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C. C. KING
VACUUM PUMP

2,765,742

Filed March 1, 1951

3 Sheets-Sheet 1

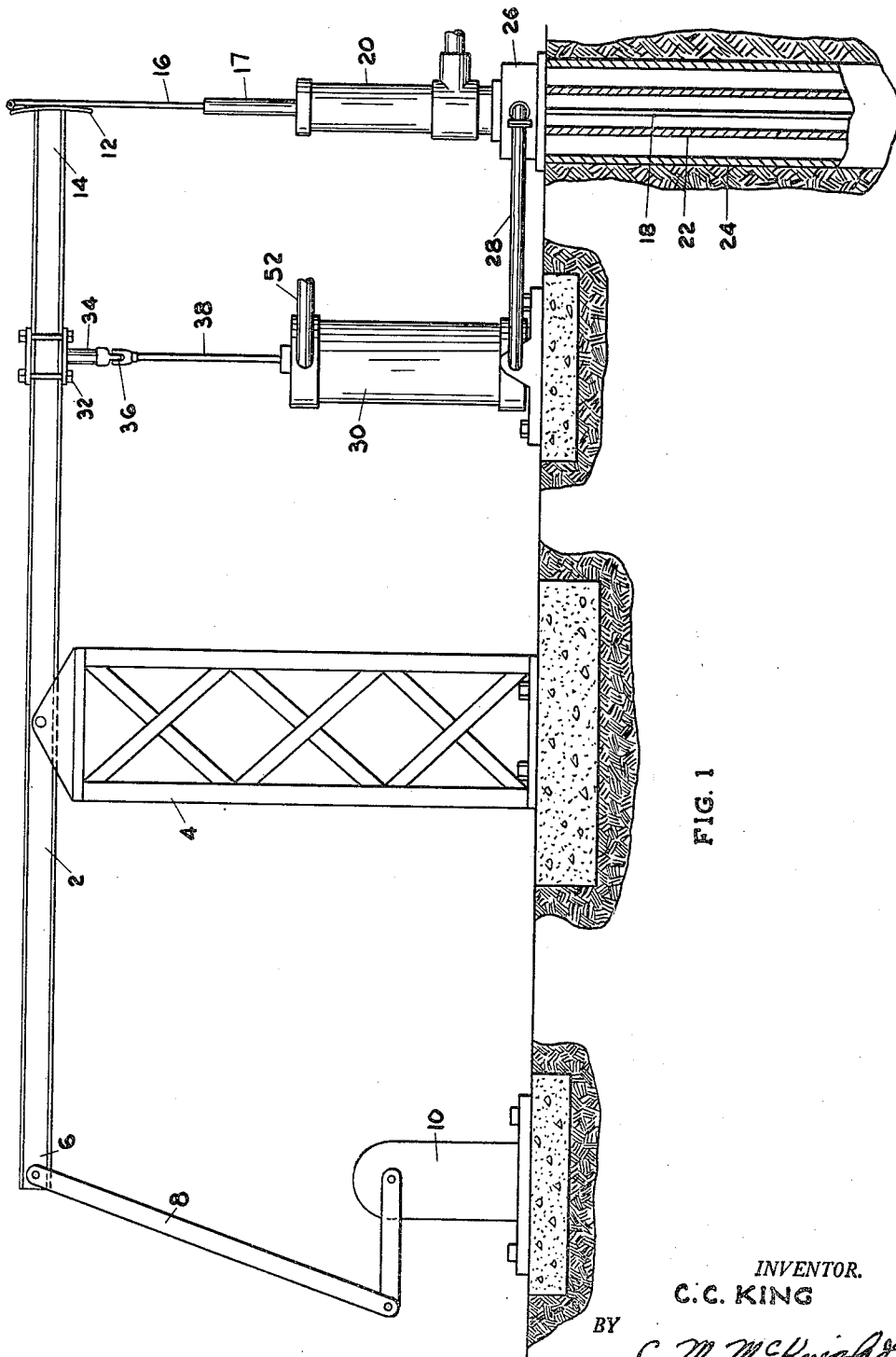


FIG. 1

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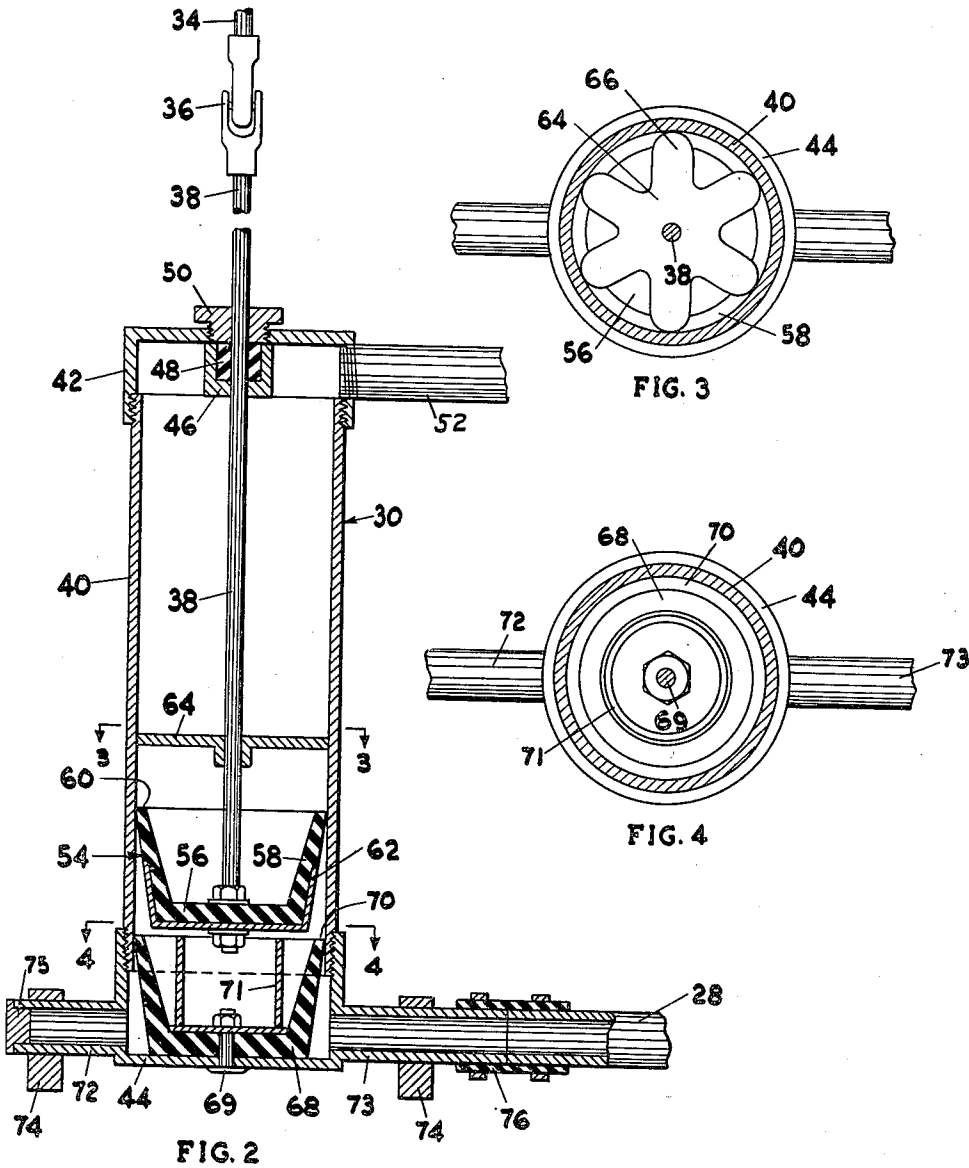
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3 Sheets-Sheet 2



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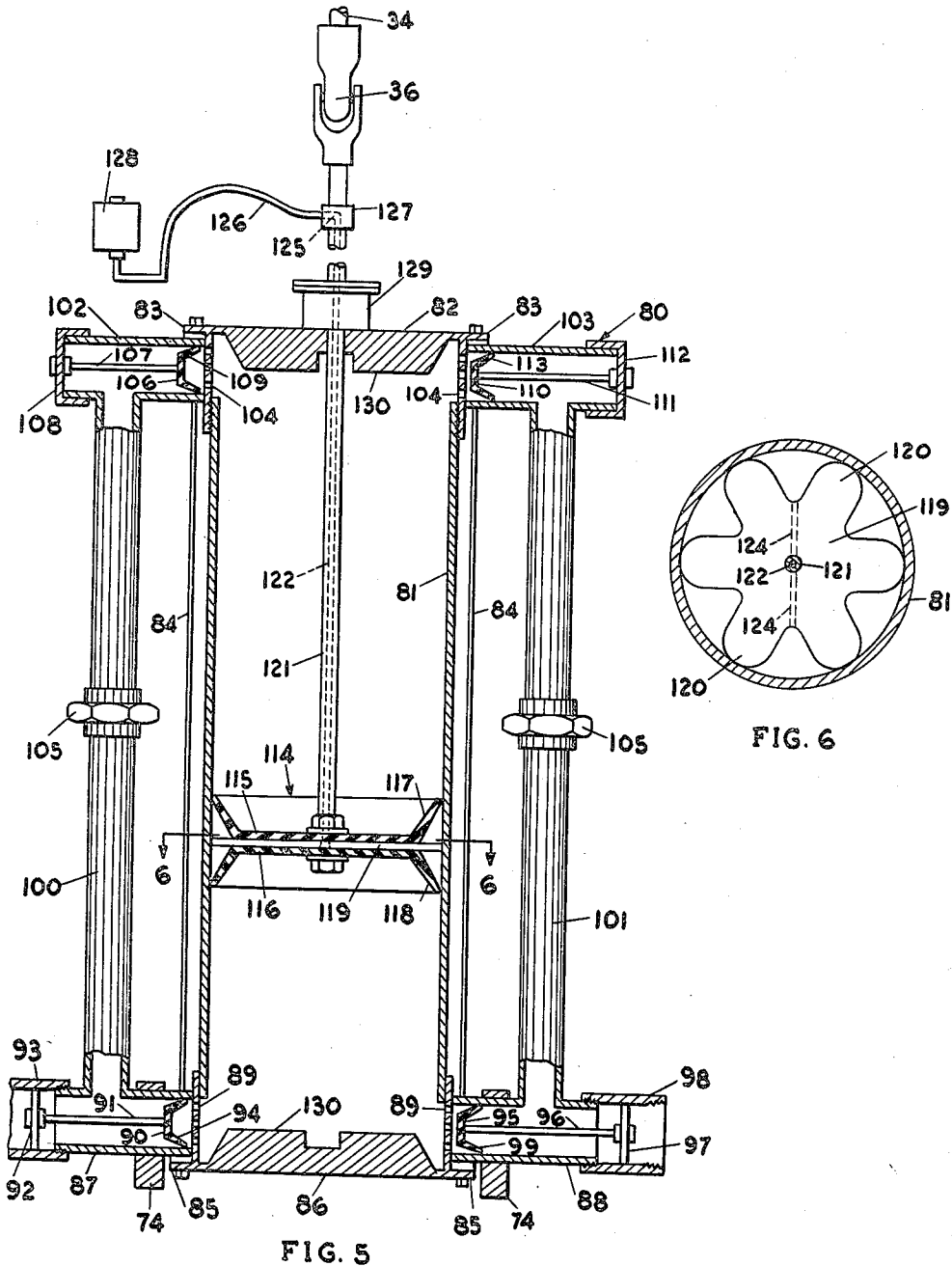
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VACUUM PUMP

Clifford C. King, Duncan, Okla.

Application March 1, 1951, Serial No. 213,397

2 Claims. (Cl. 103-6)

This invention relates to improvements in well pumping equipment, and more particularly, but not by way of limitation, to an improved vacuum pump.

As it is well known in the oil industry, the recovery of oil from a nearly depleted oil well may be increased, and the producing life of the well extended, by inducing a vacuum in the oil well casing. This method of recovery, commonly called secondary recovery, has not received widespread usage because the cost of the required equipment usually exceeds the benefits of the increased recovery. Formerly, it has been the practice to provide a suitable vacuum pump near the well head and to drive the pump with suitable motors auxiliary to the usual surface equipment provided at the surface of the well. It will be readily seen that a very substantial increase in production would be necessary to finance the purchase of the vacuum pump and the auxiliary motive equipment, as well as the maintenance thereof.

The present invention contemplates the provision of a novel vacuum pump adapted to be operated by the walking beam of an oil well or the like. The pump is adapted to be placed under a walking beam and pivot during operation of the beam to compensate for the arcuate movement of the beam and reduce the wear of the pump structure to a minimum.

This invention also contemplates a novel pump structure wherein the plunger and valves are resilient cup shaped members. The pump plunger structure eliminates the use of a traveling valve by automatically providing a bypass of fluid thereby during the return stroke and precluding the flow of fluid during the power stroke. The valves remain in a fixed position, as compared to the conventional reciprocating valve, and alternately permit and preclude flow of fluid thereby, depending upon the pressure of the fluid on the opposite sides thereof.

An important object of this invention is to provide means for efficiently increasing the recovery of oil wells.

Another object of this invention is to provide a novel pump for pulling a vacuum on the casing of an oil well.

Another object of this invention is to provide a novel vacuum pump adapted to be operated by the existing oil well surface equipment.

A further object of this invention is to provide a novel vacuum pump adapted for use under the walking beam of an oil well.

A still further object of this invention is to provide a simply constructed vacuum pump which may be economically manufactured.

Other objects and advantages of the invention will be evident from the following detailed description, read in conjunction with the accompanying drawings, which illustrate my invention.

In the drawings:

Figure 1 is a side elevational view, partially schematic, of a novel vacuum pump installed under the walking beam of an oil well.

Figure 2 is a vertical sectional view of the pump shown in Fig. 1.

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Figure 3 is a sectional view taken on lines 3-3 of Fig. 2.

Figure 4 is a sectional view taken on lines 4-4 of Fig. 2.

Figure 5 is a vertical sectional view of a modified vacuum pump.

Figure 6 is a sectional view taken on lines 6-6 of Fig. 5.

Referring to the drawings in detail, and particularly Fig. 1, reference character 2 designates a walking beam pivotally supported on a standard or Sampson post 4. One end 6 of the walking beam 2 is connected by linkage 8 to a suitable power unit shown schematically at 10 in the usual manner. A hanger 12, commonly called a "Mule Head" is provided on the opposite end 14 of the walking beam 2 to receive a cable or other connecting member 16. The cable 16 extends into a polish rod hanger 17 in the usual manner. The hanger 17 is connected to a polish rod 18 extending downwardly through a tubing hanger and stuffing box shown schematically at 20. The polish rod 18 is in turn connected to suitable sucker rods (not shown) extending downwardly through the well tubing 22 to a sucker rod pump (not shown). The well tubing 22 is suspended in the well casing 24 which extends downwardly to the producing sands (not shown). A cap 26 is provided over the upper end of the casing 24 to seal off the casing in the usual manner. A conduit 28 is connected to the cap 26 to provide communication between the well casing 24 and a novel vacuum pump 30, disposed directly underneath the walking beam 2. A removable bracket 32 is secured on the walking beam 2 above the pump 30 and has a rod 34 depending therefrom. A suitable universal joint 36 interconnects the rod 34 to the upper end of the pump plunger rod 38 to operate the pump 30 during operation of the power unit 10 and walking beam 2 as will be more fully hereinafter set forth.

The pump 30 (Fig. 2) comprises a pump cylinder 40 having upper and lower cylinder heads 42 and 44 respectively threadedly secured to the opposite ends thereof. An apertured boss 46 is provided in the central portion of the upper head 42 to receive the plunger rod 38. Suitable packing 48 is retained in the boss 46 around the rod 38 by a packing nut 50 threadedly secured in the head 42. An outlet conduit 52 is secured transversely in the head 42 and provides communication between the pump cylinder 40 and any desired disposal (not shown). A suitable check valve (not shown) is preferably interposed in the conduit 52, to preclude a retrograde flow of fluid there-through.

A novel plunger 54 is secured on the lower end of the plunger rod 38 within the pump cylinder 40. The plunger 54 comprises a cup shaped resilient member 56 having outwardly tapered side walls 58. The walls 58 are slightly thinned toward their upper ends 60 for purposes as will be hereinafter set forth. A metallic, or other type of rigid material, cup 62 is disposed over the lower end of the resilient cup 56 to provide rigidity for the plunger 54. A guide plate 64 is rigidly secured to the rod 38 above the plunger 54 to retain the plunger 54 centrally in the cylinder 40 during operation thereof. The guide plate 64 is cut away as clearly shown in Fig. 3 to provide a plurality of circumferentially spaced fingers 66 extending into contact with the walls of the cylinder 40. The plate 64 will therefore provide the minimum restriction to flow in the cylinder 40.

A valve 68 (Fig. 2) similar in construction to the plunger 54, is secured in an upright position in the lower cylinder head 44 by a suitable bolt 69. The upper end 70 of the valve 68 contacts the inner periphery of the pump cylinder 40 as will be hereinafter set forth. A nipple 71 is secured in a vertical position in the valve 68 by the bolt 69 and provides a stop for the plunger 54

in the event the plunger 54 moves too far downwardly in the cylinder 40 to prevent damage of the valve 68.

A pair of diametrically opposed conduits 72 and 73 extend from the lower head 44 and communicate with the interior of the pumping cylinder 40. The conduits 72 and 73 extend transversely to the walking beam 2 (see also Fig. 1) and into suitable pillow block type bearings 74 provided on opposite sides of the pump 30 to act as supports for the pump 30. The pump 30 may therefore be pivoted in a vertical plane including the walking beam 2 as will be hereinafter set forth. A suitable plug 75 is secured in the conduit 72 to preclude flow of fluid there-through, and the conduit 73 communicates with the conduit 28. The conduit 73 therefore acts as an inlet for the pump 30. A resilient coupling 76 interconnects the conduits 73 and 28 to permit partial rotation of the conduit 73 without disrupting communication between the conduits. It will be understood that the conduits 73 and 28 may be interconnected by any suitable type of swivel connection.

Operation

During operation of the power unit 10, the walking beam 2 is pivoted on the standard 4 through the medium of the linkage 8 in the usual manner to reciprocate the sucker rod 18 and operate a suitable sucker rod pump (not shown). It will be readily seen that the walking beam 2 will simultaneously reciprocate the pump plunger 54 through the medium of the clamp 32, rod 34, universal joint 36 and plunger rod 38. Since any given point on the walking beam 2 will be moved on the arc of a circle during operation of the beam 2, the clamp 32 and the rod 34 will not be moved in a truly vertical direction to operate the pump 30. It will be readily seen that the universal joint 36, as compared to a rigid connection between the rods 34 and 38, reduces the horizontal movement of the rod 38 to a minimum during reciprocation thereof. Furthermore, the pump 30 is pivotally supported by the conduits 72 and 73 in the bearings 74, therefore the pump cylinder 40 will be pivoted during operation of the rod 38 to retain the cylinder 40 in alignment with the rod 38. It is therefore apparent that wear of the rod 38, pump cylinder 40 and plunger 54 is retained at a minimum to provide a long service life for the pump 30.

During the upstroke of the plunger 54, air or gas in the cylinder 40 above the plunger 54 will force the upper edge 60 of the plunger 54 into sealing contact with the inner periphery of the cylinder 40 and provide a vacuum in the lower portion of the cylinder 40. Resulting vacuum pulls the upper thinned portion 70 of the valve 68 inwardly away from the walls of the cylinder 40 to provide an annular passageway (not shown) around the valve 68. Gas or air in the well casing 24 will therefore flow through conduits 23 and 73 and around the valve 68 into the cylinder 40 below the plunger 54. Simultaneously, air or gas above the plunger 54 will be forced out of the cylinder 40 through the outlet 52 and check valve (not shown) to any desired disposal (not shown).

On the downstroke of the plunger 54, the gas entrained in the cylinder 40 below the plunger 54 will force the upper edge 70 of the valve 68 outwardly into sealing contact with the walls of the cylinder 40 to preclude a retrograde flow of gas around the valve 68. Simultaneously, the gas below the plunger 54, cooperating with the induced vacuum above the plunger 54, forces the upper edge 60 of the resilient cup 56 inwardly to provide an annular passageway around the plunger 54. The gas below the plunger 54 is therefore forced into the upper end of the cylinder 50 preparatory to being discharged on the subsequent upstroke.

The guide plate 64 assures the central disposition of the plunger 54 in the cylinder 40 during operation. As previously set forth, the guide plate 64 provides a negligible restriction to flow of fluid in the cylinder 40. It will

be readily appreciated that the clamp 32 may be selectively secured to the walking-beam 2 to regulate the stroke of the plunger 54 in accordance with the length of the cylinder 40.

When a large amount of gas is present in the casing 24, the pump 30 may be replaced with a double acting pump 80 as shown in Fig. 5 to pull the desired vacuum in the casing 24. The pump 80 comprises a cylinder 81 having an upper apertured head 82 threadedly secured thereto. A plurality of circumferentially spaced brackets 83 extend outwardly from the head 82 to receive tightening bolts 84. The bolts 84 extend downwardly along the cylinder 81 and are connected at their lower ends to complementary brackets 85 extending from the lower cylinder head 86. It is readily seen that the lower head 86 is retained in contact with the cylinder 81 by the rods 84 and may be sealed thereto by any suitable means (not shown).

A pair of diametrically opposed conduits 87 and 88 are secured to the head 86 and communicate through groups of small apertures 89 with the interior of the cylinder 81. The conduits 87 and 88 are adapted to extend into the bearings 74 in the same manner as the conduits 72 and 73 to pivotally support the pump 80. A valve 90, similar in construction to the valve 68 in the pump 30 (Fig. 2), is secured in the conduit 87 adjacent the head 86 by a bolt 91 through the medium of a suitable spider 92 and collar 93. The collar 93 may be placed in communication with the conduit 28 by a suitable swivel connection (not shown). The open end 94 of the valve 90 is disposed adjacent the respective apertures 89 for purposes as will be hereinafter set forth.

A similar valve 95 is secured in the conduit 88 adjacent the opposed group of apertures 89 by a rod 96 through the medium of a spider 97 and collar 98. The collar 98 communicates with any desired disposal (not shown). The open end 99 of the valve 95 is disposed remotely from the head 86. Each of the rods 91 and 96 may be provided with a suitable guide plate (not shown) similar to the guide plate 64 in the pump 30 if desired to assure the central disposition of the respective valve in the respective conduit.

Vertically disposed conduits 100 and 101 extend upwardly from the conduits 87 and 88 respectively and are connected at their upper ends to horizontal conduits 102 and 103 respectively. The conduits 102 and 103 are connected to opposite sides of the upper head 82 and communicate through apertures 104 in the head 82 with the interior of the cylinder 81. A union 105 is preferably interposed in each of the vertical conduits 100 and 101 to facilitate the assembly and disassembly of the pump 80.

A valve 106, similar to valves 90 and 95, is secured in the conduit 102 adjacent the head 82 by a rod 107 through the medium of a cap 108 provided on the outer end of the conduit 102. The open end 109 of the valve 106 is disposed adjacent the head 82. A similar valve 110 is secured in the conduit 103 adjacent the head 82 by a rod 111 through the medium of a cap 112 provided on the outer end of the conduit 103. The open end 113 of the valve 110 is disposed remotely from the head 82. Suitable guide plates (not shown) may also be provided on the rods 107 and 111 if desired to position the respective valves.

A plunger generally indicated at 114 is reciprocally disposed in the cylinder 81. The plunger 114 comprises a pair of oppositely extending resilient cups 115 and 116. The outer portion 117 of the upper cup 115 is turned upwardly and thinned for purposes as will be hereinafter set forth. The outer portion 118 of the lower cup 116 is turned downwardly and thinned. An apertured guide plate 119 is provided between the cups 115 and 116 to retain the cups 115 and 116 centrally in the cylinder 81. The guide plate 119 is cut away as shown in Fig. 6 to provide a plurality of fingers 120 extending into contact with the walls of the cylinder 81.

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The plunger 114 (Fig. 5) is secured to the lower end of a plunger rod 121 extending upwardly through the upper head 82. The upper end of the plunger rod 121 is interconnected by the universal joint 36 to the rod 34 for reciprocating the plunger 114. A vertical lubrication passageway 122 (see also Fig. 6) is provided through a portion of the rod 121. A pair of transverse apertures (not shown) in the lower end of the rod 121 provide communication between the vertical passageway 122 and a pair of apertures 124 provided in the plunger guide plate 119 to lubricate the cups 115 and 116 as will be hereinafter set forth.

A transverse aperture 125 is also provided in the rod 121 at the upper end of the passageway 122 as shown by dotted lines in Fig. 5. A flexible tube 126 is secured in communication with the aperture 125 by a suitable coupling 127. The opposite end of the tube 126 is connected to a lubricator 128, and the lubricator 128 is supported on the pump 80 in any suitable manner (not shown). A suitable stuffing box 129 is provided on the upper head 82 around the rod 121 in the usual manner. Cylindrical shoulders 130 may be provided on the inner faces of the upper and lower heads 82 and 86 if desired to receive the cups 115 and 116 at the upper and lower positions of the plunger 114. The shoulders or projections 130 provide for the maximum removal of fluid from the cylinder 81 on each stroke of the plunger 114 to obtain the maximum in pumping efficiency.

It will be apparent that the plunger 114 may be reciprocated by the walking beam 2 and the pump 80 will pivot about the bearings 74 to align the plunger rod 121 with the cylinder 81. On the upstroke of the plunger 114, a suction will be created in the lower portion of the cylinder 81 to pull gas or air from the well casing 24 through the conduits 28 and 87. The induced vacuum will also force the open end 94 of the valve 90 inwardly and permit passage of gas through the adjacent apertures 89 into the cylinder 81. It will be apparent that since the valve 95 on the opposite side of the cylinder head 86 is disposed in the opposite direction with respect to the cylinder 81, the conduit 88 will be closed off from the cylinder 81. Also during the upstroke of the plunger 114, gas in the upper portion of the cylinder 81 will force the open end 113 of the valve 110 inwardly and flow around the valve 110 into the conduit 103. From the conduit 103, the pressured gas will be discharged through the communicating conduits 101 and 88 to a suitable disposal (not shown). Simultaneously, the pressured gas in the upper portion of the cylinder 81 will force the open end 109 of the valve 106 outwardly to seal off the conduit 102 from the cylinder 81.

On the downstroke of the plunger 114, a vacuum will be created in the upper portion of the cylinder 81 to force the open end 109 of the valve 106 inwardly and permit passage of gas from the well casing 24 through the conduits 28, 87, 100 and 102 into the upper end of the cylinder 81. The valve 110 will be simultaneously closed to seal off the cylinder 81 from the conduit 103. Also during the downstroke of the plunger 114, gas previously drawn into the lower portion of the cylinder 81 will be placed under pressure to force the open end 99 of the valve 95 inwardly. The pressured gas will then flow through the adjacent apertures 89 and conduit 88 to a desired disposal. The pressured gas will also force the open end 94 of the valve 90 outwardly to seal off the conduit 87 from the cylinder 81.

From the foregoing it will be apparent that the pump 80 will pump gas from the well casing 24 during each stroke thereof and is particularly adapted to pull a vacuum on wells having a large amount of gas therein. During the upstroke of the plunger 114, the outer edge 117 of the upper plunger cup 115 will obviously be forced into sealing contact with the inner walls of the cylinder 81, whereas the outer portion 118 of the lower plunger cup 116 will be forced inwardly by the induced

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vacuum below the plunger 114. Therefore, a vacuum is obtained between the cups 115 and 116 to draw lubricant into the cylinder 81 through the apertures 124, passageway 122, aperture 125 and tube 126 from the lubricator 128. The lower cup 116 and inner surface of the cylinder 81 will thereby be efficiently and automatically lubricated to reduce the wear of the plunger 114 and facilitate the seal of the cup 116 to the cylinder 81 during the subsequent downstroke. It will be readily seen that during the downstroke of the plunger 114, the upper plunger cup 115 will be lubricated in a similar manner.

From the foregoing it is apparent that the present invention provides a novel pump for pulling a vacuum on the casing of an oil well to increase the recovery in the well. The pump is adapted to be operated by the walking beam of the oil well, thereby precluding the use of an auxiliary source of motive power. It is also apparent that means are provided to automatically compensate for the arcuate movement of the walking beam. Furthermore, the present invention provides a novel pump structure wherein the usual traveling valve is eliminated and the valves are automatically operated by fluid pressure.

Changes may be made in the combination and arrangement of parts as heretofore set forth in the specification and shown in the drawings, it being understood that any modification in the precise embodiment of the invention may be made within the scope of the following claims without departing from the spirit of the invention.

I claim:

1. In a pump for pulling a vacuum on the casing of a well having a walking beam actuating means, comprising a pump cylinder disposed under the walking beam, means for maintaining the cylinder in a vertical plane during pivotal movement of the walking beam, said means comprising transverse shafts extending from the cylinder and journaled in bearing members for providing a pivotal movement for the pump cylinder, an inlet and outlet for the pump cylinder, a conduit interconnecting the inlet of the pump cylinder with the well casing, a plunger in the pump cylinder and connected with the walking beam to provide reciprocation of the plunger during operation of the beam, a valve disposed below the plunger to cooperate with the plunger and interconnecting conduit for providing a vacuum within the well casing upon reciprocation of the plunger by alternately providing and precluding flow of fluid through the pump.

2. In a pump for pulling a vacuum on the casing of a well having a walking beam, comprising a pump cylinder disposed under the beam, supports extending from opposite sides of the pump cylinder and transversely to the walking beam, bearings for the supports to provide a pivotal movement for the pump cylinder in a vertical plane including the walking beam, an inlet and outlet for the pump cylinder, a conduit interconnecting the inlet of the pump cylinder and the well casing, a plunger in the cylinder, means connecting the plunger and the walking beam to provide reciprocation of the plunger in the cylinder upon actuation of the beam, said means comprising a rod member, a bracket secured to the walking beam, a universal joint providing connection of the rod to the walking beam in a manner to maintain a substantially longitudinal alignment between the cylinder and the rod during vertical reciprocation of the rod upon operation of the beam, a valve secured adjacent one end of the cylinder and in spaced relation to the pump plunger, said valve cooperating with the plunger and interconnecting conduit to alternately provide and preclude flow of fluid through the pump upon reciprocation of the plunger for creating a vacuum within the casing.

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