Sept. 10, 1963 H. C. HUMPHREY 3,103,175

PUMPING APPARATUS

Filed July 24, 1961

Fig. 1.

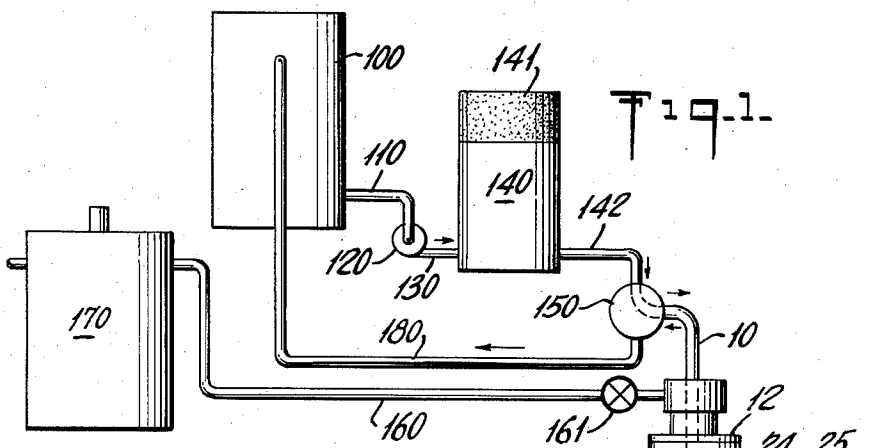
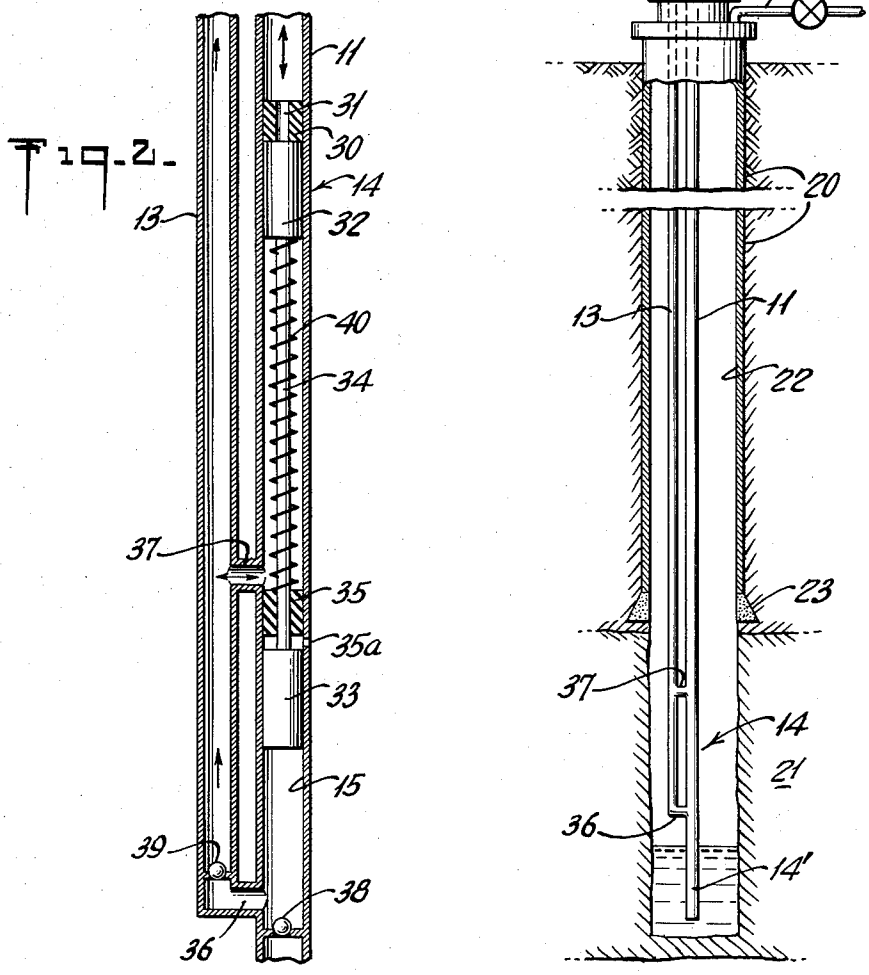



Fig. 2.



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# PUMPING APPARATUS

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6 Claims. (Cl. 103—46)

This invention relates generally to petroleum production and, in one specific aspect, to a hydraulic oil well pumping system for use particularly in the pumping of deep producing wells.

Among the advantages of subsurface hydraulic pumping is that the use of sucker rods, with its attendant problems of rod breakage, wear, counterbalance and the like, is eliminated. Furthermore, with the provision of a central installation, hydraulic power is available for the pumping operation of a number of wells of varying depths and at varying distances from the source of hydraulic power.

The bottom hole pump for subsurface hydraulic pumping, referred to as a production unit, includes a hydraulic engine connected directly to a displacement pump. The engine consists of a reciprocating piston whose motion is controlled by a hydraulically actuated valve and which is driven and lubricated by power oil transmitted from the surface to the engine in the well.

The pump, at the lower end of the production unit, comprises a reciprocating piston connected directly to the engine piston. The pump intake is at the bottom end of the production unit and its discharge is drawn off by production tubing.

Since the power fluid used to operate the production unit is crude oil drawn off from a surface tank battery, it is feasible to allow the power oil exhaust from the engine to be discharged into the pumped production fluid.

Although prior art subsurface, reciprocating piston type pumping engines are efficient in oil well production, automatic operation of the valves in the engine to provide power oil alternately to opposite ends of the engine while positioned in the well leads to problems of adjustment, requiring the production unit to be returned to the surface at intervals.

Accordingly, it is an object of this invention to provide a more efficient subsurface production unit.

It is another object of the invention to provide a simple pumping apparatus which requires minimum upkeep and care for proper pumping operation.

Still another object of the invention is to provide a simple pumping system for deep producing wells which is efficient yet requires a minimum of maintenance.

These and other objects, features and advantages of the invention will be apparent from the following description and claims when read in conjunction with the accompanying drawing wherein:

FIG. 1 is a diagrammatic partial showing of the installation for use with the present invention; and

FIG. 2 is an enlarged diagrammatic showing of the production unit.

The invention comprises reciprocating interconnected pump and power pistons, with pressurized fluid used for actuating the power piston for delivery of production fluid, the return of the power piston to original position comprising the intake pumping stroke for the production fluid.

Referring to FIG. 1 of the drawing, the surface installation comprises a low pressure, power oil supply source or tank **100**, receiving a relatively small volume of oil released by the transmitter (not shown), a power oil line at **110** leading to pump **120**, whence the power oil is delivered under pressure by line **130** leading from the pump to the high pressure power oil supply tank, indicated at **140**, which not only holds the pressurized power oil but also a gas cushion indicated as **141**. The power oil leaves tank **140** through pipe **142**, passing through the intermitter at **150**, which controls the direction of flow of the power oil and is shown diagrammatically simplified as a two way valve. After leaving the intermitter, the power oil passes through pipe **10**, (as shown herein) which is joined to power oil line tubing **11** at the casing head **12**, closing the top of a producing well, with the production fluid, e.g. crude oil, being led off by production tubing **160** discharging into a stock tank, as at **170**.



A well hole **20**, leading to the producing formation **21**, is provided with a casing **22** held in position as by cement at **23**. A string of production tubing **13** is shown suspended in the well, joined to power oil line tubing **11** in a manner known in the art and held in position by the casing head **12** and spaced from the casing **22**. The well production unit **14** is shown disposed at the lower end of the power oil line tubing string, which forms the housing for the power piston and pump plunger, and is joined to the production tubing at its lower end, and also is spaced from the casing. The production unit **14** is actuated by the power oil provided through the power oil line tubing **11**.

Referring to FIG. 2, showing the production unit **14** in enlarged form, there is disclosed, diagrammatically, a bumper block **30**, e.g. a spring-loaded shock absorber, seated in the power oil line tubing **11**. This bumper block is perforated at **31** to allow flow of power oil and is used as a stop on the return stroke of the power piston **32**, which is joined in spaced relationship to the pump plunger **33** by means of the piston rod **34**. A packing gland at **35** surrounds piston rod **34** and prevents any production fluid from leaking past the pump plunger. The vent in tubing **11** at **35***a* is to equalize the pressure on the plunger **33**, viz. to avoid building up pressure or a vacuum between the packing gland and the plunger.

Adjacent and shown parallel to the power oil line tubing **11** is the production fluid tubing **13** interconnected through duct means defining the delivery passage at **36** and the by-pass port at **37**. The inlet valve for the production or well fluid is shown at **38** and the exhaust valve controlling its passage into the production tubing is shown at **39**. These valves are shown diagrammatically and in use would be caged. The use of a loading spring, indicated generally at **40**, seated in the power oil line tubing **11** between the power piston **32** and the packing gland **35**, for additional control of the return of the power piston and pump plunger, is optional.

The operation of the pumping process will now be described briefly. The power stroke of the production unit begins with the supply of power oil from the surface through the tubing **11** to the passage **31**, forcing the free power piston **32** and so the pump plunger **33** downward to close the intake check valve **38** and to eject the production fluid from the production fluid chamber **15**, defined in the tubing **11** between the pump plunger and the check valve at **38**, through the exhaust check valve at **39** into the production tubing **13**, up to the surface past the back pressure control means **161** in tubing **160** and then into the stock tank **170**.

At the same time, production fluid retained within the power line tubing between the power piston **32** and the packing gland **35** is forced out through the passage **37**, which is in open communication at all times between the power oil tubing **11** and the production tubing **13**.

On the upstroke of the power piston **32** in the tubing **11** and so the intake stroke of the pumping cycle, the pressure of the production fluid upstream of the bumper **30** is lowered by cut-off of the intermitter at **150**, that is, the flow of pressurized power oil is shut off and the

power oil which is in the power tubing **11** is permitted to flow back through the pipe **10** into the low pressure, power oil supply tank **100** through the pipe line **180**. This reversal of flow is possible because the hydrostatic head of the production fluid in the tubing **13**, together with the loading spring **40**, are sufficient to force the piston upward on its pumping stroke, thereby discharging the power oil into the low pressure supply tank at **100**, the hydrostatic pressure in tubing **13** also closing the check valve at **39**. The succeeding downstroke of the power piston is produced when the intermitter cuts off the flow of the low pressure fluid from the power tubing **11** and permits pressurized power oil from the tank at **140** to pass through the pipe **10** into the power tubing **11**.

The length of the power stroke is variable and is determined by the intermitter, which is regulated to produce the amount of production fluid desired, i.e. the allowable, or to obtain a stroke to produce the maximum amount of well fluid possible. In addition, the produced fluid is relatively gas-free, for with the intake **14'** to the production unit extending below the surface of the fluid in the well bore, the released gas would pass up in the annulus between the tubings **11** and **13** and casing **22** and would be bled off through the conduit **24** with control valve **25** therefor. Also, two or more of these production units can be placed in series.

Due to the proximity of the sources of supply, the hydraulic fluid used herein has been disclosed as power oil.

Thus there has been shown and described an improved deep well production system which is simple to construct, economical to use, and has a minimum of working parts to require maintenance.

The present application is a continuation-in-part of my co-pending application, Serial No. 783,245, filed December 29, 1958, now abandoned.

Other modifications and variations of the invention, as hereinbefore set forth, may be made without departing from the spirit and scope thereof, and therefore only such limitations should be imposed as are indicated in the appended claims.

I claim:

1. A free piston pump for a producing well having a casing and with power fluid tubing and production tubing positioned in said producing well and spaced from said casing thereof comprising the combination of a pair of spaced imperforate pistons housed in said power fluid tubing, rod means interconnecting and spacing said pair of imperforate pistons from each other, inlet means for production fluid leading to said power fluid tubing and located below one of said pair of pistons and including a check valve which opens when said pistons move on an intake stroke and closes when said pistons move on a discharge stroke, duct means establishing communication between said power fluid tubing and said production tubing, one of said duct means being in open communication at all times between said production tubing and said power fluid tubing leading to the chamber therein between said pistons and another of said duct means being located adjacent said inlet means, and discharge control means comprising a second check valve which opens when said pistons move on a discharge stroke and closes when said pistons move on an intake stroke and being located adjacent said another of said duct means adjacent said inlet means.

2. In the pump as defined in claim 1, a packing gland surrounding said rod means interconnecting said imperforate pistons and being positioned in said power fluid tubing below said one of said duct means and sealing said power tubing against the flow of production fluid past said packing gland.

3. In the pump as defined in claim 2, said power fluid tubing having an opening in the wall thereof located below said packing gland surrounding said rod means and above the uppermost position of said one of said pair of pistons, said power fluid tubing and said production tubing being parallel to each other.



4. In a production unit for subsurface pumping for discharging production fluid into production tubing having a valve housed therein for checking reverse flow of said production fluid, the combination of an imperforate power piston and an imperforate pump plunger spaced from each other, a piston rod interconnecting said power piston and said pump plunger, a packing gland surrounding said piston rod, power fluid tubing housing said piston and said plunger and providing power fluid for linear movement of said power piston and so a corresponding movement of said pump plunger, an inlet valve for production fluid and with said pump plunger defining a chamber for production fluid having discharge means into said production tubing adjacent said valve housed therein, said production tubing having open communication with said power fluid tubing through duct means ending adjacent said packing gland and leading to the chamber in said production fluid tubing between said piston and said pump plunger whereby production fluid under hydrostatic pressure acts on said power piston on the pumping intake stroke.

5. In the production unit as defined in claim 4, resilient means spaced between said power piston and said packing gland in said power fluid tubing for additional control of the intake stroke of the pumping cycle of said production unit.

6. In combination with a subsurface pumping apparatus for discharging production fluid into production tubing having a check valve against reverse flow of said production fluid and comprising a production unit of an imperforate power piston and an imperforate pump plunger spaced therefrom, a piston rod interconnecting said power piston and said pump plunger, a packing gland surrounding said rod and power fluid tubing housing said piston and said plunger and providing power fluid for linear movement of said power piston and so a corresponding movement of said plunger and a check valve located in said power fluid tubing and defining with said pump plunger a chamber therewithin, said production tubing being joined to said chamber and said check valve in said production tubing being located adjacent said chamber, the improvement comprising a power fluid circuit joined to said power fluid tubing for providing power fluid thereto, and including sources of low pressure and high pressure power fluid and interconnecting pressurizing means and a valve means joining said power fluid circuit to said power fluid tubing for connecting said sources in turn with said power fluid tubing whereby high pressure power fluid is directed against said power piston for the discharge stroke of the pumping cycle and at the end of said discharge stroke said high pressure fluid acting against said power piston being released to the source of low pressure power fluid through said valve means, said production unit including resilient means spaced between said power piston and said packing gland around said rod in said power fluid tubing, said production tubing having open communication with the chamber between said piston and said plunger in said power fluid tubing adjacent said packing gland whereby production fluid under hydrostatic pressure acts on said power piston on the intake stroke of the pumping cycle.

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