Nov. 14, 1939. C. J. COBERLY 2,179,481

PUMP INLET MEANS

Filed April 22, 1937

Fig. 1.

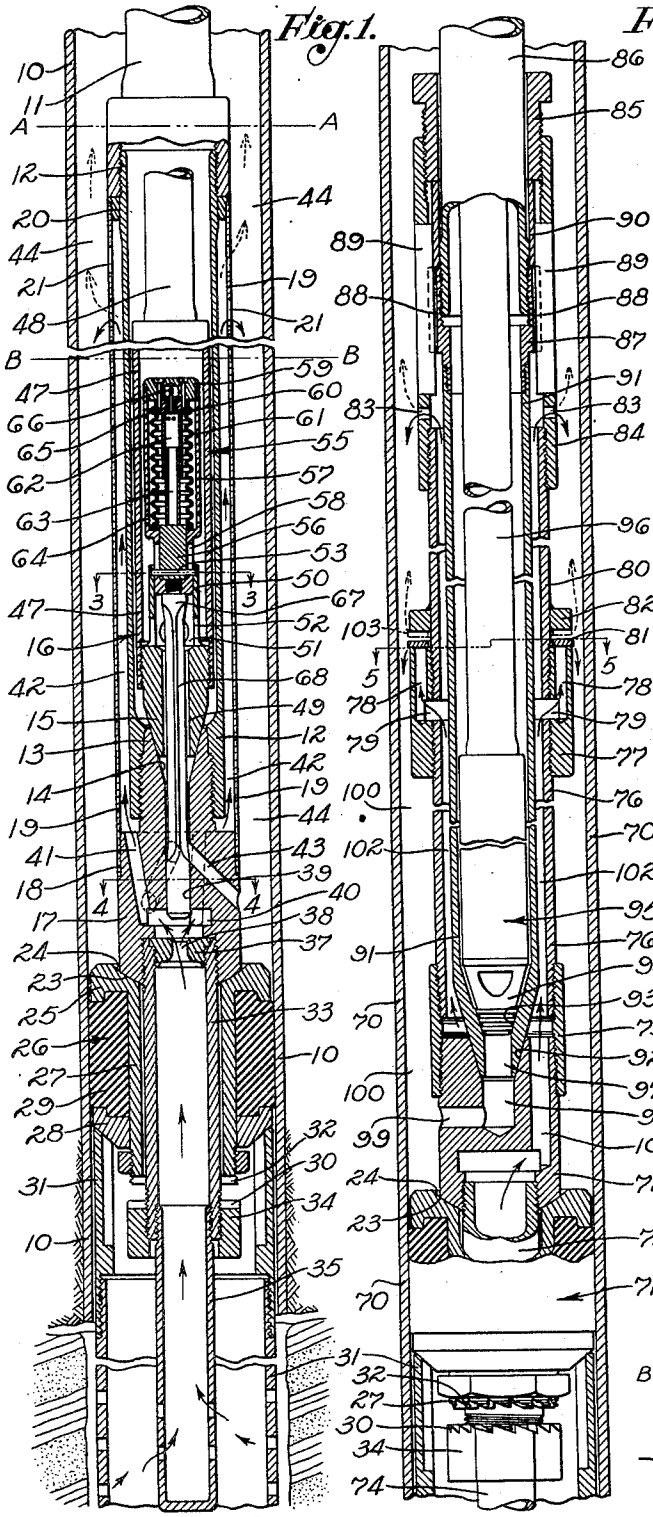


Fig. 2.

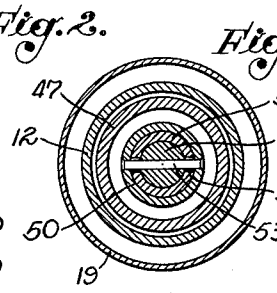


Fig. 3.

Fig. 4.

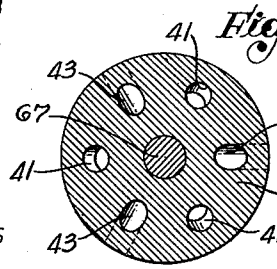


Fig. 5.

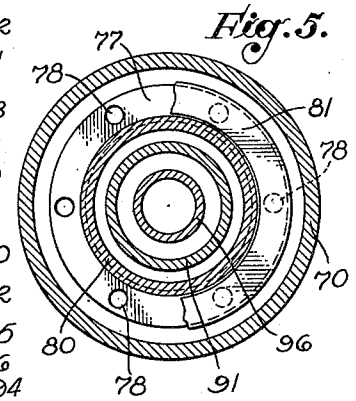
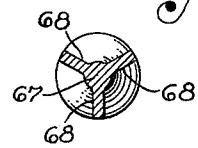


Fig. 6.



INVENTOR
CLARENCE J. COBERLY
BY HARRIS, KIECH, FOSTER & HARRIS
Fred W. Harris
ATTORNEYS.

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2,179,481

PUMP INLET MEANS

Clarence J. Coberly, Los Angeles, Calif., assignor to Roko Corporation, Reno, Nev., a corporation of Nevada

Application April 22, 1937, Serial No. 138,345

10 Claims. (Cl. 103—40)

My invention relates to the deep well pumping art, and more particularly to an apparatus for introducing a fluid to be pumped into a deep well pump.

Although my invention is susceptible of many uses, it is of particular utility in the oil industry and will be described in connection with a deep well pump adapted to pump oil from an oil well. It is to be understood, however, that this application of the invention is for the purpose of illustration only, and I do not intend to be limited thereby to the specific use described.

In the pumping of oil wells numerous types of pumps may be successfully utilized, as is well known in the art. Although the type of pump utilized forms no part of my present invention, I prefer to use my invention in conjunction with a fluid operated deep well pump of the type disclosed in my Patent No. 2,081,223, issued May 25, 1937, entitled "Fluid operated deep well pump", which discloses a pump and motor unit adapted to be positioned in a well so as to pump fluid therefrom.

As is well known in the art, oil to be pumped from a well frequently has a substantial quantity of gas mixed therewith or in solution therein. The amount of gas in solution under equilibrium conditions depends on the temperature and pressure in the well and the analysis of both the oil and the gas. It is possible for the oil to be supersaturated, i. e., to have more gas in solution than the amount normally corresponding to equilibrium conditions. When the pressure on the well fluid is decreased, the temperature increased, or when the fluid is agitated, relatively large quantities of the gas therein are frequently liberated and separate from the oil and form a foam or an emulsion therewith. Such gas produces a number of detrimental effects in the pumping, treating, conveying, and storing of the pumped fluid, and numerous devices have been devised and are common in the art for separating such gas from the oil. Prior art devices for separating the gas from the oil prior to the pumping of the oil from the well have not produced satisfactory results, and it is a primary object of my invention to provide a method and apparatus for separating at least a portion of the gas in the fluid to be pumped from a well therefrom prior to pumping such fluid from the well.

It is another object of my invention to provide an apparatus for introducing into a pump a liquid normally having a high degree of gas saturation, in which the degree of gas saturation is reduced before the liquid enters the pump.

Another object of my invention is to supply an apparatus for introducing into a pump a liquid normally supersaturated with gas, in which the supersaturation of the liquid is eliminated, and the degree of saturation is then further reduced so that the liquid is less than saturated when it enters the pump. I prefer to accomplish this by reducing the pressure on the liquid to decrease the amount of gas in solution and then increasing the pressure thereon to reduce the degree of saturation.

Another object of my invention is to provide an apparatus for use in connection with a deep well pump of the character described above for reducing to a minimum the tendency of the pump to cause the release of gas from the pumped fluid and the resulting loss of pump capacity due to the space occupied by such gas.

Another object of my invention is to provide an apparatus for introducing fluid into a deep well pump in which the pressure of the fluid to be pumped is reduced to casing pressure so as to liberate gas therefrom, and the fluid is then conveyed to the inlet of the pump under sufficient pressure so that said fluid is less than saturated with gas when it enters the pump.

Still another object of the invention is to provide an apparatus for introducing liquid into a deep well pump, in which a desired head of the liquid is maintained above the inlet of the pump.

A further object of my invention is to provide an apparatus for introducing fluid into a deep well pump, in which the fluid is conveyed to a fluid reservoir communicating with the pump inlet, and the amount of fluid in the reservoir is automatically controlled.

Another object of the invention is to provide an apparatus for introducing well fluid into a deep well pump, in which gas pressure in the well is utilized to lift the fluid to a point adjacent the inlet of the pump, and the amount of fluid so lifted is automatically controlled.

A still further object of my invention is to provide an apparatus for introducing well fluid into a deep well pump positioned above a packer, in which the back pressure on the well formation is reduced as the level of fluid above the packer is lowered. I prefer to accomplish this by conveying the well fluid to be pumped through a passage of variable length, and controlling the length of the passage in accordance with the height of the fluid level above the packer.

Another object of the invention is to provide a novel apparatus for disconnecting a well inlet member from a packer adapted to be set in a well

tubing so that the inlet member may be removed from the well without displacing the packer.

Other objects and advantages will appear from the following specification and drawing, which is for the purpose of illustration only, and in which:

Fig. 1 is a sectional view of the inlet member of my invention installed in conjunction with a deep well pump.

Fig. 2 is a sectional view of an alternative form of the invention.

Fig. 3 is a sectional view taken on the line 3—3 of Fig. 1.

Fig. 4 is a sectional view taken on the line 4—4 of Fig. 1.

Fig. 5 is a sectional view taken on the line 5—5 of Fig. 2.

Fig. 6 is an enlarged sectional view of the channeled valve stem shown in Fig. 1.

Referring to the drawing, Fig. 1 shows a well casing 10 installed in an oil well having a production pipe 11 extending down through the casing adapted to carry pumped fluid to the surface of the ground, the pipe having a collar at the lower end thereof threadedly receiving a tubular pump receptacle 12 in the lower end of which a pump seat element 13 is threaded. The pump seat element 13 is provided with a conical seat 14 adapted to receive the tapered end 15 of a pump unit 16, preferably being of the fluid operated type, and the seat element has an enlarged lower portion 17. The lower portion 17 has an external annular channel 18 in which an external tubular member 19 makes a sliding fit, the upper end of the tubular member also making a sliding fit in a suitable external channel formed on an annular ring 20 engaging the lower end of the production pipe collar, the ring fitting over the pump receptacle 12. The upper end of the tubular member 19 is provided with perforations 21 above the upper end of the pump unit 16.

The enlarged lower portion 17 of the pump seat element 13 has a lower convex face 23 adapted to seat in a concave seat 24 formed in an upper clamp ring 25 of a packer means 26. The upper clamp ring 25 has a tubular extension 27 on which a lower clamp ring 28 is free to slide, there being a packing element 29 held between the two clamp rings and adapted to form a seal between the casing 10 and the packer means 26. The tubular extension 27 has a suitable collar threaded onto its lower end to hold the lower clamp ring 28 in engagement with the packing element 29. The lower clamp ring 28 engages the upper end of a standard tubular liner 31 which is perforated at its lower end in the usual way and which acts as a support for the packer means 26. The packing element 29 is formed of an expansible material, such as oil-resisting rubber, so that when the seat element 13 and connected structure are lowered into engagement with the packer means 26, the packing element is compressed and expanded to form a seal between the casing 10 and the packer means.

The enlarged lower portion 17 of the pump seat element 13 is provided with a threaded bore receiving a lower pipe 33 which extends downwardly through the tubular extension 27 of the packer means 26 and is externally threaded at its lower end to receive an internally left-hand threaded nut 34, and is internally threaded to receive the upper end of a skeeter bill 35 which projects downwardly in the liner 31. The skeeter bill 35 has perforations therein to permit the free passage of fluid therethrough, and has its lower end closed, and operates to prevent large pieces of foreign materials from passing into the lower pipe 33, as is well known in the art. The upper end of the nut 34 and the lower end of the tubular extension 27 are provided with left-hand ratchet teeth 30 and 32, respectively, as more fully illustrated in Fig. 2, which are adapted to be engaged for a purpose to be described more fully hereinafter. The nut 34 may be used as a jar to loosen the packer means 26 from the casing 10 when it is desired to remove the packer means, the nut engaging the lower end of the tubular extension 27 and the lower clamp 28 when it is raised relative thereto, the ratchet teeth 30 and 32 also being engaged. Threaded into the upper end of the lower pipe 33 is a plunger seat element 37 having a bore 38 tapered at its upper end. Axially aligned with the bore 38 is a plunger bore 39 formed in the pump seat element 13 which communicates at its lower end with a chamber 40, also formed in the pump seat element, which in turn communicates with the bore 38. As shown in Figs. 1 and 4, flow passages 41 formed in the pump seat element 13 communicate between the chamber 40 and an annular space 42 formed between the tubular member 19 and the pump receptacle 12, and although I prefer to use three of such flow passages, it will be apparent that any suitable number may be utilized in my construction. Also formed in the pump seat element 13 are inlet passages 43 communicating between the plunger bore 39 and a reservoir space 44 between the casing 10 and the tubular member 19, the space 44 constituting a fluid reservoir as will be described hereinafter. Three inlet passages 43 are shown, but it will be apparent that any suitable number may be utilized.

The pump unit 16 has a pump barrel 47 attached as by threads to the tapered end 15 thereof, and although any suitable type of pump may be used, I prefer to use a fluid operated pump in which actuating fluid is conveyed to the pump unit through macaroni tubing 48 connected thereto. The tapered end 15 has a central bore 49 adapted to be substantially axially aligned with the plunger bore 39 but somewhat larger in diameter, and has a tubular projection 50 formed thereon or attached thereto. The tubular projection 50 forms a chamber 51 which is in open communication with the interior of the pump barrel 47 through orifices 52, and a transverse pin 53 projects through the upper end of the projection. The transverse pin 53 passes through the lower end of a plunger actuating means 55 journalled in the tubular projection 50.

The plunger actuating means 55 may be of any suitable type, but I prefer to use a Sylphon construction in which a base element 56 is rigidly fixed on the transverse pin 53, and a sliding plunger shell 57 is adapted for vertical movement on the base element with which it makes a sliding fit. The plunger shell 57 is provided with perforations 64 therein affording fluid communication between the interior of the shell and the pump barrel 47. The lower end of the plunger shell 57 is provided with vertical slots 58 through which the transverse pin 53 extends, and which permit vertical movement of the shell but prevent its rotation. The upper end of the plunger shell 57 is closed by a closure plate 59 to the under side of which is bolted a retaining plate 60 to which is fixed in fluid-tight relation the upper end of a flexible Sylphon bellows 61, the lower end of the

bellows being secured to the base element 56 in fluid-tight relation. Also fixed to the retaining plate 60 and depending therefrom is an upper tube 62, having a plurality of small perforations at its upper end, into which telescopes a lower tube 63 fixed to the base element 56. The telescoping tubes 62 and 63 serve to maintain the plunger shell 57, the bellows 61, and the base element 56 in axial alignment. Threaded into the retaining plate 60 is a nipple element 65 having a nipple 66 projecting upwardly into a suitable receiving chamber formed in the closure plate 59. The nipple 66 is preferably made of copper which is crimped over and then soldered, as is well known in the art, its purpose being to provide a means for introducing fluid under pressure into the interior of the Sylphon bellows 61, but it will be apparent that any suitable form of valve mechanism may be substituted therefor without departing from the invention.

The lower end of the plunger shell 57 carries a plunger member 67, preferably threaded thereto, which extends downwardly through the central bore 49 and the plunger bore 39, and which has its lower end tapered to seat in the tapered upper end of the bore 38 of the plunger seat element 37 so as to close the bore 38 to prevent the passage of fluid therethrough. As shown in Figs. 1 and 6, the plunger member 67 has vertical channels 68 formed in the exterior surface thereof which communicate with the inlet passages 43 and with the chamber 51 in all of the operating positions of the plunger.

In installing the device shown in Fig. 1, the liner 31 is first lowered into the casing 10 in the usual manner, the liner being of a length considerably less than the height to which well fluid would normally rise in the well, as represented, for example, by the line A—A. To the lower end of the production pipe 11 are connected the pump receptacle 12, the pump seat element 13, the tubular member 19, the packer means 26, and associated mechanism, which are then lowered into the casing 10 by means of the production pipe until the lower clamp ring 28 of the packer means engages and is supported on the upper end of the liner 31. The weight of the production pipe 11 and connected mechanism bears on the upper clamp ring 25 of the packer means 26, causing the upper clamp ring to move down relative to the lower clamp ring 28 to compress and expand the packing element 29 into sealing relation with the casing 10. The convex face 23 and concave seat 24 insure that a fluid-tight joint is made between the packer means 26 and the seat element 13 even though the packer means 26 and the seat element are not axially aligned, which is a feature of the invention. The Sylphon bellows 61 of the plunger actuating means 55 is filled with fluid under pressure, such as air, as by a suitable pressure pump applied to the nipple 66, the pressure used therein being determined by operating conditions in the well. I have found that 100 pounds per square inch in the Sylphon bellows 61 will provide sufficient head of fluid over the packer, as described hereinafter, but it will be understood that this pressure may be increased or decreased to conform to the conditions in a particular well. The pump unit 16 is then assembled and connected to the macaroni 48 by means of which it is lowered through the production pipe 11 until the tapered end 15 seats in the conical seat 14 to form a fluid-tight joint therewith. Although I have disclosed a preferred system in which the pump unit 16 is sufficiently small in diameter to be lowered into operating position through the production pipe 11, it will be apparent that a pump of any suitable size and design may be utilized without departing from the invention, and that the pump unit may be assembled in the production pipe and lowered into the well therewith.

When it is desired to remove the packer means 26 from the casing 10, the pump unit 16 may first be removed by withdrawing the macaroni 48, or the macaroni and production pipe 11 may be raised together. Frequently, silt, sediment, and other foreign materials will lodge around the packer means 26, making it difficult to loosen the packer from the casing 10. To obviate this difficulty, it will be noted that the lower pipe 33 extends some distance below the lower end of the tubular extension 27 and that the nut 34 is spaced from the extension. By raising the production pipe 11, the lower pipe 33 is raised relative to the packer means 26 until the nut 34 strikes the lower end of the tubular extension 27, delivering thereto a sharp impact which acts as a jar to loosen the packer means from the casing 10. The production pipe 11 may then be raised, carrying with it the packer means 26 which rests on the nut 34. If sediment and other foreign materials have lodged around the packer 26 to such an extent that the packer cannot be removed from the well, additional means are provided for removing the pump inlet members without removing the packer. To accomplish this, the production pipe 11 is raised until the nut 34 engages the lower end of the tubular extension 27 so as to cause engagement of the ratchet teeth 30 and 32. By rotating the production pipe 11, the engaging ratchet teeth 30 and 32 cause the nut 34 to rotate therewith, thus unscrewing the nut 34 which then drops to the bottom of the well, permitting the production pipe and connected elements to be raised from the well independently of the packer 26 which remains in place in the casing 10. The packer means 26 may then be drilled out of the casing 10, or otherwise removed therefrom, and this means of removing the pump receptacle assembly independent of the packer is an important feature of the invention.

In operation, oil from the well formation flows through the perforations in the liner 31 and the skeeter bill 35 and is forced upwardly through the lower pipe 33 by the fluid pressure on the fluid below the packer. As is well known in the oil industry, formation pressure in an oil well is ordinarily sufficient to lift the well fluid, being a mixture of gas and oil, through considerable distances, which fact has been widely utilized in various well known types of oil lifts. In Fig. 1, the course of the well fluid is indicated by solid arrows, the fluid flowing upwardly from the lower pipe 33, through the bore 38, through the flow passages 41, into the annular space 42 between the tubular member 19 and the pump receptacle 12. The fluid then flows upwardly through the annular space 42 and out of the perforations 21 into the space 44, which is at casing pressure ordinarily slightly above atmospheric pressure. If, as frequently happens, the oil is supersaturated with gas as it enters the lower pipe 33, on flowing out through the bore 38 the pressure thereon is suddenly reduced to approximately atmospheric pressure, and gas is liberated so that the amount of gas saturated in the oil is greatly decreased and corresponds approximately to equilibrium conditions at the temperature and pres-

sure in the chamber 40. The liberated gas with the oil flows upwardly through the annular space 42 and out through the perforations 21 into the casing 10, as indicated by the dotted arrows, and the oil flows downwardly in the space 44 to form a sump or reservoir of well fluid therein just above the packer means 26 and communicating with the inlet passages 43, the upper level of which quickly rises to a point above the plunger actuating means 55, as indicated by the line B—B, for example. The head of oil in the space 44 causes oil to flow through the inlet passages 43, the channels 68 in the plunger 67, into the chamber 51, from whence it flows out through the orifices 52 into the pump barrel 47 and upwardly therein to approximately the level which it occupies in the space 44 as indicated by the line B—B above the plunger actuating means 55. It will be apparent that the levels A—A and B—B are for the purposes of illustration only, and will vary considerably in actual operation due to variations in pumping conditions. Fluid in the pump barrel 47 will flow through the perforations 64 in the plunger shell 57 and will fill the shell outside of the Sylphon bellows 61. Since the Sylphon bellows 61 is filled with pressure fluid at a definite operating pressure, such as, for example, 100 pounds per square inch, when the head of well fluid in the pump barrel 47 rises to a point at which it exerts more than the operating pressure on the plunger shell 57, the plunger shell will move downwardly relative to the fixed base element 56, compressing the Sylphon bellows. Since the plunger 67 is fixed to the plunger shell 57, the plunger will move with the shell to tend to close the upper end of the bore 38 by seating therein. If the fluid pressure acting on the plunger actuating means 55 is high, the plunger will seat in the upper end of the bore 38 to completely shut off the fluid flow therethrough, but if such pressure is but slightly higher than the operating pressure inside the Sylphon bellows 61, the plunger will merely partially close the upper end of the bore 38 to throttle the fluid flow therethrough. If the fluid pressure acting on the plunger actuating means 55 is lower than the operating pressure within the Sylphon bellows 61, the operating pressure will expand the bellows to force the plunger shell 57 upwardly to open the bore 38. It will thus be understood that the plunger actuating means 55 functions to control the flow of well fluid through the device and into the space 44 in accordance with the height of the oil level in the space or reservoir 44. This is an important feature of the invention, because I have found that it is desirable to maintain the oil level B—B above the inlet of the pump unit 16 below a predetermined maximum for maximum pumping efficiency.

It is another important feature of the invention to arrange the elements so that the inlet of the pump unit 16 is below the level B—B of oil in the reservoir 44 at all times during normal operation. As stated, when the well fluid flows through the bore 38 into the chamber 40, the pressure thereon is reduced to atmospheric or casing pressure, and sufficient gas is liberated to reduce the gas saturation to equilibrium at the temperature and pressure in the casing. By providing a head of oil, such as indicated by the line B—B, above the inlet of the pump unit 16, the degree of gas saturation of the oil is further reduced as the oil enters the pump unit, and the oil entering the pump unit is always less than saturated with gas. This prevents liberation of gas in the pump unit 16 during pumping, and insures that the pump is entirely filled with oil and free from gas bubbles, which maintains a high pumping efficiency.

An alternative embodiment of the invention is shown in Fig. 2, in which no means is shown for automatically controlling the amount of well fluid flowing through the device. It will be understood, however, that the embodiment shown in Fig. 2 may be provided with means for controlling the flow of fluid into the reservoir similar to that shown in Fig. 1, without departing from the invention. A well casing 70 receives a packer means 71, substantially similar to the packer means 26, in which seats a seating element 72 generally similar in function to the seating element 17, having a lower pipe 73 threaded thereto and communicating with a skeeter bill 74 similar to the skeeter bill 35. Threaded to the upper end of the seating element 72 is a collar 75 which is in turn threaded to a lower tubular section 76. Threaded to the upper end of the tubular section 76 is an annular valve collar 77 having a plurality of vertical passages 78 communicating through suitable radial openings 79 with the interior of the tubular section. The upper end of the valve collar 77 is threaded to an upper tubular section 80, the lower end of which is spaced from the upper end of the lower tubular section 76. An annular flapper valve plate 81 is carried on the upper tubular section 80 and is free to move up and down thereon, being limited in its upward movement by an annular ring 82 welded or otherwise fixed to the upper tubular section, and engaging the upper end of the valve collar 77 when in its lowermost position so as to close the vertical passages 78 for a purpose to be described hereinafter.

Threaded to the upper tubular section 80 is a tube element 84 threadedly connected to an annular nut 85, the tubular member having radial orifices 83 at the lower end thereof. Extending down through the nut 85 is a production pipe 86, to the lower end of which is threadedly connected a splined tube 87 having keyways 88 therein receiving keys 89 projecting through suitable slots formed in the tube element 84. A pipe section 90 is positioned on the production pipe 86 by the nut 85, and the lower end thereof forms an engaging shoulder for engagement with the upper end of the splined tube 87. The lower end of the splined tube carries a pump receptacle 91 threaded thereto, the lower end of which is externally tapered to seat in a receptacle seat 92 formed in the seating element 72. The lower end of the pump receptacle 91 has an internal conical seat 93 which receives the lower tapered end 94 of a pump unit 95 which may be of any suitable design but is preferably of the fluid operated type specified hereinabove and connected to a suitable macaroni tubing 96. Formed in the lower end of the pump receptacle 91 is a vertical passage 97 which communicates between the inlet of the pump unit 95 through inlet passages 98 and 99 formed in the seating element 72 and a fluid reservoir space 100 in the casing 70 and just above the packer means 71. A suitable production passage 101 is also formed in the seating element 72, communicating between the upper end of the lower pipe 73 and an annular flow space 102.

The operation of the device shown in Fig. 2 is similar to the operation of Fig. 1, as follows. Well fluid is forced upwardly through the skeeter bill 74 by gas pressure from the well formation, and

flows upwardly through the lower pipe 73 and the production passage 101 into the flow space 102, the flow of the fluid being indicated by solid arrows. The well fluid continues its upward flow through the flow space 102 and flows outwardly through the radial openings 79, and upwardly through the vertical passages 78, raising the flapper valve plate 81 to the position shown in dotted lines 103, and flows outwardly into the reservoir space 100 in the casing 70. Since the interior of the casing 70 is at substantially atmospheric pressure, the fluid pressure on the well fluid is immediately reduced thereto, and gas is liberated therefrom as described above in connection with Fig. 1, the gas passing upwardly in the casing as indicated by dotted arrows, and the oil flowing downwardly in the reservoir space 100 to form a reservoir of oil above the packer means 71. As the level of oil in the reservoir space 100 rises, oil flows through the inlet passages 99 and 98, and the vertical passage 97, into the pump unit 95. The level of oil in the reservoir space 100 quickly rises above the inlet of the pump unit 95, so that during operation the degree of gas saturation of oil flowing into the pump is always less than the saturation point under equilibrium conditions, as described above.

If the normal flow of well fluid through the flow space 102 is greater than the capacity of the pump unit 95, as frequently occurs, the oil level in the reservoir space 100 rises above the flapper valve plate 81. Well fluid continues to flow from the vertical passages 78 into the reservoir space 100 until the oil level in the space rises to a point adjacent the orifices 83, at which time the head of oil above the flapper valve plate 81 operates to move the plate down into engagement with the collar 77, the plate closing the passages 78. Well fluid then flows out of the flow space 102 through the orifices 83 and into the reservoir space 100. The primary purpose of this construction and method of operation is to insure that the well fluid will be reduced to substantially casing pressure as it flows into the reservoir space 100, so as to reduce the amount of gas saturated in the oil and to automatically increase the length of the reservoir space for gas-free oil as the fluid level rises. Although I have shown only one flapper valve plate mechanism, in actual use it is frequently desirable to use a number of such flapper valves spaced at frequent intervals between the seating element 72 and the tube element 84, there being, of course, additional tubular sections similar to the sections 76 and 80 used in connection therewith. The number and spacing of such flapper valves are determined for a particular installation by the static fluid level and draw-down of the well, which can be determined readily by one skilled in the art.

It will be apparent that with the construction shown in Fig. 2 if the flow rate of the well or the well pressure decreases, the level of oil in the reservoir space 100 will subside, and that when the level drops a substantial distance below the orifices 83, the well fluid pressure will cause the flapper valve plate 81 to again rise to the position shown by dotted lines 103, and the flow of well fluid will be resumed through the vertical passages 78 into the reservoir space. This feature is also important, because it insures that the annular flow space 102 will always have a minimum effective length to maintain the friction drop of the well fluid flowing therethrough at a minimum. When the fluid level above the packer is decreased, the back pressure on the well formation is accordingly reduced, permitting a maximum flow from the well formation into the well at all times. The operation of the flapper valve plate 81 is thus automatic, depending on the level of oil in the reservoir space 100.

It is to be noted that although it is preferable to have the casing pressure above the level of fluid in the fluid reservoir of my invention at approximately atmospheric pressure to insure maximum efficiency of my device in separating gas from the well fluid, as described above, it is sometimes desirable in actual field operations to maintain the casing pressure slightly above atmospheric pressure. This occurs when it is desired to pipe the separated gas to other points in an oil field for any one of a number of well known uses, in which case it is desirable to build up a low casing pressure sufficient to force the gas through such piping. If a low casing pressure, below 100 pounds per square inch, for example, is built up in the well casing, my invention is still practically operable, the only effect being to reduce slightly the efficiency of the system, and, accordingly, I intend to cover such a use of the invention. Consequently, for the purpose of this specification and the appended claims, I define "substantially atmospheric pressure" as being any pressure sufficiently near to atmospheric pressure to permit my invention to operate with commercial efficiency.

I claim as my invention:

1. In a device for introducing well fluid into a deep well pump, the combination of: walls forming a reservoir for receiving well fluid from a well; a deep well pump having an inlet communicating with said reservoir; and means independent of said pump for maintaining the amount of well fluid in said reservoir below a predetermined value.

2. In a device for introducing well fluid into a deep well pump, the combination of: walls forming a reservoir; walls forming a passage communicating between said reservoir and the fluid in the well; and means for varying the point of discharge of said well fluid into said reservoir.

3. In a device for introducing well fluid into a deep well pump, the combination of: packer means adapted to fit into a well casing to confine well fluid therebelow, said packer means and said casing forming a fluid reservoir above said packer means; walls forming a passage communicating between said reservoir and said well fluid below said packer means for permitting the flow of well fluid into said reservoir; pumping means having an inlet communicating with said reservoir, said inlet being positioned below the normal level of well fluid in said reservoir; and means for controlling the amount of fluid in said reservoir independent of said pumping means.

4. In a device for introducing well fluid into a deep well pump, the combination of: packer means adapted to fit into a well casing to confine well fluid under pressure below said packer means, said packer means and said casing forming a fluid reservoir above said packer means; means for conveying said well fluid from below said packer means to said reservoir, including means for discharging said well fluid into said reservoir at substantially atmospheric pressure; and pumping means having an inlet communicating with said reservoir, said inlet being positioned below the normal level of well fluid in said reservoir so that fluid flowing into said in-

let from said reservoir is under a fluid pressure substantially higher than atmospheric pressure.

5. In a device for introducing well fluid into a deep well pump, the combinaiton of: walls forming a reservoir; walls forming a passage communicating between said reservoir and the fluid in the well; a deep well pump having an inlet communicating with said reservoir; and valve means independent of said pump for regulating the flow of well fluid through said passage into said reservoir.

6. In a device for introducing well fluid into a deep well pump, the combination of: walls forming a reservoir; walls forming a passage communicating between said reservoir and the fluid in the well; a deep well pump having an inlet communicating with said reservoir; and means independent of said pump for regulating the flow of well fluid through said passage into said reservoir in accordance with the amount of well fluid in said reservoir.

7. In a device of the character described, the combination of: walls forming a reservoir for receiving well fluid from a well; walls forming a passage communicating between said reservoir and the fluid in the well; valve means associated with said passage for controlling the flow of well fluid through said passage; and means responsive to the pressure of well fluid in said reservoir for controlling the operation of said valve means.

8. In a device of the character described, the combination of: walls forming a reservoir; walls forming a passage communicating between said reservoir and the fluid in the well; and means for varying the point of discharge of said well fluid into said reservoir, including a plurality of openings at different levels between said passage and said reservoir, one of said openings being provided with valve means.

9. In a device for introducing well fluid into a deep well pump, the combinaiton of: packer means adapted to fit into a well casing to confine well fluid under pressure below said packer means; a pump inlet member adapted to receive well fluid from below said packer means and convey said well fluid to the pump; and means for permitting relative oscillatory movement between said inlet member and said packer means but maintaining a fluid-tight fit therebetween.

10. In a device for introducing well fluid into a deep well pump, the combination of: a packer member adapted to fit into a well casing to confine well fluid under pressure below said packer member; and a pump inlet member adapted to receive well fluid from below said packer member and convey said well fluid to the pump, one of said members being provided with a concave seat and the other of said members being provided with a convex seating element adapted to seat in said concave seat to form a fluid-tight joint therebetween but permitting movement therebetween.

CLARENCE J. COBERLY.