April 12, 1949. W. J. CONERY 2,466,792

JET PUMPING SYSTEM AND APPARATUS

Filed Jan. 24, 1947 3 Sheets-Sheet 1

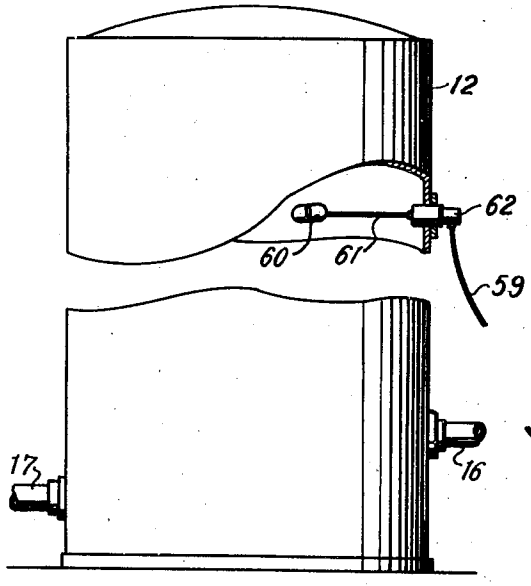
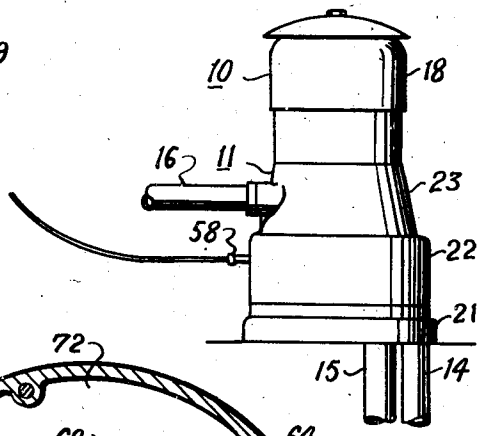


Fig. 1



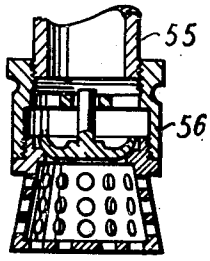


Fig. 4

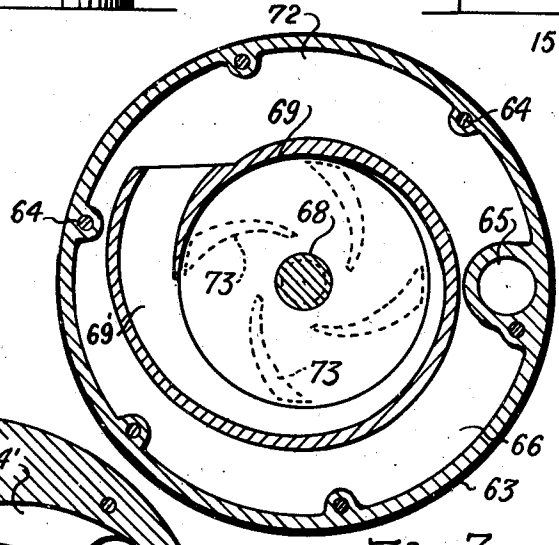
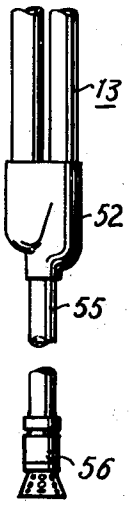


Fig. 7



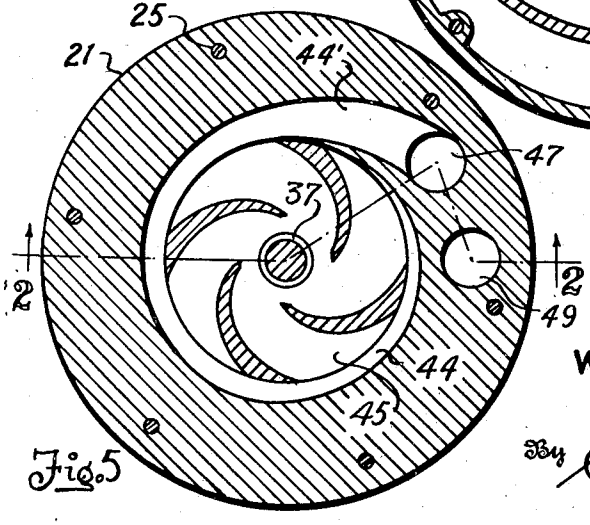


Fig. 5

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JET PUMPING SYSTEM AND APPARATUS

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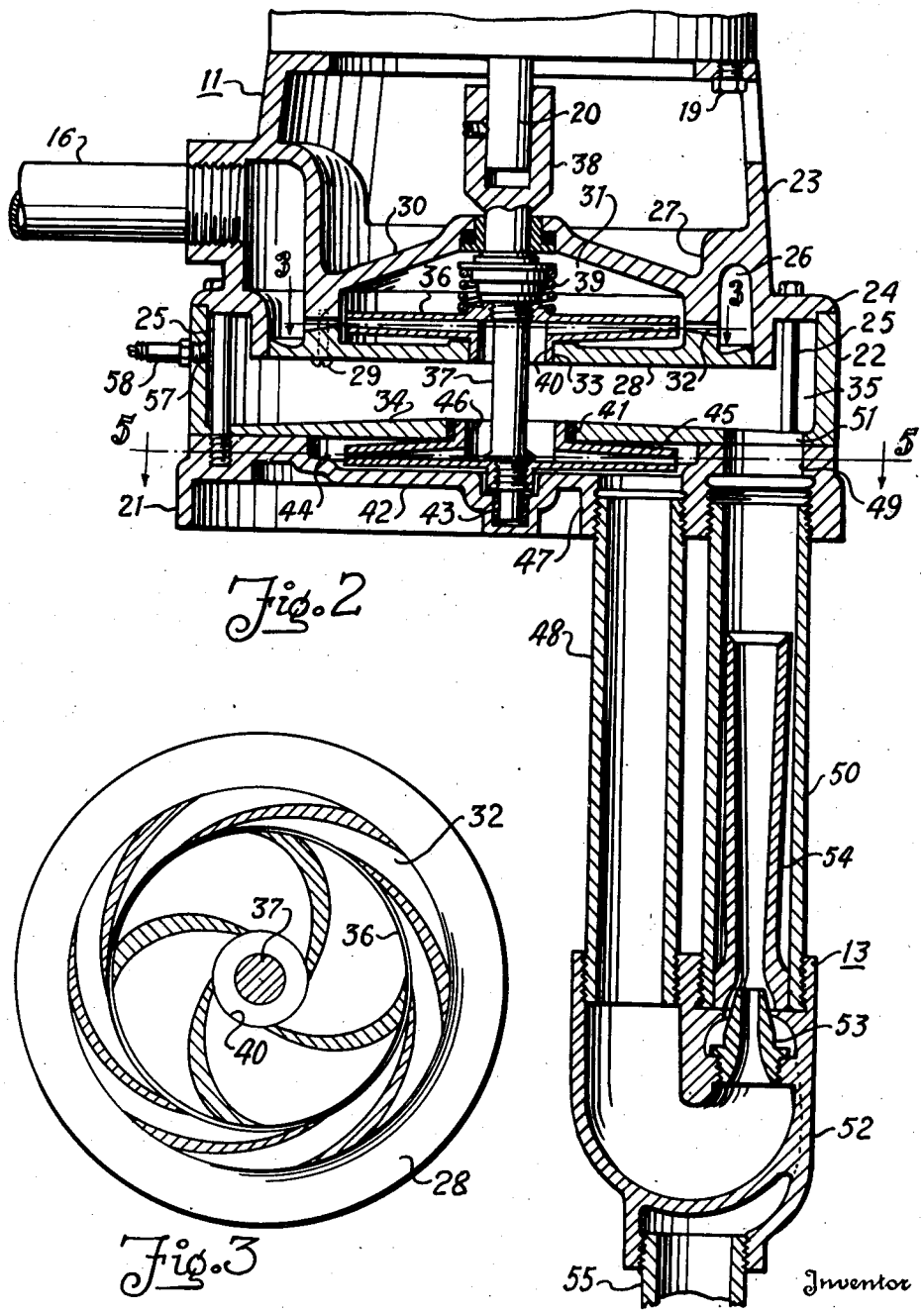

Fig. 2

Fig. 3

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JET PUMPING SYSTEM AND APPARATUS

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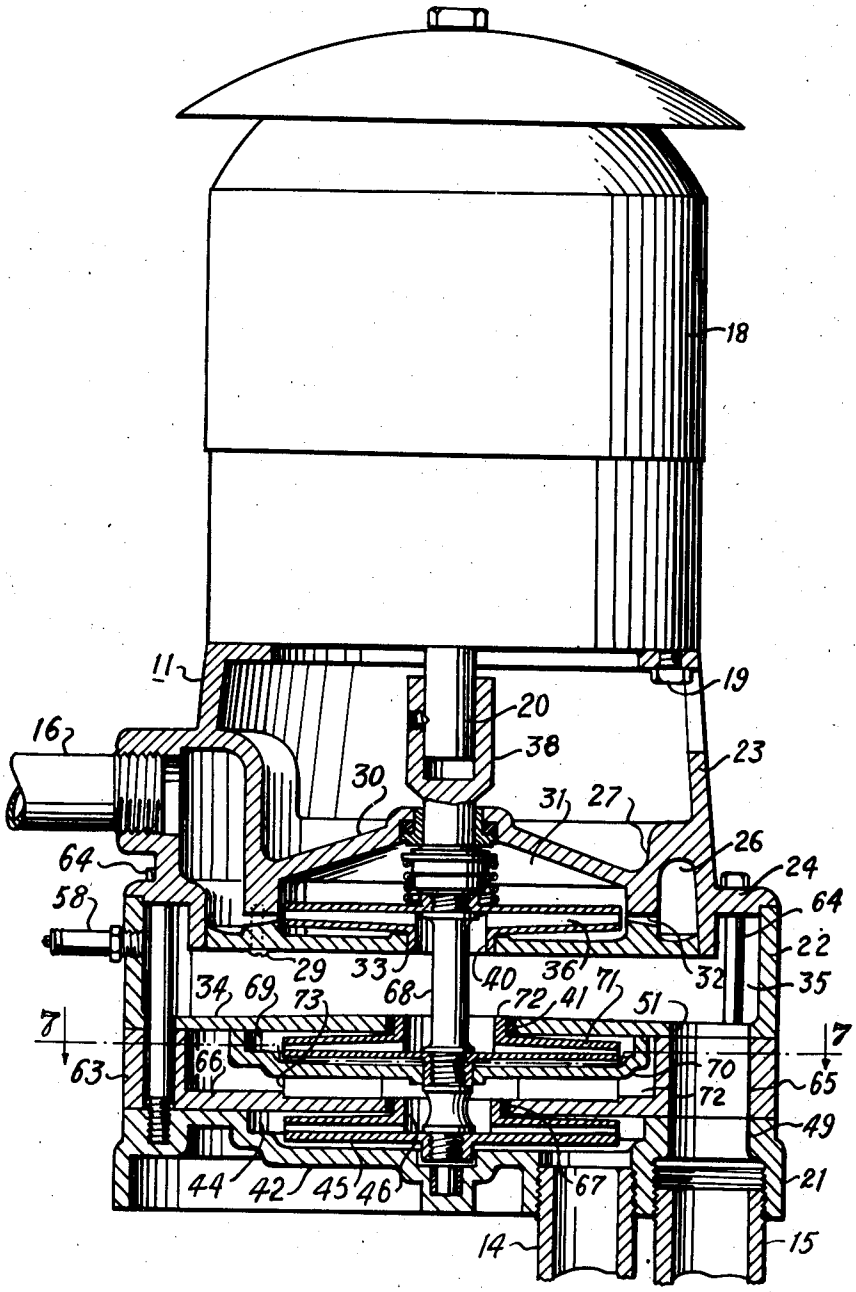

Fig. 6

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JET PUMPING SYSTEM AND APPARATUS

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12 Claims. (Cl. 103—5)

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This invention relates to new and useful improvements in jet pumping systems and apparatuses.

One object of the invention is to provide an improved pumping system of the jet type which is adapted for use in shallow or deep wells without changing the construction thereof and which operates from depths much greater than is possible with conventional jet pumps.

An important object of the invention is to provide an improved jet pumping system having a pressure pump for supplying fluid under pressure to an ejection unit and separate or second pressure pump for withdrawing fluid delivered by the ejection unit, there being a constant supply of fluid to the jet or first pressure pump to prevent the entrainment of air and consequent loss of prime, whereby the efficiency of the pumping system is materially increased.

A particular object of the invention is to provide an improved pumping system, of the character described, wherein a suction and air separation chamber is disposed between and in communication with the inlets of the pumps so as to maintain the jet pump submerged in fluid and prevent the introduction of air thereto, whereby the prime of the system is maintained.

Another object of the invention is to provide an improved jet pumping system which is adapted to operate at any discharge pressure and in wells of any depth without the necessity of employing valves or regulating means for maintaining the pressure of the ejection unit and which is of such construction that it may be readily converted to multi-stage operation for increasing the discharge pressure or pumping depth.

A further object of the invention is to provide an improved jet pumping system which is arranged so as to maintain the air supply of its pressure tank without loss in efficiency and which is adapted to pump fluid having air or gas entrained therein without becoming air bound.

A construction designed to carry out the invention will be hereinafter described together with other features of the invention.

The invention will be more readily understood from a reading of the following specification and by reference to the accompanying drawings, wherein an example of the invention is shown, and wherein:

Fig. 1 is an elevational view of a pumping system, constructed in accordance with the invention,

Fig. 2 is a transverse, vertical, sectional view,

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taken substantially on the line 2—2 of Fig. 5, showing the pumps, the suction and air separation chamber and the ejection unit of the system,

Fig. 3 is a horizontal, cross-sectional view, taken on the line 3—3 of Fig. 2,

Fig. 4 is a detailed, sectional view of the foot valve,

Fig. 5 is a horizontal, cross-sectional view taken on the line 5—5 of Fig. 2,

Fig. 6 is a view, partly in section and partly in elevation, of a multi-stage pump unit, and

Fig. 7 is a horizontal, cross-sectional view, taken on the line 7—7 of Fig. 6.

In the drawings, the numeral 10 designates a pumping system which includes a pump housing or unit 11, an air-tight, communicating, pressure tank 12 and an ejection unit 13. In surface or shallow well pumping, the ejection unit 13 is connected directly to the housing 11 (Fig. 2); however, the ejection unit may be disposed in spaced, communicating relation to the housing by means of well conductors or pipes 14 and 15 (Fig. 1) so as to permit suspension of said unit within a deep well (not shown) below the liquid level thereof. A discharge pipe 16 leads from the interior of the pump housing to the pressure tank 12 and a service line 17 extends from said tank.

A motor 18 is supported by the pump housing, being secured thereto by suitable screws 19 and having its shaft 20 depending axially into said housing (Fig. 2). The latter is preferably formed of three cylindrical, superimposed sections which include a base or lower case 21, an annular, spacer collar or case 22 and an upper or pump case 23. It is pointed out that the base 21 and collar 22 are of greater diameter than the pump case 23 and that a radial flange 24 is formed adjacent the lower end of said pump case for permitting fastening of the sections together by means of suitable bolts 25 which extend through the flange and collar and are threaded into said base. The bolts 19 connect the motor 18 to the upper end of the pump case 23. An annular discharge chamber 26 is formed at the lower outer portion of the pump case in communication with the discharge pipe 16 by a depending, circumferential skirt 27 which is angular in cross-section and preferably made integral with said case. For closing the lower ends of the case and chamber, a circular plate or partition 28 engages within the lower end of said case and is secured to the skirt 27 by suitable screws 29. Above the plate 28, the skirt 27 has a circular plate or partition 30 made integral therewith to provide

an impeller or pump chamber 31 internally of the annular discharge chamber 26. Communication between the chambers is established by means of the usual volute openings 32 which are most clearly shown in Fig. 3.

An axial opening 33 is formed in the plate 28 for establishing communication between the impeller chamber 21 and the interior of the collar 22 which has its lower end closed by a transverse partition 34 to provide a suction and air separation chamber 35. The chamber 31 has an impeller or pressure pump 36 mounted therein upon an axial shaft 37 and a coupling 38 connects the shaft to the motor shaft 20. A suitable spring-pressed packing gland 39 seals off around the coupling 38 to prevent the escape of fluid from the impeller chamber. It is pointed out that the impeller 36 functions as a delivery or suction pump and has its inlet collar 40 disposed within the opening 33 of the plate 28 so as to draw fluid from the suction chamber 35 and discharge the same outwardly through the ports 32 into the discharge chamber 26 and through the pipe 16 to the tank 12.

The shaft 37 extends downwardly through the inlet collar 40 of the impeller, through the suction chamber 35 and through an axial opening 41 formed in the partition 34 of the collar 22. A transverse plate or partition 42 extends across the base 21 and the lower end of the shaft 37 is journaled in the partition 34 and base plate 42, an impeller or pump chamber 44 is formed for receiving an inverted impeller or pressure pump 45 which is carried by the shaft 37 and has its inlet collar 46 engaging within the opening 41 so as to communicate with the lower portion of the suction chamber 35 in axial alinement with the inlet collar 40. As shown in Fig. 5, the impeller chamber 44 has a volute outlet 44' communicating with a discharge port 47 which, in turn, communicates with the pressure or inlet pipe 48 of the ejection unit 13 (Fig. 2).

A similar port 49 is formed in the base plate 42 for receiving the discharge end of the suction or ejection pipe 50 of the ejection unit and this port communicates with the suction chamber 35 through an alined opening 51 formed in the partition 34. Communication between the lower ends of the pipes 48 and 50 is established by a return bend T or body 52 into the upper end of which said pipes are screw-threaded. A jet nozzle 53 is mounted in the body 52 in axial-communicating alinement with a venturi or suction tube 54 which is disposed within the ejection pipe 50. The body 52 communicates with a supply or tail pipe 55 which has a suitable check or foot valve 56 mounted therein (Fig. 4) and which extends into a well or to other source of fluid supply (not shown).

As has been hereinbefore pointed out, the discharge chamber 26 of the pump case 23 communicates with the tank 12 through the pipe 16. A supply of fluid under pressure is maintained in the tank for priming the pumping system and maintaining the discharge pressure thereof. Air under pressure is adapted to be supplied to the tank by the impeller 36. For admitting air to the impeller 36, an inlet opening 57 is formed in the wall of the collar 22 adjacent its upper end and receives a suitable check valve 58 which has a hose or tube 59 connected thereto. A float 60 is mounted in the tank upon a pivoted arm 61 and the arm extends through the wall of said tank for controlling the operation of an air inlet valve 62 communicating with the outer end

of the tube 59. When the fluid level within the tank rises above a predetermined point, the float 60 and its arm 61 swing upwardly to open the valve 62 and admit atmospheric air to the tube 59. This air is drawn through the tube and its valve 58 into the suction chamber 35 due to the suction created within the upper portion of said chamber by the impeller 36. From the suction chamber, the air passes through the impeller, and is forced through the volute ports 32, discharge chamber 26 and pipe 16 into the tank.

In surface or shallow well pumping, the pipes 48 and 50 of the ejection unit 13 may be connected directly in the openings 47 and 49 of the base plate 42 and the pipe 55 leads to a source of fluid supply such as within a well (not shown). To commence operation of the pumping apparatus, the same is filled with fluid through the pipe 16 and this fluid may be obtained directly from the tank 12. The foot valve 56 prevents the fluid from escaping through the pipe 55. When the motor 18 is started, priming is rapidly accomplished by the action of the ejection unit 13. Since the impeller 45 is inverted, its suction inlet 46 is submerged or flooded by the fluid in the chamber 35, whereby the full pressure created by said impeller is directed downwardly through the pipe 48 and upwardly through the jet nozzle 53 and Venturi tube 54 to develop a high vacuum around said nozzle and within the pipe 55. This vacuum rapidly removes air from the tail pipe together with other fluid and, upon entering the chamber 35, said air rises to the top thereof and enters the inlet 40 of the impeller 36, from which it is discharged through the ports 32 into the discharge chamber 26 and by the pipe 16 into the tank 12. This fast positive priming action without the use of valves or other regulating means is a novel feature of the invention.

It is pointed out that the suction chamber 35 is of sufficient depth to maintain a fluid level above the inlet 46 of the inverted impeller 45 and thereby maintain said impeller submerged or flooded. Thus, the jet action created by this impeller is constant irrespective of the discharge pressure or the amount of air drawn into the apparatus, whereby said apparatus cannot lose its prime. By providing two impellers, one for discharging fluid and the other for supplying fluid under pressure to the jet, the capacity is increased over that of pumping systems having the same power input and this is especially true at low discharge pressures. Due to the depth of the suction chamber and the disposition of the impellers in spaced relation, with their inlets in axial communication with said chamber, the impeller 36 only withdraws fluid from the chamber in excess of the fluid required by the impeller 45 and the latter is maintained flooded or submerged to prevent the entrainment of air in the fluid supplied to the ejection unit.

For deep well operation, such as when the fluid level is more than twenty-five (25') feet below the impellers, the ejection unit 13 is disposed below said fluid level and is connected to the suction and impeller chambers by the conductors 14 and 15, respectively, as shown in Fig. 1. The foot valve 56 (Fig. 4) is necessarily employed in such well installations. The apparatus is primed in the same manner by filling the same with fluid through the pipe 16. Upon starting the motor 18, fluid under pressure is forced by the impeller 45 through the conductor 15, pipe 48 and body 52 to the jet nozzle 53 so as to create a vacuum

around said nozzle and in said body 52 and pipe 55 so as to draw well fluids through the check valve 56. This fluid mixes with the fluid ejected by the nozzle and is carried upwardly through the venturi tube 54, pipe 50 and conductor 14 into the suction chamber 35. Fluid in excess of that required by the impeller 45 is drawn upwardly and discharged by the impeller 36.

When it is desired to pump from greater depths, increased pressure is necessary and is preferably obtained by employing an additional impeller or impellers. It is pointed out that the construction of the pump housing 11 facilitates the addition of impellers for multi-stage operations. As shown in Fig. 6, the general construction of the pump housing remains substantially unchanged and includes substantially all of the same elements. In order to accomplish the conversion, the bolts 25 are removed and the base section 21 is separated from the spacer collar 22 and an intermediate section or case 63 is interposed therebetween and fastened in place by means of similar bolts 64 of slightly greater length than the bolts 25. The case 63 is of the same diameter as the sections 21 and 22 and has a port 65 alined with and establishing communication between the port 49 and opening 51. A partition 66, having an axial opening 67 for receiving the inlet collar 46 of the impeller 45, extends across the lower end of the case 63 and forms a top or upper closure for the impeller chamber 44. A spacer shaft 68 is substituted for the shaft 37 and has the impellers 36 and 45 mounted thereon in spaced relation within the chambers 41 and 44, respectively. The top of the intermediate case is closed by the bottom partition 34 of the spacer collar 22 and an impeller chamber 69 is formed below and in cooperation with said partition by an intermediate, circular partition 70. An inverted impeller or pressure pump 71 is supported within the chamber 69 by the shaft 68 and has its inlet collar 72 disposed within the opening 41 of the partition 34. The chamber 69 has a volute outlet 69' communicating with a discharge chamber 72 disposed externally of and below said impeller chamber, as shown in Fig. 7. A plurality of helical or volute, stationary vanes 73 depend from the lower portion of the partition 70 and rest upon the bottom partition 66 for directing fluid from the discharge chamber 72 to the inlet collar 46 of the impeller 45.

To commence operation, the apparatus shown in Figs. 6 and 7 is primed by being filled with fluid. Starting of the motor 11 causes fluid under pressure to be delivered immediately to the jet nozzle 53 by the impellers 45 and 71, thereby creating a flow through the suction chamber 35. Fluid in excess of that required for the operation of the impellers 45 and 71 is withdrawn from the suction chamber and discharged by the impeller 36. With the impellers 45 and 71 operating in series, a constant supply of high pressure fluid is provided for the jet and the delivery impeller 36 discharges fluid at required discharge pressures independent of the jet operating pressure. Since the inlet of the impeller 71 is always flooded, operation from any depth within range of the ejection unit 13 may be accomplished without the use of control or pressure regulating valves. It is pointed out that this multi-stage arrangement affords the highest efficiency possible for extreme lifts. Although only one intermediate stage or impeller has been illustrated, it is manifest that any number of additional stages may be employed, provided the power input is

increased. It is sometimes desirable to use the multi-stage arrangement in surface or shallow well installations so as to increase the discharge pressure of the pumping apparatus.

The foregoing description of the invention is explanatory thereof and various changes in the size, shape and materials, as well as in the details of the illustrated construction may be made, within the scope of the appended claims, without departing from the spirit of the invention.

What I claim and desire to secure by Letters Patent is:

1. A pump system comprising a casing, an upper pump in said casing and a lower pumping means in said casing, said pump and pumping means being rotatable as a unit with suction inlets in juxtaposed relation and facing each other, a suction and air separating chamber in said casing and disposed between said pump and pumping means inlets, a fluid connection from said upper pump to a point of use, a jet pump having a nozzle, a discharge from said pumping means connected to the nozzle side of said jet pump, a fluid connection from the outlet side of said jet pump to said suction and air separating chamber, and a source of fluid to be pumped connected to the inlet side of said jet pump.

2. A pump system comprising a casing, an upper pump in said casing and a lower pump in said casing, said upper pump and said lower pump being rotatable as a unit with suction inlets in juxtaposed relation and facing each other, a suction and air separating chamber in said casing and disposed between said upper and lower pumps, a fluid connection from said upper pump to a point of use, a jet pump having a nozzle and a Venturi element, a discharge from said lower pump connected to the nozzle side of said jet pump, a fluid connection from the outlet side of said jet pump to said suction and air separating chamber, and means for introducing the fluid to be pumped at a position between the nozzle and the venturi of the said jet pump.

3. A pump system comprising a casing, an upper pump in said casing and a plurality of lower pumps in said casing, said upper pump and said lower pumps being rotatable as a unit with suction inlets in juxtaposed relation, the inlet of said upper pump facing the inlet of one of said lower pumps, a suction and air separating chamber in said casing and disposed between said upper pump and said lower pump inlets, a fluid connection from said upper pump to a pressure tank, a jet pump including a nozzle, a discharge from one of said lower pumps connected to the nozzle side of said jet pump, a fluid connection from the outlet side of said jet pump to said suction and air separating chamber, and a source of fluid to be pumped connected to the inlet side of said jet pump.

4. A pump system comprising a casing, an upper pump in said casing and a plurality of lower pumps in said casing, said upper pump and said lower pumps being rotatable as a unit with suction inlets in juxtaposed relation, the inlet of said upper pump facing the inlet of one of said lower pumps, a suction and air separating chamber in said casing and disposed between said upper pump and said lower pump inlets, a fluid connection from said upper pump to a pressure tank, a jet pump including a nozzle, a discharge from one of said lower pumps connected to the nozzle side of said jet pump, a fluid connection from the outlet side of said jet pump to said suction and air separating chamber, and a source of

fluid to be pumped connected to the inlet side of said jet pump, said lower pumps being arranged one above the other, and means for detachably connecting one of said lower pumps to said casing, said lower pumps comprising at least a two-stage pump system and said upper pump comprising at least a one-stage pump system.

5. A pump system comprising a casing, an upper pump in said casing and a plurality of lower pumps in said casing, said upper pump and said lower pumps being rotatable as a unit with suction inlets in juxtaposed relation, the inlet of said upper pump facing the inlet of one of said lower pumps, a suction and air separating chamber in said casing and disposed between said upper pump and said lower pump inlets, a fluid connection from said upper pump to a pressure tank, a jet pump including a nozzle, a discharge from one of said lower pumps connected to the nozzle side of said jet pump, a fluid connection from the outlet side of said jet pump to said suction and air separating chamber, and a source of fluid to be pumped connected to the inlet side of said jet pump, and a common shaft means for mounting all of said rotatable pumps.

6. A pump system comprising a casing, an upper pump in said casing and a plurality of lower pumps in said casing, said upper pump and said lower pumps being rotatable as a unit with suction inlets in juxtaposed relation, the inlet of said upper pump facing the inlet of one of said lower pumps, a suction and air separating chamber in said casing and disposed between said upper pump and said lower pump inlets, a fluid connection from said upper pump to a pressure tank, a jet pump including a nozzle, a discharge from one of said lower pumps connected to the nozzle side of said jet pump, a fluid connection from the outlet side of said jet pump to said suction and air separating chamber, and a source of fluid to be pumped connected to the inlet side of said jet pump, said lower pumps being arranged one above the other, and means for detachably connecting one of said lower pumps to said casing, said lower pumps comprising at least a two-stage pump system and said upper pump comprising at least a one-stage pump system, and a common shaft means for mounting all of said rotatable pumps.

7. A pump system comprising a casing, an upper pump in said casing and a lower pumping means in said casing, said pump and pumping means being rotatable as a unit with suction inlets in juxtaposed relation and facing each other, a suction and air separating chamber in said casing and disposed between said pump and pumping means inlets, a fluid connection from said upper pump to a pressure tank, a jet pump including a nozzle, a discharge from said pumping means connected to the nozzle side of said jet pump, a fluid connection from the outlet side of said jet pump to said suction and air separating chamber, and a source of fluid to be pumped connected to the inlet side of said jet pump, and an air line connected to said suction and air separating chamber, and means actuated by the fluid level within said pressure tank for admitting atmospheric air through said air line to said chamber.

8. A pump system comprising a casing, an upper pump in said casing and a lower pumping means in said casing, said pump and pumping means being rotatable as a unit with suction inlets in juxtaposed relation and facing each other, a suction and air separating chamber in said casing and disposed between said pump and

pumping means inlets, a fluid connection from said upper pump to a pressure tank, a jet pump, a discharge from said pumping means connected to the inlet side of said jet pump, a fluid connection from the outlet side of said jet pump to said suction and air separation chamber, and a source of fluid to be pumped connected to the inlet side of said jet pump, and an air line connected to said suction and air separating chamber, and means actuated by the fluid level within said pressure tank for admitting atmospheric air through said air line to said chamber, said pumping means including a plurality of pumps whereby to comprise a multi-stage pump system.

9. A pump system comprising a casing, an upper pump in said casing and a lower pump in said casing, said upper pump and said lower pump being rotatable as a unit with suction inlets in juxaposed relation and facing each other, a suction and air separating chamber in said casing and disposed between said upper and lower pumps, a fluid connection from said upper pump to a point of use, a jet pump including a nozzle and venturi element, a discharge from said lower pump connected to the nozzle side of said jet pump, a fluid connection from said outlet side of said jet pump to said suction and air separating chamber, and means for introducing the fluid to be pumped at a position between the nozzle and the venturi of the said pump, said point of use comprising a pressure tank and said lower pump discharging directly into said discharge that is connected to the nozzle side of said jet pump.

10. A pump system comprising a casing, an upper pump in said casing and a lower pumping means in said casing, said pump and pumping means being rotatable as a unit with suction inlets in juxtaposed relation and facing each other, a suction and air separating chamber in said casing and disposed between said pump and pumping means inlets, a fluid connection from said upper pump to a point of use, a jet pump including a nozzle, a discharge from said pumping means connected to the nozzle side of said jet pump, a fluid connection from the outlet side of said jet pump to said suction and air separating chamber, and a source of fluid to be pumped connected to the inlet side of said jet pump, said casing comprising a plurality of sections and means for removably securing said sections to each other.

11. A pump system comprising a casing, an upper pump in said casing and a lower pump in said casing, said upper pump and said lower pump being rotatable as a unit with suction inlets in juxtaposed relation and facing each other, a suction and air separating chamber in said casing and disposed between said upper and lower pumps, a fluid connection from said upper pump to a point of use, a jet pump including a nozzle and Venturi element, a discharge from said lower pump connected to the nozzle side of said jet pump, a fluid connection from said outlet side of said jet pump to said suction and air separating chamber, and means for introducing the fluid to be pumped at a position between the nozzle and the venturi of the said pump, said casing comprising a plurality of sections and means for removably securing said sections to each other.

12. A pump system comprising a casing, an upper pump in said casing and a lower pumping means in said casing, said pump and pumping means being rotatable as a unit with suction inlets in juxtaposed relation and facing each other, a suction and air separating chamber in said cas-

ing and disposed between said pump and pumping means inlets, a fluid connection from said upper pump to a point of use, a jet pump including a nozzle, a discharge from said pumping means connected to the nozzle side of said jet pump, a fluid connection from the outlet side of said jet pump to said suction and air separating chamber, and a source of fluid to be pumped connected to the inlet side of said jet pump, said casing comprising a plurality of sections and means for connecting said sections together on substantially horizontal planes.

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