June 29, 1954 C. J. COBERLY 2,682,225

FLUID-OPERATED PUMP WITH BOOSTER

Filed Aug. 19, 1948 3 Sheets-Sheet 1

Fig. 1

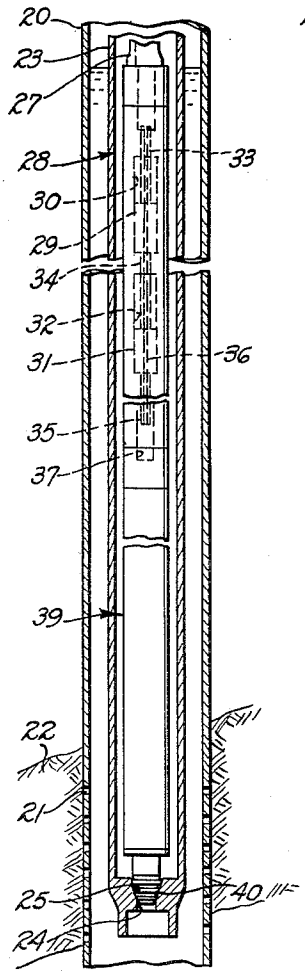


Fig. 2

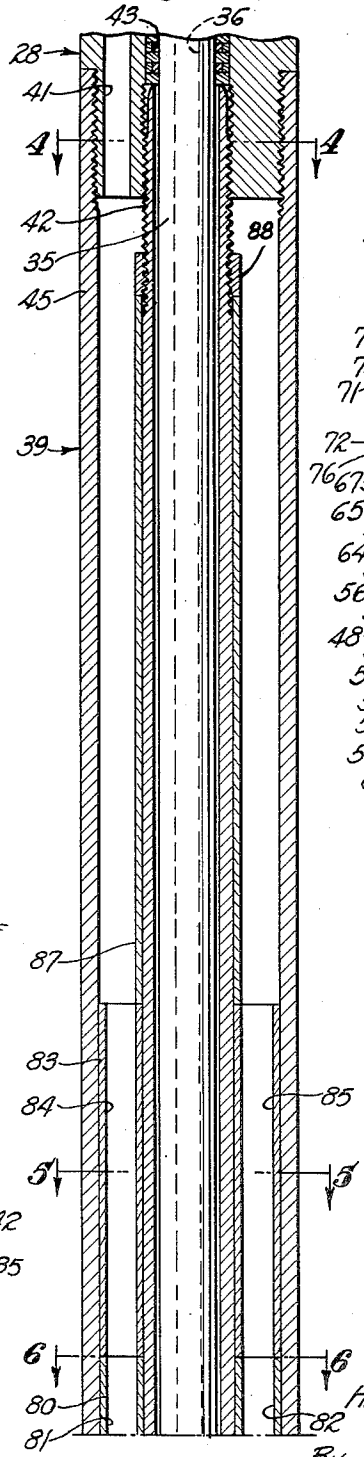


Fig. 3

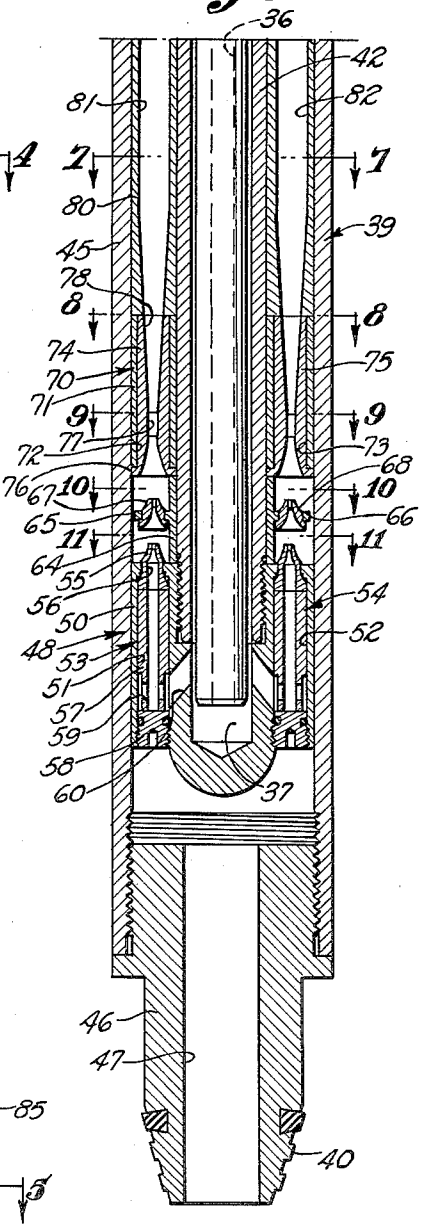
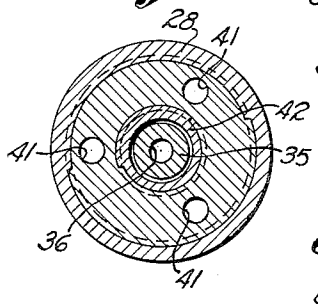


Fig. 4



INVENTOR:
CLARENCE J. COBERLY
By His Attorneys
HARRIS, KIECH, FOSTER & HARRIS
By

June 29, 1954 C. J. COBERLY 2,682,225

FLUID-OPERATED PUMP WITH BOOSTER

Filed Aug. 19, 1948 3 Sheets-Sheet 2

Fig. 5

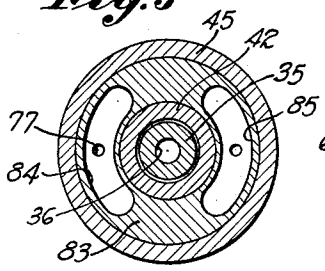


Fig. 10

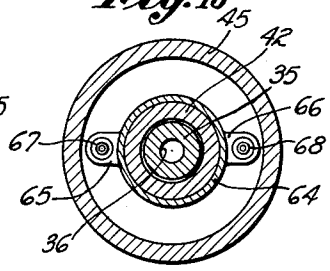


Fig. 13

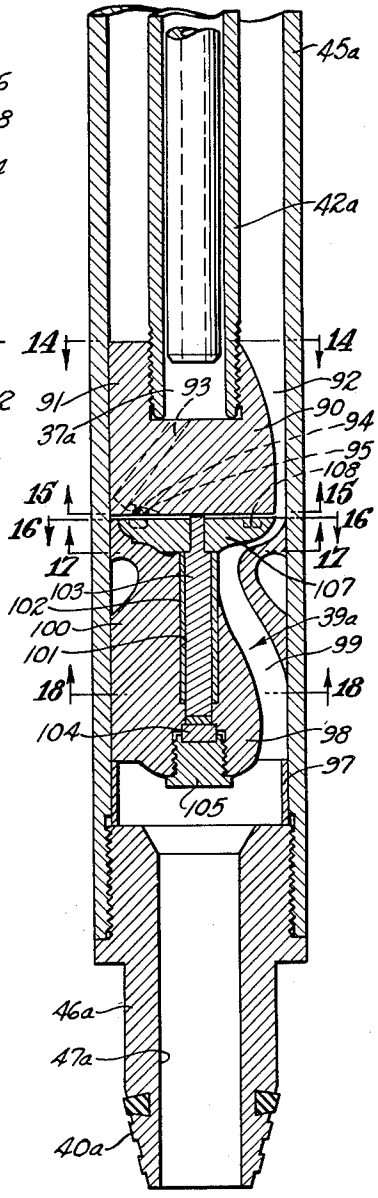


Fig. 6

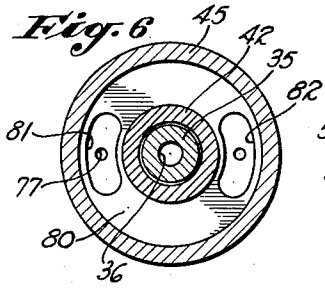


Fig. 11

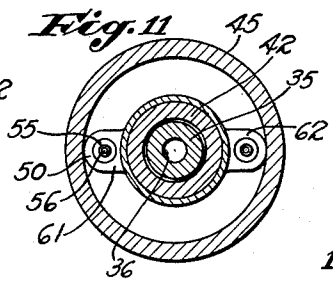


Fig. 7

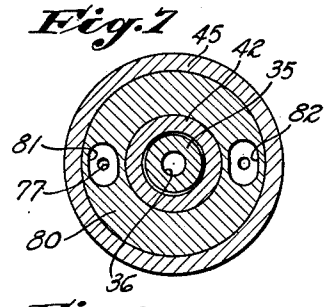


Fig. 12

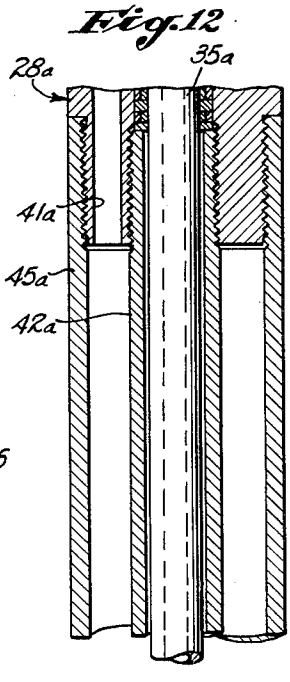


Fig. 8

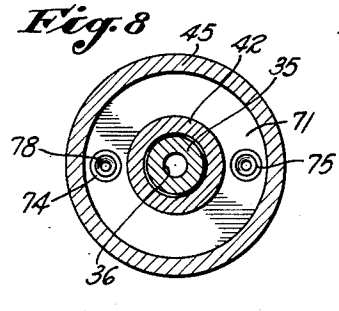
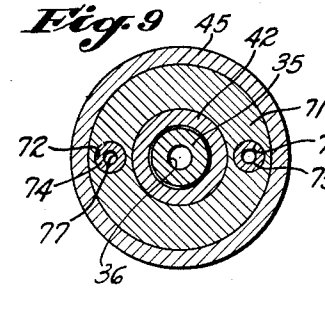


Fig. 9



INVENTOR:
CLARENCE J. COBERLY
BY HIS ATTORNEYS
HARRIS, KIECH, FOSTER & HARRIS
By

June 29, 1954 C. J. COBERLY 2,682,225

FLUID-OPERATED PUMP WITH BOOSTER

Filed Aug. 19, 1948 3 Sheets-Sheet 3

Fig. 14

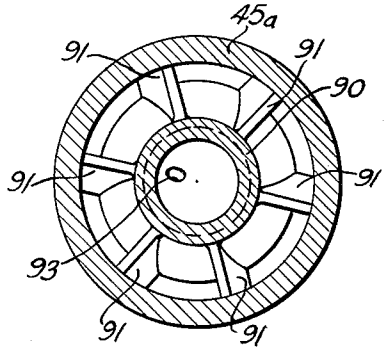


Fig. 15

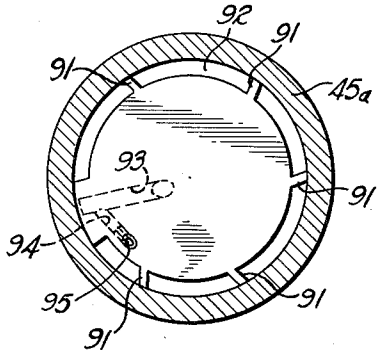


Fig. 16

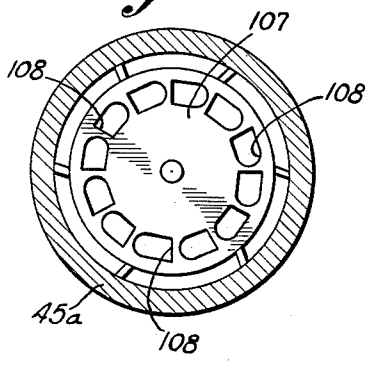


Fig. 17

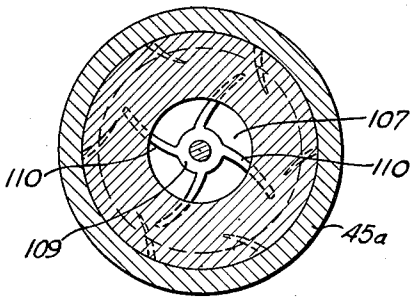
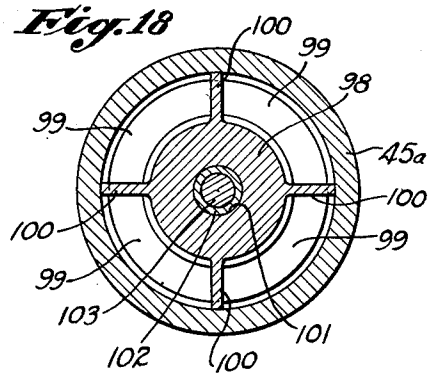


Fig. 18



INVENTOR:
CLARENCE J. COBERLY
BY HIS ATTORNEYS
HARRIS, KIECH, FOSTER & HARRIS
By

Patented June 29, 1954 2,682,225

UNITED STATES PATENT OFFICE

2,682,225

FLUID-OPERATED PUMP WITH BOOSTER

Clarence J. Coberly, Los Angeles, Calif., assignor, by mesne assignments, to Dresser Equipment Company, Cleveland, Ohio, a corporation of Ohio

Application August 19, 1948, Serial No. 45,048

11 Claims. (Cl. 103—5)

1

This invention relates to fluid-operated pumps for wells and, more particularly, to a fluid-operated pump having an auxiliary booster pumping means associated therewith for raising the pressure of the well fluid delivered to the inlet of the fluid-operated pump.

In the oil industry it is common practice to use a fluid-operated pump in pumping oil from a well, such a pump generally comprising a coupled motor and pump combination set in the well at the level from which it is desired to pump the oil. In such a pumping device, the motor is normally actuated by admitting operating fluid, such as oil, under relatively high pressure alternately to opposite ends of a motor piston to reciprocate the same, the reciprocation of the motor piston being suitably communicated to a pump piston in the pump end of the device so as to pump oil from the well. Most of the fluid-operated pumps used commercially incorporate a double acting pump piston, i. e., one that alternatively pumps from both ends thereof on both the upstroke and downstroke of the pump piston, creating a suction stroke alternatively so as to alternatively fill the ends of the pump with well fluid.

In pumping oil from a well, the well oil frequently contains mixed therewith or in solution therein varying quantities of natural gas produced from the well together with the oil, the quantity of such gas depending upon local conditions for particular wells. Since such fluid-operated pumps are normally of the displacement type, considerable difficulty has been experienced, with gas pockets forming in the pump cylinder as a result of the reduction of fluid pressure on the well fluid during the suction stroke of the pump piston. If the well oil is saturated or super-saturated with natural gas at the prevailing pressure at the depth at which the pump is set, during the suction stroke of the pump piston a large portion of the gas may flash off to collect as a pocket in the pump. Also, of course, in many well pumps the well fluid is merely a froth composed largely of gas with a relatively small volumetric amount of solid oil mixed therethrough. In either case, a pocket of natural gas forms in the pump. When such gas pockets form in the pump cylinder of such a pump, the pumping load is materially reduced until the pump piston compresses the gas in the pocket and strikes solid well fluid in the cylinder.

Such fluid-operated pumps are ordinarily operated at relatively great depths in oil wells and, accordingly, a large volume of operating fluid under high pressure is confined in the supply tubing between the well pumping mechanism in the well and the operating pump on the surface of the ground which supplies the operating fluid. Due to the compressibility of this large volume of operating fluid, and due to the expansion of the supply

2

tubing under the relatively high fluid pressure of the operating fluid exerted thereon, a large amount of energy is stored in the system under normal operating conditions. If for any reason the pumping load on the fluid-operated pump decreases, due to the presence of gas in the well liquid, or otherwise, a sudden sharp increase in the rate of flow of operating fluids to the pump occurs, speeding up the rate of operation of the motor and pump. Such increase in speed frequently becomes excessive and the pump may race for a portion of a stroke, or for a number of successive strokes, which is normally very harmful to certain parts of the pumping equipment. Various expedients have been attempted for preventing such racing of the pump, upon a gas pocket forming in the pump cylinder, such as, for example, flow regulators disposed in the line of the operating fluid tubing so as to maintain the rate of flow of operating fluid to the fluid-operated pump below a value at which it might be harmful to the pumping equipment. While such flow governors are practical under most conditions of operation, they have disadvantages, such as increased cost in the pumping equipment and an increased complication of the parts thereof, which it is an object of the present invention to obviate.

It is a primary object of the present invention to provide, in combination with a conventional fluid-operated pump, an auxiliary booster pump adapted to draw well fluid from the well and to deliver it to the inlet of the fluid-operated pump at an elevated pressure such that the major portion of gas in solution in the well fluid will remain in solution and will not flash out to form a gas pocket in the pump cylinder of the fluid-operated pump. I accomplish this by providing a booster pump such as will insure that the well fluid passing into the fluid-operated pump is maintained at a pressure equal to or above the prevailing pressure in the well at the inlet of the fluid-operated pump.

It is a further object of the invention to provide a booster pump in combination with a fluid-operated pump such that the booster pump will substantially compress any free gas entrained in the well fluid before it is delivered to the inlet of the fluid-operated pump.

As suggested above, the volumetric efficiency of such a conventional fluid-operated pump is inversely proportional to the volume of free gas in the pump cylinder, and by the provision of such a booster pump the efficiency of the fluid-operated pump is raised substantially. Thus, if in a given installation a conventional fluid-operated pump has 30% of its pump cylinder volume occupied by free gas, the efficiency of the pump will be only 70%. By the use of the present invention, if the particular booster pump utilized is adapted to

raise the pressure of the well fluid delivered to the inlet of the fluid-operated pump, which for example may be 50 p. s. i. to a pressure of 300 pounds per square inch, the free gas which otherwise would occupy 30% of the volume of the pump cylinder will be compressed to occupy only approximately 4% of the volume of the pump cylinder, and, correspondingly, the efficiency of the fluid-operated pump will be raised to approximately 96% under such conditions.

Another object of the present invention is to provide such a booster pump combination in which the booster pump is fluid-operated. While it is contemplated that the booster pump may be operated by an independent source of high pressure operating fluid, it is particularly advantageous to operate such a booster pump from the same source of operating fluid provided for the fluid-operated pump used in the combination, and, accordingly, this is still another object of the invention.

A further object of the invention is to provide in such a combination a booster pump of the jet type, in which a supply of high pressure operating fluid is delivered to suitable jet means in the booster pump to raise the pressure of the well fluid delivered to the inlet of the fluid-operated pump.

Still another object of the present invention is to provide an alternative type of booster pump in such combination, comprising a rotary turbine type pump in which high pressure fluid is utilized to rotate the turbine element of the booster pump.

Other objects and advantages of the present invention reside in the details of construction described in the following specification and illustrated in the drawings, which are for the purpose of illustration only, and in which:

Fig. 1 is a utility view of the invention installed in a well, partly in longitudinal section;

Fig. 2 is an enlarged longitudinal sectional view of the upper portion of a preferred form of booster pump of the present invention;

Fig. 3 is a longitudinal sectional view of the lower portion of the booster pump, being a downward extension of Fig. 2;

Fig. 4 is a cross-sectional view taken on the line 4—4 of Fig. 2;

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

Fig. 6 is a cross-sectional view taken on the line 6—6 of Fig. 2;

Fig. 7 is a cross-sectional view taken on the line 7—7 of Fig. 3;

Fig. 8 is a cross-sectional view taken on the line 8—8 of Fig. 3;

Fig. 9 is a cross-sectional view taken on the line 9—9 of Fig. 3;

Fig. 10 is a cross-sectional view taken on the line 10—10 of Fig. 3;

Fig. 11 is a cross-sectional view taken on the line 11—11 of Fig. 3;

Fig. 12 is a longitudinal sectional view of the upper end of an alternative form of booster pump;

Fig. 13 is a downward extension of Fig. 12;

Fig. 14 is a cross-sectional view taken on the line 14—14 of Fig. 13;

Fig. 15 is a cross-sectional view taken on the line 15—15 of Fig. 13;

Fig. 16 is a cross-sectional view taken on the line 16—16 of Fig. 13;

Fig. 17 is a cross-sectional view taken on the line 17—17 of Fig. 13;

Fig. 18 is a cross-sectional view taken on the line 18—18 of Fig. 13.

Referring to Fig. 1 of the drawings, I show a well casing 20 having perforations 21 adjacent the lower end thereof and set in a well so that the perforations are disposed adjacent to an oil sand 22. Extending downwardly within the casing 20 is a production tubing 23, the lower end thereof being provided with an inlet opening 24 and a conical seat 25.

Extending downwardly within the production tubing 23 is a power tubing 27, the upper end of which is suitably connected to a source of high pressure operating fluid (not shown), as is well known in the art. In practice, such operating fluid is normally clean crude oil. The lower end of the power tubing 27 is suitably connected to a fluid-operated pump 28 of any suitable design, such as that shown in my Patent No. 2,031,220, granted May 25, 1937, to which reference is hereby made for a full and detailed explanation of the construction of such a pump. The fluid-operated pump 28, as diagramatically shown in Fig. 1, includes a motor piston 29 operating in a motor cylinder 30 and a pump piston 31 operating in a pump cylinder 32. The motor piston 29 has connected to its upper end a valve rod 33, the pistons 29 and 31 are connected together by an intermediate rod 34, and connected to the lower side of the pump piston 31 is a lower rod 35. The rods 33, 34, and 35, and the pistons 29 and 31, are provided with longitudinal passage means 36 therethrough, the upper end of which is at all times in communication with the interior of the power tubing 27, and the lower end of which is at all times in communication with a lower balancing chamber 37 so as to provide at all times a supply of high pressure operating fluid in the balancing chamber.

Connected to the lower end of the fluid-operated pump 28 is an auxiliary booster pump 38, the lower end of which is provided with a tapered seating face 40 which is adapted to seat in fluid-tight relation in the conical seat 25 of the production tubing 23.

As shown in Figs. 2 and 4, the lower end of the fluid-operated pump 28 is provided with a plurality of circumferentially-spaced longitudinal inlet ports 41, and has centrally threaded therein a depending balance tube 42 downwardly through which extends the lower rod 35 of the pump piston 31, there being suitable packing 43 provided around the rod in the lower end of the fluid-operated pump so as to form a fluid-tight seal between the pump and the rod.

As best shown in Figs. 2 and 3, the auxiliary booster pump 38 includes an outer tubular shell 45, the upper end of which is threaded to the lower end of the fluid-operated pump 28. Threaded into the lower end of the shell 45 is an inlet member 46 having an intake port 47 extending longitudinally therethrough, the lower end of the inlet member being provided with the tapered seating face 40 adapted to seat on the conical seat 25 of the production tubing 23. Secured to the lower end of the balance tube 42 is a jet assembly 48.

The jet assembly 48 includes a primary jet support 50 which is threaded to the lower end of the balance tube 42 and which closes the lower end of the balance tube, and provides the lower balancing chamber 37. The primary jet support 50 is provided with a pair of longitudinal bores 51 and 52 which contain, respectively, primary jets 53 and 54. As the jets 53 and 54 are of identical construction, only the jet 53 will be described.

The jet 53 includes a jet element 55 provided with an upwardly directed jet orifice 56, the jet element being retained in position by a tubular jet spacer 57 which is retained in place by a plug 58 threaded into the lower end of the longitudinal bore 51. The spacer 57 is provided at its lower end with radial ports 59 which communicate with radial passages 60 formed in the primary jet support 50 and providing communication between the lower end of the primary jets 53 and 54 and the lower balancing chamber 37. As best shown in Fig. 11, the longitudinal bores 51 and 52 are provided in bosses 61 and 62, the spaces between them permitting a free flow of fluid from the intake port 47 past the primary jet support 50.

The upper end of the primary jet support 50 engages the lower end of a secondary jet support 64 which is tubular in form and is carried on the balance tube 42. The secondary jet support 64 is provided with a pair of diametrically disposed ears 65 and 66 in which are disposed secondary jet elements 67 and 68 which are axially aligned with the primary jets 53 and 54, respectively.

The upper end of the secondary jet support 64 engages the lower end of a tertiary jet assembly 70 which includes a tertiary jet support 71 carried on the balance tube 42 and which is tubular in form and which, as best shown in Figs. 3 and 9, fills the interior of the tubular shell 45. The tertiary jet support 71 is provided with a pair of diametrically disposed bores 72 and 73 in which are disposed, respectively, tertiary jet members 74 and 75. The jet members 74 and 75 are of identical construction, the jet member 74 being provided with a radial flange 76 at its lower end which engages against the tertiary jet support 71 and also against the upper end of the secondary jet support 64. The tertiary jet members 74 and 75 are, of course, axially aligned with the secondary jet elements 67 and 68. The tertiary jet member 74 is provided with a jet passage 77 therethrough, the upper end 78 of which is generally in the form of an inverted cone and acts as a lower diffuser.

The upper end of the tertiary jet assembly 70 engages the lower end of a central diffuser member 80 which is generally tubular in form and which is carried on the balance tube 42. The central diffuser member 80 is provided with a pair of central diffuser passages 81 and 82 which communicate with the diffuser passages of the tertiary jet members 74 and 75, registering therewith. The upper end of the central diffuser member 80 engages the lower end of an upper diffuser member 83, as best shown in Figs. 2 and 5, being provided with upper diffuser passages 84 and 85. As will be understood from Figs. 5, 6, 7 and 8, the diffuser passages in the various elements increase in cross-sectional area as they extend upwardly, being aligned and registering so as to provide a pair of smooth, continuous diffuser passages.

The upper end of the upper diffuser member 83 engages the lower end of a spacer sleeve 87 carried on the balance tube 42, the upper end of which engages a nut 88 threaded on the upper end of the balance tube. As will be apparent, the secondary jet support 64, the tertiary jet assembly 70, the central diffuser member 80, and the upper diffuser member 83 are thereby clamped rigidly relative to each other and relative to the balance tube 42 and the shell 45.

In installation, the fluid-operated pump 28 and the auxiliary booster pump 39 are assembled together and then run into the production tubing 23 to the position shown in Fig. 1. The production tubing 23 is disposed so that the inlet opening 24 thereof communicates with well fluid in the casing 20 which flows thereinto through the perforations 21 from the producing zone 22 in the well, the pump assembly, of course, being run into the production tubing on the lower end of the power tubing 27.

In operation, operating fluid under high pressure, such as clean crude oil, is conveyed downwardly through the power tubing 27 from the surface of the ground to the fluid-operated pump 28 from any suitable source (not shown). A portion of such operating fluid passes downwardly through the longitudinal passage means 36 of the upper valve rod 33, the motor piston 29, the intermediate valve rod 34, the pump piston 31, and the lower valve rod 35 into the lower balancing chamber 37. Such operating fluid then flows from the lower balancing chamber 37 outwardly through the radial passages 60 into the primary jets 53 and 54 from which it is discharged upwardly at high velocity into the secondary jet elements 67 and 68, being in turn discharged therefrom upwardly at relatively high velocity into the tertiary jet members 74 and 75. Since well fluid from the well can readily flow upwardly through the intake port 47 and upwardly around the primary jet support 50 it fills the space between the primary jet support and the tertiary jet assembly 70. The upward discharge from the primary jet elements 53 and 54, the secondary jet elements 67 and 68, and the tertiary jet members 74 and 75 forces well fluid under substantial pressure upwardly through the diffuser passages and into the lower inlet port 41 in the fluid-operated pump 28. As will be apparent, employing a plurality of jet elements in series insures more effective utilization of the energy of the power oil delivered to the auxiliary booster pump. The auxiliary booster pump 39 thus pumps well fluid into the inlet ports 41 of the fluid-operated pump at a pressure substantially higher than that in the casings adjacent the lower end of the production tubing 23. The extent of such rise in pressure of the well fluid by the auxiliary booster pump 29 is, of course, dependent upon the design of the booster pump as well as upon the fluid pressure of the operating fluid in the lower balancing chamber 37, as will be well understood by those skilled in the art. In the design illustrated in the drawings, I am able to obtain by the booster pump 39 a rise in pressure of the well fluid flowing therethrough of approximately 300 pounds per square inch where the normal pressure of the operating fluid in the balancing chamber 37 is 3000 pounds per square inch. Such rise in pressure impressed on the well fluid passing to the inlet port 41 of the fluid-operated pump 28 is sufficient to compress to a very small volume any free gas in solution in the well fluid. Also, by the action of the booster pump 39 the pressure of the well fluid in the pump cylinder 32 of the fluid-operated pump 28 is maintained at a value equal to or greater than the pressure of the well fluid in the well adjacent the lower end of the production tubing. This prevents or reduces any tendency of gas contained in solution in the well fluid from flashing out as free gas in the pump cylinder.

As will be understood by those skilled in the art, the major portion of the operating fluid supplied to the fluid-operated pump 28 through the

power tubing 27 is utilized in the fluid-operated pump to actuate the motor piston 29 thereof so as to reciprocate the pump piston 31 so as to pump fluid from the pump cylinder 32 upwardly through the production tubing 23, as is well known. The spent operating fluid which has actuated the auxiliary booster pump 39, is of course, mixed with the well fluid passing therethrough, which is a further feature of the invention.

An alternative form of auxiliary booster pump, which may be substituted for the auxiliary booster pump 39, is shown in Figs. 12 to 18, inclusive. In such figures, parts identical with those shown in the preceding figures of the preferred form of the invention are given the same numbers, with the suffix "*a*" added thereto. In this form of the invention the auxiliary booster pump 39*a* includes an upper element 90 which is threadedly connected to the lower end of the balance tube 42*a*. The upper element 90, as best shown in Figs. 14 and 15, includes a plurality of curved diffuser vanes 91 which are circumferentially spaced so as to provide diffuser passages 92 extending upwardly therebetween. The element 90 closes the lower end of the balance tube 42*a*, providing a lower balancing chamber 37*a* in the lower end thereof. The element 90 is provided with an angled passage 93 which communicates at its lower end with a branch passage 94, the lower end of which is provided with an orifice member 95 which is directed tangentially to the circumference of the element 90 but spaced inwardly therefrom.

Supported on the upper end of the inlet member 46*a*, by a spacer ring 97, is a fixed bowl assembly 98 provided with fluid passages 99 extending upwardly therethrough, the fluid passages being separated by webs 100. Provided in an axial bore 101 in the bowl assembly 98 is a sleeve bearing 102 which journals an impeller shaft 103 the lower end of which rests on a thrust bearing assembly 104 adjustably secured in the lower end of the bowl assembly by a threaded plug 105.

The upper end of the impeller shaft 103 is rigidly connected, as by press fitting, or otherwise, into a rotatable impeller element 107 the upper face of which, as best shown in Fig. 16, is provided with a series of circumferentially spaced cup-shaped pockets 108 which approximately register with the orifice member 95 of the upper element 90. As best shown in Fig. 17, the lower side of the impeller element 107 is provided with a hub 109 from which radially extend curved impeller vanes 110. As will be understood, the upper element 90, the bowl assembly 98, and the impeller element 107 form a turbine pump which is operated by high pressure operating fluid delivered from the balancing chamber 37*a* through the passages 93 and 94 and the orifice member 95 to impinge on the impeller member and rotate it so as to pump well fluid from the intake port 47*a* through the booster pump 39*a* to the inlet 41*a* of the fluid-operated pump 28*a*. The auxiliary booster pump 39*a* therefore accomplishes the same general purpose and functions as the auxiliary booster pump 39, described above, and is merely an alternative form of booster pump mechanism.

Although I have shown and described a preferred form of the present invention, in two embodiments, it will be understood that changes may be made in the mechanism without departing from the spirit of the invention, and I therefore intend to be afforded the full scope of the following claims.

I claim as my invention:

1. In a fluid-operated pumping device, the combination of: a fluid-operated pump of the reciprocating type having connected motor and pump pistons disposed in motor and pump cylinders, respectively, said pump being adapted to be disposed in a well and actuable by an operating liquid under high pressure, said pump having an inlet adapted to receive well fluid; auxiliary liquid-operated pumping means secured relative to said pump and actuable by an operating liquid under high pressure, said auxiliary pumping means including an intake port adapted to communicate with the well fluid in the well, and having a discharge port communicating with said inlet; and passage means for supplying operating liquid under high pressure to said pump and to said auxiliary pumping means so as to actuate them, said auxiliary pumping means being operable to pump well fluid from the well into said inlet at a fluid pressure higher than that in said intake port.

2. In a fluid-operated pumping device, the combination of: a fluid-operated pump of the reciprocating type having connected motor and pump pistons disposed in motor and pump cylinders, respectively, said pump being adapted to be disposed in a well and actuable by an operating liquid under high pressure, said pump having an inlet adapted to receive well fluid; auxiliary liquid-operated pumping means secured relative to said pump and actuable by an operating liquid under high pressure, said auxiliary pumping means including an intake port adapted to communicate with the well fluid in the well, and having a discharge port communicating with said inlet; and passage means for supplying operating liquid under high pressure to said pump and to said auxiliary pumping means so as to actuate them, said auxiliary pumping means being operable to pump well fluid from the well into said inlet at a fluid pressure higher than that in said intake port, spent operating liquid from said auxiliary pumping means being discharged into and mingling with the well fluid being pumped thereby.

3. In a fluid-operated pumping device, the combination of: a fluid-operated pump of the reciprocating type having connected motor and pump pistons disposed in motor and pump cylinders, respectively, said pump being adapted to be disposed in a well and actuable by an operating liquid under high pressure, said pump having an inlet adapted to receive well fluid; auxiliary liqud-operated pumping means secured relative to said pump and actuable by an operating liquid under high pressure, said auxiliary pumping means including an intake port adapted to communicate with the well fluid in the well, and having a discharge port communicating with said inlet; and connecting passage means for supplying operating liquid under high pressure to said pump and to said auxiliary pumping means so as to actuate them, said auxiliary pumping means being operable to pump well fluid from the well into said inlet at a fluid pressure higher than that in said intake port.

4. In a liquid-operated pumping device, the combination of: a liquid-operated pump, including a motor piston, a pump piston, an upper rod connected to the upper end of said motor piston, an intermediate rod connecting said pistons, and a lower rod connected to the lower end of said

pump piston, said rods and pistons having connecting, longitudinal passage means therethrough adapted to communicate at its upper end with a source of high pressure operating liquid, said pump having a pressure port communicating with the lower end of said passage means, and having an inlet; and auxiliary liquid-operated pumping means connected to said pump and communicating with said pressure port, including an intake port adapted to communicate with the fluid in the well, and having a discharge port communicating with said inlet, said auxiliary pumping means being adapted to be actuated by operating liquid supplied thereto through said passage means and said pressure port to pump well fluid from the well into said inlet at a fluid pressure higher than that in said intake port.

5. In a liquid-operated pumping device, the combination of: a liquid-operated pump, including a motor piston, a pump piston, an upper rod connected to the upper end of said motor piston, an intermediate rod connecting said pistons, and a lower rod connected to the lower end of said pump piston, said rods and pistons having connecting, longitudinal passage means therethrough adapted to communicate at its upper end with a source of high pressure operating liquid, said pump having a pressure port communicating with the lower end of said passage means, and having an inlet; and auxiliary liquid-operated pumping means connected to said pump and communicating with said pressure port, including an intake port adapted to communicate with the fluid in the well, and having a discharge port communicating with said inlet, said auxiliary pumping means being adapted to be actuated by operating liquid supplied thereto through said passage means and said pressure port to pump well fluid from the well into said inlet at a fluid pressure higher than that in said intake port, spent operating liquid from said auxiliary pumping means being discharged into and mingled with the well fluid being pumped thereby.

6. In a fluid-operated pumping device, the combination of: a fluid-operated pump of the reciprocating type having connected motor and pump pistons disposed in motor and pump cylinders, respectively, said pump being adapted to be disposed in a well and actuable by an operating liquid under high pressure, said pump having an inlet adapted to receive well fluid; auxiliary liquid-operated pumping means secured relative to said pump and actuable by an operating liquid under high pressure, said auxiliary pumping means including an intake port adapted to communicate with the well fluid in the well, and having a discharge port communicating with said inlet, and having fluid jet means; and passage means for supplying operating liquid under high pressure to said pump and to said jet means of said auxiliary pumping means so as to actuate them, said jet means of said auxiliary pumping means being operable to pump well fluid from the well into said inlet at a fluid pressure higher than that in said intake port.

7. A fluid-operated pumping device as set forth in claim 6 in which said jet means includes a series of aligned jet elements, said passage means communicating with the first jet element in said series.

8. A fluid-operated pumping device as set forth in claim 7 in which said jet means further includes an elongated diffuser passage aligned with said jet elements and communicating at one end with the last jet element in said series, said diffuser passage communicating at its other end with said discharge port.

9. In a liquid-operated pumping device, the combination of: a liquid-operated pump, including a motor piston, a pump piston, an upper rod connected to the upper end of said motor piston, an intermediate rod connecting said pistons, and a lower rod connected to the lower end of said pump piston, said rods and pistons having connecting, longitudinal passage means therethrough adapted to communicate at its upper end with a source of high pressure operating liquid, and having a pressure port communicating with the lower end of said passage means, and having an inlet; and auxiliary liquid-operated pumping means connected to said pump and communicating with said pressure port, including an intake port adapted to communicate with the fluid in the well, and having a discharge port communicating with said inlet, and having liquid jet means communicating with said pressure port, said auxiliary pumping means being adapted to be actuated by operating liquid supplied to said jet means through said passage means and said pressure port to pump well fluid from the well into said inlet at a fluid pressure higher than that in said intake port.

10. In a pumping system, the combination of: a liquid-operated pump of the reciprocating type adapted to be disposed in a well, said pump including an intake for an operating liquid under pressure and including an inlet for well fluid to be pumped; and auxiliary pumping means connected to the lower end of said pump, said auxiliary pumping means including an intake for operating liquid which is connected in fluid communication with said intake of said pump, including an inlet adapted to communicate with the well fluid in the well and connected in fluid communication with said inlet of said pump, and including an exhaust for spent operating liquid which also communicates with said inlet of said pump so that the spent operating liquid discharged by said auxiliary pumping means mixes with the well fluid delivered to said inlet of said pump by said auxiliary pumping means, whereby said auxiliary pumping means delivers the well fluid and the spent operating liquid to said inlet of said pump at an increased pressure and with a minimum of free gas so as to increase the volumetric efficiency of said pump.

11. A pumping system as set forth in claim 10 in which said auxiliary pumping means includes a rotary turbine means which delivers the fluid which is to be pumped from the well to the inlet of the pump and the turbine means is driven by the operating liquid under pressure.

References Cited in the file of this patent

UNITED STATES PATENTS

Number	Name	Date
265,895	Vanduzen	Oct. 10, 1882
904,449	Rennerfelt	Nov. 17, 1908
1,729,794	Newnham	Oct. 1, 1929
1,845,675	Martin	Feb. 16, 1932
1,852,251	McCune	Apr. 5, 1932
2,022,781	Pigott	Dec. 3, 1935
2,081,220	Coberly	May 25, 1937
2,272,906	Da Col	Feb. 10, 1942
2,327,637	Harris	Aug. 24, 1943
2,444,100	Hill	June 29, 1948