March 18, 1952 C. J. COBERLY 2,589,670

CLOSED FLUID-OPERATED FREE-PUMP SYSTEM WITH TWO PARALLEL TUBINGS ONE OF WHICH ENCLOSES A THIRD TUBING

Filed May 16, 1949 2 SHEETS—SHEET 1

Fig. 1

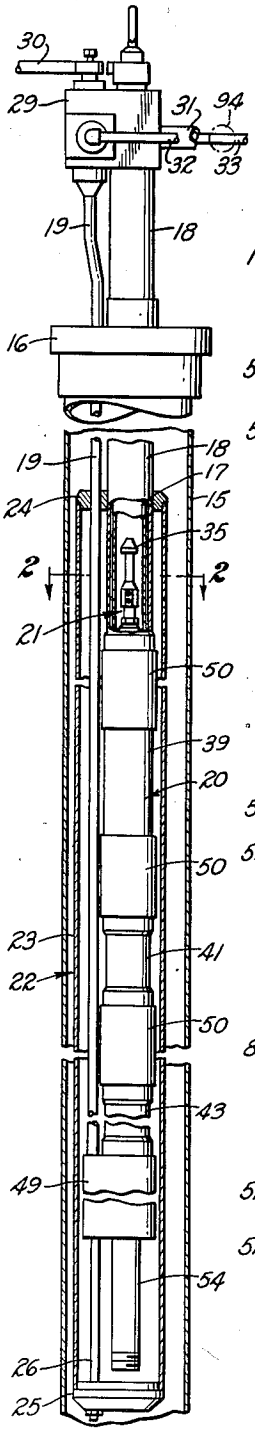
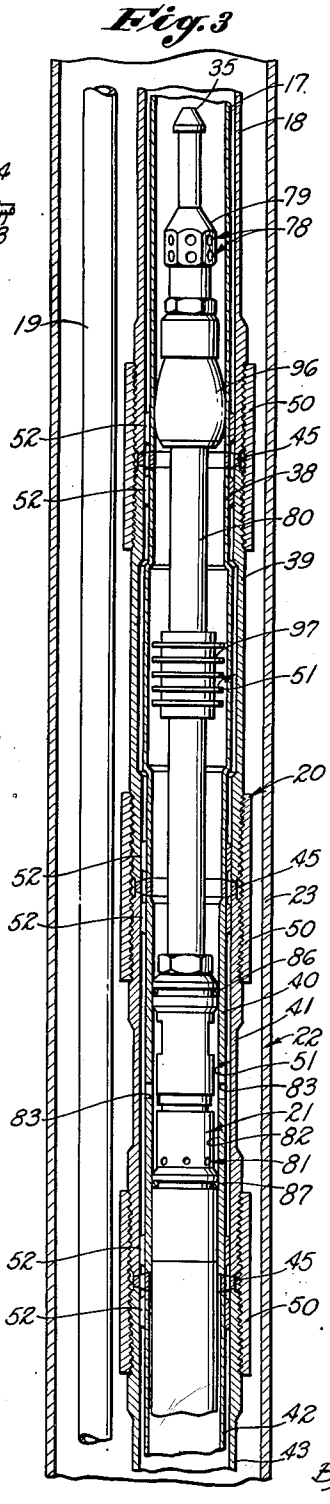


Fig. 3



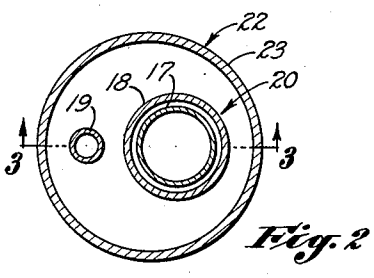
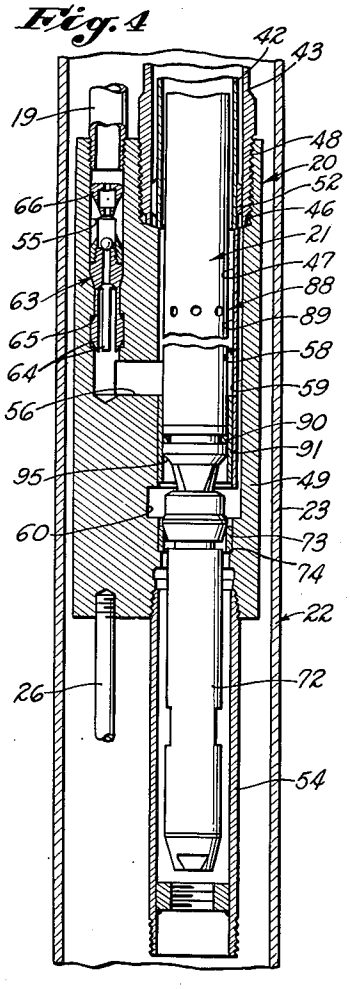


Fig. 2

Fig. 4



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2 SHEETS—SHEET 2

Fig. 5

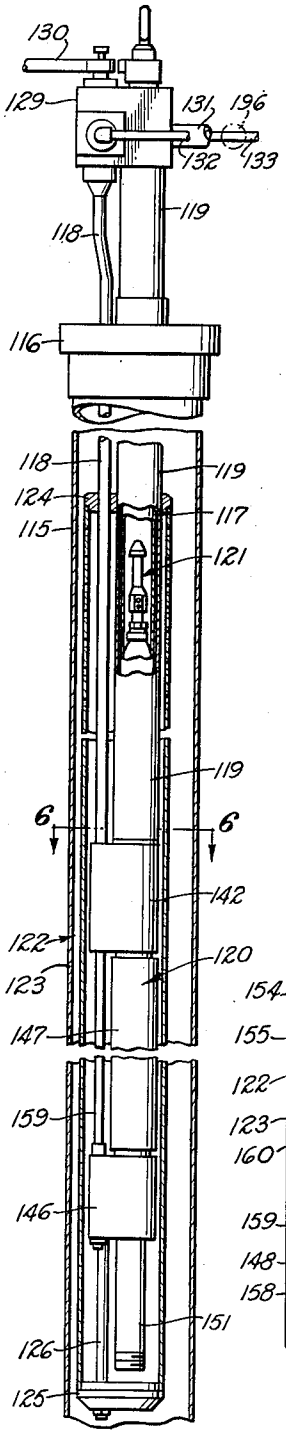


Fig. 7

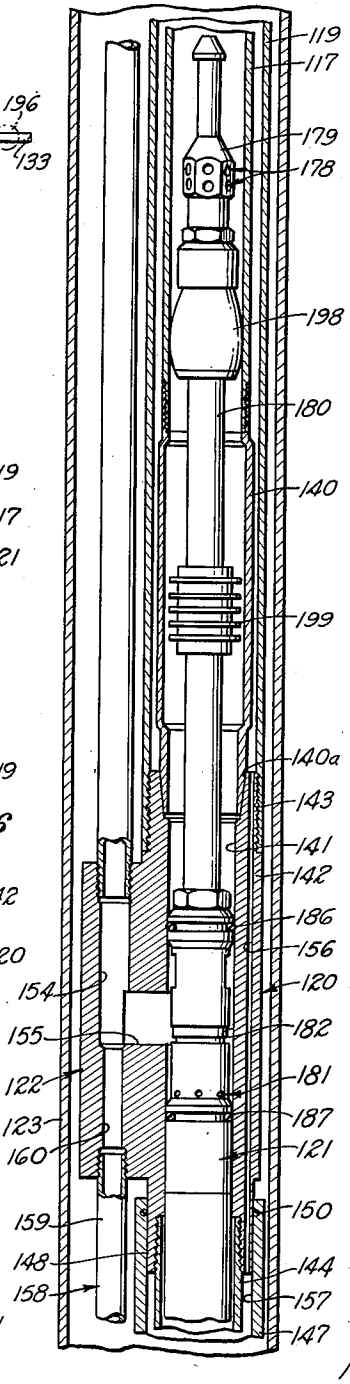


Fig. 6

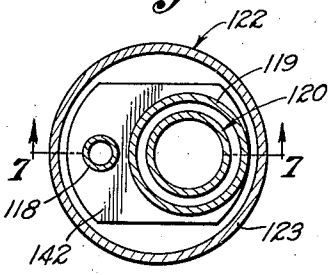
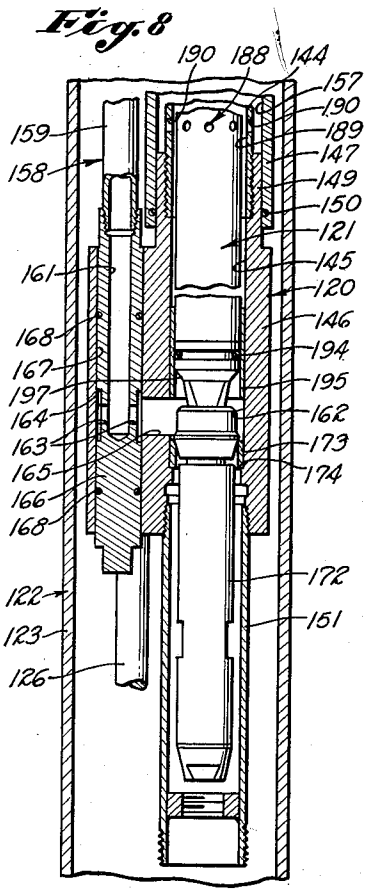


Fig. 8



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Patented Mar. 18, 1952

2,589,670

UNITED STATES PATENT OFFICE

2,589,670

CLOSED FLUID-OPERATED FREE-PUMP SYSTEM WITH TWO PARALLEL TUBINGS, ONE OF WHICH ENCLOSES A THIRD TUBING

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Application May 16, 1949, Serial No. 93,482

31 Claims. (Cl. 103—46)

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My invention relates in general to tubing systems for fluid-operated well pumps and, more particularly, to a closed tubing system for a fluid-operated well pump of the so-called "free" type.

Reference is hereby made to my copending applications Serial No. 93,483, filed May 16, 1949, Serial No. 93,484. filed May 16, 1949, and Serial No. 93,481, filed May 16, 1949.

It is conventional in the oil industry to employ a well pumping apparatus which includes a free fluid-operated pump, such a pump being movable into and out of the well through a tubing set in the well and being adapted to assume an operating position at the lower end of such tubing. Examples of such fluid-operated, free-pump systems are disclosed in my Patent Nos. 2,230,830, granted February 4, 1941, and 2,338,903, granted January 11, 1944.

In conventional fluid-operated, free-pump systems, such as those disclosed in my aforementioned patents, two tubings are employed, one for conveying operating fluid downwardly in the well to the pump and the other for conveying fluid produced by the well upwardly therein from the pump to the surface, the two tubings being referred to hereinafter as the supply and production tubings, respectively. In such conventional systems, the pump is movable into its operating position through the supply tubing. The supply and production tubings are interconnected at their lower ends in fluid communication with each other and with the well so that the pump may receive operating fluid from the supply tubing and well fluid from the well and so that it may discharge well fluid into the production tubing as production fluid.

In installing such a free pump in the well, it is moved downwardly through the supply tubing into its operating position at the lower end thereof either by the action of gravity or by the application of fluid pressure to the upper end of the pump. After the pump has been installed in its operating position, operating fluid, which is usually clean crude oil, is delivered to the motor section of the pump under relatively high pressure through the supply tubing. As is well known in the art, such operating fluid is alternately directed by a suitable valve mechanism in the motor section of the pump to opposite ends of a motor piston which is coupled to a pump piston in the pump section of the device, fluid from the well being admitted to the pump section by a suitable valve mechanism therein. Such alternating application of operating fluid pressure to the ends of the motor piston produces reciprocation of the motor and pump pistons with the result that the pump piston pumps fluid produced by the well into the production tubing, the latter conveying the production fluid upwardly therein to the surface. When removal of the pump from the well is desired for any reason, as for service or repair, fluid pressure is applied to the lower end of the pump to move it upwardly out of its operating position and through the supply tubing to the surface. This is accomplished by conventionally reversing the flow through the system so that operating fluid flows downwardly in the production tubing to the lower end of the pump and acts on the pump to move it upwardly through the supply tubing to the surface.

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In a conventional free-pump system of the foregoing character, the spent operating fluid discharged by the motor section of the pump is delivered to the production tubing so that the spent operating fluid and the production fluid are intermixed and conveyed upwardly together through the production tubing. Since the operating fluid delivered to the pump through the supply tubing must be clean, in order to prevent abrasion and corrosion of the moving parts of the pump, fresh operating fluid must be supplied to the system continuously. The continuous provision of such fresh operating fluid requires considerable surface equipment, normally in the form of settling tanks or filters, which is expensive to install and operate. Also, in the particular arrangement hereinbefore mentioned wherein the pump is disposed in the supply tubing, the flow reversal necessary to remove the pump from the well may carry any sand or other foreign matter present in the production fluid into the supply tubing with the result that such foreign matter may enter the motor section of the pump upon resumption of operation after reinstallation with the attendant possibility of damage to the pump.

In view of the foregoing, it is a primary object of this invention to provide a closed system for the fluid-operated, free pump which includes a third tubing separate from the supply and production tubings for returning the spent operating fluid to the surface independently of the well fluid, the tubing for returning the spent operating fluid being referred to hereinafter as the return tubing. With such a closed system, the spent operating fluid is separately conveyed back to the surface for storage and re-use to actuate the fluid-operated pump so that there is very little loss of operating fluid from the system and, consequently, the surface equipment necessary to supply fresh operating fluid to the system needs have only a relatively small capacity and can be relatively cheap and economical, both as regards initial cost and operating costs. Also, the reversed flow necessary to move the pump upwardly to the surface during removal of the pump may take place through the return tubing to avoid carrying said and other foreign matter into that portion of the system reserved for the operating fluid, which is an important feature.

As will be pointed out in more detail hereinafter, further objects of the invention reside in certain modifications of the pump and in the tubing arrangements employed to provide such a closed system.

Considering the invention more specifically, an object thereof is to provide a closed system for a fluid-operated, free pump comprising supply, return and production tubings which are set in the well and one of which is adapted to receive the pump and to provide an operating position for the pump at its lower end, the supply, return and production tubings respectively being adapted to convey operating fluid for actuating the pump downwardly into the well to the pump, spent operating fluid discharged by the pump upwardly in the well from the pump to the surface and production fluid discharged by the pump upwardly in the well from the pump to the surface.

An important object of the invention is to provide a closed system wherein the supply, return and production tubings are set in the well with one of the tubings disposed within another. A further object in this connection is to provide a closed system wherein one of the tubings is disposed within a second and wherein the third tubing is disposed beside the second.

Another object is to provide such a closed system wherein the three tubings are interconnected at their lower ends in fluid communication with each other and with the well so that the pump may, when in its operating position, receive operating fluid for its actuation from the supply tubing through an intake, discharge spent operating fluid into the return tubing through an exhaust, receive well fluid from the well through an inlet and discharge well fluid into the production tubing through an outlet.

Another object is to provide a closed system having means whereby a downward flow of fluid through one of the tubings, other than the tubing in which the pump is disposed, may be applied to the lower end of the pump to move it upwardly out of its operating position and through the tubing in which it is disposed to the surface whenever removal of the pump from the well is desired.

Another object is to provide a closed system which includes a tubular pump receiver disposed at the lower end of and in alignment with the tubing through which the pump is movable, the pump receiver being, in effect, an extension of such tubing and providing the aforementioned operating position for the pump. A related object is to provide a pump receiver having a seat at its lower end for the pump, the pump being seated on such seat when it is in its operating position.

Another object is to provide a pump receiver having passages which place the interior thereof in fluid communication with the supply, return and production tubings and with the well in such a manner as to provide fluid communication between the intake, the exhaust, the inlet and the outlet of the pump and the supply tubing, the return tubing, the well and the production tubing, respectively, when the pump is disposed in the pump receiver and seated on the pump seat.

Another object is to provide sealing means for normally preventing direct flow between the tubings and the well by way of the pump receiver when the pump is in its operating position so that operating fluid may flow only from the supply tubing through the motor section of the pump to the return tubing and so that well fluid may flow only from the well through the pump section of the pump to the production tubing. More specifically, an object in this connection is to provide a sealing means which, when the pump is in its operating position, places the supply tubing in fluid communication with only the intake of the pump, the return tubing in fluid communication with only the exhaust of the pump, the well in fluid communication with only the inlet of the pump and the production tubing in fluid communication with only the outlet of the pump.

Another object is to provide a system wherein the aforementioned sealing means comprises annular sealing elements which are carried by the pump adjacent various of the ports, such as the intake, exhaust, etc., therein and which are engageable with the inner wall of the pump receiver to prevent direct flow between the tubings.

Another object is to provide passage means communicating at one end with one of the tubings, other than the tubing aligned with the pump receiver, and at its other end with a chamber in the pump receiver between the pump seat and the pump for applying a downward flow of fluid through such tubing to the lower end of the pump to move it upwardly out of the pump receiver and to the surface.

Another object is to provide a sealing device for normally preventing fluid flow between two of the tubings by way of the aforementioned passage means and the pump receiver when the pump is in its operating position. Another object in this connection is to provide a system wherein the aforementioned sealing device is an annular sealing element adapted to be disposed between the pump and the pump receiver.

Another object is to provide a system wherein the tubing with which the aforementioned passage means communicates is the return tubing so that the pump may be moved upwardly to the surface by a downward flow of clean fluid through the return tubing to prevent introducing sand and other abrasive matter into the pump receiver.

Still another object is to provide a closed system wherein the pump is movable into its operating position in the pump receiver through the supply tubing and wherein the pump is movable upwardly to the surface by a downward flow of clean fluid through the return tubing so as to avoid carrying any of the sand or other abrasive material which may be in the fluid in the production tubing into the pump receiver during the pump-removal operation.

Another object is to provide a closed system in which damage from any corrosive substances in the production fluid is minimized by permitting the production fluid to come in contact with only the production tubing. This is accomplished by locating the supply and return tubings without the production tubing, which is an important feature.

Another object is to minimize the power required to overcome friction between the production fluid moving upwardly through the production tubing and the wall of the production tubing by employing a production tubing having a large internal diameter. This feature is particularly important under well conditions such that a pump having a motor section of small capacity and a pump section of large capacity may be employed.

Another object is to maximize the external diameter of the pump by making the tubing for receiving the pump of large internal diameter. This permits the employment of a pump having motor and/or pump sections of maximum capacity, which is an important feature.

Another object is to facilitate paraffin control in such a closed system by limiting contact of the production fluid to the production tubing, i. e., by disposing the supply and return tubings without the production tubing.

The foregoing objects and advantages of the present invention, together with other objects and advantages thereof which will become apparent, may be attained through the employment of the exemplary embodiments of the invention which are illustrated in the accompanying drawings and which are described in detail hereinafter. Referring to the drawings:

Fig. 1 is a utility view of a closed, fluid-operated, free-pump system which embodies the invention;

Fig. 2 is an enlarged, horizontal sectional view taken along the broken line 2—2 of Fig. 1;

Fig. 3 is an enlarged, vertical sectional view taken along the broken line 3—3 of Fig. 2.

Fig. 4 is a downward continuation of Fig. 3;

Fig. 5 is a utility view of another embodiment of the invention;

Fig. 6 is an enlarged, horizontal sectional view taken along the broken line 6—6 of Fig. 5;

Fig. 7 is an enlarged, vertical sectional view taken along the broken line 7—7 of Fig. 6; and,

Fig. 8 is a downward continuation of Fig. 7.

Considering first the embodiment illustrated in Figs. 1 to 4 of the drawings and referring particularly to Fig. 1 thereof, the numeral 15 designates a well casing which is set in an oil well with its lower end open to an oil producing formation adjacent the well as is well known in the art, the casing being provided with a casing head 16 at its upper end. Set in the well within the casing 15 and connected to the casing head 16 is a closed tubing system of the invention which comprises supply, return and production tubings respectively designated by the numerals 17, 18 and 19. The tubings 17, 18 and 19 are interconnected at their lower ends in fluid communication with each other and with the well by a tubular pump receiver 20 which is aligned with and which, in effect, forms a downward extension of one of the tubings. In the particular embodiment presently under consideration, the pump receiver 20 is aligned with the supply tubing 17, the supply tubing being concentrically disposed within and spaced from the return tubing 18 and the production tubing 19 being disposed beside the return tubing. The pump receiver 20 provides an operating position for a free fluid-operated pump 21 which is movable downwardly through the supply tubing 17 into its operating position in the pump receiver, the internal diameter of the pump receiver being substantially equal to that of the supply tubing. As will be discussed in more detail hereinafter, the supply tubing 17 is adapted to convey operating fluid, such as clean crude oil, under pressure downwardly in the well from the surface to the pump 21 to actuate the pump, and the return tubing 18 is adapted to receive spent operating fluid discharged by the pump and to convey the spent operating fluid upwardly around the supply tubing 17 to the surface. The pump 21 is adapted to receive well fluid from the well and to discharge it into the production tubing 19 as production fluid, the production tubing conveying the production fluid upwardly in the well to the surface.

In the particular construction illustrated, the lower ends of the tubings 17, 18 and 19 and the pump receiver 20 are enclosed by a gas anchor 22 having a perforated barrel 23 which is closed at its upper and lower ends by heads

24 and 25, respectively, the upper head having suitable openings therethrough for the tubings. The gas anchor 22 is secured to the pump receiver 20 by a bolt 26 connecting the lower head 25 to the pump receiver.

The supply, return and production tubings 17, 18 and 19 are connected at their upper ends to a pump head 29 having valve means (not shown) therein which is operable from the surface by a handle 30 to direct flows of fluid through the tubing in the proper manner as will be discussed in more detail hereinafter. Also connected to the pump head 29 are supply, return and production lines 31, 32 and 33 which, during operation of the pump 21, are adapted to be connected in fluid communication with the supply, return and production tubings 17, 18 and 19, respectively, by the valve means in the pump head. The supply line 31 leads to a suitable source (not shown) of operating fluid under pressure, which source may be a conventional triplex pump having its intake connected to a suitable reservoir. The return line 32 leads to the reservoir and the production line 33 leads to a suitable point of disposal or storage for the production fluid. As disclosed in my aforementioned Patent No. 2,338,903, the pump head 29 may also include a suitable pump catcher (not shown) for the pump 21, the latter having at its upper end a tapered head 35 which is receivable by the pump catcher during removal of the pump from the well.

Referring now to Figs. 3 and 4 of the drawings, the pump receiver 20 is, as previously indicated, aligned with the lower end of the supply tubing 17, the pump receiver having at its upper end inner and outer sleeves 38 and 39 which are concentrically arranged in spaced relationship and which register with the supply and return tubings 17 and 18, respectively. Disposed below and registering with the inner and outer sleeves 38 and 39 are inner and outer sleeves 40 and 41, respectively, the sleeves 40 and 41 being arranged concentrically in spaced relationship. Disposed below and registering with the sleeves 40 and 41, respectively, are inner and outer sleeves 42 and 43 which are concentrically arranged and spaced apart. The lower ends of the supply and return tubings 17 and 18 and the ends of the pairs of sleeves 38 and 39, 40 and 41, and 42 and 43 are beveled in such a manner as to form conical surfaces. The conical surface at the lower ends of the supply and return tubings 17 and 18 and the conical surface at the upper end of the pair of sleeves 38 and 39 are seated against opposite sides of a spacer 45 having two complementary conical surfaces. Another spacer 45 is disposed between the pair of sleeves 38 and 39 and the pair of sleeves 40 and 41 and still another spacer 45 is disposed between the pair of sleeves 40 and 41 and the pair of sleeves 42 and 43. The conical surface at the lower end of the pair of sleeves 42 and 43 is seated against a complementary conical surface 46 formed at the junction of a major bore 47 and a counterbore 48 in a fitting 49 forming part of the pump receiver 20, the lower end of the outer sleeve 43 being threaded into the counterbore 48. The outer sleeve 39 and the return tubing 18 are threadedly connected by a coupling 50 and the outer sleeve 39 and the outer sleeve 41 are threadedly connected by another such coupling. Still another coupling 50 threadedly connects the outer sleeve 41 to the outer sleeve 43.

It will be apparent, that, with the foregoing

construction, the inner sleeves 38, 40 and 42 are clamped between the supply tubing 17 and the fitting 49, the conical surfaces on the spacers 45 and the conical surface 46 of the fitting 49 serving to center the various inner sleeves within the corresponding outer sleeves 39, 41 and 43. In order to insure maintaining the proper spacing between the various inner and outer sleeves, spacers 52 are disposed therebetween, the spacers 52 being provided with passages therethrough. The spacers 45 are provided with passages therethrough which communicate with the various annular spaces between the pairs of sleeves 38 and 39, 40 and 41, and 42 and 43, such passages and annular spaces being collectively regarded hereinafter as a return passage 51. As will be apparent, the return passage 51 communicates at its upper end with the interior of the return tubing 18 so that spent operating fluid may flow upwardly through the return passage and enter the annular space between the supply and return tubings.

Referring particularly to Fig. 4 of the drawings, threaded into the lower end of the major bore 47 in the fitting 49 is an inlet sleeve 54 which communicates at its lower end with the well through the perforated gas anchor barrel 23. The fitting 49 is provided with a minor bore 55 which is spaced from the major bore 47 therein and into the upper end of which is threaded the lower end of the production tubing 19. The lower end of the minor bore 55 communicates with the major bore 47 through a lateral passage 56 to provide fluid communication between the production tubing 19 and the interior of the pump receiver 20. Thus, with the foregoing construction, the pump receiver interconnects the lower ends of the supply, return and production tubings 17, 18 and 19 in fluid communication with each other and with the well.

The fitting 49 of the pump receiver 20 is provided with a passage means 58 for applying a downward flow of fluid through the return tubing 18 to the lower end of the pump 21 to move the pump upwardly out of the pump receiver 20 and through the supply tubing 17 to the surface when removal of the pump is desired for any reason, this passage means comprising one or more longitudinal passages 59 formed in the fitting 49. The passage 59 communicates at its upper end with the lower end of the return passage 51 and communicates at its lower end with an annular chamber 60 at the lower end of the pump 21.

The minor bore 55 in the fitting 49 contains a standing valve 63 which is adapted to prevent downward flow of fluid from the production tubing 19 into the interior of the pump receiver but which is adapted to permit upward flow of production fluid discharged by the pump 21 into the production tubing. The valve 63 is provided with spring fingers 64 which engage shoulders 65 in the minor bore 55 to hold the valve in its operating position, and includes an inside spear fitting 66 which is adapted to be engaged by a suitable tool lowered into the well through the production tubing 19 when removal of the valve is desired, as is well known in the art.

Disposed in the lower end of the major bore 47 in the fitting 49 and extending downwardly into the inlet sleeve 54 is an inlet fitting 72 which serves as a seat for the pump 21, the latter being in its operating position when it is disposed in the pump receiver 20 and seated on the pump seat provided by the inlet fitting. The pump 21 is adapted to seat on the inlet fitting 72 automatically when it is moved downwardly through the supply tubing 17 into the pump receiver 20 so that it automatically assumes its operating position. The inlet fitting 72 also serves to convey fluid from the well to an inlet of the pump 21 when the pump is in its operating position, the inlet fitting preferably being provided with a check valve (not shown) therein which permits upward flow of well fluid into the interior of the pump receiver 20, but which prevents downward flow of fluid out of the pump receiver into the well. The inlet fitting 72 is seated on an annular insert 73 which is disposed in the major bore 47 and which is seated on a shoulder 74 therein.

Except for certain modifications required to adapt it to the closed tubing system of the invention, the fluid-operated, free pump 21 may be of conventional design and will not be described in detail. In general, the pump 21 includes a motor section and a pump section disposed below the motor section, the motor and pump sections respectively including coupled motor and pump pistons (not shown). The motor section of the pump 21 is actuable by operating fluid under pressure delivered thereto by the supply tubing 17, the operating fluid under pressure being adapted to enter the motor section of the pump through ports which serve as an intake 78 for the pump and which are in fluid communication with the supply tubing when the pump is in its operating position. The ports of the intake 78 are formed in an intake fitting 79 which carries the aforementioned tapered head 35 and which is connected to the upper end of a tubular rod 80 extending upwardly from the motor section of the pump 21, the rod being adapted to convey operating fluid under pressure from the intake to the motor section of the pump.

After the operating fluid admitted to the motor section of the pump 21 through the intake 78 has actuated the pump, it is discharged from the motor section through ports forming an exhaust 81 of the pump. When the pump 21 is in its operating position, the exhaust 81 communicates with an annular space 82 between the pump and the intermediate inner sleeve 40, the annular space 82 communicating with the return passage 51 through lateral ports 83 in the intermediate inner sleeve. Thus, the operating fluid under pressure in the supply tubing 17 flows through the motor section of the pump 21 to actuate it and is discharged into the return tubing 18 as spent operating fluid by way of the exhaust 81, the annular space 82, the ports 83 and the return passage 51.

In order to prevent direct flow of operating fluid between the supply and return tubings 17 and 18 by way of the pump receiver 20, I provide sealing means comprising an annular sealing element 86 which is carried by the pump 21 intermediate the intake 78 and the exhaust 81 and which is adapted to engage the intermediate inner sleeve 40 above the ports 83 therein when the pump is in its operating position. The annular sealing element 86 is preferably of the O-ring type and is formed of oil resistant rubber, or other suitable material. The pump 21 carries another, similar annular sealing element 87 below the exhaust 81, this sealing element being adapted to engage the intermediate inner sleeve 40 below the ports 83 therein when the pump is in its operating position. Thus, the annular sealing elements 86 and 87 isolate the

intake 78 and the exhaust 81 when the pump 21 is in its operating position so that the intake may communicate only with the supply tubing 17 and so that the exhaust may communicate only with the return tubing.

As previously indicated, the pump section of the pump 21 is provided with an inlet at its lower end through which well fluid is adapted to enter the pump section by way of the inlet fitting 72, the inlet of the pump not being shown specifically. The pump section of the pump is also provided with ports forming an outlet 88 for production fluid discharged by the pump section, the outlet communicating with an annular space 89 around the pump. The annular space 89 communicates with the lateral passage 56 connecting the interior of the pump receiver 20 with the minor bore 55 in the fitting 49 so that production fluid discharged through the outlet 88 may enter the production tubing 19.

It will be noted that the annular sealing element 87 is disposed between the exhaust 81 and the outlet 88 so that it prevents flow between the return and production tubings 18 and 19 when the pump is in its operating position. Also, since the pump 21 is seated on the inlet fitting 72 when in its operating position, the pump seat provided by the inlet fitting serves to prevent direct flow between the well and tubings 17, 18 and 19. Flow between the return and production tubings 18 and 19 by way of the passage means 58 is prevented by an annular sealing element 90 which is adapted to engage a liner 91 in the major bore 47 in the fitting 49 below the lateral passage 56 therein when the pump is in its operating position. Thus, the annular sealing element 90 also serves to isolate the production tubing 19 from the return tubing 18 when the pump is in its operating position.

Considering the operation of the embodiment of the invention hereinbefore described, it will be assumed that the pump 21 is in operation to pump fluid from the well upwardly through the production tubing 19 to the surface. Under such conditions, the pump 21 is in its operating position in the pump receiver 20 wherein it is seated on the inlet fitting 72, and the aforementioned valve means in the pump head 29 respectively connects the supply, return and production tubings 17, 18 and 19 to the supply, return and production lines 31, 32 and 33. Thus, operating fluid under pressure is conveyed downwardly to the pump 21 through the supply tubing 17 and enters the motor section of the pump through the intake 78 to actuate the pump, spent operating fluid being discharged into the return tubing 18 through the exhaust 81 and being conveyed upwardly in the well to the surface by the return tubing. The well fluid entering the pump section of the pump 21 through its inlet is discharged into the production tubing 19 through the outlet 88 and is conveyed upwardly in the well to the surface as production fluid. It will be apparent that, with this construction, the spent operating fluid is returned to the surface separately from the production fluid so that it may be re-used to actuate the pump 21, which is a primary feature of the invention.

In the event that removal of the pump 21 from the well is necessary in order to service or repair the pump, or for any other reason, the operator sets the handle 30 controlling the valve means in the pump head 29 in a position such that the valve means connects the supply line 31 to the return tubing 18 so that the operating fluid under pressure now flows downwardly into the well through the return tubing. Preferably, the valve means also connects the supply tubing 17 to the return line 32 under such conditions, and prevents fluid communication between the production tubing 19 and the production line 33. Alternatively, fluid flow through the production tubing 19 and the production line 33 may be prevented by closing a valve 94 in the production line 33.

Under the conditions outlined in the preceding paragraph, operating fluid under pressure flows downwardly through the return tubing 18 and into the annular chamber 60 at the lower end of the pump 21 by way of the return passage 51 and the passage means 58. The pressure of the operating fluid entering the annular chamber 60 in the foregoing manner is applied to an annular area 95 at the lower end of the pump 21 so as to unseat the pump from the inlet fitting 72 and is then applied to the entire area of the pump so as to move it upwardly in the pump receiver 20, upward flow of the operating fluid applied to the lower end of the pump in this manner past the pump being prevented by the annular sealing elements 86, 87 and 90. After the pump 21 has moved upwardly in the pump receiver 20 a distance such that the annular sealing elements 86 and 87 disengage the intermediate inner sleeve 40 and the annular sealing element 90 disengages the liner 91, upward flow of operating fluid past the pump is prevented by packing devices 96 and 97 which are carried by the rod 80 and which are adapted to engage the inner wall of the supply tubing 17 in a substantially fluid-tight manner, the portions of the pump 21 which carry the annular sealing elements 86, 87 and 90 preferably being of smaller diameter than the internal diameter of the supply tubing so as to prevent damage to these sealing elements during movement of the pump through the supply tubing. After the pump has cleared the ports 83 in the intermediate inner sleeve 40, the downward flow of operating fluid through the return tubing 18 is applied to the lower end of the pump directly through such ports.

During the foregoing pump-removal operation, flow of the operating fluid employed to remove the pump out of the pump receiver into the well is prevented by the check valve in the inlet fitting 72 and flow thereof into the production tubing 19 is prevented because flow through the production tubing is prevented by closing the aforementioned valve 94, or by means of the valve means in the pump head 29. It will be noted that, since the standing valve 63 prevents downward flow of the production fluid out of the production tubing 19 and into the pump receiver, none of the production fluid can enter the pump receiver during the pump-removal operation, which is an important feature since it prevents sand and other foreign matter which may be in the production fluid from entering the pump receiver. Thus, any possibility of such foreign matter entering the motor section of the pump 21 upon reinstallation thereof is prevented, which eliminates possible damage to the motor section from this source.

It will be noted that, under the conditions hereinbefore outlined, the operating fluid in the supply tubing 17 above the pump 21 is returned to the reservoir through the return line 32 during the pump-removal operation so that substantially none of it is lost from the system, which is an

important feature. As will be understood, when the pump 21 reaches the surface, it is caught by the aforementioned pump catcher in the pump head 29 and may subsequently be removed through the pump head.

When reinstallation of the pump 21, or installation of a replacement pump 21, is desired, the pump to be installed is inserted into the upper end of the supply tubing 17 through the pump head 29. The operator then sets the handle 30 controlling the valve means in the pump head 29 in a position such that the supply tubing 17 is placed in fluid communication with the supply line 31 and the return tubing 18 is placed in communication with the return line 32. Thus, the operating fluid under pressure entering the system through the supply line 31 acts on the upper end of the pump 21 to move it downwardly through the supply tubing 17 and into its operating position in the pump receiver 20 wherein it is seated on the inlet fitting 72, the operating fluid previously introduced below the pump during the pump-removal operation being displaced upwardly through the return tubing 18 and into the return line 32 leading to the reservoir on the surface. During the operation of installing the pump, the valve 94, or the valve means in the pump head 29, preferably prevents flow through the production tubing 19 and the production line 33 so that all of the fluid employed during the pump-removal operation is returned to the reservoir during the reinstallation of the pump. However, it will be understood that if the operating fluid in the supply tubing has become contaminated prior to reinstallation of the pump 21 for any reason, returning such contaminated operating fluid to the reservoir may be avoided by preventing fluid flow through the return tubing 18 and by permitting fluid flow through the production tubing 19.

As will be apparent, one advantage of the embodiment hereinbefore discussed is that it is possible to remove and reinstall the pump 21 with substantially no loss of operating fluid from the system, the production tubing 19 being isolated from that portion of the system reserved for the operating fluid during both the pump-removal operation and the pump-installation operation.

It will be noted also that since the production fluid comes in contact with only the interior of the production tubing 19, because of the fact that the supply and return tubings 17 and 18 are located without the production tubing, paraffin control is simplified and damage to the system by the action of any corrosive substances which may be present in the production fluid is minimized, such corrosion damage being restricted to the production tubing.

Turning now to the embodiment of the invention which is illustrated in Figs. 5 to 8 of the drawings and referring particularly to Fig. 5 thereof, the numeral 115 designates a well casing which is set in an oil well and which is open at its lower end to an oil producing zone of the well as is well known in the art, the casing being provided with a casing head 116 at its upper end. Set in the well within the casing 115 and connected to the casing head 116 is a closed tubing system which comprises supply, return and production tubings respectively designated by the numerals 117, 118 and 119. The supply tubing 117 is disposed concentrically within and spaced from the production tubing 119 and the return tubing 118 is set beside the production tubing. The tubings 117, 118 and 119 are interconnected at their lower ends in fluid communication with each other and with the well by a tubular pump receiver 120 which is aligned with and which, in effect, forms a downward extension of the supply tubing 117. The pump receiver 120 provides an operating position for a fluid-operated, free pump 121 which is movable downwardly through the supply tubing 117 into its operating position in the pump receiver, the internal diameter of the pump receiver being substantially equal to that of the supply tubing. As in the previously discussed embodiment, the supply tubing 117 is adapted to convey operating fluid under pressure downwardly in the well to the pump 121 to actuate the pump, and the return tubing 118 is adapted to convey spent operating fluid discharged by the pump upwardly in the well. The pump 121 is adapted to receive well fluid from the well and to discharge it into the production tubing 119 as production fluid, the production tubing then conveying the production fluid upwardly to the surface.

As in the previously described embodiment, the lower ends of the tubings 117 to 119 and the pump receiver 120 may be enclosed by a gas anchor 122 having a perforated barrel 123 which is closed at its upper and lower ends by heads 124 and 125, respectively, the upper head having suitable openings therethrough for the tubings. The gas anchor 122 is secured to the pump receiver 120 by a bolt 126.

The supply, return and production tubings 117, 118 and 119 are connected at their upper ends to a pump head 129 which is similar to the pump head 29, the pump head 129 having valve means (not shown) therein which is operable by a handle 130 to direct flows of fluid through the tubings in the proper manner. Supply, return and production lines 131, 132 and 133 are also connected to the pump head 129 and are adapted to be connected in fluid communication with the supply, return and production tubings 117, 118 and 119, respectively, by the valve means in the pump head during operation of the pump 121. As in the preceding embodiment, the supply line 131 leads to a suitable source of operating fluid under pressure, the return line 132 leads to a reservoir for the source and the production line 133 leads to a suitable point of disposal for the production fluid.

Referring now to Figs. 7 and 8 of the drawings, the pump receiver 120 is aligned with the lower end of the supply tubing 117 and is connected to the lower ends of the supply and production tubings 117 and 119, the pump receiver having at its upper end a sleeve 140 which is threaded onto the lower end of the supply tubing. The lower end of the sleeve 140 is tapered and is seated on a tapered seat 140a in the upper end of a major bore 141 in an upper fitting 142 which forms part of the pump receiver 120, the lower end of the production tubing being threaded onto a cylindrical projection 143 on the upper fitting. Threaded into the lower end of the major bore 141 is a sleeve 144, the lower end of this sleeve being threaded into the upper end of a major bore 145 in a lower fitting 146 which also forms part of the pump receiver. Encircling and spaced from the sleeve 144 is another sleeve 147 which is telescoped over a cylindrical projection 148 at the lower end of the upper fitting 142 and over a cylindrical projection 149 at the upper end of the lower fitting 146, the sleeve 147 carrying sealing rings 150 which engage the

projections 148 and 149 in a fluid-tight manner. This construction permits sliding movement of the outer sleeve 147 relative to the upper and lower fittings 142 and 146 as the inner sleeve 144 is threaded into such fittings during assembly. Threaded into the lower end of the major bore 145 in the lower fitting 146 is an inlet sleeve 151 which communicates at its lower end with the well through the perforated gas anchor barrel 123.

The upper fitting 142 of the pump receiver 120 is provided with a minor bore 154 which is spaced laterally from the major bore 141 therein, the lower end of the return tubing 118 being threaded into the upper end of this minor bore. The minor bore 154 communicates with the interior of the tubular pump receiver 120 through a lateral passage 155 in the upper fitting 142. The upper fitting 142 is also provided with one or more longitudinal passages 156 therethrough which communicate at their upper ends with the interior of the production tubing 119, i. e., which communicate at their upper ends with the annular space between supply and production tubings, and which communicate at their lower ends with an annular space 157 between the sleeves 144 and 147, this annular space being sealed at its ends by the aforementioned sealing rings 150. Production fluid discharged by the pump 121 enters the annular space 157 in a manner to be discussed hereinafter and flows upwardly through the longitudinal passages 156 into the production tubing 119. It will be apparent that, with the foregoing construction, the pump receiver 120 interconnects the supply, return and production tubings 117, 118 and 119 in fluid communication with each other and with the well.

The embodiment under consideration is provided with a passage means 158 for applying a downward flow of fluid through the return tubing 118 to the lower end of the pump 121 to unseat the pump and move it upwardly out of the pump receiver 120 when removal of the pump is desired for any reason, the passage means 158 including a tube 159 which is threaded at its upper end into the lower end of the bore 160 communicating with the minor bore 154 in the upper fitting 142. The lower end of the tube 159 is threaded into the upper end of a bore 161 adjacent the major bore 145 in the lower fitting 146, the bore 161 communicating with an annular chamber 162 within the pump receiver 120 at the lower end of the pump 121 through lateral passages 163, an annular groove 164 and a lateral passage 165. In practice, instead of forming the bore 161 directly in the fitting 146, I prefer to form this bore, the lateral passages 163 and the groove 164 in an insert 166 which is disposed in a bore 167 formed in the lower fitting proper, the tube 159 being threadedly connected to this insert and the insert carrying sealing rings 168 above and below the annular groove 164. This construction facilitates assembly of the upper and lower fittings 142 and 146, the inner and outer sleeves 144 and 147 and the tube 159 since the insert 166 may slide in the bore 167 as the inner sleeve 144 is threaded into the upper and lower fittings.

Disposed in the lower end of the major bore 145 in the lower fitting 146 and extending downwardly into the inlet sleeve 151 is an inlet fitting 172 for the pump 121, the latter having an inlet which is adapted to receive well fluid from the well through the inlet fitting when the pump is in its operating position. As is well known in the art, the inlet fitting 172 is provided with a check valve (not shown) therein which permits upward flow of well fluid, but which prevents downward flow of fluid out of the pump receiver 120 into the well. The inlet fitting 172 is seated on an annular insert 173 which is disposed in the major bore 145 in the lower fitting 146 and which is seated on a shoulder 174 therein.

As in the previously described embodiment, the inlet fitting 172 also serves as a seat for the pump 121, the latter being in its operating position when it is disposed in the pump receiver 120 and seated on the pump seat provided by the inlet fitting. The pump 121 is adapted to seat on the inlet fitting 172 automatically when it is moved downwardly through the supply tubing 117 into the pump receiver 120 so that it automatically assumes its operating position.

The pump 121 is substantially identical to the pump 21 and includes a motor section which is actuable by operating fluid under pressure delivered thereto through the supply tubing 117, the operating fluid under pressure being adapted to enter the motor section of the pump through an intake 178 which comprises ports formed in a fitting 179 carried by a tubular rod 180 which extends upwardly from the motor section of the pump. The rod 180 is adapted to deliver the operating fluid under pressure entering the intake 178 to the motor section of the pump 121. After the operating fluid admitted to the motor section of the pump 121 in this manner has actuated the pump, it is discharged from the motor section through ports forming an exhaust 181 of the pump. The exhaust 181 communicates with an annular space 182 between the pump and the upper fitting 142 of the pump receiver 120 when the pump is in its operating position, the annular space 182 communicating with the return tubing 118 through the lateral passage 155 and the minor bore 154 in the upper fitting. Thus, the operating fluid under pressure in the supply tubing 117 flows through the motor section in the pump 121 to actuate the pump and is discharged into the return tubing 118 as spent operating fluid.

The embodiment under consideration includes sealing means for preventing direct flow between the supply, return and production tubings 117, 118 and 119 when the pump 121 is in its operating position, such sealing means comprising annular sealing elements 186 and 187 which are carried by the pump respectively above and below the exhaust 181 and which are adapted to engage the upper fitting 142 respectively above and below the lateral passage 155 when the pump is in its operating position. This arrangement places the annular sealing element 186 between the intake 178 and the exhaust 181. Thus, the annular sealing elements 186 and 187 isolate the intake 178 and the exhaust 181 when the pump 121 is in its operating position so that the intake may communicate only with the supply tubing 117 and so that the exhaust may communicate only with the return tubing 118.

As previously mentioned, the pump section of the pump 121 is provided with an inlet at its lower end through which well fluid is adapted to enter the pump section by way of the inlet fitting 172, the pump section inlet not being shown specifically. The pump section is also provided with ports forming an outlet 188 for production fluid discharged by the pump section, the outlet communicating with an annular space 189 between the pump and the inner sleeve 114. The

annular space 189 communicates with the annular space 157 between the inner and outer sleeves 144 and 147 through ports 190 so that production fluid discharged by the pump section of the pump 121 through the outlet 188 enters the production tubing 119 by way of the annular space 189, the ports 190, the annular space 157 and the longitudinal passage or passages 156.

In order to prevent the production fluid discharged through the outlet 188 into the annular space 189 from mixing with the spent operating fluid in the annular chamber 162 at the lower end of the pump 121, the pump carries an annular sealing element 194 which is disposed below the outlet and which engages a liner 195 in the major bore 145 in the lower fitting 146 when the pump is in its operating position. Thus, the annular sealing element 194 serves to isolate the outlet 188 from the return tubing so that it communicates only with the production tubing when the pump is in its operating position. Also, since the pump is seated on the inlet fitting 172 when it is in its operating position, the pump seat provided by the inlet fitting serves to prevent direct flow between the well and the return tubing 118.

Considering the operation of the embodiment disclosed in Figs. 5 to 8 of the drawings, it will be assumed that the pump 121 is in operation to pump fluid from the well upwardly through the production tubing 119 to the surface. Under such conditions, the pump is in its operating position in the pump receiver 120 wherein it is seated on the inlet fitting 172, and the aforementioned valve means in the pump head 129 respectively connects the supply, return and production tubings 117, 118 and 119 to the supply, return and production lines 131, 132 and 133. Thus, operating fluid under pressure is carried downwardly to the pump 121 through the supply tubing 117 and enters the motor section of the pump through the intake 178 to actuate the pump, the spent operating fluid being discharged into the return tubing 118 through the exhaust 181 and being conveyed upwardly in the well to the surface by the return tubing. The well fluid entering the pump section of the pump 121 through its inlet is discharged into the production tubing 119 through the outlet 188 and is conveyed upwardly in the well separately from the spent operating fluid.

Whenever removal of the pump 121 is desired, the operator sets the handle 130 controlling the valve means in the pump head 129 in a position such that the valve means connects the supply line 131 to the return tubing 118 so that operating fluid under pressure flows downwardly in the well through the return tubing. Preferably, the valve means also connects the supply tubing 117 to the return line 132 so that operating fluid above the pump 121 may be returned to the reservoir. In order to prevent flow of operating fluid into the production tubing 119, flow through the production tubing and the production line 133 is preferably prevented, as by closing a valve 196 in the production line, or by means of the valve means in the pump 129.

Under the conditions outlined in the preceding paragraph, operating fluid under pressure flows downwardly through the return tubing 118 and into the annular chamber 162 at the lower end of the pump 121 by way of the passage means 158 and acts on an annular area 197 at the lower end of the pump so as to unseat the pump from the inlet fitting 172 and then acts on the entire area of the pump so as to move it upwardly in the pump receiver 120, the various annular sealing elements carried by the pump preventing upward flow of the operating fluid past the pump. After the pump 121 has moved upwardly in the pump receiver 120 a distance such that annular sealing elements 186 and 187 disengage the wall of the major bore 141 and such that the annular sealing element 194 disengages the liner 195, upward flow of operating fluid past the pump is prevented by packing devices 198 and 199 carried by the rod 180. The packing devices 198 and 199 are adapted to engage the inner wall of the supply tubing 117 in a substantially fluid-tight manner, the portions of the pump which carry the annular sealing elements 186, 187 and 194 preferably being of smaller diameter than the internal diameter of the supply tubing so as to prevent damage to the sealing elements during movement of the pump through the supply tubing.

It will be noted that after the pump 121 clears the lateral passage 155 in the upper fitting 142, the downward flow of operating fluid through the return tubing 118 may enter the interior of the pump receiver 120 through such lateral passage. Continuing downward flow of operating fluid under pressure through the return tubing 118 ultimately results in upward movement of the pump 121 through the supply tubing 117 to the surface so that it may be removed from the supply tubing through the pump head 129, the operating fluid in the supply tubing above the pump being displaced into the return line 132 under the conditions specified. During the foregoing pump-removal operation, flow of the operating fluid employed to remove the pump downwardly into the well is prevented by the check valve in the inlet fitting 172.

When reinstallation of the pump 121 is desired, the pump may be inserted into the upper end of the supply tubing 117 through the pump head 129. The operator then sets the handle 130 controlling the valve means in the pump head in a position such that the supply tubing is placed in fluid communication with the supply line 131 and the return tubing 118 is placed in fluid communication with the return line 132. Preferably, the production tubing 119 remains closed, as by means of the valve 196 in the production line 133, or by means of the valve means in the pump head 129. Under such conditions, the operating fluid under the pressure entering the system through the supply line 131 acts on the upper end of the pump 121 to move it downwardly through the supply tubing 117 and into its operating position in the pump receiver 120 wherein it is seated on the inlet fitting 172. The operating fluid previously introduced below the pump during the pump-removal operation may be displaced upwardly through the return tubing 118 so as to be returned to the reservoir for re-use. However, it will be understood that if operating fluid in the supply tubing has become contaminated prior to reinstallation of the pump 121 for any reason, returning such contaminated operating fluid to the reservoir may be avoided by preventing fluid flow through the return tubing 118 and by permitting fluid flow through the production tubing 119.

As will be apparent, one advantage of the embodiment now under consideration is that it is possible to remove and reinstall the pump 121 with substantially no loss of operating fluid from the system, the production tubing 119 being iso-

lated from that portion of the system reserved for the operating fluid during both the pump-removal operation and the operation of reinstalling the pump, as long as the valve 194 in the production line 133 remains closed.

While the embodiment under consideration has one disadvantage in that it permits the production fluid to come in contact with both the supply and production tubings, it has an important advantage in that it permits the use of a production tubing of relatively large diameter so as to minimize frictional losses between the production stream and the production tubing, which is important in wells permitting the use of a pump having a pump section of large capacity and a motor section of small capacity.

Although I have disclosed exemplary embodiments of my invention herein for purposes of illustration, it will be understood that I do not intend to be limited specifically thereto since various changes, modifications, and substitutions may be incorporated in such embodiments without departing from the spirit of the invention.

I claim as my invention:

1. In a closed, fluid-operated, free-pump system for a well, the combination of: supply, return and production tubings set in the well and respectively adapted to convey operating fluid downwardly into the well from the surface, spent operating fluid upwardly in the well to the surface and fluid produced by the well upwardly therein to the surface, one of said tubings being disposed within another of said tubings which encloses said one tubing; means for interconnecting the lower ends of said tubings in fluid communication with each other and with the well; and a fluid-operated free pump movable in one of said tubings other than said enclosing tubing into an operating position at the lower end thereof, said pump having an intake, an exhaust, an inlet and an outlet which communicate with said supply tubing, said return tubing, the well and said production tubing, respectively, when said pump is in said operating position.

2. In a closed, fluid-operated, free-pump system for a well, the combination of: three tubings set in the well and respectively adapted to convey operating fluid downwardly into the well from the surface, spent operating fluid upwardly in the well to the surface and fluid produced by the well upwardly therein to the surface, at least one of said tubings being disposed within another of said tubings which encloses said one tubing; means for interconnecting the lower ends of said tubings in fluid communication with each other and with the well; a pump seat at the lower end of and aligned with one of said tubings other than said enclosing tubing; and a fluid-operated, free pump movable in the tubing having said pump seat at its lower end into an operating position wherein said pump is seated on said pump seat, said pump having an intake, an exhaust and an outlet which communicate with said tubings, respectively when said pump is in said operating position, and having an inlet which communicates with the well when said pump is in said operating position.

3. In a closed, fluid-operated, free pump system for a well, the combination of: supply, return and production tubings set in the well and respectively adapted to convey operating fluid downwardly into the well from the surface, spent operating fluid upwardly in the well to the surface and fluid produced by the well upwardly therein to the surface, one of said tubings being disposed within another of said tubings which encloses said one tubing; a tubular pump receiver at the lower end of and aligned with one of said tubings other than said enclosing tubing, said pump receiver being connected to the lower ends of said tubings in fluid communication therewith and being in fluid communication with the well; and a fluid-operated, free pump movable in said tubing having said pump receiver aligned therewith and movable into an operating position in said pump receiver, said pump having an intake, an exhaust, an inlet and an outlet which communicate with said supply tubing, said return tubing, the well and said production tubing, respectively, when said pump is in said operating position in said receiver.

4. A closed system as set forth in claim 3 including sealing devices for normally preventing direct flow of fluid between said tubings and the well when said pump is in said operating position.

5. In a closed, fluid-operated, free-pump system for a well, the combination of: supply, return and production tubings set in the well and respectively adapted to convey operating fluid downwardly into the well from the surface, spent operating fluid upwardly in the well to the surface and fluid produced by the well upwardly therein to the surface, one of said tubings being disposed within another of said tubings which encloses said one tubing; a tubular pump receiver connected to the lower ends of said tubings in alignment with one of said tubings other than said enclosing tubing, said pump receiver communicating at its upper end with and having substantially the said internal diameter as the tubing with which it is aligned, and said pump receiver having passages which provide fluid communication between the others of said tubings and said pump receiver and between the well and said pump receiver; a pump seat carried by said pump receiver at the lower end thereof and in alignment therewith; a fluid-operated, free pump movable in the tubing with which said pump receiver is aligned and movable into an operating position in said pump receiver wherein it is seated on said pump seat, said pump having an intake, an exhaust, an inlet and an outlet which communicate with said supply tubing, said return tubing, the well and said production tubing, respectively, when said pump is in said operating position; and sealing devices for normally preventing direct flow of fluid between said tubings and the well by way of said pump receiver when said pump is in said operating position.

6. In a closed, fluid-operated, free-pump system for a well, the combination of: supply, return and production tubings set in the well and respectively adapted to convey operating fluid downwardly into the well from the surface, spent operating fluid upwardly in the well to the surface and fluid produced by the well upwardly therein to the surface, one of said tubings being disposed within another of said tubings which encloses said one tubing; a tubular pump receiver connected to the lower ends of said tubings in alignment with one of said tubings other than said enclosing tubing, said pump receiver communicating at its upper end with and having substantially the same internal diameter as the tubing with which it is aligned, and said pump receiver having passages which provide fluid communication between the others of said tubings and said pump receiver and between the well and said pump receiver; a pump seat carried by said

pump receiver at the lower end thereof and in alignment therewith; a fluid-operated, free pump movable in the tubing with which said pump receiver is aligned and movable into an operating position in said pump receiver wherein it is seated on said pump seat, said pump having an intake, an exhaust, an inlet and an outlet which communicate with said supply tubing, said return tubing, the well and said production tubing, respectively, when said pump is in said operating position; sealing devices for normally preventing direct flow of fluid between said tubings and the well by way of said pump receiver when said pump is in said operating position; a chamber in said pump receiver between said pump seat and said pump; and passage means providing fluid communication between said chamber and one of the tubings which are not aligned with said pump receiver so as to deliver fluid flowing downwardly through said one nonaligned tubing to said chamber to move said pump upwardly out of said pump receiver and through the tubing in registry with said pump receiver to the surface.

7. In a closed, fluid-operated, free-pump system for a well, the combination of: supply, return and production tubings set in the well and respectively adapted to convey operating fluid downwardly into the well from the surface, spent operating fluid upwardly in the well to the surface and fluid produced by the well upwardly therein to the surface, one of said tubings being disposed within another of said tubings which encloses said one tubing; a tubular pump receiver connected to the lower ends of said tubings in alignment with one of said tubings other than said enclosing tubing, said pump receiver communicating at its upper end with and having substantially the same internal diameter as the tubing with which it is aligned, and said pump receiver having passages which provide fluid communication between the others of said tubings and said pump receiver and between the well and said pump receiver; a pump seat carried by said pump receiver at the lower end thereof and in alignment therewith; a fluid-operated, free pump movable in the tubing with which said pump receiver is aligned and movable into an operating position in said pump receiver wherein it is seated on said pump seat, said pump having an intake, an exhaust, an inlet and an outlet which communicate with said supply tubing, said return tubing, the well and said production tubing, respectively, when said pump is in said operating position; sealing devices for normally preventing direct flow of fluid between said tubings and the well by way of said pump receiver when said pump is in said operating position; a chamber in said pump receiver between said pump seat and said pump; passage means providing fluid communication between said chamber and one of the tubings which are not aligned with said pump receiver so as to deliver fluid flowing downwardly through said one nonaligned tubing to said chamber to move said pump upwardly out of said pump receiver and through the tubing in registry with said pump receiver to the surface; and another sealing device for normally preventing flow of fluid between said passage means and said production tubing.

8. A closed system as set forth in claim 7 wherein said other sealing device comprises an annular sealing element adapted to be positioned between said pump and said pump receiver.

9. In a closed, fluid-operated, free-pump system for a well, the combination of: supply, return and production tubings set in the well and respectively adapted to convey operating fluid downwardly into the well from the surface, spent operating fluid upwardly in the well to the surface and fluid produced by the well upwardly therein to the surface, one of said tubings being disposed within another of said tubings; means for interconnecting the lower ends of said tubings in fluid communication with each other and with the well; a fluid-operated, free pump movable in said one tubing into an operating position at the lower end thereof, said pump having an intake, an exhaust, an inlet and an outlet which communicate with said supply tubing, said return tubing, the well and said production tubing, respectively, when said pump is in said operating position; means for normally preventing direct flow of fluid between said tubings and the well by way of said interconnecting means when said pump is in said operating position; and passage means communicating with said one tubing and with one of the others of said tubings for applying a downward flow of fluid through said one other tubing to the lower end of said pump to move said pump upwardly from its operating position through said one tubing to the surface.

10. A closed system as set forth in claim 9 wherein said one tubing is said supply tubing.

11. A closed system as set forth in claim 9 wherein said one other tubing with which said passage means communicates is said return tubing.

12. A closed system as set forth in claim 9 wherein said supply and return tubings are without said production tubing.

13. A closed system as set forth in claim 9 wherein said one tubing is of larger diameter than one of the others of said tubings.

14. A closed system according to claim 9 wherein said production tubing is of larger diameter than at least one of the others of said tubings.

15. A closed system as defined in claim 9 wherein said production tubing is of larger diameter than either of the other two tubings.

16. A closed system according to claim 9 wherein the tubing within which said one tubing is disposed is located beside the other of said tubings.

17. In a closed, fluid-operated, free-pump system for a well, the combination of: supply, return and production tubings set in the well and respectively adapted to convey operating fluid downwardly into the well from the surface, spent operating fluid upwardly in the well to the surface and fluid produced by the well upwardly therein to the surface, said supply tubing being disposed within one of the others of said tubings; a tubular pump receiver at the lower end of and registering with said supply tubing, said pump receiver being connected to the lower ends of said tubings and being in fluid communication with said tubings and with the well; a pump seat carried by said pump receiver and disposed at the lower end thereof in registry therewith; a fluid-operated, free pump movable in said supply tubing and movable into an operating position in said pump receiver wherein it is seated on said pump seat, said pump having an intake, an exhaust, an inlet and an outlet which communicate with said supply tubing, said return tubing, the well and said production tubing, respectively, when said pump is in said operating position; means for normally preventing direct flow of fluid between said tubings and the well through said pump receiver when said pump is in said

operating position; and passage means communicating with one of said other tubings and with said pump receiver above said pump seat for applying a downward flow of fluid in said one other tubing to the lower end of said pump to move it upwardly out of said pump receiver and through said supply tubing to the surface.

18. A closed system as set forth in claim 17 wherein said passage means communicates with said return tubing and wherein said means for normally preventing direct flow comprises a sealing device for preventing fluid communication between said return tubing and said production tubing when said pump is in said operating position.

19. A closed system as set forth in claim 18 wherein said sealing device comprises an annular sealing element adapted to be positioned between said pump and said receiver.

20. A closed system as set forth in claim 17 wherein said supply tubing is disposed within said return tubing.

21. A closed system as set forth in claim 17 wherein said supply tubing is disposed within said production tubing.

22. A closed system as set forth in claim 17 wherein said supply tubing is of larger diameter than one of the others of said tubings.

23. A closed system as set forth in claim 17 wherein said production tubing is of larger diameter than one of the others of said tubings.

24. A closed system as set forth in claim 17 wherein said production tubing is of larger diameter than either of the others of said tubings.

25. In a closed, fluid-operated, free-pump system for a well, the combination of: supply, return and production tubings set in the well and respectively adapted to convey operating fluid downwardly into the well from the surface, spent operating fluid upwardly in the well to the surface and fluid produced by the well upwardly therein to the surface, said supply tubing being disposed within one of the others of said tubings; a tubular pump receiver at the lower end of and aligned with said supply tubing, said pump receiver being connected to the lower ends of said tubings in fluid communication therewith and being in fluid communication with the well; a fluid-operated, free pump movable in said supply tubing into an operating position in said pump receiver, said pump having an intake, an exhaust below said intake, an outlet below said exhaust and an inlet below said outlet, said intake, said exhaust, said inlet and said outlet respectively communicating with said supply tubing, said return tubing, the well and said production tubing when said pump is in said operating position; an annular sealing element carried by said pump intermediate said intake and said exhaust and engageable with said pump receiver when said pump is in said operating position; another annular sealing element carried by said pump intermediate said exhaust and said outlet and engageable with said pump receiver when said pump is in said operating position; and sealing means providing a fluid-tight seal between said inlet and said outlet when said pump is in said operating position.

26. A closed system according to claim 25 including a passage communicating at one end with said return tubing and at its other end with said pump receiver at a point which is intermediate said other annular sealing element and said sealing means when said pump is in said operating position, said system including a sealing device

for normally preventing flow from said return tubing through said passage to said production tubing when said pump is in said operating position.

27. A closed system as set forth in claim 26 wherein said sealing device comprises an annular sealing element carried by said pump and engageable with said pump receiver.

28. In a closed, fluid-operated, free-pump system for a well, the combination of: supply, return and production tubings set in the well and respectively adapted to convey operating fluid downwardly into the well from the surface, spent operating fluid upwardly in the well to the surface and fluid produced by the well upwardly therein to the surface, said supply tubing being disposed within one of the other tubings and the second of the other tubings being disposed without and beside said one other tubing; means for interconnecting the lower ends of said tubings in fluid communication with each other and with the well; and a fluid-operated, free pump movable in said supply tubing into an operating position at the lower end thereof, said pump having an intake, an exhaust, an inlet and an outlet which communicate with said supply tubing, said return tubing, the well and said production tubing, respectively, when said pump is in said operating position.

29. A closed system as set forth in claim 28 wherein said one other tubing and said second other tubing are said return tubing and said production tubing, respectively.

30. A closed system as set forth in claim 28 wherein said one other tubing and said second other tubing are said production tubing and said return tubing, respectively.

31. In a closed, fluid-operated, free-pump system, the combination of: a primary tubing and a pair of secondary tubings set in the well with one of said secondary tubings enclosing at least one of the other two tubings, said primary tubing being of a size to receive a fluid-operated, free pump and providing for movement of the pump between an operating position at the lower end of said primary tubing and the surface; means interconnecting the lower ends of said tubings, said interconnecting means having passage means providing fluid communication between one of said secondary tubings and said primary tubing and having passage means providing fluid communication between the other of said secondary tubings and said primary tubing; and inlet means connected to said primary tubing and having a passage providing fluid communication between the well and said primary tubing, said inlet means having means for preventing flow of fluid from said primary tubing into the well through said passage.

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