March 20, 1951 J. L. BOVEE, JR., ET AL 2,545,915

PUMPING SYSTEM AND PRIMER THEREFOR

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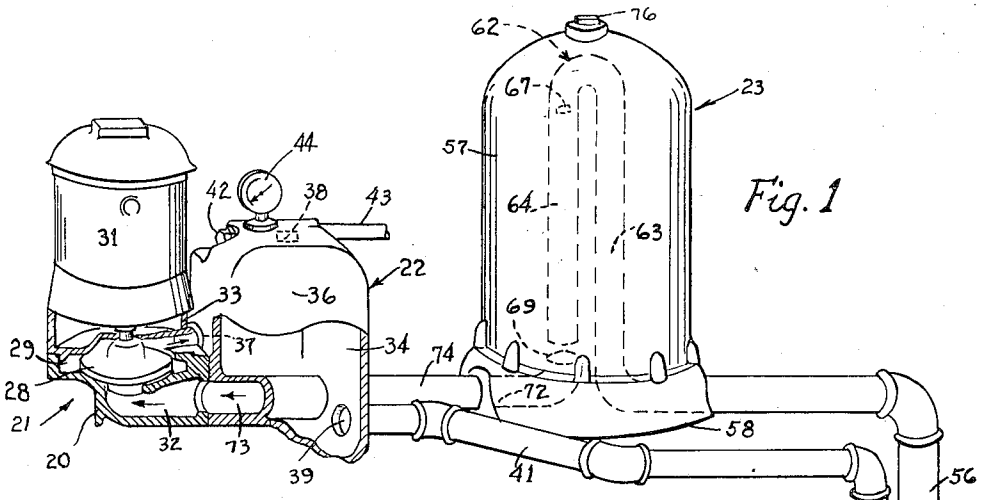


Fig. 1

Fig. 2

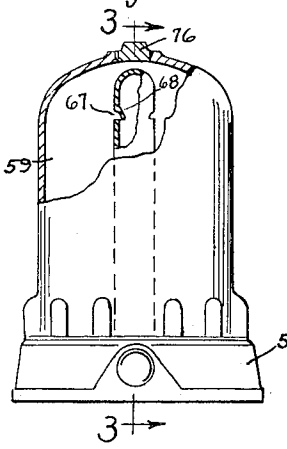


Fig. 3

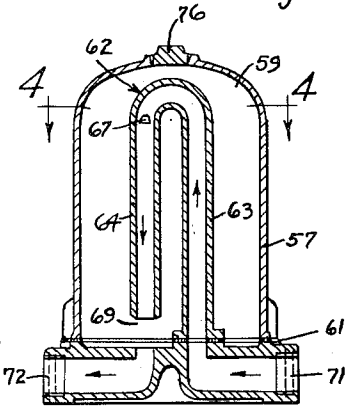
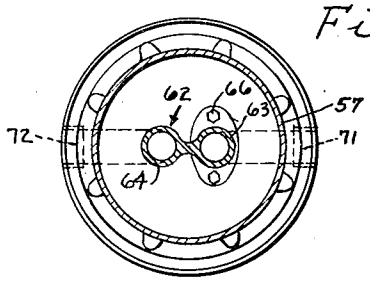
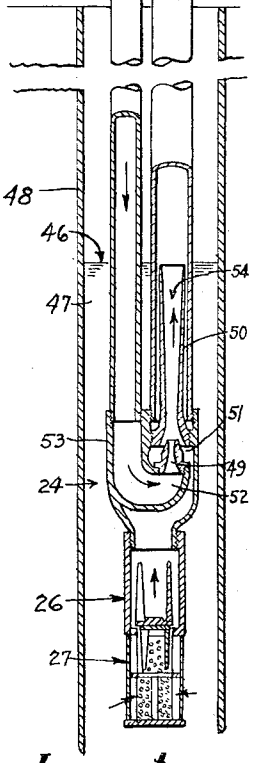


Fig. 4





Inventor

John L. Bovee, Jr.
Elmer M. Deters

By McCanna and Morshach

Atty's

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PUMPING SYSTEM AND PRIMER THEREFOR

John L. Bovee, Jr., Anaheim, Calif., and Elmer M. Deters, Davenport, Iowa, assignors to Red Jacket Manufacturing Co., Davenport, Iowa, a corporation of Iowa

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8 Claims. (Cl. 103—5)

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This invention relates to pumps and has special reference to a deep well pumping system employing centrifugal and similar type pumps.

An important object of the invention is the provision of a novel structure for rendering a centrifugal pumping system self-priming.

Another object is the provision of a liquid pumping system in which the discharge of liquid will be unaffected by the entrance of large quantities of air or other gas into the suction piping.

Another object is the provision of a discharge box for a centrifugal pump, all necessary permanent piping being connected to the discharge box; thus the pump may be removed for replacement or repair without disturbing the piping.

A still further object is the provision of a discharge box or separator chamber so constructed as to effect a high degree of separation of gas from the liquid stream.

An important feature of our invention is the means we utilize to eliminate unpriming gas from a pump system, first, by collecting and storing the gas in a priming chamber, second, returning it to the liquid stream at a rate slow enough that it will not cause the pump to lose its prime, and third, eliminating it from the system in a discharge or separator box of novel design.

Other objects and advantages will appear from the following description and the accompanying drawing, in which—

Figure 1 is a partially cut-away perspective view of a pumping system embodying one form of our invention;

Fig. 2 is a partially cut-away end view of the priming chamber unit shown as part of Figure 1;

Fig. 3 is a section taken on the line 3—3 of Fig. 2, and

Fig. 4 is a section taken on the line 4—4 of Fig. 3.

Like parts are designated by like reference characters throughout the figures.

Referring now more particularly to the drawing, the pumping system shown includes the motor driven centrifugal pump 21, discharge box 22, priming chamber unit 23, injector 24, foot or check valve 26, and strainer 27.

The pump 21 is preferably of the centrifugal type having the impeller 28 rotatable within the volute chamber 29 by the motor 31 and serves to draw fluid through the inlet passage 32 and discharge it through the outlet passage 33 into the separation chamber 34 of the discharge box 22 in the direction of the arrows.

The housing 36 of the discharge or separator box 22 is formed to enclose the storage chamber 34 where the fluid entering at the inlet port 37

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is divided, as will be considered in greater detail below, into two streams, one stream passing through the upperly positioned discharge port 38, and the other stream passing to the recirculation port 39 and through the pressure pipe 41 to the jet pump or injector 24. A conventional plug cock or valve 42 is provided in the upper part of the discharge box housing 36 to control the rate of flow through the port 38 into the discharge pipe 43, thereby controlling the back pressure built up in the chamber 34; a pressure gauge 44 is mounted on the housing and communicates with the chamber 34 for indicating this back pressure.

The injector or jet pump 24 is shown as it would normally be positioned beneath the surface 46 of the water 47 in a well pipe 48. Both the discharge, or high pressure, pipe 41 and the intake, or low pressure, pipe 56 lead downwardly into the well and terminate in the injector housing 53, into the upper portion of which each pipe is threaded. An injector nozzle 49 is threaded through the lower end of the low pressure recess 51 into the high pressure chamber 52 into which the high pressure pipe 41 leads. The nozzle 49 is adapted to direct its jet vertically upward through the low pressure recess 51 into a diffuser or Venturi tube 50 which is threaded into the housing 53 at the upper end of the recess 51. The eductor or diffuser tube 50 has a bore 54 of gradually increasing taper flaring upward into the return or low pressure pipe 56.

The priming chamber unit 23 has a housing comprising an inverted shell or dome 57 mounted on the base portion 58 and has a priming chamber 59 of substantial storage capacity. An inverted U-tube member 62, having upstanding inlet and outlet legs 63 and 64, is mounted upon the base member 58 in any suitable manner, as by bolts 66. Apertures 67, formed in the upper part of the outlet leg 64, having inwardly extending lips 68 on the upstream side of the apertures, serve to regulate the flow of air or gas in and out of the priming chamber in a novel manner presently to be described in detail; and the opening 69 at the lower part of the outlet leg 64 cooperates with the apertures 67 to facilitate the passage of priming liquid in and out of the storage chamber in a novel manner, also presently to be described. Inlet and outlet passages 71 and 72 formed in the base portion 58 are so spaced as to be in registration with the inlet and outlet legs 63 and 64, respectively.

Another important part of our invention lies in the manner in which we have joined the priming

unit outlet passage 72 to the pump inlet passage 32. This is accomplished by providing the ported by-pass passage 73 extending completely through the discharge box housing 36 and by-passing the separating chamber 34; thus, by joining the priming unit outlet passage to one end of the by-pass passage 73 by means of the conduit 74, and by bolting the pump casing 20 directly upon the discharge box so that the pump inlet 32 and the other end of the by-pass passage 73 are in registry, the pump may be dismantled for repair or replacement without disturbing any piping connection.

To consider the operation of the pumping system, assume the injector 24 is immersed in a source of water supply 47 and the discharge pipe 43 is connected to a point of water delivery such as a conventional pressure tank (not shown). The system will be initially primed by removing the plug 76 and introducing water into the priming chamber 59 until it is filled; this will substantially fill the system with water except for air pockets at various locations which must be purged by pumping. The valve or cock 42 is closed and the motor is then started, causing rotation of the impeller 28, which in turn draws water from the priming chamber 59 through the opening 69, conduit 74, by-pass passage 73 and inlet passage 32 into the eye of the impeller which discharges the water into the volute 29 from which it flows through the discharge box inlet 37 into the separating chamber 34. Inasmuch as the discharge port 38 is entirely closed off by the valve 42 during the initial or priming phase of the starting operation, all the water (and air included with it) which enters the chamber 34 is forced through the recirculation port 39, down the pressure pipe 41 to the injector, and back up the return pipe 56 through the priming unit 23, drawing the air from the various parts, conduits and passages. As the water containing air bubbles is passed through the inverted U-shaped tube 62, the bubbles or slugs of air, separate out and pass through the apertures 67 into the upper part of the priming chamber 59, displacing an equivalent volume of water from the priming chamber which enters the flowing water stream through the opening 69 at the bottom of the leg 64 and passes through the priming unit outlet port 72 back to the pump. Continued rotation of the impeller causes this action to be repeated continuously, thus continuously drawing air through the inverted U-tube until all the air in the system is separated out into the priming shell 57 and an equivalent quantity of make-up water has passed into the water stream through the opening 69. After the system is primed in this manner, the operator opens the cock 42 to the required degree as indicated by the pressure gauge 44, the extent to which the cock is opened depending upon the amount of pressure which the operator desires to apply against the nozzle 49. The cock 42 is then fixed in the required position and thenceforth will require no change or adjustment during the life of the pump, or until it is necessary to dismantle the pump or for some reason the system loses the charge of water in the priming chamber. Upon opening of the cock 42 a part of the water handled by the impeller passes out through the pipe 43 to a point of discharge (not shown), and the remainder is recirculated through the nozzle 49 and the Venturi tube 50 to continue the pumping action.

With the cock 42 open to permit discharge from the system, when water under pressure is forced through the nozzle 49 the jet entering the diffuser tube 50 creates a partial vacuum in the recess 51; since this recess communicates with the foot valve 26 the well water is forced by atmospheric and submersion pressure through the strainer 27, foot valve 26 and recess 51 into the diffuser tube 50 where the two streams mix. Herein, as the velocity of the water is lowered, the velocity head is converted into pressure head which is capable of lifting the column of water within the return pipe 56 to the pump.

Water flowing past the apertures 67 in the inverted U-tube 62 will create a low pressure area within the U-tube adjacent each aperture; this will cause the air previously stored in the upper part of the dome 57 to be aspirated back into the water stream at a rate slow enough that it will not cause the pump to lose its prime. This air passes through the pump into the discharge box separating chamber 34 which is so constructed as to effect the separation and discharge of this air. To take maximum advantage of the buoyancy of the air bubbles in carrying out this separation, the discharge port 38 is located in the upper portion of the housing; and the recirculation port 39 is positioned in the opposite wall somewhat lower than the inlet port 37 so that flow to the recirculation port must be horizontal in addition to downwardly. It is preferable that there be no direct line between the inlet and recirculation ports so that water passing therebetween must move in a curved or non-rectilinear path to further facilitate the separation of air bubbles; this is accomplished in the construction shown by positioning the bypass passage portion 73 within the housing so that fluid passing from the inlet port 37 must flow around this passage to reach the recirculation port.

It will be obvious that our pumping system is adaptable to deep well service as the force exerted by the pump may be applied at the bottom of a column of water in the pipe 48. The height of the pump 21 above the water line is not limited to 25', the greatest practical height to lift water by atmospheric pressure.

Thus it will be obvious that we have provided a new and useful pumping system which is especially advantageous for use in pumping against heads exceeding 25' of water, which is self-priming even when used with gas producing wells, and which will eliminate gas from the system without the use of additional moving parts such as the ball float valves and the like which are conventionally used for this purpose.

The foregoing description has been given by way of illustration of a preferred embodiment of the invention and is believed to convey a full and fair description of the principles thereof adequate to permit those skilled in the art to practice the same.

We claim:

1. A priming chamber unit for a pumping system comprising a base portion, a shell mounted upon said base portion and enclosing a storage chamber therebetween, an inverted U-shaped tube mounted upon said base portion having inlet and outlet legs within said storage chamber, said base portion having inlet and outlet passages communicating with said inlet and outlet legs, respectively, said U-shaped tube having aspirating means at an upper portion thereof and aperture means at a lower portion thereof, both of said means providing communication between said storage chamber and the interior of said

tube, whereby when said tube contains a flowing mixture of air and water the air of said mixture will be collected at a rapid rate in said storage chamber and an amount of water equivalent to the volume of said collected air will be displaced from said chamber through said aperture means, and whereby when said tube contains substantially only water flowing therein said collected air will be returned to said tube at a slow rate by said aspirating means and an amount of water equivalent to the volume of said returned air will be drawn into said storage chamber through said aperture.

2. A priming chamber unit for a pumping system comprising a base portion, a shell mounted in a leak-proof manner upon said base portion and enclosing a combination gas and liquid storage chamber therewithin, an inverted U-shaped tube mounted upon said base portion having inlet and outlet legs within said storage chamber, said base portion having inlet and outlet passages communicating with said inlet and outlet legs, respectively, said U-shaped tube having apertured aspirating means at an upper portion thereof providing communication with said storage chamber to effect the flow of gas between said tube and storage chamber, and the end of one of said legs being in spaced relation to the corresponding passage in the base to provide communication with said storage chamber to permit the flow of make-up liquid between said storage chamber and said outlet passage as required to compensate for the flow of gas through said aspirating means.

3. A priming chamber unit for a pumping system comprising a base portion, a shell mounted upon said base portion and enclosing a storage chamber therebetween, an inverted U-shaped tube mounted upon said base portion having inlet and outlet legs within said storage chamber, said base portion having inlet and outlet passages communicating with said inlet and outlet legs, respectively, said U-shaped tube member having an aperture at an upper portion thereof providing communication with said storage chamber, and one of said legs having an opening in spaced relation to the corresponding passage in the base portion and positioned to provide communication with said storage chamber.

4. In a deep well pumping system of the character described, the combination of: a pump for pumping fluid from a well and having an inlet passage and an outlet passage; conduit means having an end connected to said inlet passage and having a portion arranged to be disposed in said well; a separator box having an inlet port in communication with said outlet passage, a discharge port for connection to a liquid receiving tank and a recirculation port, a jet pump connected to said recirculation port and operatively associated with said portion of the conduit means in the well to aid said pump in pumping fluid through said conduit means, and air separation means in said conduit means between said portion of the conduit means in the well and said pump for separating large quantities of gas from the fluid stream flowing through said conduit means during the pump priming process and for subsequently restoring said gas to said conduit means at a relatively low rate after the pump is primed.

5. In a deep well pumping system of the character described, the combination of: a pump for pumping fluid from a well and having inlet and outlet passages; conduit means connected to said inlet passage and effecting communication between said pump and said well; a separator box having an inlet port communicating with said outlet passage, a discharge port for connection to a liquid receiving tank, and a recirculation port; a jet pump for aiding said pump in pumping fluid from said well including an eductor tube and a nozzle positioned to discharge into said tube, said nozzle being in communication with said recirculation port and said eductor tube being operatively associated with said conduit means, and a priming unit disposed in said conduit means adjacent said pump comprising a housing having a chamber, a port forming part of said conduit means and in direct communication with said inlet passage and an apertured inverted U-shaped tube positioned in said chamber to have one end in communication with said jet pump and one end spaced from said last mentioned port.

6. In a device of the character described, the combination of: a pump for pumping fluid from a well and having inlet and outlet passages; conduit means connected to said pump inlet passage and having an end portion arranged to be disposed in said well, a discharge box having an inlet port in communication with said outlet passage, a discharge port positioned above said inlet port and arranged for connection to a liquid receiving tank, and a recirculation port spaced apart from and below said inlet port; a jet pump connected to said recirculation port and in communication with and forming a part of said end portion of the conduit means to aid in pumping fluid from the well; and a priming unit connected in said conduit means between said pump and said jet pump comprising a casing having a chamber, an inlet port connected with said jet pump through said conduit means and an outlet port in communication with said inlet passage of said pump through said conduit means and an inverted U-shaped tube mounted in said priming chamber having one leg directly connected with said inlet port and the other leg in spaced relation to the outlet port, said other leg having an aperture formed therein at a position adjacent the top of said chamber.

7. A deep well pumping system comprising: a pump for pumping fluid from a well and having inlet and outlet passages; a discharge box having an air separation chamber, an inlet port, a discharge port and a recirculation port, said inlet port being in communication with said pump outlet passage, said ports being positioned to have a generally upwardly directed flow from the inlet port to the discharge port and a generally downwardly directed flow in a non-rectilinear path from the inlet port to the recirculation port to effect maximum separation of gas from the fluid as it flows from the inlet to the recirculation port, a jet pump disposed in said well in communication with said recirculation port and the inlet passage to aid said pump in pumping fluid from the well, and a combination gas separating and priming chamber unit connected between said jet pump and said pump comprising a fluid tight casing having a single chamber for storing both gas and liquid and an inverted substantially U-shaped tube having spaced legs, one of said legs positioned in said housing to receive fluid after delivery from the jet pump and said other leg positioned to discharge fluid to said inlet passage, said inverted U-shaped tube having aperture means at an up-

per position and at a lower position on said last mentioned leg providing communication between the interior of the tube and said chamber, said aperture means being operable to remove gas from fluid flowing from said jet pump to said pump and temporarily storing said gas in said chamber until the pump is primed and said aperture means thereafter effecting the removal of gas from said chamber at a rate slow enough to prevent the formation of air pockets.

8. In a device of the character described, the combination of: a pump for pumping fluid from a well and having an inlet passage and an outlet passage; conduit means in communication with said pump and having a remote portion arranged to be disposed in a well; a separator box having an inlet port in communication with said outlet passage, a discharge port positioned above said inlet port for connection to a liquid receiving tank, a recirculation port spaced from and below said inlet port and a tubular portion forming a part of said conduit means in said box disposed between said inlet port and said recirculation port to form an obstruction to cause the fluid to flow in a curved path between these ports; a jet pump connected to said recirculation port and operatively associated with said remote portion of the conduit means in the well to aid said pump in pumping fluid through said conduit means, and air separation means in said conduit means between said remote portion of the conduit means and said pump for separating large quantities of gas from the fluid stream flowing through said conduit means during the pump priming process and for subsequently restoring said gas to said conduit means at a relatively low rate after the pump is primed.

JOHN L. BOVEE, JR.
ELMER M. DETERS.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
784,185	Sharood	Mar. 7, 1905
1,724,690	Aldrich	Aug. 13, 1929
2,274,987	Lung	Mar. 3, 1942
2,319,509	Lung	May 18, 1943
2,335,109	Conery	Nov. 23, 1943

FOREIGN PATENTS

Number	Country	Date
202,595	Great Britain	Aug. 18, 1923
373,039	Germany	Mar. 21, 1922