Feb. 8, 1927. 1,616,774

J. A. WARREN

PUMPING MECHANISM AND SYSTEM

Filed Sept. 20, 1924 2 Sheets-Sheet 1

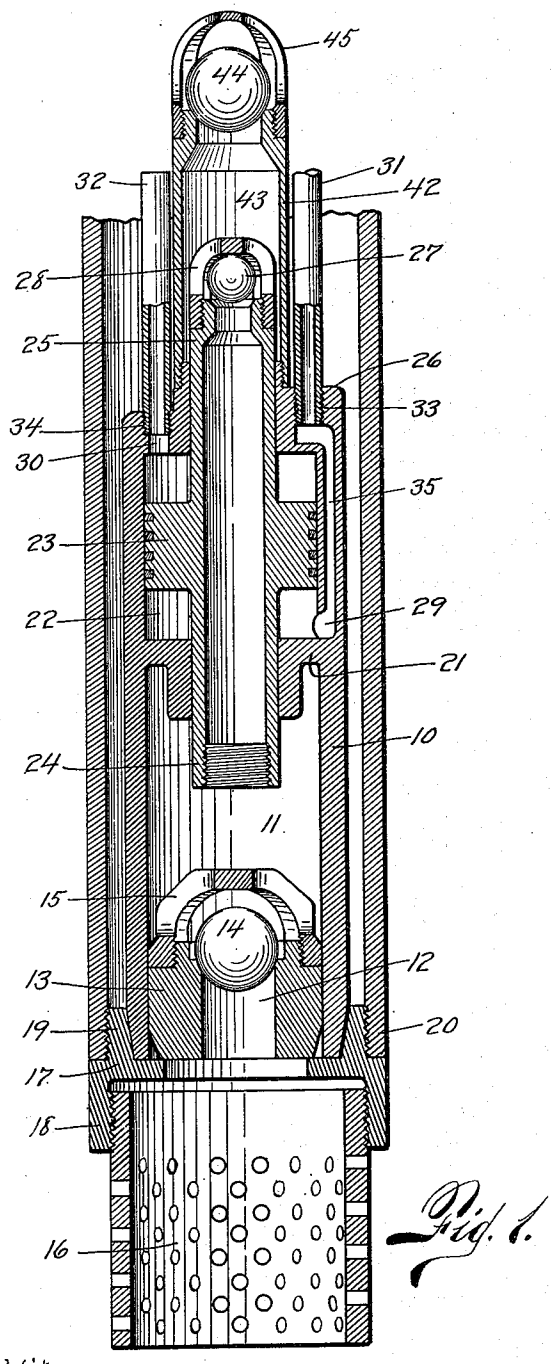


Fig. 1.

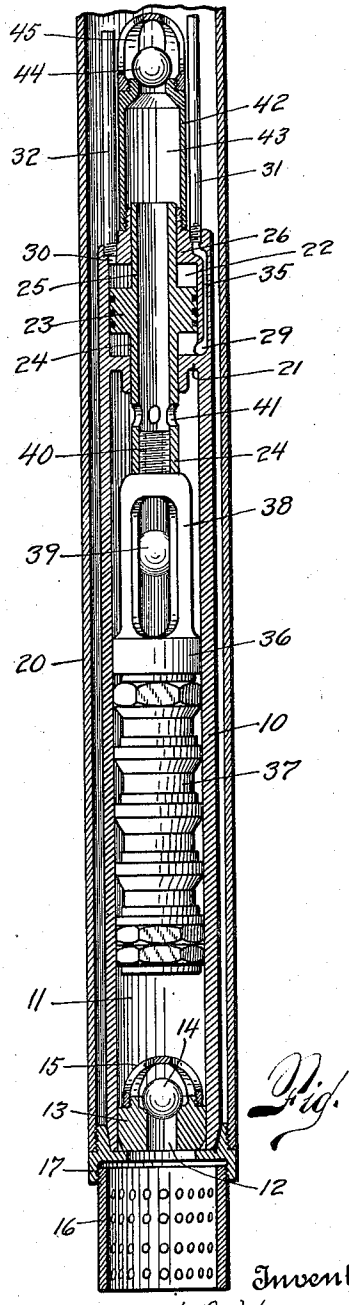


Fig. 2.

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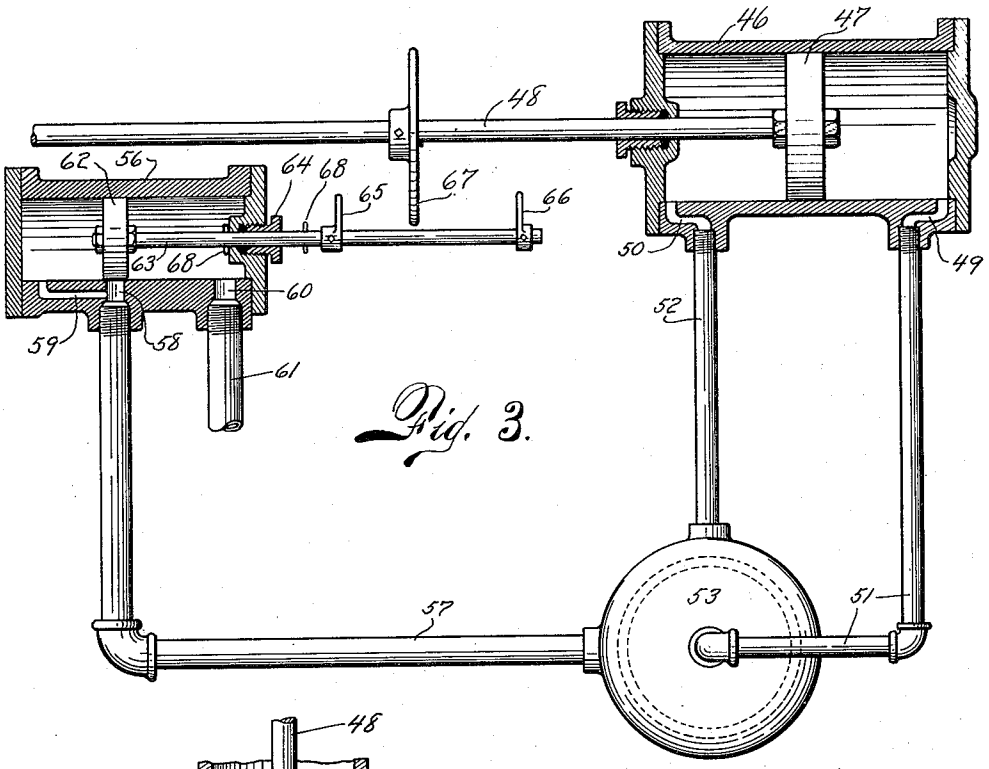


Fig. 3.

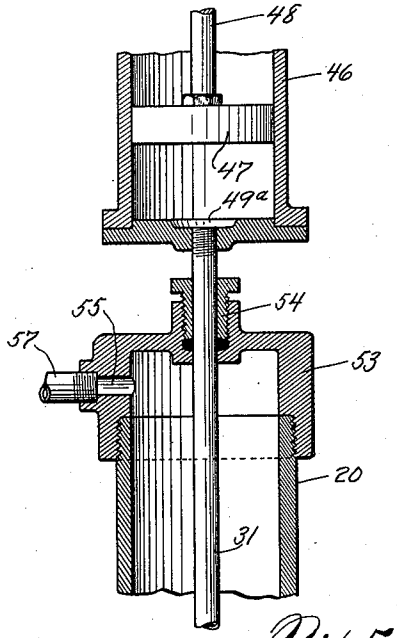


Fig. 5.

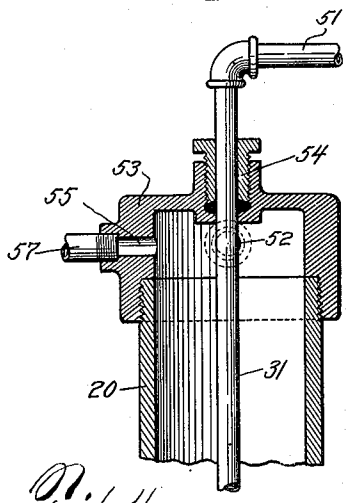


Fig. 4.

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Patented Feb. 8, 1927. 1,616,774

UNITED STATES PATENT OFFICE.

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PUMPING MECHANISM AND SYSTEM.

Application filed September 20, 1924. Serial No. 738,861.

This invention embodies improvements in pumping mechanism and systems.

The invention has been devised primarily for use in the pumping of oil wells, but it will be evident that the particular improvements may likewise be employed with other deep wells or shafts containing fluids or liquids, or for that matter in association with fluid or liquid bodies or volumes generally, where the working barrel of the pump is to be substantially immersed or submerged therein. For the purposes of simplicity of illustration and description, however, the improvements may be more conveniently disclosed with reference to oil wells or analogous liquid containing shafts, but in doing so it is to be distinctly understood and emphasized, at the outset, that the essential characteristics of the improvements might well be employed in various other pumping relations.

In attaining the usual desired ends of simplicity, durability, efficiency and economy generally, it has heretofore been proposed to employ a specially devised type of pump and operating pressure fluid line system therefor, whereby pumping pulsations are caused to be semi-automatically effected, as it were, under an operating pressure fluid supply that is wholly auxiliary to or distinctively independent of the body of the liquid to be pumped, which operating pressure fluid is alternately delivered to the opposite pressure faces of a piston that forms a part of a hollow liquid displacing plunger element, having valvular means to control the passage therethrough of the liquid to be pumped. In this arrangement, however, when viewed broadly from one aspect or more specifically from another, it is necessary to run a double pipe line from the pump to the operating pressure fluid supply source, which may be a cylinder that is in communication at its opposite ends with a complementary pipe, respectively, of said double pipe line, the cylinder containing a piston that is actuated to alternately force the pressure fluid in opposite directions.

Such an arrangement has been disclosed in an earlier application of mine, filed Dec. 26, 1923, under Serial No. 682,721, and is also generally disclosed herein, in many respects, but as altered by the elimination of one of the pipe lines and supplying, as an auxiliary or additional unit, an outlet valve controlled stationary casing that surmounts or encompasses the discharge end of the piston-plunger element in housing relation, whereby it is made possible to dispense with the said one of said pipe lines, to be substituted for by the actual body of the liquid being pumped.

In my application aforesaid, as originally filed, there was also disclosed a modified construction, it is true, for dispensing with one of the pipe lines, although the illustration and description of such modified construction has now been deleted therefrom. In that modified construction, however, the operating pressure fluid always enters the piston-plunger cylinder, alternately at opposite faces of the piston, by way of the same main inlet port, and finally discharges into the liquid being pumped by way of an outlet port, so that there is no alternately reversed flow of the operating pressure, relatively to the said main inlet and outlet ports, because the said outlet port does not alternately function as an inlet, nor does the said main inlet port alternately function as an outlet, for the piston-plunger cylinder. Furthermore, the body of the liquid being pumped does not function at any time as a part of the operating pressure line.

One of the primary objects of my present improvements, therefore, has been to devise means that not only provide for the elimination of one of the aforesaid pipe lines, utilizing the body of the liquid being pumped in substitution therefor, and thus doing away with such additional equipment, but which also provides for the aforesaid alternately reversed flow of the operating pressure, relatively to the inlet and outlet ports of the pump, and thus avoiding the use of inlet and exhaust control valves for the piston-plunger cylinder, which would be required without such alternately reversed flow in such a construction.

The foregoing as well as other objects and advantages of the invention, however, will be so clearly apparent it is believed, as incidental to the following disclosure, that no useful purpose would be served by further enlarging upon the same initially, and having thus generally outlined the nature of the improvements, reference will now be immediately had to the accompanying drawings, illustrating certain practical embodiments of the same in which drawings—

Figure 1 is a longitudinal sectional view through the working barrel and associated elements of one form of the pump, with the

piston-plunger element centrally positioned and moving downwardly; Figure 2 is an analogous view on a smaller scale and additionally showing the attachment of a standard oil well working valve, which may or may not be employed with my improvements as desired; Figure 3 is a diagrammatically arranged view, partly in plan and partly in section, of that portion of one arrangement of the pumping system located exteriorly of the well; Figure 4 is a fragmentary sectional view longitudinally of the top portion of the well tubing as associated with the arrangement of Figure 3; and Figure 5 is a view analogous to Figure 4, but of a modified nature to eliminate some of the features of Figure 3.

Referring first to Figure 1, although excepting as noted the same description also generally applies to Figure 2, the numeral 10 designates the pump barrel which has an inlet chamber 11, for the inflow of the liquid to be pumped, and the inlet opening 12 thereto may be and perhaps preferably should be controlled by a lower check or foot valve element, functioning as a suctional and pressure actuated inlet valve that is operated to its open position by a combined suctional force, on its inner face, and pressure force, on its outer face, and to its closed position by gravitation combined with a pressure force on its inner face. This foot valve, although it may not always be necessary to employ an inlet valve control at all, is specifically shown as of standard construction, embodying an axially bored base-closure valve seat 13 for the pump barrel 10, a ball valve 14 therefor, and a spider-like crown or top cage 15.

The lower end of the pump barrel 10 is preferably associated with the usual strainer 16, which is shown attached to a centrally apertured coupling member 17 that has a cylindrical extension 18, for threaded connection with the strainer, and also a reversely disposed cylindrical extension 19 that may be externally threaded, for connection with a tubular element indicated at 20 as the well tubing, and which preferably is formed with an internal conical seat for a conically formed end of the pump barrel.

The pump barrel 10 is transversely partitioned, as at 21, to provide for a distinctively separate chamber 22, at the end of the pump barrel distant from the foot valve, which said chamber 22 is wholly out of communication with the inlet chamber 11, being in fact a working cylinder for a piston 23 that is carried by and more or less centrally of a hollow or tubular-like plunger liquid-displacing element, the said working or pump piston cylinder 22 being in communication only with an operating pressure fluid line, embodying in part the body of the liquid to be pumped, for the positive actuation of the piston-plunger, as distinguished from its actuation by an auxiliary operating pressure fluid line that is wholly independent of said body of liquid to be pumped.

One end 24 of the hollow plunger is in communication with said inlet chamber 11, while the other end 25 thereof is shown as being in valve-controlled communication with an independently encased space outside of the head of the pump barrel 10, which independently encased space would be located within the well tubing 20, or its equivalent, and will be hereinafter more particularly referred to as being an essential factor in the pump construction by the present improvements. It is understood that the well tubing, as distinguished from the well casing, and which tubing may be withdrawn from time to time for any purposes as desired, is lowered within and extends entirely through the well casing proper, and in most of the instances of very deep wells, where the well bore is through rock, shale or other hard formations, the tubing extends a very great distance below the lower end of the casing, but in any such instances where the well casing itself should extend approximately to the bottom of the well, then the independently encased space before referred to would, of course, be located within the well casing. In this latter event, the conical seating of the pump barrel might be substituted for by threaded connection with the strainer element 16, or the coupling element 17 therefor, without any connection whatsoever with the well casing.

At all events, the hollow plunger element is reciprocatingly disposed through axial bearing apertures of the partitioning wall 21 and the head 26 of the pump barrel, and in the construction shown at Figure 1 the end 25, although it could be the end 24, is provided with a suitable check valve control, indicated by the ball valve 27 and spider-like crown or cage 28 therefor, which particular feature is not essential to and is omitted from the construction shown at Figure 2, as will hereinafter appear.

The wall of the cylinder 22 is provided with a port 29 that is in communication with one end of the cylinder, on one side of the piston 23, and with a port 30 that is in communication with the other end of the cylinder, on the opposite side of the piston, the ports 29 and 30 being in respective communication with operating pressure fluid line pipes 31 and 32, which may be threaded into apertures 33—34 through the head 26 of the pump barrel 10, and with the wall itself of the pump piston cylinder formed, if desired, with an elongated portway 35 extending from the aperture 33 to the port 29.

It may not be amiss to emphasize at this point, however, although the feature will

be hereinafter more fully referred to, that the pipe 32 of itself, unlike the pipe 31, does not extend to the source of the operating pressure fluid supply, but may terminate at any desired position, being open-ended of course, and in fact it might appear that it could be dispensed with entirely, as it is merely a continuation of the port 30. On the other hand, by employing this upstanding pipe 32, it would doubtless assist in preventing any foreign matter, settling around the pump barrel, from entering the cylinder 22 through the port 30.

The immediately foregoing feature of employing substantially only a single pipe line extending from the surface to the pump at the bottom of the well, while still providing for an alternately reversed flow of the operating pressure fluid by utilizing the body of the liquid to be pumped as the other portion of the operating pressure line, is as has before been stated the primary feature of the present improvements, or in other words the ports 29 and 30 alternately function as inlet and exhaust ports with reference to the cylinder 22 of the pump.

In the accomplishment of this, however, certain additions are requisite both as associated with the pump itself, located towards the bottom of the well, and as associated with the source of operating pressure supply, located exteriorly of the well.

As to the pump addition, although a very important factor of the present improvements, this simply comprises what I term a head or o'ertopping valve arrangement, for the piston actuated plunger element, embodying an elongated casing 42 that is suitably attached fixedly to and is closed at its lower end by the head 26 of the pump barrel 10, which casing provides for the independently encased space, hereinbefore referred to, or a chamber 43 in which the upper end 25 of the plunger reciprocates in housed relation, and the upper open end of the elongated casing 42 is provided with a valve seat for a ball check valve 44 that is surmounted by a spider-like crown or cage 45, or their equivalents. The other addition, as associated with the source of operating pressure supply, will be later described with more particular reference to Figures 3, 4 and 5.

The showing at Figure 2 is substantially identical with that described with reference to Figure 1, excepting for the fact that the ends of the hollow plunger are of slightly different structure, and the inlet chamber 11 is made much longer to provide for the attachment of the additional element 36. This attachment 36 is a standard oil well working valve, as will be fully understood without going into details, but which may be briefly described as embodying the plural cup section 37 having an elongated spider-like crown or cage element 38, housing a ball check valve 39 and terminating in a hollow open-ended nipple 40, for threaded attachment to the end 24 of the tubular plunger. When this valve attachment 36 is employed with my improvements, and it may be so employed or not as desired, the end part 24 of the tubular plunger may preferably be provided with a plurality of apertures 41 to permit of the passage therethrough, into the hollow plunger, of the liquid being pumped, additionally of its passage thereinto through the hollow nipple 40. Where this attachment 36 is employed, there is apparently no necessity of the plunger check valve 27 and its cage 28, the functioning thereof being fully supplied for by the check valve elements 38—39 of the attachment, so that the elements 27—28 have been omitted from Figure 2. These elements 27—28 could be employed, however, as in Figure 1, but in that event the inlet chamber 11 of Figure 1 would have to be substantially lengthened, and other minor changes made to provide an arrangement substantially as in Figure 2, with the elements 27—28 included.

The operating pressure line pipe 31 that opens to the lower end of the cylinder 22 through the port 29 (for causing the elevation of the piston-plunger on its pumping stroke) is in uninterrupted or direct communication with one end of a pressure establishing supply or creating source. As the nonpumping stroke, however, does not require the application of as great an amount of pressure as is required to elevate said piston-plunger in forcing a column of liquid upwardly, the other portion of said operating pressure line which opens to the upper end of the cylinder 22 through the port 30 (for assisting a certain later referred to suctional force and gravitation in actuating the piston-plunger downwardly) may preferably be in separated or interrupted and indirect communication with the other end of said operating pressure source, as is disclosed in Figures 3 and 4, the column of oil upstanding in the well tubing forming a liquid portion of said latter pressure line immediately above the open-ended pipe 32, or the port 30 if the pipe 32 be not actually employed, and there being a pipe connection leading from said pressure source to the upper end of the capped well tubing, or, which would be the equivalent, to the upper end of a capped well casing, if the casing be extended above the upper end of the tubing.

In the foregoing, however, I have advisedly employed the expression "may preferably be", for in actual practice it may be satisfactorily demonstrated that the weight of the column of liquid over the port 30, either with or without externally supplied pressure thereon from a source other than the afore-

said pressure establishing supply, will of itself be found to be sufficient to cause the proper downward actuation or non-pumping return stroke of the piston-plunger, without any additional pressure as actually supplied from said operating pressure source, because there is added to the columnar weight of the liquid not only the normal tendency of the piston-plunger to descend, by gravity, but also a suctional force, as aforementioned, established or impressed upon the underneath face of the piston, on its downstroke, as will later more fully appear. It may not therefore be absolutely necessary, even through preferable as at present advised, to have the upper end of the well tubing in actual communication at all with said operating pressure establishing source, it possibly being amply sufficient to simply employ the single pipe line 31 directly communicating between said operating pressure supply and the port 29, as is illustrated by the showing at Figure 5.

However, first describing the arrangement illustrated at Figures 3 and 4, although any suitable equivalent means might be employed, the aforementioned connections are disclosed as embodying the coupling pipes 51 and 52 leading respectively from the pipe 31 and the capping head 53, for the upper end of well tubing 20, and respectively opening to the opposite ends of an operating pressure creating or pumping cylinder 46, having a piston 47 therein that is reciprocated by a connecting or power rod 48, actuated by any suitable power, whereby the operating pressure which would be liquid, at least on the upper face of the piston 23, is caused to flow alternately in reverse directions through the respective lines embodying the ports 29 and 30 of the cylinder 22, and the ports 49 and 50 of the pressure pumping cylinder 46.

The head 53 is shown as capping the well tubing, as the most practical arrangement, but it will be obvious that if the well casing, not shown, should extend up beyond its contained tubing, then the casing would be capped by the head 53.

At any event the capping head 53, having a bushing gland 54 for the passage of the pipe 31, is provided with a liquid outlet 55 that communicates with a liquid flow control valve chest 56 by means of the conduit 57, the inlet port 58 and a by-pass 59 extending from said inlet port to one end of the valve chest, the other end of said valve chest or cylinder 56 being provided with a liquid outlet 60 in communication with the flow or discharge line 61 for the liquid being pumped. 62 designates a piston control valve, in the chest or cylinder 56, attached to an actuating valve rod 63, passing through a stuffing box or bushing gland 64 in a head of the chest, the said valve rod being provided, exteriorly of the chest, with a pair of spaced adjustably mounted limiting or engaging lugs or stops 65 and 66, between which there is operated an engaging actuating member 67, shown as a disk although it could be otherwise, that is adjustably carried on the power rod 48, to which the pressure pumping piston 47 is also attached.

Before describing the operation of the system as a whole, with reference to either the main or modified arrangements, I will first briefly describe the modification of Figure 5, which latter simplified structure may perhaps be very satisfactorily employed in some instances, although possibly not with as much positive effectiveness, in substitution for the liquid flow control arrangement of Figure 3, the port 50 and the connecting pipe 52.

In this modified structure, one end of the pressure pumping cylinder 46 is as heretofore still in communication with the pressure line pipe 31 leading directly to the piston-plunger cylinder 22 of the liquid pumping device, but there is no communication at all between the other end of the pumping pressure cylinder and the well tubing 20, the pipe 57 functioning solely as the liquid flow line conduit, without the interposition of the valve chest 56 with its associated parts, and the connecting pipe 52 with the port 50 being omitted, although a relief port equivalent to the port 50 might be employed at that end of the pressure pumping cylinder, broken away in the illustration. In Figure 5, the pressure pumping cylinder 46 is shown in axial alignment with the well tubing 20, the port 49ª being located in the head of the cylinder, but functioning the same as the port 49 of Figure 3, although in this connection it is obvious that the same disposition of the cylinder could be arranged for as in Figure 3. It will also be obvious that a pressure tank or stand pipe might be disposed in the flow line conduit 57, for reasons hereinafter appearing and if desired.

In operation, and referring first to Figures 1, 3 and 4, it being assumed that, as shown, the pressure pumping piston 47 is disposed in centralized position, moving to the left by its actuating power rod 48, with the valve piston 62 closing the port 58, and with the plunger piston 23 in centralized position and moving downwardly under pressure as later referred to, it will then follow that the foot valve 14 is closed, the chamber 11 being filled with the liquid to be pumped, and that the check valve 27 is elevated from its seat by the pressure of the displaced liquid forced up through the hollow plunger 24—25, from the chamber 11 into the chamber 43 encasing the upper end of said hollow plunger.

This non-pumping or return stroke of the piston-plunger is mainly or at least more positively effected by virtue of pressure,

from the cylinder 46 through the port 50 and connecting pipe 52, imposed upon the head or a column of the liquid in the well tubing 20, the flow line 57 being closed by the valve piston 62 covering the port 58, whereby a portion of the body of the liquid upstanding in the well tubing is forced through the port 30 against the upper face of the substantially balanced piston 23.

This positive pressure, however, which obviously may be much lower than that required to actuate said piston-plunger on its pumping stroke, is more or less augmented by the actual columnar weight of the body portion of the liquid disposed over the port 30, being also aided by the force of gravity on the plunger piston when the pressure on the lower face thereof is relieved by the partial suctional force established through the pressure line 29—35—31—51—49, as the pressure pumping piston 47 moves to the left in its cylinder 46.

During the aforesaid non-pumping stroke, the o'ertopping or surmounting check valve 44, for the chamber 43 of the fixed casing 42, is held down on its seat by the weight of the body of liquid, in the well tubing thereabove, as augmented by the head pressure aforesaid, so that the liquid in the chamber 11 is free to flow up through the hollow plunger, into the chamber 43, as the next pumping charge, there being no head pressure impressed thereon.

As the plunger piston 23 closely approaches the end of the non-pumping stroke, the pressure pumping piston 47 will have likewise closely approximated the end of its left stroke, whereupon the member 67, carried by the power rod 48, will have engaged the abutment lug 65, on the piston valve rod 63, for actuating the piston valve 62 towards the left and thus uncover the port 58. During this movement the by-pass 59 allows for the escape of any cushioning fluid or liquid, around to the right side of the piston valve, by way of the port 58. Although perhaps unnecessary, any suitable means may be employed for limiting the travel or thrust of the piston valve 62 in either or both directions, such means being simply shown conventionally by limiting stops or pins 68 carried by the rod 63 on opposite sides of the valve chest head.

At the end of the non-pumping stroke of the plunger piston 23, therefore, with the piston valve 62 uncovering the port 58, communication is established between the outlet end 61, of the liquid discharge flow line, and the well tubing 20, by way of the line 55—57—58—56—60, while at the same time the pressure pumping piston 47 starts its stroke to the right. During this right hand stroke of the piston 47, it follows that pressure fluid is forced from the right end of the cylinder 46 directly to the bottom of the cylinder 22, underneath the piston 23, by way of the uninterrupted line 49—51—31—35—29. This direct pressure fluid, which may be in the nature of a liquid such as oil, although not necessarily so, will positively elevate the piston-plunger on its pumping stroke, the liquid in the cylinder 22 above the piston 23 escaping through the then outlet port 30 in to the body of the liquid in the well tubing, and, the check valve 27 closing down on its seat, the liquid charge in the chamber 43 will be displaced upwardly into said body of liquid in the well tubing, unseating the surmounting or o'ertopping check valve 44 during its passage upwardly, as will be apparent. During this pumping stroke of the piston-plunger, the check valve 14 is automatically unseated by the pressure of the liquid from the well and a suctional force created within the chamber 11, allowing the chamber 11 and the upmoving hollow plunger to fill up again.

As the plunger piston 23 closely approaches the end of the pumping stroke, the pressure pumping piston 47 will have likewise closely approximated the end of its right stroke, whereupon the engaging member 67 will have engaged the abutment lug 66 to reversely actuate the piston valve 62 for resetting the same to close the port 58, when the cyclical operations may be repeated indefinitely, as long as the well produces and power is imparted to the power shaft 48.

It may be stated here that any suitable means, not shown, may be provided for regulating the length of the strokes of the piston 47 relatively to the piston 23, the cylinders therefor being of properly proportioned volumes, and the opening and closing movements of the piston valve 62 may be properly timed by the regulation of the adjustable abutments 65 and 66.

From the foregoing description, the operation of the system, with particular reference to the structure of Figure 2, will likewise be apparent, as the operation is substantially the same as that just described, especially in view of the disclosure in my prior filed application aforesaid, excepting that in attaching the standard oil well working valve element 36, as supplementary to my improvements, the upper or head check valve elements 27—28 may be omitted, although they may be included as before stated, because the valve elements 38—39 function in substantially the same relation; but with the latter structure charges of larger volume may be pumped with each pumping stroke, the lift being from a position substantially below the piston-plunger element, whereas in Figure 1 the lift is from a position at the top of the hollow plunger element. Of course, the volume of the charges might largely depend, however, upon the cross-sectional areas of the cham-

ber 43 and the chamber housing the working valve 36.

With reference to the modified structure of Figure 5, as associated with the structures of either Figures 1 or 2, it is assumed that, owing to the depth of the well or for other reasons, the columnar weight of the liquid in the well tubing, over the port 30, will be sufficient to actuate the piston-plunger on its non-pumping stroke, regardless of any external pressure additionally impressed as a head upon the body of liquid in the well tubing, especially as such actuation would be aided by the force of gravity on the plunger piston when the pressure on the lower face thereof is relieved by the partial suctional force hereinbefore referred to. Likewise, it is assumed that the columnar weight of the liquid body as a whole, within the well tubing, will be sufficient to maintain the surmounting or o'ertopping check valve 44 firmly closed down upon its seat during the downward or non-pumping stroke of the piston-plunger. Even if such additional pressure were required, however, in connection with the structure of Figure 5, it could be supplied by a source other than the pressure pumping cylinder 46, as for instance by a receiving tank or standpipe interposed in the liquid discharge outflow line 57. At any event, the structure of Figure 5 is designed to do away with, in some instances, the connecting pipe 52, between the pressure pumping cylinder 46 and the well tubing, and also the valve chest 56, with its associated elements 58 to 68, as disclosed at Figure 3. With this explanation, it is believed that the operation of the system, as embodying the structure of Figure 5, will be clearly apparent when viewed in connection with the description of operations hereinbefore described.

In all cases, there is only one operating pressure fluid pipe line that positively and directly leads from the pressure pumping cylinder 46 to the liquid pump cylinder 22 underneath its piston 23, which pipe line alternately functions as an inlet and exhaust for the lower end of the cylinder 22, whereas the upper end of the cylinder 22 is in open communication at all times with the well tubing, and alternately functions as an inlet and exhaust for the upper end of the cylinder 22. These are two of the important features of the present improvements, and when supplemented by the o'ertopping valve 44 as associated with the fixed surmounting casing 42, forming a chamber in which the upper end 25 of the piston operated plunger reciprocates, which features are essential to the present improvements, there is provided a substantially perfected pumping system of the character disclosed. In fact, it is furthermore believed that this fixed surmounting casing 42, with its o'ertopping valve, might even be employed with great advantage in the pumping system disclosed in my prior filed application aforementioned.

Although I have thus fully set forth the improvements from various angles, the objects, advantages and functioning of which will be clearly apparent it is believed, it will nevertheless be understood that I do not wish to unnecessarily restrict the invention to all of the details exactly as disclosed, excepting as they may come within the terms of the ensuing claims, or equivalent elements or combinations thereof, or as fairly interpreted in the light of the specification if requisite.

What I do claim, as new and patentable, is:—

1. The combination with a pump barrel embodying a piston cylinder that is at all times maintained out of communication with the incoming body of liquid to be pumped, of an elongated plunger providing a longitudinal passageway, with end inlet and outlet means therefor, and mounting a piston between its ends, the said piston operating in said cylinder and with the inlet end of said plunger disposed for projection into the incoming body of liquid to be pumped, valve control means associated with said plunger, a stationary casing that encompasses the outlet end of said plunger in housing relation, to provide a liquid charge receiving chamber having outlet means, and valve controlling means for the latter.

2. The combination with a pump barrel embodying a piston cylinder and an inlet chamber, for receiving the inflowing liquid to be pumped, of an open-ended tubular plunger mounting a piston between its ends, one of which ends functions as an inlet end and the other as an outlet end, the said piston operating in said cylinder and with the inlet end of said plunger so disposed for projection into said inlet chamber as to at all times maintain said inlet chamber out of communication with said cylinder, valve control means associated with said plunger, a stationary casing that encompasses the outlet end of said plunger in housing relation, to provide a liquid charge receiving chamber having outlet means, and valve control means for the latter.

3. The combination with a pump barrel embodying a piston cylinder that is at all times maintained out of communication with the incoming body of liquid to be pumped, of an elongated plunger providing a longitudinal passageway, with end inlet and outlet means therefor, and mounting a piston between its ends, the said piston operating in said cylinder and with the end portions of said plunger operating through the heads of said cylinder, the inlet end of said plunger being disposed for projection into the in-

coming body of liquid to be pumped, a check valve in controlling association with one of the ends of said plunger, a casing rigidly supported by said pump barrel in stationary and closing relation therewith, which casing houses the outlet end of said plunger, to provide a liquid charge receiving chamber having outlet means, and a check valve control for said last named outlet means.

4. The combination with a pump barrel embodying a piston cylinder and an elongated inlet chamber therebelow, of an open-ended tubular plunger mounting a piston between its ends, the said piston operating in said cylinder and with the inlet end of said plunger disposed for projection into said inlet chamber, a working valve operating in said inlet chamber and embodying a hollow base section having end inlet and outlet means, a check valve control for the outlet means of said working valve, means connecting the outlet end of said working valve to the inlet end of said plunger in open communication therewith, a stationary casing that surmounts the outlet end of said plunger in housing relation, to provide a liquid charge receiving chamber having outlet means, and o'ertopping valve control means for the latter.

5. In pumping systems, the combination with a pump barrel adapted to be lowered into a tubing associated with the liquid to be pumped, of a pumping element reciprocatingly housed within said pump barrel and associated with suitable coacting elements regulating its pumping and non-pumping strokes, and means for actuating said pumping element embodying a conduit line extending in unobstructed direct communication between a downwardly disposed face portion of said pumping element and a source of operating pressure fluid supply, with an upwardly disposed face portion of said pumping element being in direct communication with said tubing.

6. In pumping systems, the combination with a pump barrel embodying a piston cylinder adapted to be lowered into tubing associated with the liquid to be pumped, of an elongated plunger providing a longitudinal passageway, with end inlet and outlet means therefor, and mounting a piston between its ends, the said piston operating in said cylinder and with the inlet end of said plunger so disposed for projection into the incoming body of said liquid as to at all times maintain said incoming liquid body out of communication with the lower portion of said cylinder, valve control means associated with said plunger, a stationary casing that surmounts the outlet end of said plunger in housing relation, to provide a liquid charge receiving chamber having outlet means, o'ertopping valve control means for the latter, and conduit means extending in direct communication between one end of said piston cylinder and a source of operating pressure fluid supply, the other end of said piston cylinder having a port opening therethrough for open communication with said tubing above said cylinder.

7. In pumping mechanism and systems, the combination with a length of tubing, of a pump barrel disposed therein and embodying a piston cylinder with an elongated liquid inlet chamber therebelow, an open-ended tubular plunger mounting a piston between its ends within said cylinder, the outlet end of said plunger operating through the end head of said cylinder and the inlet end thereof operating in said inlet chamber, a working valve operating in said inlet chamber and embodying a hollow base section that has respective end inlet and outlet means, a check valve control for the outlet means of said working valve, means connecting the outlet end of said working valve to and in open communication with the inlet end of said plunger, a stationary casing that surmounts the outlet end of said plunger in housing relation, to provide an upper liquid charge receiving chamber having outlet means, o'ertopping valve control means for the latter, and conduit means in communication between one end of said piston cylinder and a source of operating pressure fluid supply, the other end of said piston cylinder having a port opening therethrough into open communication with said tubing.

8. In pumping mechanism and systems, the combination with a length of tubing, of a pump barrel disposed therein and embodying a pump piston cylinder, an open-ended tubular plunger mounting a piston between its ends within said cylinder, the outlet end of said plunger operating through an end head of said cylinder and the inlet end thereof operating through the other head of said cylinder into association with the liquid to be pumped, a check valve in controlling association with one of the ends of said plunger, a rigidly supported stationary casing that encompasses the outlet end of said plunger in housing relation, to provide a liquid charge receiving chamber having outlet means, check valve controlling means for the latter, an operating pressure establishing cylinder having a suitably actuated piston therein, and conduit means in communication between one end of said pressure establishing cylinder and one end of said pump piston cylinder, the other end of said pump piston cylinder having a port therethrough in open communication with said tubing.

9. In pumping mechanism and systems, the combination with a length of tubing, of a pump barrel disposed therein and embodying a pump piston cylinder, an open-ended tubular plunger mounting a piston between its ends within said cylinder, the outlet end

of said plunger operating through an end head of said cylinder and with its inlet end operating through the other head thereof into association with the liquid to be pumped, suitable coacting check valve elements regulating the pumping and non-pumping strokes of said plunger, an operating pressure establishing cylinder having a suitably actuated piston therein, a pipe leading from one end of said pressure establishing cylinder into open communication with said tubing, a pipe leading from the other end of said pressure establishing cylinder into open communication with one end of said pump piston cylinder, the other end of said pump piston cylinder having a port in open communication with said tubing, a valve chest having an outlet towards one end and a relief by-pass leading from its other end to an intermediately located inlet port, a communicating conduit between said tubing and said inlet port, a piston valve within said chest for controlling its said inlet port, and suitable actuating means interposed between said piston valve and the piston of said pressure establishing cylinder.

In testimony whereof, I affix my signature.

JAMES A. WARREN.