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STANDING VALVE ASSEMBLY FOR DOWNHOLE PLUNGER PUMPS AND ATTACHMENT THEREFOR

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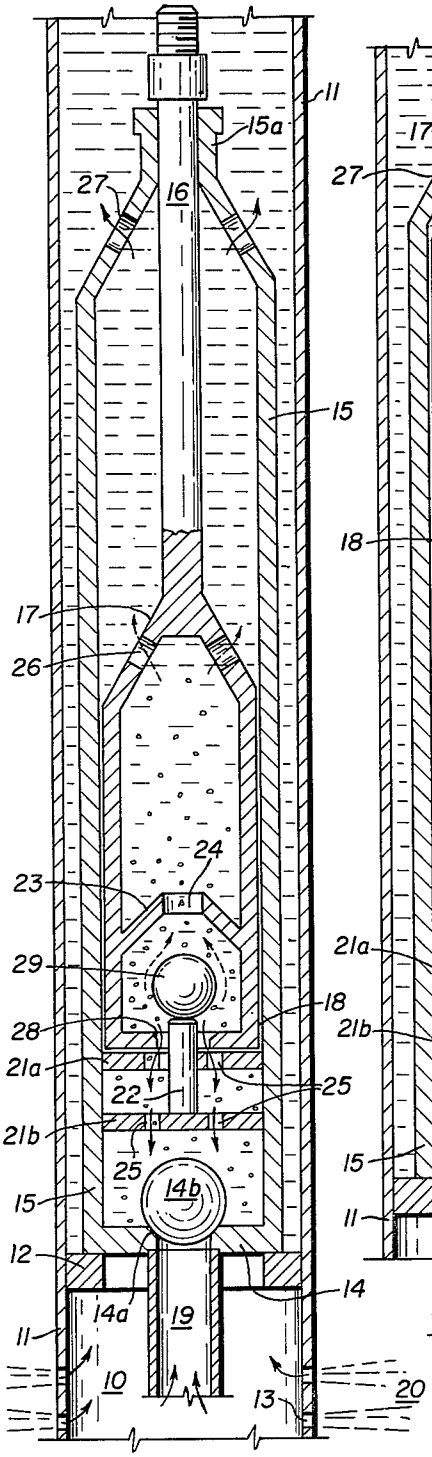


Fig_1

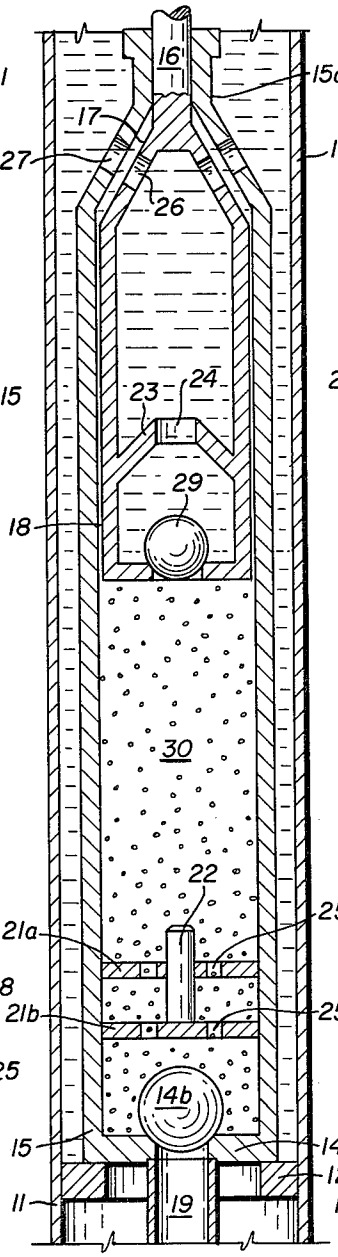


Fig_2

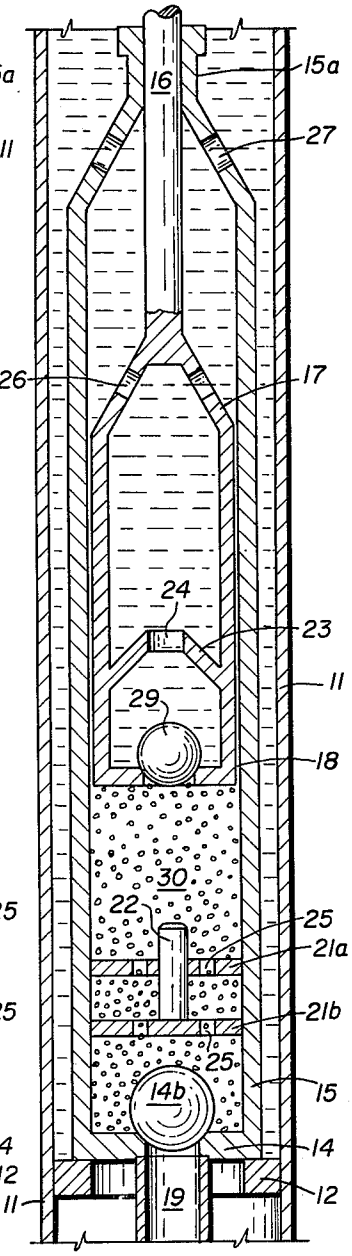


Fig_3

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STANDING VALVE ASSEMBLY FOR DOWNHOLE PLUNGER PUMPS AND ATTACHMENT THEREFOR

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This invention relates to improvements in downhole plunger pumps for lifting oil through a well to the surface and more particularly relates to a standing valve assembly for utilization in such a pump.

Downhole plunger pumps are used extensively in the oil industry for elevating formation fluids through a completed well to the surface. Recently, because of the economics attained, such pumps are used in conjunction with what is termed "tubeless completion" wherein the casing after completion of the well is pulled from the well and a string of small diameter tubing is inserted into the well to the depth of the perforated portion of the formation through which the formation fluids enter the well.

The plunger pumps used in such operations comprise a lower standing valve member inclusive of a cage and a plunger carrying a traveling valve which is oscillated toward and away from the standing valve and has its lowermost position in the downstroke spaced from the top of the standing valve assembly. Generally the plunger pumps are run to a depth in the well at which the pump will stay covered by the fluid during the pumping operation. The pumping cycle starts with an upward stroke of the rods which pulls the plunger up through the working barrel. In such action, the traveling valve closes to elevate oil standing above said valve and the standing valve opens, permitting formation fluids to enter the working barrel from the bottom of the well. On the downstroke of the plunger, the traveling valve opens due to the resistance of the contained fluid toward which it moves, the standing valve closes, and the contained fluid is forced from the working barrel upwardly through the plunger and into the tubing. Repeated strokes bring the fluid to the surface.

One of the chief difficulties encountered in this type of pumping is what is termed "gas locking." Even a small volume of gas collecting between the standing valve and the traveling valve forms a compressible fluid which will compress during the downstroke and expand during the upstroke to such an extent that the standing valve is held in place throughout the cycle and no formation fluids are permitted to enter. In some wells, the gas lock may be broken after a period of time by accumulated pressure of the formation fluids which will unseat the ball and admit sufficient liquid to entrain or dissolve the contained gas, thus permitting the pump to resume normal functioning by unseating the traveling valve due to the incompressibility of the reconstituted contained fluid.

One practice in breaking the gas lock is to bump the top of the pump with the pull rod with a sufficient force to unseat the traveling valve and allow a flow of oil from the barrel into the standing valve cage in which the contained gas is entrained. This displacement effect and entrainment will allow the pump to resume normal functioning, but frequently results in damage to pump components. Also, if a sufficient volume of gas is confined between the valves, the unseating action may be of too short a duration to entrain sufficient gas to render the contained fluid incompressible and thereby break the gas lock effect.

The present invention provides an innovation over prior practice in providing a positive or mechanical unseating of the ball of the traveling valve during each downstroke, if the valve remains seated during such stroke, with the result that contained gas escapes from the standing valve cage in each pumping cycle and consequently cannot accumulate within the working barrel in a quantity sufficient to effect a gas lock. Also in such action, a small volume of oil above the standing valve assembly is allowed to enter the space between the valves whenever such space is not filled with liquid and this oil will entrain gas present in the barrel which was not released by the unseating of the valve. The timing interval of the unseating action is so brief that the volume of oil permitted to descend is too small to appreciably lessen the volume of oil being elevated to the surface by the continuous operation of the pump.

The gas release device of the present invention also performs another useful function in the operation of such pumps. Particularly when the pump is operating in unconsolidated sand wells or fine grain sand wells, small particles of sand frequently come to rest on the seat of the standing valve preventing it from seating as required, and the barrel remains empty instead of filling. The admission of the small flow of oil in the action previously described will provide a washing action on the ball seat which removes the sand grain and thus allows the ball to return to its normal seated position as required and thereby continue filling the barrel in each pump cycle.

It is an object of my invention to provide a simple, durable and efficient standing valve assembly for downhole plunger pumps which is arranged to unseat the traveling valve during each downstroke if it remains seated and thus prevent accumulation of enough gas in the working barrel to produce a gas lock effect.

Another object of my invention is to provide a simple, durable and economical attachment for the standing valve assembly of a downhole plunger pump which prevents gas locking of the pump by unseating the traveling valve for a brief interval in each downstroke if it remains seated.

A further object of my invention is to provide a novel pumping system for downhole plunger pumps which includes mechanical unseating of the traveling valve during each downstroke of the pump if pressure differentials in said pump prevent normal unseating of said valve at the beginning of the downstroke.

Other objects reside in novel details of construction and novel combinations and arrangements of parts which will be set forth in the course of the following description.

The practice of my invention will be described with reference to the accompanying drawings in the several views of which like parts bear similar reference numerals.

In the drawings:

FIG. 1 is a vertical section through the bottom portion of a completed well in which a plunger pump utilizing one form of standing valve assembly of my invention is shown in the downstroke operating position;

FIG. 2 is a fragmentary section corresponding to FIG. 1 showing the upstroke position in conjunction with an assumed gas lock condition; and

FIG. 3 illustrates an intermediate downstroke position in relation to the assumed gas lock condition.

As shown in FIG. 1, the well **10** is of the tubeless completion type in which a string of tubing **11** forming an outer shell is run into the well after the casing has been removed. The lower end of tubing **11** has a seating nipple or mechanical hold down **12** which establishes the elevation of the pump after the producing formation has been fractured, the tubing perforated as shown at **13**, and the tubing has been cemented in place.

The pump shown in FIG. 1 comprises a stationary or standing valve **14** suitably secured on seating nipple **12**, and enclosed by an outer shell **15** which forms a part of the cage of valve **14**. Shell **15** has an upper neck or

throat portion **15***a* through which a sucker rod **16** extends and carries a plunger **17** having a traveling valve assembly **18** at its lower end. The plunger pump shown in FIG. 1 is run to a depth in well **10** at which the pump will stay covered by the oil or formation fluids through the range of its oscillatory movement as represented by the oil level shown in FIG. 1.

The assembly of standing valve **14** includes a base member having a seat **14***a* for a ball **14***b* which controls flow of formation fluids through a conduit **19** filled from fractured formation **20** adjacent perforations **13**. The cage portion of valve **14** has two disc-like members **21***a* and **21***b* at its top attached to shell **15** and supporting a pin or projection **22** extending upwardly from the cage in alinement with ball valve **18**. The cage of valve **18** includes a conical partition **23** formed as a part of plunger **17** and having a central opening **24** for passage of fluids. Members **21***a* and **21***b* have ports or passages **25** through which the fluids are directed in the pumping action. Plunger **17** has passages **26** and shell **15** has ports **27** at its upper end through which the oil being pumped is caused to travel in its elevating movement. Traveling valve **18** has a seat **28** in its base portion and a ball **29** cooperates therewith in controlling flow into and out of the traveling valve.

As my invention deals primarily with a gas lock condition in a pump of this type, the drawings represent a gas lock condition at three stages of the pumping cycle which begins with an upward stroke depicted in FIG. 2. The plunger is shown in its position at the completion of the upstroke with ball **29** seated because of the hydrostatic pressure of the oil or other liquid standing above it. In this position, ball **14***b* also remains seated because the body of gas in barrel **30** exerts sufficient pressure to overcome the pressure of formation fluids in conduit **19** which would enter barrel **30** if ball **14***b* were unseated as occurs in normal functioning during the upstroke.

FIG. 3 depicts the next stage of the cycle in which the plunger **17** is descending with ball **29** seated because of compression of the body of gas in barrel **30** and lack of sufficient displacement effect. Ball **14***b* also remains seated in this action and no formation fluid enters from conduit **19**. However, when the plunger descends to a point where projection **22** engages ball **29** the hydrostatic pressure on the oil contained in the plunger forces the oil past seat **28** and into barrel **30** while gas ascends through the descending liquid flow and any gas remaining in the barrel after valve **29** again seats at the beginning of the next upstroke is entrained or dissolved in the oil. Consequently, the pump resumes its normal functioning with valve **14***b* unseated on the following upstroke to permit entrance of formation fluids into barrel **30**.

The plunger pump illustrated in the drawings is intended to represent a typical pump of the type now in general usage. While such pumps are produced in a variety of forms and sizes, they all employ a combination of a standing valve and a traveling valve functioning in substantially the manner described and depicted herein. Consequently, the gas lock prevention means of my invention may be produced as an attachment for existing pump installations as well as being incorporated in new assemblies. All such units will be effective in preventing gas lock in downhole plunger pumps.

As an example of the effectiveness of such a unit, a valve assembly essentially the same as shown in FIG. 1 was installed in a completion well which previously had had irregular production and much operating difficulty due to gas locking. Two and one-half months after said valve assembly was installed, the production of this well was 40% above its average for the period preceding installation, and not a single instance of gas locking occurred after the installation.

Changes and modifications may be availed of within the spirit and scope of my invention as defined in the hereunto appended claims.

I claim:

1. The combination with a downhole pump for oil recovery, including a stationary ball valve assembly, a plunger carrying a ball valve assembly movable toward and away from the stationary valve, and means for oscillating said plunger, of an abutment member held in the stationary assembly in alinement with the ball valve in the plunger and having its top surface disposed with respect to each downstroke of said plunger to engage and unseat the latter ball during each downstroke of the plunger whereby to entrain contained gas in the stationary assembly in oil descending through the plunger past the unseated valve.

2. The combination with a downhole pump for oil recovery, including a stationary ball valve assembly, a plunger carrying a ball valve assembly movable toward and away from the stationary valve, and means for oscillating said plunger, of an abutment member held in the stationary assembly in alinement with the ball valve in the plunger and having its top surface disposed with respect to each downstroke of said plunger to engage and unseat the latter ball at the end of each downstroke of the plunger whereby to entrain contained gas in the stationary assembly in a small volume of oil descending through the plunger past the unseated valve.

3. The combination with a downhole pump for oil recovery, including a stationary ball valve assembly, a plunger carrying a ball valve assembly movable toward and away from the stationary valve, and means for oscillating said plunger, of an abutment member held in the stationary assembly in alinement with the ball valve in the plunger and having its top surface disposed with respect to each downstroke of said plunger and at a higher elevation than the lowermost travel of the plunger ball valve so as to engage and unseat the latter ball at each downstroke of the plunger whereby to entrain contained gas in the stationary assembly in a small volume of oil descending through the plunger past the unseated valve.

4. The combination with a downhole pump for oil recovery, including a stationary ball valve assembly, a plunger carrying a ball valve assembly movable toward and away from the stationary valve, and means for oscillating said plunger, of an abutment member held in the stationary assembly in alinement with the ball valve in the plunger, said member being of lesser diameter than the seat of the latter valve and having its top surface disposed with respect to each downstroke of said plunger to engage and unseat the latter ball during each downstroke of the plunger whereby to entrain contained gas in the stationary assembly in oil descending through the plunger past the unseated valve.

5. The combination with a downhole pump for oil recovery, including a stationary ball valve assembly with a wall portion and a stationary ball valve secured at the lower end of the wall portion for controlling the inflow of formation fluids, a plunger carrying a ball valve assembly movable toward and away from the stationary valve, and means for oscillating said plunger, of a horizontal member held in the wall portion above the stationary ball valve, said member having passage means for egress and ingress of fluids and an abutment secured on the member extending upwardly therefrom having its top surface disposed with respect to each downstroke of said plunger to engage and unseat the latter ball at the end of the downstroke of the plunger whereby to entrain compressed gas in the stationary assembly in a small volume of oil descending through the plunger past the unseated valve with a portion of said oil descending through said passage means and onto said stationary ball valve.

6. A gas release device for downhole plunger pumps having passage means for directing formation fluid thereto, comprising a standing valve cage for mounting in a fixed position at the bottom of such a pump, including an outer wall member, a ball valve secured at the

lower end of the wall member for controlling the inflow of said formation fluids, a plunger carrying a ball valve assembly movable toward and away from the cage, said cage having a transversely-disposed member supported by the wall member and defining the top of the cage, said member having passage means for egress and ingress of fluids, and an abutment secured on the cage extending upwardly therefrom and having its top surface disposed with respect to each downstroke of said plunger for engaging and unseating the ball of a traveling ball valve on each downstroke of said plunger to entrain compressed gas between the cage and plunger in a small volume of oil descending through the plunger past the unseated valve with a portion of said oil descending through said passage means and onto said stationary ball valve in the operation of a pump in which the cage is installed.

7. A gas release device for downhole plunger pumps having passage means for directing formation fluids thereto, comprising a standing valve cage for mounting in a fixed position at the bottom of such a pump, including an outer wall member, a ball valve secured at the lower end of the wall member for controlling the inflow of formation fluids, a horizontal member supported by the wall member and defining the top of the cage, said member having passage means for egress and ingress of fluids, and an abutment secured on the cage and extending upwardly therefrom and having its top surface disposed with respect to each downstroke of said plunger for engaging and unseating the ball of a traveling ball valve on each downstroke of said plunger to entrain compressed gas between the cage and plunger in a small volume of oil descending through the plunger past the unseated valve with a portion of said oil descending through said passage means and onto said stationary ball valve in which the cage is installed.

8. A gas release device for downhole plunger pumps having passage means for directing formation fluids thereto, comprising a standing valve cage for mounting in a fixed position at the bottom of such a pump, including an outer wall member, a ball valve secured at the lower end of the wall member for controlling the inflow of said formation fluids, a plunger carrying a ball valve assembly movable toward and away from the cage, said cage having a transversely-disposed member supported by the wall member and defining the top of the cage, said

member having passage means for egress and ingress of fluids, and a centrally-disposed pin secured on the cage extending upwardly therefrom and having its top surface disposed with respect to each downstroke of said plunger for engaging and unseating the ball of a traveling ball valve on each downstroke of said plunger of entrain compressed gas between the cage and plunger in a small volume of oil descending through the plunger past the unseated valve with a portion of said oil descending through said passage means and onto said stationary ball valve in the operation of a pump in which the cage is installed.

9. A gas release device for downhole plunger pumps having passage means for directing formation fluids thereto, comprising a standing valve cage for mounting in a fixed position at the bottom of such a pump, including a tubular wall member, a ball valve secured at the lower end of the wall member for controlling the inflow of said formation fluids, a plunger carrying a ball valve assembly movable toward and away from the cage, said cage having a transversely-disposed member supported by the wall member and defining the top of the cage, said member having passage means for egress and ingress of fluids, and a concentric pin secured on the cage extending upwardly therefrom and having its top surface disposed with respect to each downstroke of said plunger for engaging and unseating the ball of a traveling ball valve on each downstroke of said plunger to entrain compressed gas between the cage and plunger in a small volume of oil descending through the plunger past the unseated valve with a portion of said oil descending through said passage means and onto said stationary ball valve in the operation of a pump in which the cage is installed.

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