United States Patent

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[54] **DOWNHOLE PRODUCING PUMP**
7 Claims, 3 Drawing Figs.

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417/435, 417/507, 417/509
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F04b 34/10, F04b 39/07
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155; 103/203, 179, 495; 417/509, 503, 507;
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[56] **References Cited**
UNITED STATES PATENTS

2,141,957	12/1938	McDaniel	103/192
2,263,144	11/1941	Scott	103/203
1,742,579	1/1930	Childers	103/163
2,171,410	8/1939	Steele	103/203
2,229,844	1/1941	Garancher	103/203
2,910,002	10/1959	Morgan	103/179
3,414,057	12/1968	Harbison	103/179

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ABSTRACT: Improved downhole piston pump for production of well fluids involving a multiplicity of quick-acting ports adapted to accelerate handling of heavy or gassy fluids.

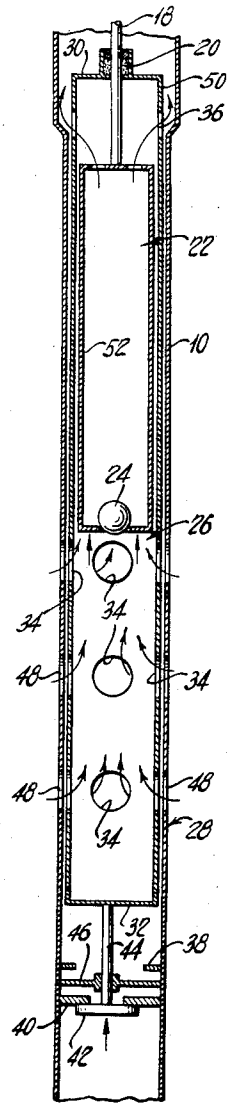


Fig. 1.

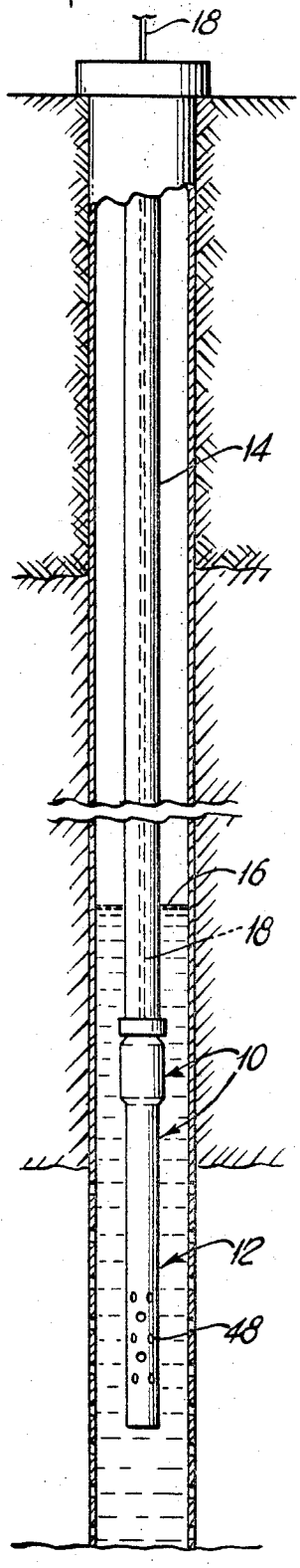


Fig. 2.

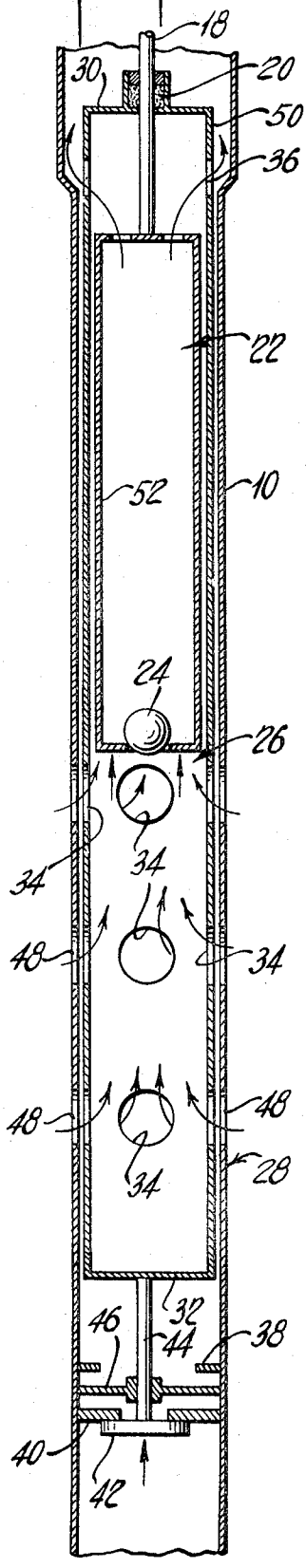
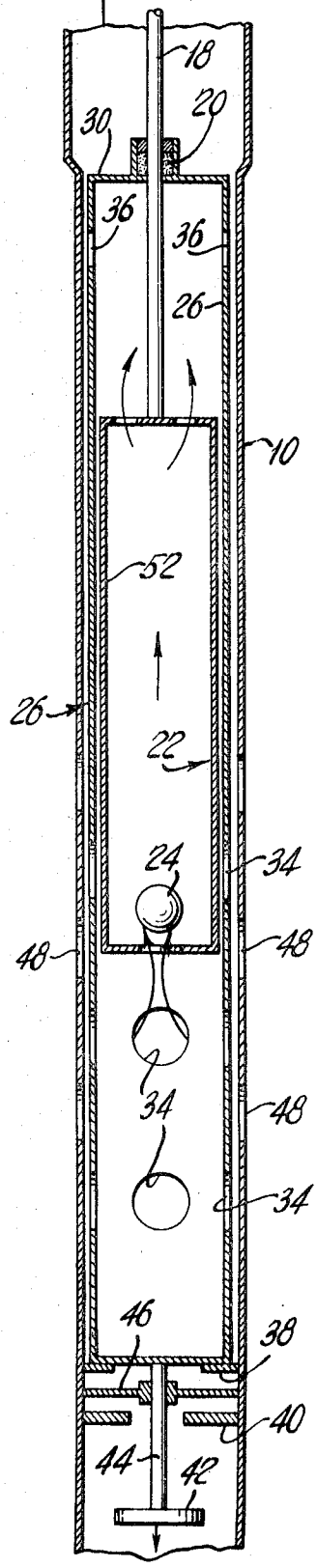


Fig. 3.



DOWNHOLE PRODUCING PUMP

The present invention relates to oil well pumping equipment and particularly to downhole reciprocating pumps for producing petroleum liquids from a subsurface reservoir.

The pumping of petroleum wells supplying a crude which has a high viscosity or a substantial gas content, or both, frequently involves serious pumping inefficiencies even with high liquid levels in the wells. A great deal of this difficulty in the past has been ascribed to a liberation or breakout of gas in the pump. This is easy to visualize when the gas is considered as a soluble constituent of the crude, with its solubility varying with pressure, and when further it is realized that the hydrostatic pressure within the pump chamber during the suction stroke may involve a pressure drop approaching the order of the entire head of fluid above the travelling valve. The net result, of course, is that gas released from solution displaces oil which would otherwise be handled by the pump. As a result, a multitude of other inefficiencies and problems are incidentally introduced.

Numerous devices and expedients have been proposed to overcome the tendency to gas locking. Among these, for example, is the disposition of separating means ahead of the inlet of the pump intended to segregate, collect and vent off the gas before the liquid is drawn into the displacement chamber of the pump. Because such arrangements obviously do not take into consideration the liberation of gas which subsequently occurs downstream of the pump inlet, and particularly beyond the standing valve of the pump during the suction stroke, this has met with limited success. Other proposals have been made to provide special means for venting the displacement chamber of the pump but in general these are of restricted benefit, particularly where relatively viscous crudes are involved.

Actually it seems to have been largely overlooked that resistance to the flow of oil thru the standing valve, particularly in the case of relatively heavy or viscous crudes largely contributes to this difficulty inasmuch as any impediment to efficient filling of the pump barrel with liquid oil necessarily involves a pressure drop and, therefore, contributes to a breakout of gas. This in turn, in a relatively gas-saturated crude, contributes in some measure to gas locking.

In accordance with the present invention there is provided a pump structure which facilitates the entry of crude into the pump chamber or barrel (as well as the release of gaseous fractions) to such an extent as to substantially eliminate any pressure drop materially below the pressure of the reservoir. As a result, crude oil flows freely into the pump barrel on the suction stroke and below the travelling valve with minimum pressure differential and therefore a greatly decreased tendency for gas breakout. This is accomplished by providing a port valve system which is not necessarily responsive to a pressure differential between the reservoir and the pump and which opens widely to the extent that there is little or no appreciable restriction of flow between the reservoir and the pump and accordingly, little or no pressure drop. Also the ports likewise facilitate release of such gas as may fail to form in the barrel. The valve ports, as above intimated, operate in response to reciprocation of the pump piston and not as a result of pressure differential.

By way of illustrating the present invention, one particular embodiment thereof is enclosed in the following drawing wherein:

FIG. 1 is a more or less diagrammatic elevation of a pumping well involving the present invention.

FIG. 2 is a detailed section elevation of the pump at the limit of the upstroke.

FIG. 3 is a detailed section elevation of the pump commencing on the downstroke.

In the drawings the numeral 10 represents a reciprocating pump constructed in accordance with the principles of the present invention and disposed within a petroleum reservoir indicated more or less diagrammatically by the reference numeral 12. As indicated, the pump 10 is attached by a threaded connection to the lower extremity of a tubing 14 and thus immersed in liquid petroleum which arises for example to the level 16.

It is to be observed that the manner in which the pump is associated with the production tubing 14 forms no part of the present invention and that this may be accomplished in no known way. For example, the pump may comprise an insert barrel type of pump as is well known, which is constructed and designed to be insertable down thru the production tubing and to be received or locked into the tubing at a point near its lower extremity. Preferably, as will appear, the insert pump is of the top lock type to engage the tubing near the upper portion of the pump barrel so that the lower portion of the pump extends freely into the pool of petroleum with inlet ports in open communication therewith as will hereinafter appear. In such an arrangement of course, the pump would be lowered thru the tubing, suspended from the sucker rod or polish rod 18. This of course, actuates the pump and is, in any event, driven by a suitable reciprocating means such as a walking beam, not shown.

Referring now to the specific structure of the tubing pump, the polish rod 18 passing thru a packing gland 20 connects with a plunger 22 and is, in turn, driven from a surface mechanism, not shown, for reciprocating the rod string as is known.

The plunger 22, provided with a travelling valve 24, rides within axially disposed inner cylinder or barrel 26 which, in turn, is axially disposed within outer barrel or cylinder 28. It is to be noted that the barrel or cylinder 26 is closed at its lower and upper extremities by transverse barrier walls 30 and 32 respectively but is provided with a multiplicity of inlet ports over its lower portion as indicated by the reference numeral 34. So, also, the upper extremity of the barrel 26 is provided with outlet ports 36.

Moreover, the inner barrel 26 is arranged for limited vertical reciprocation within the outer barrel, as indicated, the limit of its movement being determined by an annular limit stop 38 which controls the bottom of the downstroke of the plunger as shown in FIGS. 2 and 3, and an annular limit stop 40 which controls the top of the upstroke of the inner barrel 26 by limiting the upward movement of the follower or square guide 42. This in turn is connected to the inner barrel 26 by means of rod 44 guided as is shown by spider guide 46.

Reciprocation of the inner barrel within the limits indicated causes the ports 34, at the limit of its upper position, to align with corresponding ports or apertures 48 in outer barrel, as clearly shown in FIG. 2; in brief, the interior of the inner barrel is at this point freely open to the liquid in the reservoir.

At the same time it will be observed that the ports 36, otherwise closed by the imperforate wall of barrel 28, now freely open into the space 50, communicating directly with the interior of the production tubing 14.

Accordingly, therefore, in the operation of the pump the start of the upstroke of the piston 22 causes the oil above it to lift the inner barrel 26 from the lower position shown in FIG. 3 to the upper position shown in FIG. 2 with the both sets of valve ports, namely ports 36 and ports 34, in open position. Therefore, oil is drawn into the pump below the piston thru ports 34 which may be in number and arrangement of such a character that the pressure drop below that of the reservoir is negligible. Moreover, by locating the upper ports or holes of the group of inlet ports 34 close to the bottom of the plunger at the top of its upstroke any gas breakout readily separates and is replaced by liquid.

During upstroke the travelling valve 24, in a conventional manner, remains closed and liquid thereabove is expelled into the production tubing 14 by way of ports 36, as indicated in FIG. 2. At the initiation of the downstroke of the plunger the internal barrel returns to its lower position as shown in FIG. 3, immediately cutting off both the inlet and the outlet ports so that as the plunger moves downwardly in the barrels the travelling valve 24 opens, as shown, to transfer the fluid to the expanding region thereabove.

The foregoing embodiment obviously lends itself to many modifications. For example, while the inner barrel may be caused to return to its lower position by frictional forces and by the head of fluid thereabove combined with the relative restriction of the upper ports, any other suitable means may be adapted to effect this, as for example by a downwardly acting spring or by selecting an internal barrel of suitable mass. On the other hand many mechanical or physical means will suggest themselves to anyone skilled in the arts for positively opening the ports on the upstroke of the piston and closing them on the downstroke. Likewise with such an arrangement it will be apparent that the internal barrel may be fixed with the external barrel, movably or alternatively a single barrel may be employed with suitable mechanical port closures.

In any event it is, as indicated, desirable to provide quick-acting control of the ports so as to actuate them sharply at the beginning of the up or down stroke as the case may be. In any event, numerous modifications will be apparent in light of the foregoing. It is also important to note that in the present embodiment the hollow plunger or piston **22** may be completely open at the top, although the imperforate annular sidewall or skirt portion **52** is obviously necessary to cover and close the ports during the lower positions of the piston.

Moreover, it is to be noted that the clearances shown in the FIGS. of the drawing, namely between the inner and outer barrels and the piston, are shown for the sake of clarity and symbolism and are not intended to indicate avenues for the diffusion or flow of the fluids involved. In short, the several parts are associated coaxially in antifriction, fluid-sealing arrangement such that the ports open and close positively and the piston operates without blowby or leakage.

I claim:

1. A downhole piston pump for producing well liquids from a subsurface reservoir involving a piston adapted to reciprocate within a cylinder, immersed in said reservoir, said piston being provided with a traveling valve, the improvement which comprises a multiplicity of inlet ports in free and open communication with said reservoir, disposed in said cylinder wall throughout the area between the lower extremity of said wall and the location of the bottom of the piston at the top of its upstroke, means opening said ports in response to initiation of movement of the piston in an upward direction and actuated by the weight of the column of produced liquid being delivered by said pump for closing said ports in response to initiation of movement of the piston in a downward direction and means to prevent communication between said inlet ports and the space above said piston.

2. A downhole piston pump as defined in claim **1** wherein said last named means comprises a piston skirt extending thereabove to cover said inlet ports during the lower portion of the piston stroke.

3. A downhole piston pump as defined in claim **1** wherein said ports extend through in the lateral sidewall of the cylinder.

4. A downhole piston pump as defined in claim **1** wherein said cylinder is arranged to reciprocate axially within a limited predetermined path to effect opening of said ports at one extremity of its path of reciprocation and to effect closure thereof at the other extremity of its path.

5. A downhole piston pump as defined in claim **1** which includes outlet port means located in the upper part of said cylinder above the piston and means in response to the opening of said inlet ports for actuating the outlet port to open and close with the said inlet ports.

6. A downhole piston pump for producing well liquids from a subsurface reservoir comprising a piston adapted to reciprocate coaxially within a cylinder adapted to be immersed within said reservoir and being provided with a travelling valve, said cylinder comprising inner and outer coaxially disposed barrels relatively movable in an axial direction, a multiplicity of inlet ports passing thru said barrels and in free and open communication with said reservoir, means to effect relative movement of said barrels in an axial direction between open position in which said inlet ports on the inner and outer barrels are in registration, and closed position where each inlet port is closed by the imperforate wall of the opposite barrel, said ports being distributed in the wall of said cylinder throughout the area between the lower extremity thereof and the lower part of the piston at the upper end of its stroke, sleeve means on said piston adapted to limit opening of said ports to the space below said piston and means to shift said barrels to inlet port open position in response to initiation of upward movement of the piston said last named means being actuated by the weight of the column of produced liquid being delivered by the pump for closing said ports in response to initiation of movement of the piston in a downward direction.

7. A downhole piston pump as defined in claim **6** wherein said last named means is adapted to shift said barrels relatively to inlet port closed position in response to initiation or movement of piston in a downward direction.