April 5, 1932. L. E. McCUNE 1,852,251

WELL PUMP

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Fig. 1.

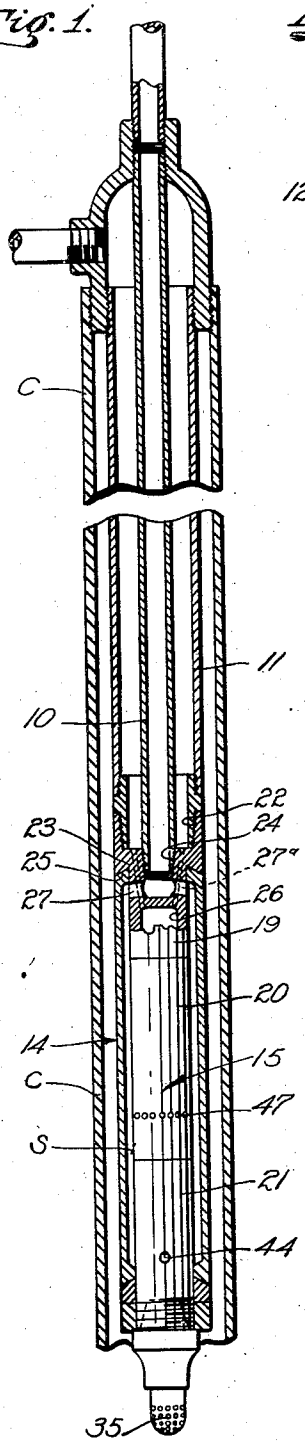


Fig. 2.

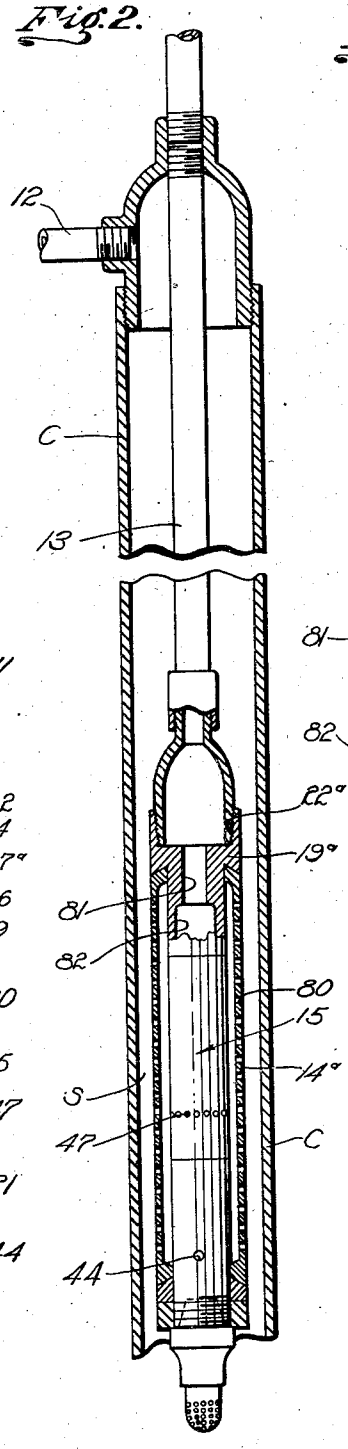
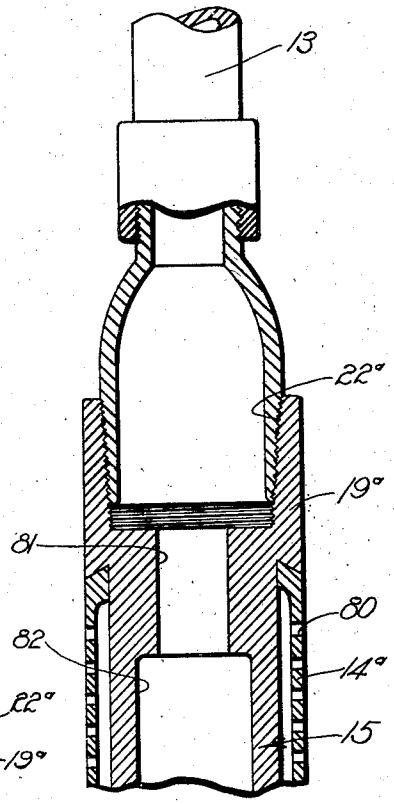


Fig. 7.



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Fig. 3.

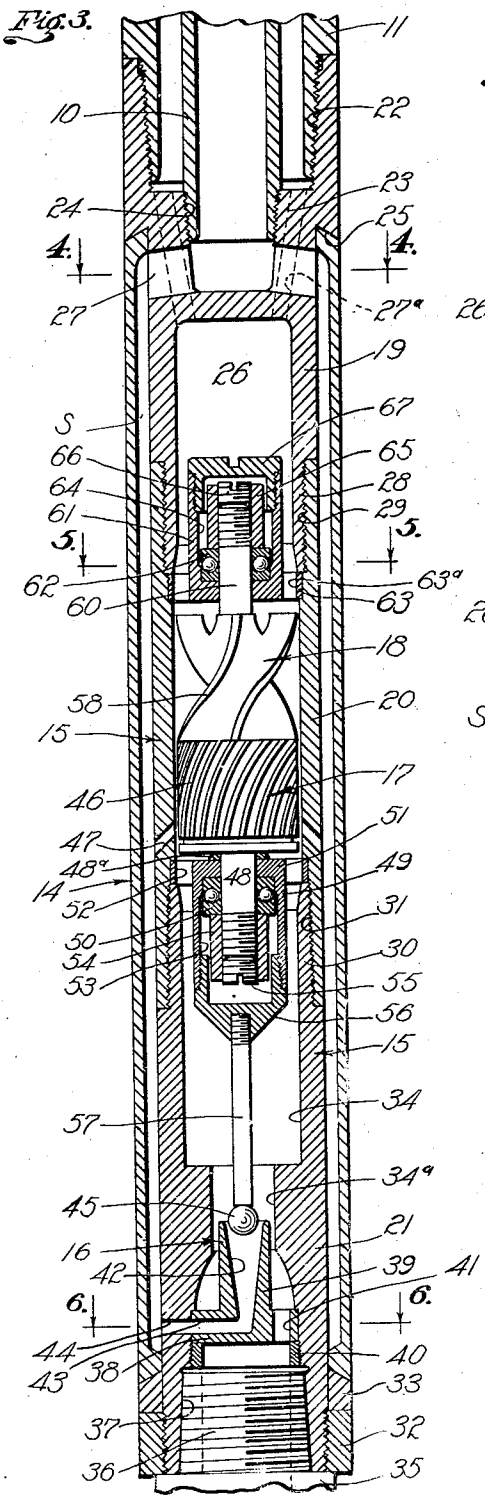


Fig. 4.

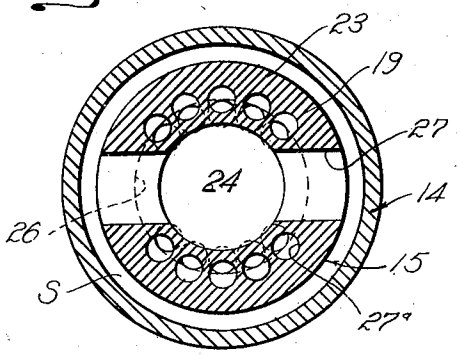


Fig. 5.

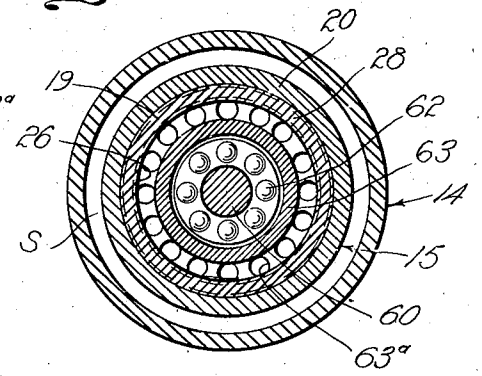
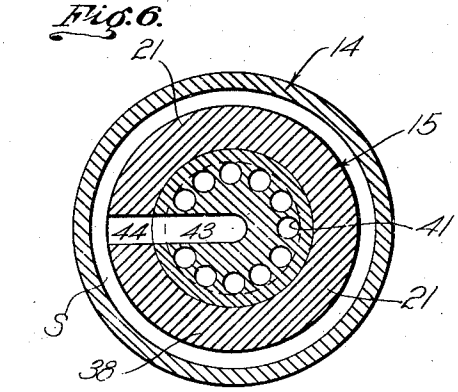


Fig. 6.



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UNITED STATES PATENT OFFICE

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WELL PUMP

Application filed May 23, 1931. Serial No. 539,490.

This invention relates to a device for handling liquid, and relates more particularly to a well pump. It is a general object of the invention to provide a simple, practical, and efficient pump for pumping or lifting water, oil, etc., from wells.

There are two general types of pumps employed for lifting or raising oil and/or water from wells, namely, the reciprocating plunger type involving a plunger carried by a rod extending to the surface and operable in a barrel in the well, and the air or gas lift type in which the liquid is lifted to the surface through the action of the gas discharged from nozzles against the liquid. A third type of well pump has been introduced involving an impeller or screw arranged in a chamber in the lower end of a discharge tube and operated by gas or air under pressure, which gas or air, in addition to operating the impeller, atomizes the liquid to greatly reduce the hydrostatic pressure of the column of pumped liquid, and also aids in lifting the liquid to the surface.

An object of the present invention is to provide a well pump of the type last mentioned that includes, in addition to the gas-driven impeller, a jet or nozzle which discharges gas under pressure to draw the liquid into the pump chamber and pass it to the rotor of the impeller.

Another object of this invention is to provide a well pump that is very efficient in operation and that is adaptable for use in various installations and situations. The liquid handling device or pump provided by the present invention is well suited for lifting oil or water from comparatively shallow wells, as well as from very deep wells, and is particularly efficient and inexpensive of operation.

It is another object of the invention to provide a liquid handling device of the character mentioned that includes a nozzle or jet discharging gas under pressure to draw liquid into the body of the pump or device and to atomize the liquid, and a combination gas-driven rotor and impeller which receives the liquid atomized by the nozzle and further atomizes it and discharges it upwardly through the discharge pipe or tubing. In accordance with the present invention, the liquid is fully atomized when it is discharged from the device so that the hydrostatic pressure of the column of pumped liquid is greatly reduced as the air or gas moves or flows along with the liquid and thus takes the pressure or load from the pump.

It is another object of the invention to provide a well pump of the character mentioned that may be embodied in a simple, compact unit or assembly.

A further object of the invention is to provide a pump of the character mentioned that is particularly adapted for use in oil wells, and the like, as it is not subjected to becoming sanded up or made inoperative by solid matter in the liquid being handled.

Other objects and features of the invention will be best and more fully understood from the following detailed description of typical forms and applications of the invention, throughout which description reference will be had to the accompanying drawings, in which:

Fig. 1 is a vertical section of a well casing showing one installation or embodiment of the invention arranged therein. Fig. 2 is a view similar to Fig. 1, illustrating another application or installation of the invention. Fig. 3 is an enlarged longitudinal detailed sectional view of the form of the invention illustrated in Fig. 1 of the drawings. Figs. 4, 5 and 6 are enlarged horizontal detailed sectional views taken as indicated by lines 4—4, 5—5, and 6—6, respectively, on Fig. 3, and Fig. 7 is an enlarged longitudinal detailed sectional view of the upper portion of the pump illustrated in Fig. 2.

The fluid handling or pumping device provided by the present invention is capable of considerable modification or variation to adapt it for use in handling liquids of different characters and to adapt it for various installations and well conditions. In Fig. 1 of the drawings, I have illustrated a form of the invention arranged within a well casing C and adapted to be operated by air or gas under pressure supplied through a pipe or tube 10. The tubing or pipe 11 for

passing the pumped liquid extends upwardly from the pump and surrounds the gas pipe 10. In Figs. 2 and 7 of the drawings, I have illustrated an embodiment of the invention in which the gas for operating the pump is passed into the upper end of the well casing C through a conduit 12. The gas under pressure is received or handled by the pump in a manner to be hereinafter described. In the case illustrated in Figs. 2 and 7 of the drawings, a discharge tubing 13 passes the pumped liquid upwardly from the pump to the surface. Throughout the following disclosure, I will describe in detail the pumping device illustrated in Fig. 1 of the drawings, it being understood that my invention is not to be taken as restricted to the particular application of the invention disclosed, nor to the specific construction about to be described.

The form of pump illustrated in Fig. 1 and Figs. 3 to 6 inclusive includes, generally, a tubular housing 14, a chambered body 15 within the housing 14, a nozzle 16 for discharging gas under pressure to raise liquid into the body 15, a gas-driven turbine or rotor 17 in the body above the nozzle 16, and a screw or impeller 18 actuated by the rotor 17.

The housing 14 is an elongated tubular member which surrounds the body 15. The opposite ends of the housing 14 are carried by the body 15. The body 15 of the pump is a sectional tubular assembly extending completely through the housing 14. In the embodiment of the invention being described, the body 15 includes an upper section 19, an intermediate section 20, and a lower section 21. The upper section 19 projects above the upper end of the housing 14 and is adapted to be connected with the liquid discharge tubing 11. A screw-threaded socket 22 is provided in the upper end of the section 19 to receive the lower end of the tubing 11 or a coupling member on the lower end of the tubing. A horizontal or transverse wall 23 closes the lower end of the socket 22 and is provided with a vertical opening 24 for receiving the lower end of the gas or air inlet pipe 10. An upwardly and inwardly extending shoulder 25 is provided on the section 19 to receive the upper end of the housing 14. The lower end portion of the section 19 which projects downwardly within the housing 14 is hollow or chambered, being provided with a central opening 26. The lower portion of the section 19 is spaced from the inner walls of the chamber 14 so that an annular space S is provided between the housing and the lower portion of the section 19. Lateral ports 27 are provided in the wall 23 to connect the pipe 10 with the upper end of the annular space S. Spaced ports or openings 27^a extend from the upper end of the opening 26 to the socket 22 to discharge the liquid upwardly from the body into the oil tubing, or discharge tubing 11.

The intermediate section 20 of the body is a plain elongated tubular member and is attached to the lower end of the section 19. The section 20 is of the same external diameter as the housed or encased portion of the section 19, so that the space S continues downwardly around the section 20. A screw-threaded connection is provided between the sections 19 and 20. This connection includes a pin 28 on the lower end of the section 19 threaded into a socket 29 in the upper end of the intermediate section. The section 20 houses or encases the rotor 17 and the impeller 19.

The lower section 21 of the body 15 is attached to the lower end of the section 20 and is of the same external diameter as the sections 19 and 20, so that the annular space S extends downwardly around the principal parts of the section 20. A pin 30 is provided on the upper end of the section 21 and is screw-threaded into a socket 31 in the intermediate section 20. The lower section 21 extends or projects downwardly from the lower end of the housing 14, and means is provided on the lower section for retaining the housing in position. A ring or collar 32 is screw-threaded on the lower end of the section 21 to maintain the housing 14 in its proper position. A suitable washer or bushing 33 may be arranged between the lower end of the housing 14 and the collar 32. With the construction just described, the tubular housing 14 is removably clamped between the downwardly facing shoulder 25 and the screw-threaded collar 32. A longitudinal opening 34 extends through the section 21 from one end to the other, and a suitable strainer cap 35 may be provided to strain the liquid passed upwardly into the opening 34. The cap 35 may have a pin 36 screw-threaded into a socket 37 at the lower end of the opening 34.

The nozzle 16 is provided to discharge gas under pressure upwardly through the opening 34^a to draw liquid into the lower end of the body and to lift or raise it through the opening 34 to the rotor 17. The nozzle 16 is arranged in the lower end portion 34^a of the opening 34 and receives gas or air under pressure from the space S to discharge it upwardly through the opening 34. In the preferred construction, the nozzle 16 is a simple integral member consisting of a base flange 38 and a tubular jet 39 projecting upwardly from the flange. The base flange 38 is circular and is arranged in the opening 34 above the socket 37. A ring 40 is screw-threaded into the opening 34^a to clamp against the lower side of the base flange 38 to retain the nozzle in position. A plurality of spaced vertical openings 41 are provided in the flange 38 to pass the liquid upwardly. The jet 39 projects upwardly from the flange 38 and is centrally disposed

in the opening 34ª. The jet 39 may be of round cross sectional configuration and is provided with a vertical discharge opening 42. The opening 42 may have upwardly and outwardly divergent walls. A lateral port or opening 43 is provided in the flange 38 to communicate with the lower end of the opening 42. A port 44 is provided in the walls of the section 21 to register with the port 43 to put the jet opening 42 in communication with the space S. In the preferred construction, the walls of the opening 36 around the lower portion of the jet 39 converge upwardly and inwardly so that the upper end of the jet is disposed within a reduced opening portion 34ª. The body opening being restricted at 34ª provides for an increase in the velocity of the liquid as it is drawn upwardly through the opening 34 by the gas discharged from the jet 39.

Check means may be provided in connection with the jet 39 to prevent liquid from passing into the space S when the pump is not in operation. A ball 45 is provided to cooperate with the tapered walls of the opening 42 in the jet when the pump is not in operation to prevent liquid from passing downwardly through the jet. The ball 45 is held against upward displacement in a manner to be hereinafter described. It will be obvious how the gas under pressure passed from the tubing 10 and through the space S is discharged upwardly from the jet or nozzle 39 to cause liquid to be drawn upwardly into the opening 34 and to be propelled or forced upwardly toward the rotor 17. Further, the gas or air discharging from the nozzle operates to atomize the liquid as it passes upwardly to the rotor.

The turbine or rotor 17 is arranged within the intermediate section 20 and is operable by the impingement of the gas under pressure against its blades to rotate the impeller 18. Further, the rotor 17 operates to mechanically atomize the liquid passed between its blades through its rotation and through the action of the inpinging gas. The rotor 17 is cylindrical in its general configuration and is rotatable about an axis coincident with the longitudinal axis of the body 15. A plurality of spaced flutes or blades 46 are provided on the exterior of the rotor. The rotor blades 46 are suitably spaced and have suitable clearance with the walls of the body opening to provide for the upward passage of the liquid through the body. The gas under pressure for operating the rotor 17 is discharged against the rotor from a plurality of spaced openings 47 in the walls of the body section 20. The openings 47 are inclined upwardly and inwardly so that the gas is directed against the rotor blades 46 in the desired manner.

The invention provides novel and improved means for rotatably mounting the rotor 17 in the body 15. A shaft 48 projects downwardly from the lower end of the rotor. A bearing retainer 49 is mounted below the rotor 17 to carry an anti-friction bearing 50 for rotatably carrying the shaft 48. The retaining member 49 is provided at its upper end with a flange 51 that is clamped in the bottom of the socket 31 by the pin 30. A plurality of spaced openings 52 are provided in the flange 51 to pass the fluid upwardly to the rotor 17. The bearing retainer 49 extends downwardly from the flange 51 and is provided with a longitudinal opening 53. The shaft 48 passes through an opening in the flange 51 to project downwardly through the opening 53. A suitable thrust washer 48ª may be arranged between the lower end of the rotor and the upper side of the retainer 49. The bearing 50 may be in the nature of a two-race ball bearing and is arranged against the upper end of the opening 53.

An adjustable thrust collar 54 is screw-threaded onto the shaft 48 to transmit the upward thrust to the bearing 50. A lock plug 55 may be screw-threaded into the lower end of the collar 54 to set the collar in the desired position. A cap 56 is screw-threaded into the lower end of the bearing retainer 49 to completely close the lower end of the opening 53. A suitable lubricant may be provided in the opening 53. A rod 57 projects downwardly from the cap 56 to a point spaced a short distance above the upper end of the jet 39. The rod 57 is provided to prevent the upward displacement of the ball 45.

The impeller 18 is provided on the upper end of the rotor 17 and is operable to mechanically lift or raise the atomized liquid upwardly into the discharge tubing 11. Due to the action of the nozzle 16 and the rotor 17, the fluid, upon passing upwardly from the rotor, is fully atomized and is travelling or passing upwardly through the body. The impeller 18 is in the nature of a screw for forcing or pushing the column of atomized liquid upwardly into and through the discharge tubing 11. The impeller 18 may be integral with the rotor 17, and is provided with a plurality of spiralled or helicoidal blades 58. When in operation, the impeller 18 picks up the atomized liquid after it has passed the rotor 17 and pushes or forces it upwardly through the opening 26 and the ports 27ª to discharge upwardly through the tubing 11. In practice, the discharge tubing for passing the liquid to the surface may be connected with the body 15 by a swedge nipple or reducing nipple, as illustrated in Fig. 2 of the drawings. If desired, the discharge tubing 11 may be directly connected with the body 15 so as to be of larger diameter.

A shaft 60 projects upwardly from the upper end of the impeller 18, and means is provided for rotatably carrying the shaft.

A bearing retainer 61 is mounted above the impeller 18 and carries an anti-friction bearing 62. A mounting flange 63 having fluid openings 63ª is provided on the lower end of the retainer 61 and is clamped in the bottom of the socket 29 by the screw-threaded pin 28. A vertical opening 64 is provided in the upper end of the retainer to carry the bearing 62, and the shaft 60 passes upwardly into the opening. An adjustable thrust collar 65 is screw-threaded on the shaft 60 to transmit the downward thrusts to the bearing 62 and to retain the bearing in its proper position. A plug 66 is threaded into the upper end of the collar to retain it in position. A cap 67 closes the upper end of the opening 64 so that a suitable lubricant may be provided in the opening.

The principal or main parts of the embodiment of the invention illustrated in Figs. 2 and 7 of the drawings may be identical with those in the form of the invention described above. In the installation illustrated in Fig. 2 of the drawings, the housing 14ª surrounds the body 15 in a manner similar to that described above. In this construction, the housing 14ª is perforated or provided with a plurality of spaced openings 80 for passing gas from the casing C into the space S between the housing and the body. As the gas in admitted into the space S through the perforations 80 directly from the well, it is not necessary to provide a pipe or tubing for carrying the gas under pressure to the pump. Accordingly, the upper section 19ª of the body completely closes off the upper end of the housing 14ª and is provided with a single longitudinal opening 81. The opening 81 extends upwardly from the body opening or chamber 82 to the socket 22ª so that the discharging liquid may pass upwardly from the opening 82 into the tubing 13. The various parts within the body 15 may be identical with those described above, it being apparent that the modified means for supplying the gas pressure to the pump does not necessitate changes in the pump construction.

It is believed that the operation of the liquid handling device or well pump provided by this invention will be readily apparent from the foregoing detailed description. During operation, the gas under pressure is supplied to the space S either through the tube 10 or through the perforations 80, as the case may be, and passes through the ports 44 and 43 to discharge from the nozzle 16. The gas discharging upwardly from the nozzle 16 draws the liquid upwardly into the body opening 34 and acts to atomize the liquid thus passing into the body. The restricted opening portion 34ª causes the liquid to pass into the body with considerable velocity so that it may be moving upwardly with considerable speed and force when passing the rotor 17. The ports 47 discharge the gas under pressure against the blades 46 of the rotor, causing it to rotate and operate the impeller 18. Under certain operating conditions, the nozzle 16 may act to force the liquid through the body with sufficient force so that it aids in rotating the rotor 17 when passing upwardly between the blades 46. The gas admitted through the ports 47 and the rotor operate to further atomize the liquid passing through the pump. After the atomized liquid has passed the rotor 17, it is picked up or acted upon by the impeller 18 and mechanically forced upwardly through the opening 26 and the ports 27ª into the discharge pipe. As the liquid discharging from the pump is thoroughly atomized in the manner described above, the hydrostatic column of liquid in the discharge tubing 11 or 13 is very small, so that the pump does not operate under a heavy load. In this manner, the pump is particularly economical and efficient in operation as it may be effectively operated at comparatively low gas pressure.

It is to be noted that the well pump provided by this invention may be readily operated in deep wells and in crooked wells where the plunger type of pump would be impractical. The pump may be installed in various manners and may be modified somewhat to adapt it for various conditions. The pump may handle liquid, for example, oil carrying a certain amount of sand or solid matter, as there are no parts easily made inoperative through the action of solid matter in the liquid. The only points on which the solid matter may collect are the flanges 51 and 63. The liquid passing openings in these flanges are spaced very close together, so that there is no possibility for the accumulation of solid matter during operation of the pump. The shafts 48 and 60 are rotatably supported in an effective manner and so that they are not exposed to the action of the liquid being handled. The ball 45 positively prevents the entrance of liquid into the space S when the pump is not in operation and also operates to divide or break up the flow of gas from the nozzle opening 52 so that it passes upwardly in an annular stream to effectively act upon the liquid passing through the body. It is to be noted that the housings 14 and 14ª are readily removable and exchangeable and that the body 15 is sectional so that the various parts may be readily replaced. The means for rotatably mounting the shafts 48 and 60 are such that the rotor and impeller may be easily and quickly dismounted.

Having described only typical preferred forms of my invention, I do not wish to limit myself to the specific details set forth, but wish to reserve to myself any changes or variations that may appear to those skilled in

the art or fall within the scope of the following claims.

Having described my invention, I claim:

1. A device of the character described including, a tubular body, a nozzle for discharging gas under pressure upwardly in the body, a rotatable impeller in the body above the nozzle for forcing liquid upward through the body, and a rotor in the body operable by gas under pressure for rotating the impeller.

2. A well pump including, a tubular body, a nozzle for discharging gas through the body, a rotatable impeller in the body spaced from the nozzle, and a rotor in the body between the nozzle and impeller operable by gas under pressure to actuate the impeller.

3. A well pump including, a tubular body, a nozzle in the lower portion of the body for discharging gas under pressure upwardly to draw liquid into the lower end of the body and to atomize it, a rotor in the body above the nozzle, and means for discharging gas under pressure against the rotor to operate it and to further atomize the liquid passing the rotor.

4. A well pump including, a tubular body, a nozzle in the lower portion of the body for discharging gas under pressure upwardly to draw liquid into the lower end of the body and to atomize it, a rotor in the body above the nozzle, an impeller above the rotor and operable by the rotor, and means for discharging gas under pressure against the rotor to operate it and to further atomize the liquid passing the rotor.

5. A well pump including, a tubular body, a nozzle in the lower portion of the body for discharging gas under pressure upwardly to draw liquid into the lower end of the body and to atomize it, the body being of reduced internal diameter at the nozzle, a rotor in the body above the nozzle, and means for discharging gas under pressure against the rotor to operate it and to further atomize the liquid passing the rotor.

6. A well pump of the character described including, a body having a longitudinal opening, a nozzle for discharging gas under pressure upwardly in the opening to draw liquid into the lower end of the opening and to atomize it, and means in the opening above the nozzle for forcing the atomize liquid upwardly, said means including a rotatable impeller, and a fluid pressure actuated rotor in vertical alignment with the nozzle and impeller for operating the impeller.

7. A well pump of the character described including, a body having a longitudinal opening, a nozzle for discharging gas under pressure upwardly in the opening to draw liquid into the lower end of the opening and to atomize it, and means in the opening above the nozzle for forcing the atomized liquid upwardly, said means including, a fluid driven rotor, an impeller carried by the rotor, and means for rotatably mounting the rotor in the body.

8. A well pumping device of the character described including, a body having a longitudinal opening, a housing surrounding the body and spaced therefrom to provide a space around the body, means for supplying gas under pressure to the said space, a nozzle for discharging upwardly through the body opening, there being a port in the body for passing gas from the space to the nozzle, an impeller in the body opening, and a rotor in the body opening between the nozzle and impeller for operating the impeller, there being a port in the body to pass gas from the said space to impinge on the rotor.

9. A well pumping device of the character described including, a body having a longitudinal opening, a housing surrounding the body and spaced therefrom to provide a space around the body, means for supplying gas under pressure to the said space, a nozzle for discharging upwardly through the body opening, there being a port in the body for passing gas from the space to the nozzle, check valve means for preventing liquid from passing through said port to the said space from the body opening, an impeller in the body opening, and a rotor in the body opening below the impeller for operating the impeller, there being a port in the body to pass gas from the said space to impinge on the rotor.

10. A well pumping device of the character described, including, a body having a longitudinal opening, a housing surrounding the body and spaced therefrom to provide a space around the body, the housing being perforated to pass gas under pressure into said space from the well, a nozzle in the body opening for discharging upwardly, there being a port in the body for passing gas from the said space to the nozzle, an impeller in the body opening, and a rotor in the body below the impeller for driving the impeller, there being a port in the body for passing gas from the said space to the rotor.

11. A well pump including, a body having a longitudinal opening, means at the lower end of the body for drawing liquid upward into the opening, and means above and independent of the first mentioned means operable by gas under pressure for acting directly upon the liquid to mechanically lift the liquid and for atomizing the liquid by its actuating gas.

12. A well pump including, a body having a longitudinal opening, nozzle means at at the lower end of the body discharging gas under pressure upwardly in the body for drawing liquid upwardly into the opening and for atomizing the liquid passed into the opening, and means in the body opening

above the first mentioned means operable by gas under pressure for mechanically lifting liquid and for further atomizing the liquid.

13. A well pump including, a body having a longitudinal opening for passing the pumped liquid upwardly, nozzle means at the lower end of the body discharging gas under pressure upwardly in the opening for drawing liquid upwardly into the opening and for atomizing the liquid passed into the opening, and means in the opening spaced above the first mentioned means operable by gas under pressure for mechanically forcing liquid upwardly and for further atomizing the liquid by its actuating gas.

In witness that I claim the foregoing I have hereunto subscribed my name this 4th day of May, 1931.

LEWIS E. McCUNE.