

Oct. 13, 1931.

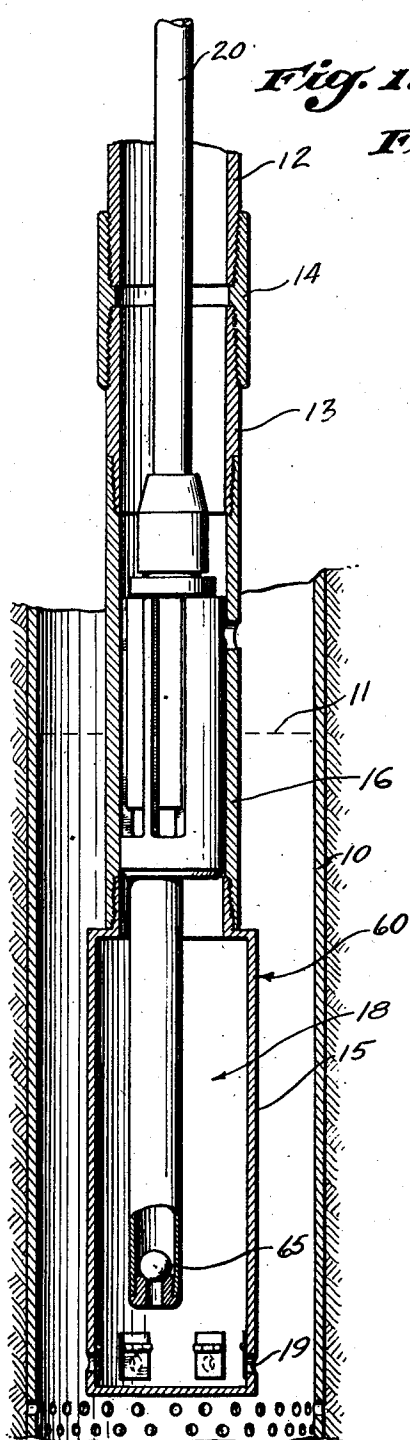
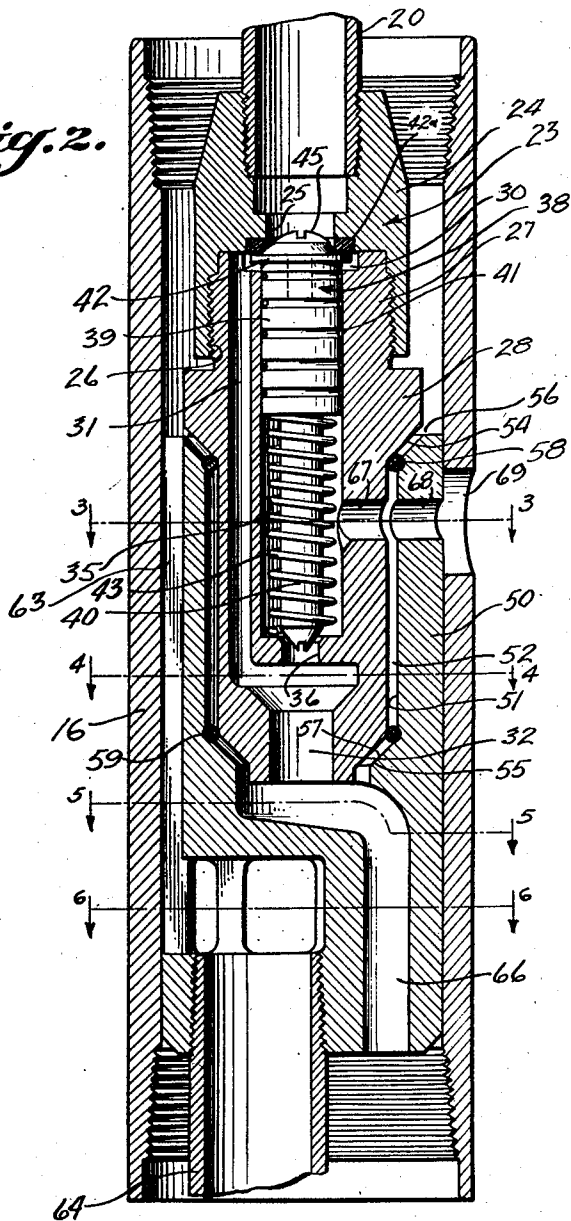
G. E. MAKINSTER

1,827,091

VALVE CONSTRUCTION FOR GAS PUMPS

Filed Nov. 19, 1928

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

Fig. 3.

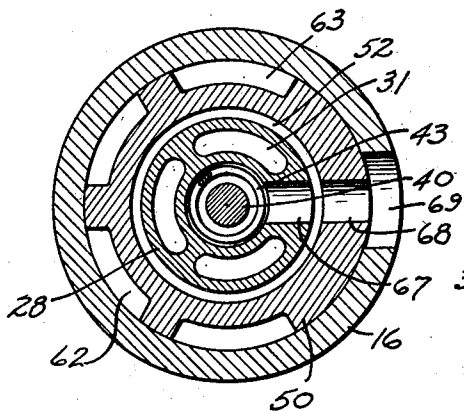


Fig. 4.

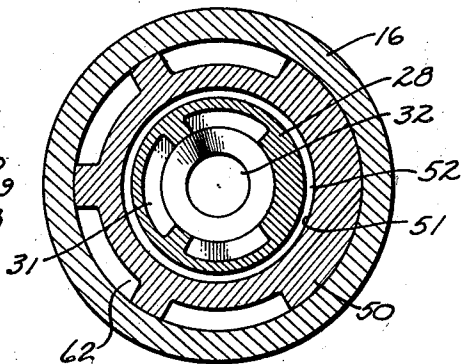


Fig. 5.

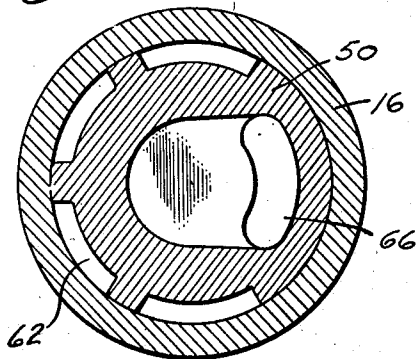


Fig. 6.

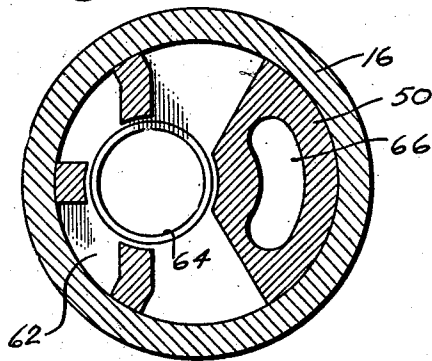
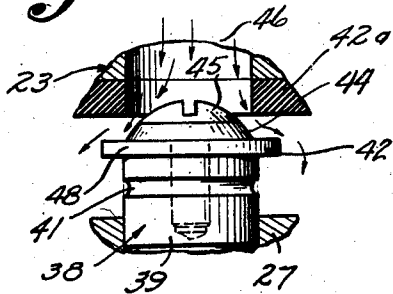


Fig. 7.



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UNITED STATES PATENT OFFICE

GLENN E. MAKINSTER, OF LOS ANGELES, CALIFORNIA, ASSIGNOR, BY MESNE ASSIGNMENTS, TO JORDAN & TAYLOR, INC., OF LOS ANGELES, CALIFORNIA, A CORPORATION OF CALIFORNIA

VALVE CONSTRUCTION FOR GAS PUMPS

Application filed November 19, 1928. Serial No. 320,372.

My invention relates to valve structures and more particularly to a valve structure for use in deep well pumps, especially those pumps which are known in the art as displacement pumps. It is in this latter capacity that I have chosen to particularly describe my invention but I desire this choice to in no way limit my invention to this particular combination, inasmuch as my valve structure finds utility outside of the particular combination to be described.

In pumping wells by means of a displacement pump, it is customary to provide a displacement chamber below the surface level of the liquid in the well, this chamber communicating with the well liquid through suitable valves. When the chamber becomes filled with well liquid, gas is forced into the chamber and displaces the liquid upward through a suitable discharge tubing extending to the surface of the ground.

It is desirable that the pressure in the displacement chamber be as low as possible during the filling of this chamber with well liquid. Most displacement pumps are so operated that the body of well liquid entering the chamber in any particular charge is forced entirely from the discharge tubing at the top of the well before another charge enters the chamber. In this way the chamber is vented to atmosphere. Such a practice is extremely wasteful of gas and time, and of late it has been suggested that the displacement chamber might be vented to casing pressure during the time that another charge is entering this chamber. This requires the use of a suitable valve, and I have found it desirable to utilize a piston valve operable by the pressure of the compressed gas used for displacing the liquid in the displacement chamber.

It is an object of this invention to provide a novel pressure-operated valve structure.

Another object of this invention is to provide a valve structure of the piston type which closes the gas supply passage, and simultaneously opens the vent passage, thus venting the displacement chamber to the pressure surrounding the walls of this chamber.

In providing such a pressure-operated valve, it is desirable that the valve be resiliently held in a manner to close the gas supply opening. When the gas pressure on this valve builds up sufficient to open the valve against the resilient means, gas will flow downward into the displacement chamber. After the pressure builds up in this chamber, there is a tendency for the valve to chatter, this valve opening only when a sufficient differential pressure has been established between the chamber and the gas supply opening.

It is an object of this invention to provide a valve mechanism in which a valve member is resiliently held in a position to close a gas supply opening, this valve member having a velocity ring placed in such a position that the gas entering the gas supply opening impinges against the ring and holds the valve open until this flow of gas has been stopped. In this way no chattering takes place, inasmuch as the valve opens as a function of the pressure of the gas supply and closes as a function of the velocity of the gasses passing through the opening.

I have found it extremely desirable to so form the valve structure that this structure may be removed from the well without removing the displacement chamber. In accomplishing this end, I support the displacement chamber on a primary tubing, and extend a secondary tubing downward therein, this secondary tubing having the valve structure provided at the lower end thereof. This valve structure engages a seat member in a novel manner, and forms a fluid-tight fit therewith.

It is an object of this invention to provide a displacement pump in which the valve structure may be readily removable without removing the displacement chamber structure from the well.

Further objects and advantages of my invention will be made evident in the following description.

The drawings illustrate the structural details of one form of my invention in conjunction with one type of displacement pump.

Referring to the drawings,

Fig. 1 is an assembled view, partly in section, illustrating my valve structure in a displacement pump.

Fig. 2 is a cross-sectional view of the valve structure of my invention.

Figs. 3 to 6 are cross-sectional views taken on corresponding lines indicated in Fig. 2.

Fig. 7 is an enlarged view of the velocity ring utilized in my invention.

The type of displacement pump illustrated in Fig. 1 is disposed inside a well casing 10 extending downward from the surface of the ground to a point below the liquid level in the well, the lower end of this well casing being suitably perforated to permit access of the liquid from the strata surrounding the casing, this liquid rising to a level such as indicated by the numeral 11 in Fig. 1.

Extending downward in the well casing 10 is a primary or outer tubing 12, which is connected to a nipple 13 by a coupling 14. Threadedly connecting the nipple 13 and a shell 15 at least partially submerged in the well liquid, is a casing 16. The shell 15 provides a displacement chamber 18 which communicates with the liquid in the well through valves 19 situated in the lower end thereof, these valves being of the flapper type, which permit a ready ingress of liquid into the displacement chamber but prevent any flow therefrom.

Extending downward through the primary or outer tubing 12 is a secondary or inner tubing 20, through which gas is intermittently supplied from the surface of the ground to the displacement chamber 18 through a valve structure 23.

The details of this valve structure are best illustrated in Figs. 2, 3, and 4. Referring to these figures, a valve head member 24 is threaded to the lower end of the inner tubing 20 and provides a gas supply opening 25 in communication therewith. Threaded into a cavity 26 of the head member 24 is a dome 27 of a valve body member 28. A valve chamber 30 is formed between the dome 27 and the head member 24, this chamber communicating with an intake passage 31 extending downward through the body member 28 and opening on a gas passage 32 which in turn opens on the lower end of the body member 28.

Formed in the body member 28 concentric with the gas supply opening 25 is a cylinder 35 which communicates at its upper end with the chamber 30 and at its lower end with the gas passage 32 through a valve opening 36. Adapted to slide in the cylinder 35 is a valve member 38 which is composed of a piston 39 and an integrally formed plunger 40. Grooves 41 are formed in the periphery of the piston 39 so that the piston will slide in fluid-tight relationship relative to the walls of the cylinder. Suitable piston rings 43 may be positioned in the grooves 41 if desired.

Positioned on the upper end of the piston 39 and forming a part thereof is a velocity ring 42 which is normally held in resilient engagement with a renewable valve seat 42^a pressed into a counterbore of the gas supply opening 25, this resilient engagement being effected by a compression spring 43 situated in the cylinder 35.

The details of this velocity ring are best illustrated in Fig. 7. Referring to this figure, the velocity ring 42 is provided with a curved surface 44 which seats against the valve seat 42^a. The velocity ring is held in place by a round-headed bolt 45, the contour of which corresponds to the contour of the curved surface 44 so that when the piston is in a lowered position, compressed gas flowing through the inner tubing 20 is guided through the space between the velocity ring and the valve seat 42^a in a direction indicated by arrows 46 of Fig. 7. This gas impinges on a ledge 48 of the velocity ring 42, thus exerting a downward force on the piston and tending to move this piston downward as long as any flow of gas takes place, after which the valve member moves upward under the influence of the spring 43. Thus, the valve member is first moved downward due to a sufficient difference in pressure being established between the gas supply opening 25 and the cylinder 35, but once opened, the velocity of the gas maintains this valve open until the velocity of the gas flowing as indicated by the arrows 46 becomes very low.

When the valve member 38 is in its lower position, the lower end of the plunger 40 is adapted to close the valve opening 36. This is made possible by preferably tapering the lower end of the plunger 40 as best illustrated in Fig. 2.

The particular mounting of the valve structure 23 is an important part of this invention. Referring particularly to Fig. 2, I provide a seat member 50 formed of such an outer diameter that it may be pressed into the casing 16. The seat member 50 provides an opening 51 into which the body member 28 of the valve structure 23 extends, the outer diameter of the body member being slightly smaller than the inner diameter of the opening 51 so as to provide an annular chamber 52 therebetween. The body member 28 has upper and lower tapered portions 54 and 55 formed therein, these portions corresponding to upper and lower tapered portions 56 and 57 formed on the seat member 50. In some instances it is desirable to utilize a direct contact between these two pairs of surfaces for defining the upper and lower ends of the annular chamber 52, but in the preferred embodiment of this invention I prefer to provide upper and lower packing rings 58 and 59 for serving this purpose. The upper packing ring 58 is preferably secured to the body member 28 in a position shown in Fig. 1.

2, while the lower packing ring 59 is preferably secured in the lower end of the opening 51 in a position shown in Fig. 2.

It should thus be clear that the pumping structure of my invention is supported by the outer tubing 12, this pumping structure being designated by the numeral 20 and comprising the shell 15, casing 16, and seat member 50, while the valve structure 23 is supported on the lower end of the inner tubing 20. It thus becomes possible to draw upward on the inner tubing 20 and raise the valve structure to the surface of the ground without disturbing the pumping structure. This is a very important feature of my invention, inasmuch as any trouble which might be experienced from the valve structure may be corrected without moving the entire pump from the well.

Formed in the outer periphery of the seat member 50 is a plurality of channels 62 which cooperate to form a discharge passage 63 communicating with the annular space between the inner and outer tubings 20 and 12. The discharge passage 63 also communicates with the interior of a discharge tube 64 threaded into the lower end of the seat member 50 and extending downward in the displacement chamber to a position near the lower end thereof. The lower end of the discharge tube is provided with a check valve structure 65 which prevents any downward flow of liquid through this pipe and into the displacement chamber, but readily permits an upward flow therethrough.

The discharge tube 64 is positioned to one side of the axis of the displacement chamber 18 so as to provide room for a channel 66 formed in the seat member 50 and communicating between the upper end of the displacement chamber 18 and the gas passage 32. This channel is intermittently utilized for supplying compressed gas to the upper end of the displacement chamber and for venting the upper end of this chamber to casing pressure through the cylinder 35 and the valve opening 36. This venting is made possible by a port 67 communicating between the cylinder 35 and the annular chamber 52, and a port 68 communicating between the annular chamber 52 and a port 69, this latter port being formed through the casing 16 and communicating with the space inside the well casing. The flow of gas through the vent means thus formed by the ports 67, 68, and 69, the valve opening 36, the gas passage 32, and the channel 66, is controlled by the plunger 40, the chamber 18 being vented to casing pressure only when the valve member 38 is in its open position shown in Fig. 1.

It should thus be apparent that it is not necessary to accurately align the ports 67 and 68 when the valve structure is lowered into engagement with the pumping structure. The ports 67 and 68 are always connected

through the annular chamber 52, this chamber being in turn sealed by the upper and lower packing rings 58 and 59.

From the foregoing description the operation of my invention should be obvious. Reiterating, compressed gas is intermittently supplied to the inner tubing 20 at the surface of the ground. When the gas pressure in this inner tubing builds up sufficient to overcome the force of the spring 43, the valve member 38 is moved downward and the gas impinges against the velocity ring 42 to maintain this valve in a downward position. Simultaneously with the valve being moved in its downward position, the plunger 40 seats in the valve opening 36, thus closing the vent means and preventing any escape of compressed gas through the ports 67, 68, and 69. The compressed gas thus passes downward through the gas passage 32 and the channel 66 and forces the body of well liquid which has previously flowed into the chamber 18 by gravity during the time the vent means is open, upward through the discharge tube 64 and the discharge passage 63 to the annular space between the inner and outer tubings 20 and 12. The intermittent valve controlling the flow of compressed gas may be so regulated that this flow is cut off before any gas rises in the discharge tube 64, or it may be adjusted to permit such a rise of gas through the discharge tube. In any event, when this intermittent valve closes, the velocity of the gas flowing as indicated by the arrows 46 of Fig. 7, is materially decreased after the gas in the inner tube has expanded and escaped through the gas supply opening 25, thus allowing the valve member 38 to rise and seat against the valve seat 42^a, venting the upper end of the displacement chamber to casing pressure and allowing a new ingress of well liquid into this chamber.

The valve structure of my invention finds utility in various other arts where it is desirable to simultaneously open one passage and close another. Similarly, the novel cooperation between the valve structure 23 and the seat member 50 also finds utility in other arts, and all of the appended claims should therefore not be limited to the pumping art.

I claim as my invention:

1. In a displacement pump for pumping wells, the combination of walls forming a displacement chamber adapted to be submerged in a liquid to be pumped, there being vent means communicating between said displacement chamber and the exterior of said walls, a piston slidable in a cylinder formed by said walls and operating, when the pressure pumping fluid exceeds a predetermined value, to admit said pressure fluid to said displacement chamber and to simultaneously close said vent means, and means for operating said piston when said pressure fluid is shut off to simultaneously close said pres-

sure fluid passage and open said vent means.

2. In a displacement pump for pumping wells, the combination of walls forming a displacement chamber adapted to be submerged in a liquid to be pumped, there being vent means communicating between said displacement chamber and the exterior of said walls; means for supplying intermittent charges of compressed gas communicating with said displacement chamber through an opening, a piston in a cylinder formed by said walls, said piston closing said opening in a manner to be operated by said intermittent gas supply, means for returning said piston to its closed position when said flow of gas ceases, and valve means operable by the movement of said piston for controlling the flow through said vent means.

3. In a displacement pump for pumping wells, the combination of walls forming a displacement chamber adapted to be submerged in a liquid to be pumped, there being vent means communicating between said displacement chamber and the exterior of said walls, a compressed gas supply means arranged to supply intermittent charges of compressed gas through a valved opening to said displacement chamber, a valve member slidable relative to said walls and resiliently closing the compressed gas opening, and means formed on said valve member whereby the velocity of said compressed gas through said opening holds said valve member in position to close said vent means until the gas velocity falls below a predetermined value.

4. In a displacement pump for pumping wells, the combination of a primary tubing suspendedly supported in the well, a pumping structure secured to the lower end of said primary tubing, a seat member secured within said primary tubing adjacent said pumping structure and having a fluid discharge passage and a gas passage each communicating with said pumping structure and a vent passage communicating with said gas passage and the exterior of said primary tubing and spaced seats, a secondary tubing positioned within said primary tubing, a valve structure secured to the lower end of said secondary tubing and provided with spaced seats arranged to seat on the spaced seats of said seat member and having a gas passage communicating with the gas passage of said seat member, a vent passage communicating with the vent passage of said seat member and a valve means for controlling said gas and vent passages.

5. In a displacement pump for pumping wells, the combination of a primary tubing suspendedly supported in the well, a pumping structure secured to the lower end of said primary tubing, a seat member secured within said primary tubing adjacent said pump-

ing structure and having a fluid discharge passage and a gas passage each communicating with said pumping structure and a vent passage communicating with said gas passage and the exterior of said primary tubing and spaced seats, a secondary tubing positioned within said primary tubing, a valve structure secured to the lower end of said secondary tubing and provided with spaced seats arranged to seat on the spaced seats of said seat member and having a gas passage communicating with the gas passage of said seat member, a vent passage communicating with the vent passage of said seat member and a valve means for controlling said gas and vent passages, and a resilient packing means positioned to be compressed between the adjacent seats of said seat member and said valve structure.

6. In a displacement pump for pumping wells, the combination of a primary tubing suspendedly supported in the well, a pumping structure secured to the lower end of said primary tubing, a seat member secured within said primary tubing adjacent said pumping structure and having a fluid discharge passage and a gas passage each communicating with said pumping structure and a vent passage communicating with said gas passage and the exterior of said primary tubing, a secondary tubing positioned within said primary tubing, a valve structure secured to the lower end of said secondary tubing and arranged to be supported by said seat member and having a gas passage communicating with the gas passage of said seat member, a vent passage communicating with the vent passage of said seat member and a valve means for controlling said gas and vent passages.

7. In a displacement pump for pumping wells, the combination of a primary tubing suspended from the top of said well, a pumping structure secured to the lower end of said primary tubing, a seat member carried within said primary tubing and adjacent said pumping structure and having ports communicating with said pumping structure, a secondary tubing positioned within said primary tubing, and a valve structure secured to the lower end of said secondary tubing and arranged to be supported by said seat member and having ports communicating with the ports of said seat member.

8. In a displacement pump for pumping wells, the combination of a primary tubing suspendedly supported in the well, a displacement chamber secured to the lower end of said primary tubing, a seat member carried by said primary tubing adjacent said displacement chamber and having a fluid discharge passage and a gas passage each communicating with said displacement chamber and said primary tubing and a vent passage communicating with the exterior of said pri-

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mary tubing, a secondary tubing positioned within said primary tubing for conveying gas under pressure, a valve structure secured to the lower end of said secondary tubing and arranged to seat and to be supported by said seat member and having a gas passage communicating with the gas passage of said seat member, a vent passage communicating with the vent and gas passages of said seat member, a valve means slidably mounted in said valve structure and operated by the gas pressure for closing said vent passage and to open said gas passage, and a resilient member yieldingly holding said valve member in position to open said vent passage and close said gas passage.

9. In a displacement pump, the combination of walls forming a displacement chamber, a valve body unit including a cylinder therein, a vent passage communicating between said cylinder and the exterior of said displacement chamber, a pressure fluid opening, a passage communicating between said cylinder and said displacement chamber, a valve member operatively mounted in said cylinder and arranged to close the said passage communicating between said cylinder and said displacement chamber when the pressure fluid pressure exceeds a predetermined value and to open said pressure fluid opening, a resilient means associated with said valve member for moving said valve member when the pressure fluid pressure drops below a predetermined value to open said passage communicating between said cylinder and said displacement chamber and to close said pressure fluid opening, a passage communicating between said pressure fluid opening and said displacement chamber.

10. In a displacement pump, the combination of walls forming a displacement chamber, a valve body member associated therewith and having a cylinder communicating with said displacement chamber through a valve opening, a vent passage communicating between said cylinder and the exterior of said displacement chamber and having a second gas passage communicating with said displacement chamber, a valve head member secured to said valve body member and having a gas supply opening, a valve member normally closing said gas supply opening and being displaceable to close said valve opening, a velocity ring formed on said valve member positioned in the path of the flow of gas through said gas supply opening whereby the velocity of said gas holds said valve member away from said gas supply opening, and a resilient member for returning said valve member to close said gas supply opening when the velocity of said gas supply falls below a predetermined value.

11. In combination, a valve body member providing a cylinder, a valve head member secured to said valve body member and pro-

viding a gas supply opening in alignment with said cylinder, a piston in said cylinder adapted to close said gas supply opening, a plunger on said piston adapted to close a vent opening of said valve body member when said piston is removed from said gas supply opening, and a velocity ring positioned upon said piston against which the gas passing through said gas supply opening impinges.

12. In a displacement pump, the combination of a pumping structure including a displacement chamber, a seat member carried by said pumping structure and including an oil discharge passage for said pumping structure, a central bore, seats positioned at the extremities of said central bore, a gas passage connecting said central bore with the displacement chamber, and a port connecting said central bore with the exterior of said pumping structure; a valve body including a cylindrical section of somewhat smaller diameter than and extending into said seat member central bore, seats adapted to engage said seat member central bore seats, whereby a chamber is formed between said valve body and said seat member, a central bore forming a cylinder, ports communicating between said valve body central bore and said chamber, a valve seat positioned at the lower end of said valve body central bore, a passage through said valve seat communicating with said seat member gas passage, and a counterbore at the upper end of said cylinder; a gas supply inlet member secured to said valve body and having a valve seat; a piston operatively mounted in said valve body cylinder, including a valve carried by the upper end of said piston, for forming a closure with said gas supply inlet seat when said piston is in its uppermost position, and a valve carried by the lower end of said piston for forming a closure with said valve body seat when said piston is in its lowermost position, a spring for resiliently holding said piston in its uppermost position; a passage connecting said valve body counterbore with said seat member gas passage whereby suitable fluid-tight passages are formed between said seat member and said valve body.

13. In a displacement pump, the combination of; means for supplying intermittent charges of compressed gas; a pumping structure including a displacement chamber, a valve to admit fluid into said chamber, a delivery tube extending to near the bottom of said displacement chamber, a valve to admit fluid into said delivery tube; a seat member carried by said pumping structure and including a discharge passage into which said delivery tube is secured, a central bore, seats positioned at the extremities of said central bore, a gas passage communicating between said central bore and said displacement chamber, and a port connecting said central

bore with the exterior of said pumping structure; a valve body including a cylindrical section of somewhat smaller diameter than and extending into said seat member central bore, seats adapted to engage said seat member central bore seats whereby a chamber is formed between said valve body and said seat member, a central bore forming a cylinder, ports communicating between said valve body central bore and said chamber, a valve seat positioned at the lower end of said valve body central bore, a passage through said valve seat communicating with said seat member gas passage, and a counterbore at the upper end of said cylinder; a gas supply inlet member in communication with said means for supplying intermittent charges of compressed gas, and secured to said valve body and having a valve seat; a piston operatively mounted in said valve body cylinder including a valve carried by the upper end of said piston, for forming a closure with said gas supply inlet seat, when said piston is in its uppermost position and a valve carried by the lower end of said piston for forming a closure with said valve body seat, when said piston is in its lowermost position, a spring for resiliently holding said piston in its uppermost position, and a passage connecting said valve body counterbore with said seat member gas passage.

14. In a displacement pump for pumping wells, the combination of; primary tubing suspendedly supported in said well, a pumping structure secured to said primary tubing and including a displacement chamber, a valve for admitting fluid into said chamber, a delivery tube extending to near the bottom of said displacement chamber, a valve for admitting fluid into said delivery tube; a seat member carried by said pumping structure, and including a discharge passage into which said delivery tube is secured, a central bore, seats positioned at the extremities of said central bore, a gas passage communicating between said central bore and said displacement chamber, and a port connecting said central bore with the exterior of said pumping structure; secondary tubing extending downward in said primary tubing; a valve body including a cylindrical section of somewhat smaller diameter than and extending into said seat member central bore, seats adapted to engage and be supported by said seat member central bore seats, whereby a chamber is formed between said valve body and said seat member, a central bore forming a cylinder, ports communicating between said valve body central bore and said chamber, a valve seat positioned at the lower end of said valve body central bore, a passage through said valve seat communicating with said seat member gas passage, and a counter-bore at the upper end of said cylinder; a gas supply inlet member se-

cured to and supported by said valve body and secured to and supporting said secondary tubing and forming a gas supply passage between said secondary tubing and said valve body and having a valve seat in said passage; a piston operatively mounted in said valve body cylinder including a valve carried by the upper end of said piston for forming a closure with said gas supply inlet seat, when said piston is in its uppermost position, and a valve carried by the lower end of said piston for forming a closure with said valve body seat when said piston is in its lowermost position; a spring for resiliently holding said piston in its uppermost position, a passage connecting said valve body counterbore with said seat member gas passage.

15. In a displacement pump, the combination of; a pumping structure; means for supplying intermittent charges of compressed gas to said pumping structure; valve means operated by said compressed gas when the pressure of said gas exceeds a predetermined value for closing a vent passage from said pumping structure and means positioned on said valve means and acted upon by the velocity of said compressed gas for retaining said vent passage valve means in closed position, and a spring arranged to return said valve means to open said vent passage when said compressed gas velocity falls below a predetermined value.

16. In a displacement pump, the combination of; a pumping structure, means of supplying intermittent charges of compressed gas to said pumping structure; valve means arranged in said pumping structure and operated by said compressed gas when the pressure of said gas exceeds a predetermined value for closing a vent passage from said pumping structure; means associated with said valve means acted upon by the velocity and pressure of said compressed gas for retaining said vent passage closed; and means for returning said valve means to open said vent passage when said compressed gas velocity and pressure fall below a predetermined value, whereby the intermittent charges of compressed gas cause the vent passage to remain closed during the pumping cycle.

17. In a displacement pump for pumping wells, the combination of walls forming a displacement chamber adapted to be submerged in a liquid to be pumped, there being vent means communicating between said displacement chamber and the exterior of said walls, gas supply means communicating with said displacement chamber through an opening, a piston in a cylinder formed by said walls, said piston closing said opening in a manner to be displaceable by a flow of compressed gas through said supply means, valve means operable by the movement of said piston for controlling the flow through said vent

means, and a velocity ring positioned on said piston, adjacent said opening, against which compressed gas passing therethrough will impinge.

5 In testimony whereof, I have hereunto set my hand at Los Angeles, California, this 9th day of November, 1928.

GLENN E. MAKINSTER.

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