this rule to the case assumed we have 60′+20′=40% distance discharge nozzle should be below water level, which distance becomes 200′−80′=120′ as represented by the line 5—6. If now compressed air be forced into the column of water in the well tubing or casing at the line 5—6, the air will mix with the water thus making the column within the tube lighter or less dense than when unmixed with air; whereupon the pressure due to the head of water without the tubing will cause the column within the tubing to rise to the surface of the ground and be discharged. It is evident that the air will be forced into the tubing against a head of 120 ft. which is equivalent to a pressure of approximately 51.5 lbs. per sq. in.; and it should be observed that this is the air pressure necessary to maintain a continuous flow from the well after it is once in operation. Considering now the air pressure necessary to start the flow after the well has been out of operation, and the water level risen to the line 1—2, the total head of water against which the air must be forced, considering but a single nozzle as before, is now 120 ft.+60 ft.=180 ft., and the pressure required 77.5 lbs. per sq. in. In the example herein given it is therefore evident that a pressure of 77.5 lbs., would be required to start the flow of water while a pressure of only 51.5 lbs., would be sufficient to maintain a continuous flow after the well had been placed in operation.

One of the objects of my invention is to provide automatic controlled means whereby the flow from the well may be started by means of air pressure no greater than that necessary to continue the flow when once established. This is accomplished by placing a series of discharge nozzles in the air supply pipe B; the first or highest nozzle being so located that a pressure of 51.5 lbs. will be sufficient to cause a flow of air into the column of water in the tubing, which will evidently be at a distance of approximately 120 ft. below the level indicated at 1—2 of the water after the well has been at rest for some time; and the other nozzle being located between such highest nozzle and the lowest nozzle by which the device is to be operated. With such an arrangement the compressed air escaping at the highest nozzle will establish a flow through the tubing; shortly after a flow has been established from said nozzle, and by means hereinafter described, the flow of air is cut off at such nozzle and established through the next lower nozzle of the series, and so on until the discharge finally takes place at the lowest nozzle of the series.

Referring now to the operation of my automatic valve shown in Figs. 2, 3, and 4, it is evident that just before compressed air begins to flow through the holes h in the column of water in the well tubing, the valve H is subjected to opposing forces as follows: To a force due to the pressure of the column of water in the tubing, as yet unmixed with air, which force tends to hold the valve in its open position as shown. To a force due to the weight of the valve and to the action of the spring M also tending to hold the valve open. To a force due to the pressure of the air in the air supply pipe B acting upon the lower annular surface of the valve, which force tends to move the valve upward and close the openings i.

As the compressed air escapes into the column of water within the tubing and mixes therewith, such column becomes less dense or lighter and consequently exerts a less force tending to maintain the valve in its open position, which force will presently be diminished to such an extent that it, together with the force of the spring, will no longer be sufficient in amount to keep the valve open, whereupon the air in the pipe B acting upon the under side of the valve H will force it upward, thereby closing the openings i and interrupting the flow of air at the nozzle in question. This operation is supposed to be taking place at the uppermost nozzle of the series, and the tension of the spring M is so adjusted that before the valve closes the density of the column of water in the tubing will be reduced to such an extent that the pressure of the air within the supply pipe B will be sufficient to establish a flow through the next lower or second nozzle of the series, after which the valve of the first mentioned nozzle is closed as above described, and the whole discharge of air takes place through the second nozzle. In like manner the valve of the second nozzle closes immediately after the flow is established through the third nozzle, and so on until finally the flow of air is established at the lowest nozzle of the series, the valves of all the nozzles above the lowest being closed when the well is finally in operation. It is obvious that the lower nozzle would not ordinarily be provided with a valve. It will thus be seen that the well is put into operation by simply supplying compressed air thereto at the same pressure as that necessary to maintain a continuous discharge therefrom and that all operations incidental to such starting operation take place automatically and without manipulation of any special mechanism by an attendant.

It will be seen that my invention provides a convenient means for varying the conditions under which a given well is operated, and for determining the best location of the air discharge nozzle to secure the maximum flow from the well, without removing the air supply pipe therefrom, for, by placing the nozzles comparatively close together, and locating the upper nozzle so that the minimum air pressure likely to be employed at any time will be greater than the pressure due to the maximum head at said nozzle, a well may be started and operated under different degrees of air pressure, the air being discharged into the casing at different points located a short distance apart. The point of discharge of air into the casing at any given pressure will depend upon such pressure and will take place, through a definite nozzle automatically selected and determined by air. Upon supplying air at a different pressure the discharge will take place through a different nozzle and by varying the air pressure through a sufficient range the pressure produced maximum flow is readily ascertained.

My device has advantages particularly adapting it for use in pumping systems in which a single air compressor supplies air to a series of wells located at a considerable distance therefrom. In such a system equipped with water elevating apparatus of the type set forth herein, if for any reason some or all of the wells momentarily stop flowing, the flow at the well or wells in question will be automatically reëstablished, and the air pressure necessary to that end will obviously be the same in degree as that under which the system will operate after the well or wells are again in operation.

I refer to the valve H as being normally open, because such is the condition of said valve when the well is at rest and before the compressed air is let into the air supply pipe B to start the flow. After the well has been put in operation and is discharging at its normal rate through the discharge pipe or tubing, all the valves except that of the lowest nozzle, if that be provided with a valve, are in their closed condition.

Having thus described my invention, and explained the operation thereof, I claim and desire to secure by Letters Patent:—

1. In apparatus for elevating water by means of compressed air, a water discharge pipe, a plurality of means for supplying compressed air thereto at different depths, and automatically controlled means for intercepting the flow through said supply means in succession, beginning with the uppermost.

2. In apparatus for elevating water by means of compressed air, a water discharge pipe, a plurality of means for supplying compressed air thereto at different depths, a normally open valve for intercepting the flow through each of said supply means, and pressure controlled means for successively closing said valves, beginning with the uppermost.

3. In apparatus for elevating water by means of compressed air, a water discharge pipe, a plurality of means for supplying compressed air thereto at different depths, a normally open valve for intercepting the flow through each of said supply means, and means operated by the pressure of the compressed air for successively closing said valves, beginning with the uppermost.

4. In apparatus for elevating water by means of compressed air, a water discharge pipe, a compressed air supply pipe located therein and provided with a plurality of openings adapted to discharge air thereinto at different depths, a normally open valve for intercepting the flow through each of said openings, and automatically controlled means for successively closing said valves, beginning with the uppermost.

5. In apparatus for elevating water by means of compressed air, a water discharge pipe, a compressed air supply pipe located therein and provided with a plurality of openings adapted to discharge air thereinto at different depths, a normally open valve for intercepting the flow through each of said openings, and pressure controlled means for successively closing said valves, beginning with the uppermost.

6. In apparatus for elevating water by means of compressed air, a water discharge pipe, a compressed air supply pipe located therein and provided with a plurality of openings adapted to discharge air thereinto at different depths, a normally open valve located adjacent each of said openings and adapted to intercept the flow therethrough, and means operated by the pressure within said air supply pipe for successively closing said valves, beginning with the uppermost.

7. In apparatus for elevating water by means of compressed air, a water discharge pipe, a compressed air supply pipe located therein and provided with a plurality of nozzles adapted to discharge air thereinto at different depths, a normally open valve for intercepting the flow through each of said nozzles, and pressure controlled means for successively closing said valves, beginning with the uppermost.

8. In apparatus for elevating water by means of compressed air, a water discharge pipe, a compressed air supply pipe located therein and provided with a plurality of nozzles adapted to discharge air thereinto at different depths, each of said nozzles being provided with a normally open valve for inter-

cepting the flow therethrough, and means operated by the pressure within said air supply pipe for successively closing said valves, beginning with the uppermost.

9. In apparatus for elevating water by means of compressed air, a water discharge pipe, a plurality of means for supplying compressed air thereto at different depths, a normally open valve for intercepting the flow through each of said supply means, and means dependent for their operation upon a reduction of the pressure due to the column of water in the discharge pipe above the discharge end of said air supply means for successively closing said valves, beginning with the uppermost.

10. In apparatus for elevating water by means of compressed air, a water discharge pipe, a compressed air supply pipe located therein and provided with a plurality of openings adapted to discharge air thereinto at different depths, a normally open valve for intercepting the flow through each of said openings, and means dependent for their pressure operation upon a reduction of the pressure due to the column of water in the discharge pipe above said openings for successively closing said valves, beginning with the uppermost.

11. In apparatus for elevating water by means of compressed air, a water discharge pipe, a compressed air supply pipe located therein and provided with a plurality of openings adapted to discharge air thereto at different depths, a normally open valve located adjacent each of said openings and adapted to intercept the flow therethrough, and means dependent for their operation upon a reduction of the pressure due to the column of water in the discharge pipe above said valves for successively closing said valves, beginning with the uppermost.

12. In apparatus for elevating water by means of compressed air, a water discharge pipe, a compressed air supply pipe located therein and provided with a plurality of nozzles adapted to discharge air thereinto at different depths, each of said nozzles being provided with a normally open valve for intercepting the flow therethrough, and means dependent for their operation upon a reduction of the pressure due to the column of water in the discharge pipe above said nozzle for successively closing said valves, beginning with the uppermost.

13. In an air discharge nozzle for air lift pumps, a coupling member adapted to be connected with a compressed air supply pipe, a plurality of compressed air conveying passages leading therefrom, a normally open valve for intercepting the flow through said passages, and pressure-controlled means for closing said valve.

14. In an air discharge nozzle for air lift pumps, a coupling member adapted to be connected with a compressed air supply pipe, a plurality of compressed air conveying passages leading therefrom, a normally open valve for intercepting the flow through said passages, and means operated by the pressure of the air in said supply pipe for closing said valve.

15. In an air discharge nozzle for air lift pumps, a coupling member adapted to be connected with a compressed air supply pipe, a valve supporting member located in said coupling member, a cylinder carried by said valve supporting member, a piston valve moving in said cylinder, air conveying passages controlled by said valve, a spring acting upon the valve to hold it normally open, and openings leading into said cylinder and through which compressed air may act upon said valve to close it.

16. In an air discharge nozzle for air lift pumps, a coupling member adapted to be connected with a compressed air supply pipe, a valve supporting member located in said coupling member, a cylinder carried by said valve supporting member, a piston valve moving in said cylinder, air conveying passages adjacent the upper end of said cylinder and controlled by said valve, a stem for said valve extending through a gland at the lower end of said cylinder, nuts on said valve stem, a spring between the nuts and the gland and holding the valve normally open, and openings leading into said cylinder below the valve through which openings compressed air may act to close said valve.

In testimony whereof I affix my signature in presence of two witnesses.

ANDREW M. LOCKETT.

Witnesses:

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