

Jan. 26, 1965

J. W. HARRIS

3,167,019

DUAL ZONE PUMPING APPARATUS

Filed March 20, 1961

2 Sheets-Sheet 1

FIG. 1.

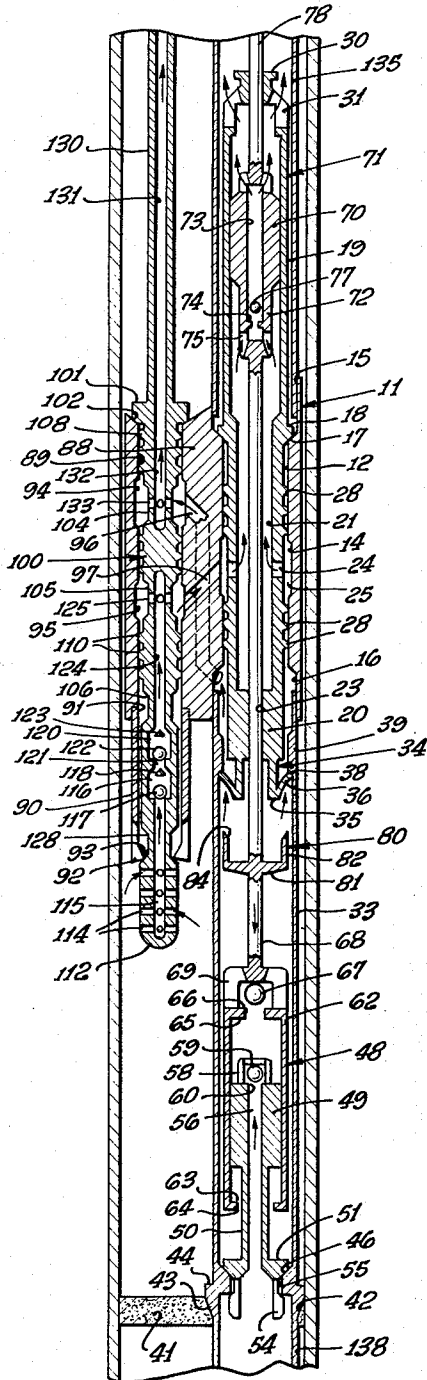
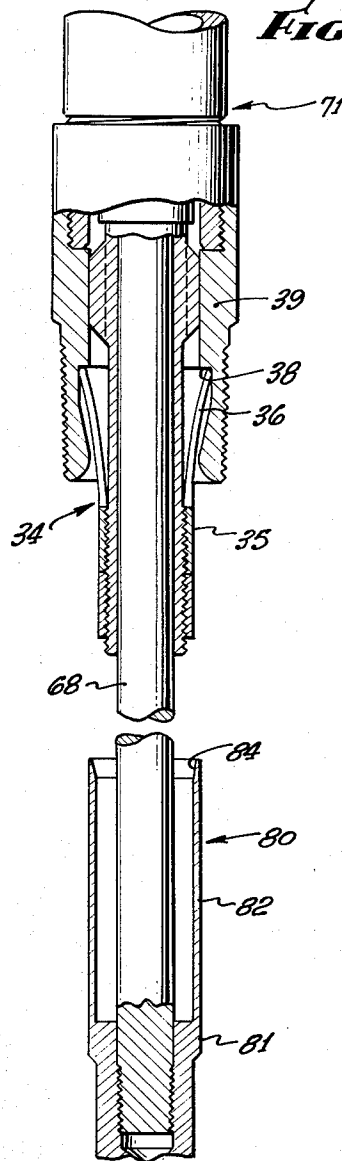


FIG. 2.



JACOB W. HARRIS
INVENTOR.

WHANN & McMANIGAL
Attorneys for Applicant

by *Sheldon Whann*

Jan. 26, 1965

J. W. HARRIS

3,167,019

DUAL ZONE PUMPING APPARATUS

Filed March 20, 1961

2 Sheets-Sheet 2

FIG. 4.

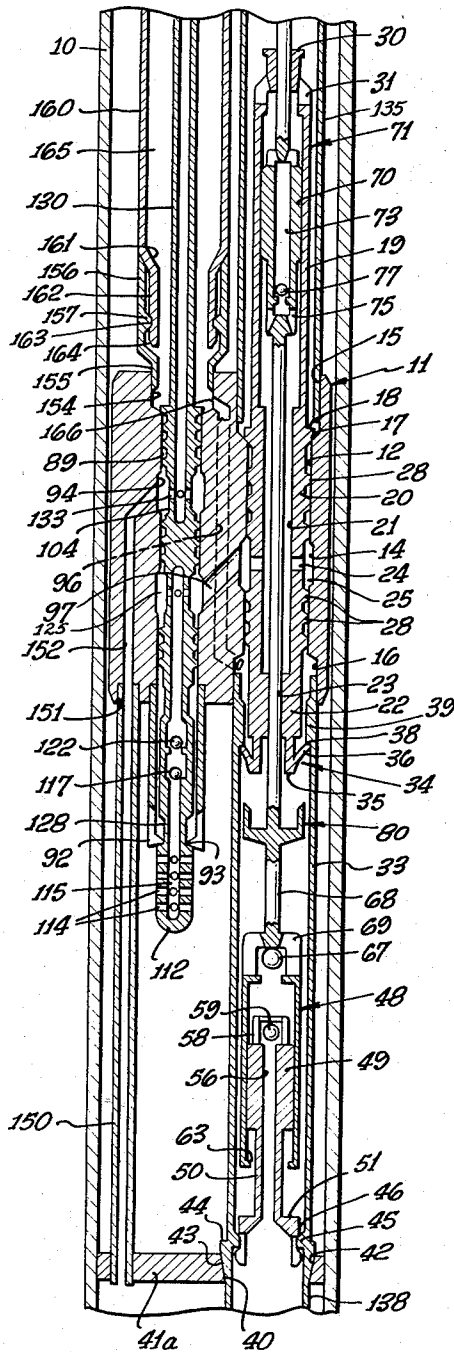
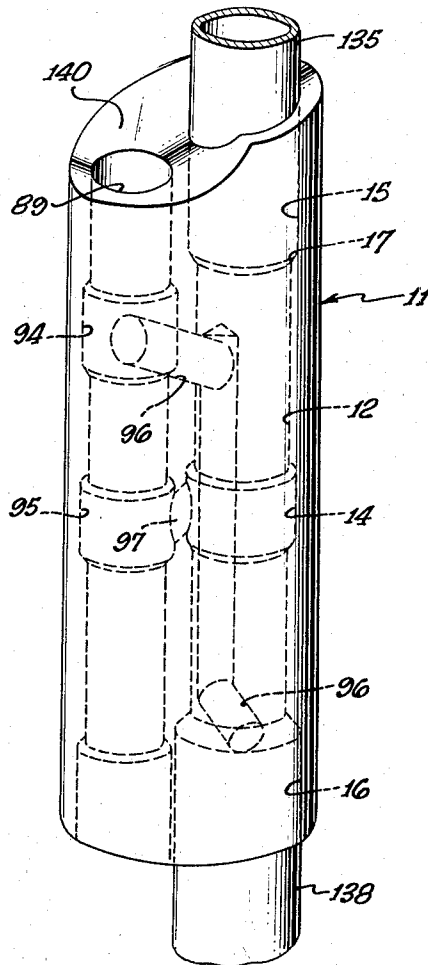


FIG. 3.



JACOB W. HARRIS
INVENTOR.

WHANN & McMANIGAL
Attorneys for Applicant

by Helen Wharrit

1

3,167,019

DUAL ZONE PUMPING APPARATUS

Jacob W. Harris, Anaheim, Calif., assignor to Dresser Industries, Inc., Dallas, Tex., a corporation of Delaware
Filed Mar. 20, 1961, Ser. No. 96,750
13 Claims. (Cl. 103-4)

This invention relates generally to oil well equipment and relates more particularly to dual zone pumping apparatus.

While the invention has particular utility in connection with dual zone oil well pumping apparatus and is shown and described in such connection, it is to be understood that its utility is not confined thereto.

Various well known problems and/or difficulties are involved in the provision of dual zone pumping equipment for oil wells and the like and it is an object of the present invention to provide apparatus that will solve such problems and overcome such difficulties.

It is another object of the invention to provide dual zone pumping apparatus with which either or both zones can be pumped or flowed independently of the other.

It is still another object of the invention to provide pumping apparatus of this character through which certain work-over and remedial operations can be performed without removing the tubing.

It is a further object of the invention to provide pumping apparatus of this character that may be easily and readily assembled.

A still further object of the invention is to provide pumping apparatus of this character wherein removal of the parts for servicing or replacement may be readily and easily effected.

It is another object of the invention to provide pumping apparatus of this character wherein maintenance costs may be kept at a minimum.

It is still another object of the invention to provide pumping apparatus of this character that is relatively simple in construction and operation.

It is a further object of the invention to provide pumping apparatus of this character that is relatively inexpensive to manufacture.

The characteristics and advantages of the invention are further sufficiently referred to in connection with the following detailed description of the accompanying drawings, which represent certain embodiment. After considering these examples, skilled persons will understand that many variations may be made without departing from the principles disclosed, and I contemplate the employment of any structures, arrangements, or modes of operation that are properly within the scope of the appended claims.

Referring to the drawings, which are for illustrative purposes only:

FIG. 1 is a diagrammatically or schematically shown longitudinal section through the pumping apparatus embodying the present invention and installed in a well;

FIG. 2 is an enlarged sectional view of the structure of the hold-down lock, lock nut, and lock-puller coupling of the mechanism;

FIG. 3 is an enlarged perspective view of the landing head of the present apparatus; and

FIG. 4 is a diagrammatic longitudinal sectional view of an alternative arrangement.

Referring more particularly to FIG. 1, there is shown a portion of a well casing 10 in which the present apparatus is operably disposed.

This apparatus includes a landing head, indicated generally at 11 in FIGS. 1 and 3, having a longitudinally extending bore 12 at one side, said bore being annularly enlarged at 14, intermediate its ends, and counterbored at the top and bottom, as indicated at 15 and 16 respec-

2

tively. The lower or inner end of the counterbore 15 is provided with a downwardly and inwardly tapered shoulder 17 on which a flange 18 of cylinder 19 of the upper pump seats, said flange 18 having its seating surface conforming to the shape of the shoulder 17.

From the lower end of cylinder 19 there is a tubular extension 20 of reduced diameter and having a longitudinally extending bore 21 therein which is closed at the lower end by an end member 22 having an axial bore 23 therein. Lateral openings 24 connect the bore 21 of the extension 20 with the annular space 25 between the adjacent exterior portion of the extension 20 and the bottom wall of the groove 14. Above and below the annular space 25 the extension 20 is provided with a plurality of external annular flanges 28 sealingly engaging the adjacent inner wall of the bore 12 of the landing head 11.

There is a primary string 135 within the casing 10, the lower end of said primary string 135 being received in the upper counterbore 15 and releasably secured therein. The parts are secured together by any suitable means and while not shown said means comprises the usual well known threads, the counterbore 15 having internal threads and the lower end of the primary string having external threads screwed into the threads of said counterbore. The upper end of cylinder 19 has an end member 30 with an axial bore therethrough and adjacent said end member there are discharge ports 31 connecting the interior of the cylinder 19 with the interior of the primary string.

At the lower end of the landing head 11 there is a tube 33 secured in the lower counterbore 16 by any suitable means such as threads or the like, not shown. The upper zone pump assembly is releasably locked in position, with the flange 18 seated on the shoulder 17, by means of a lock, indicated generally at 34, said lock comprising a plurality of annularly spaced locking members, each of which includes a supporting part 35 shown as being integral with the lower end wall 22 although the support part may be a separate element secured to said wall by any suitable means. At the lower end of the support part 35 there are a plurality of outwardly extending arcuately shaped resilient fingers 36. The fingers 36 are adapted to engage a shoulder 38 of an internal annular flange 39 of said tubular member 33.

The lower end of said tubular member 33 extends through an opening 40 of a packer 41 operably disposed within the casing 10. The packer 41 is of well known character and the upper end portion of the opening 40 is outwardly flared to provide an inwardly tapering shoulder 42 on which is seated the lower inwardly tapered portion 43 of an exterior flange 44 of tubular member 33. In this lower end portion of the tubular member 33 there is an internal flange 45 having a beveled seat 46.

A lower zone pump, indicated generally at 48, is operably disposed in the lower end portion of the tubular member 33. Pump 48 includes a piston 49 having a depending piston rod 50 terminating at its lower end in an annular flange 51, the lower side of said flange 51 having a taper corresponding to the taper of the seat 46 and said tapered portion of flange 51 rests on seat 46. The piston 49 is held against movement by latching means comprising a plurality of annularly spaced resilient fingers 54 which depend from the flange 51. These fingers may be separate elements attached to the flange 51 but are shown as being integral therewith and are provided with outwardly facing notches 55 in which the flange 45 is received. The portions of the fingers 54 below the notches 55 thereof releasably engage the lower inner edge portion of the flange 45 to hold the piston 49 against movement under normal operating conditions.

A passage 56 extends longitudinally through the piston 49 and piston rod 50. At its upper end piston 49 is pro-

3

vided with a valve cage 58 in which is disposed a valve ball 59 adapted to seat on the port 60 at the upper end of passage 56. The ball or valve member 59 will allow fluid to flow upwardly through the passage 56 but will prevent reverse flow through said passage. The cage 58 serves the usual purpose of retaining the valve member or ball 59 in operating position.

Piston 49 is operably disposed within a pump cylinder 62 which in turn is disposed within the tube or tubular member 33. At its lower end the pump cylinder is provided with an inturned flange 63 which defines a relatively large opening 64 in which the piston rod 50 operably moves. The opening 64 is of sufficient size to permit fluid in the tubular member 33 to flow into the cylinder and out of the cylinder with operative movements of said cylinder without interfering with such operative movements. At its upper end the cylinder is provided with an internal annular flange 65 which defines port 66 for the discharge of oil from the upper end of the cylinder 2, said port being controlled by a ball valve 67.

Cylinder 62 is connected to a polished or pump rod 68. The lower end of rod 68 is provided with a plurality of annularly spaced arms 69 defining a valve cage for the ball valve 67. Arms 69 have their lower ends connected to the flange 65 at the upper end of the cylinder 62, the spaces between the arms 69 permitting the flow of fluid, such as oil, upwardly in the tube or tubular member 33.

Rod 68 extends upwardly through the axial bore 23 in the end member 22 of the tubular extension 20. Rod 68 extends upwardly through the bore 21 of the tubular extension 20 and is connected to a piston 70 of an upper pump indicated generally at 71. Pump rod 68 is of substantially smaller diameter than the bore 21 in the extension 20 to provide a flow passage for the flow of fluid. Piston 70 is operably disposed in the cylinder 19 of the upper pump and said piston has a depending reduced diameter neck 72 to which the upper end of rod 68 is secured by any suitable means. As shown in FIG. 1 the rod and piston are integral, but since the figure is a schematic or diagrammatic one the piston would normally be removably attached to the rod. There is a longitudinally extending passage 73 having an internal flange 74 defining an opening leading to the inlet ports 75 at the lower end of said neck 72. A valve ball 77 is disposed in the passage 73 above the flange 74 and is adapted to seat on said flange and close said port or passage defined thereby.

The upper end of piston 70 is connected to a pump rod 78 which extends upwardly through a bore provided therefor in the end member 30 of pump cylinder 19, the upper end of rod 78 being connected to the usual mechanism for actuating same to operate the pumps.

The apparatus has means for releasing the lock mechanism which holds the upper pump cylinder and extension thereof in position in the landing head 11. This unlocking means comprises an unlocking collar, indicated generally at 80, attached to the pump rod 68. Collar 80 includes a base 81 on the pump rod 68 and a cylindrical flange 82 which extends upwardly of the periphery of the base 81. The free edge of the flange 82 is beveled internally so as to flare outwardly, as at 84. The external diameter of the cylindrical flange 82 is sufficiently smaller than the diameter of the opening defined by the annular flange 39 of the tubular member 33, said cylindrical flange 82 being adapted to engage the fingers 36 and force them inwardly into the interior of said flange 82 for unlocking the upper pump and permitting removal thereof. Since the external diameter of the flange 82 is less than the opening defined by the flange 39, said flange 82 will pass upwardly through said opening and it is to be noted that the external diameter of the lower pump cylinder 62 is also such as to pass through the opening defined by flange 39, so that the lower zone pump may also be readily removed under predetermined conditions, which will be described hereinafter.

Landing head 11 includes a cross-over body 88 having

4

a longitudinally extending passage 89 therethrough. At the lower end of passage 89 there is secured to the landing head a hold-down sleeve 90 having a longitudinal passage 91 therethrough. Passage 91 is of the same diameter as the passage 89 and forms an extension thereof. At its lower end the sleeve 90 is provided with a plurality of annularly spaced locking fingers 92 which have points 93 at their inner lower ends.

Passage 89 is provided with an upper groove 94 which provides an enlargement of said passage and a lower groove 95 spaced downwardly from said groove 94 to provide a second enlargement of said passage 89. There is a flow passage 96 connecting the groove 94 with the counterbore 16 at the lower end of the landing head and groove 95 is connected by a passage 97 with the groove or enlargement 14 of the bore 12 through the landing head.

Within passage 89 of the cross-over body there is a landing spear, indicated generally at 100. Landing spear 100 is removably disposed in passage 89 and is provided at its upper end with an external flange 101 which seats on a beveled seat 102 provided therefor at the upper end of the passage or bore 89.

The landing spear 100 has three external annular grooves therein indicated respectively at 104, 105 and 106. Grooves 104 and 105 are aligned with the grooves 94 and 95 in the cross-over body. Above the groove 104 there are a plurality of longitudinally spaced external annular flanges 108 on the spear and similar flanges between the groove 104 and the groove 105. Below the groove 105 said landing spear has a plurality of similar flanges 110. Flanges 108, 109 and 110 serve as sealing means between the spear and the walls of the passage 89.

At the lower end of the landing spear there is a strainer 112 having a plurality of cross-bores 114 therein which communicate with a longitudinally extending passage 115, said passage 115 being closed at its lower end and communicating at its upper end with an enlarged chamber 116 in which a ball 117 is disposed to serve as a movable valve member within the chamber 116. Ball 117 permits fluid to flow upwardly into the chamber 116 from passage 115 but seats at the upper end of said passage to prevent reverse flow therethrough. At the upper end of chamber 116 there is a stop member 118 which limits upward movement of the ball 117. Above chamber 116 there is a chamber 120 and said chambers are connected together by means of a passage 121. Within chamber 120 there is a ball valve 122 which seats at the upper end of passage 121, permitting upward flow of fluid therethrough but preventing reverse flow. A stop member 123 is provided at the upper end of chamber 120 to limit upward movement of ball 122. From chamber 120 there is a passage 124 extending upwardly in the spear and communicating with the groove 105 by means of cross-bores 125. Just above the strainer 112 there is an external annular groove 128 in the landing spear and the lower wall of said groove provides a shoulder engaged by the points 93 of the fingers 92 to releasably secure the landing spear in position.

The upper end of the landing spear is connected with a secondary parallel string 130 having a passage 131 therethrough which is connected with a passage 132 extending downwardly in the landing spear and being connected with the groove 104 by cross-bores 133.

The landing head 11 is lowered into the casing 10 by means of a primary string 135, the lower end of which is secured in the counterbore 15 by any suitable means such as screw threads or the like. The primary string extends from the surface and supports said landing head. It is to be noted that the packer 41 is installed in the usual well known manner and the lower end portion 138 of member 33 below the flange 44 extends through the opening 40 of said packer with the tapered portion 43 of flange 44 seated in the correspondingly tapered upper portion of said opening 40.

With the landing head 11 and the upper and lower zone pumps thus installed, upward and downward movement of the pump rod 78, which is connected to the pumping mechanism at the surface, will effect upward and downward pumping action of the upper pump piston 70 and the cylinder 62 of the lower zone pump, it being noted that the cylinder 19 of the upper pump and the piston 49 of the lower pump are held stationary.

With upward movement of cylinder 62 oil is drawn upwardly through the lower end portion 138 of the tubular member 33, through the piston passage 56 and into the upper portion of the cylinder, ball 59 moving off its seat during this stroke of the pump, ball 67 then closing port 66. When the cylinder 62 moves in the opposite direction ball valve 59 seats on its seat 60 and prevents reverse flow of oil, while ball valve 67 moves off its seat to open port 66. On the down stroke of cylinder 62 oil is forced upwardly through the port 66, spaces between the arms 69, into the tubular member 33 and into the counterbore 16 from which it flows through the passage 96 into the annular space formed by the grooves 94 and 104, through the cross-bores 133 and thence upwardly to the surface through the passage 131 in the secondary parallel string 130.

The landing spear may be installed after the landing head has been installed in the casing 10. When installing the landing spear after the landing head has been installed, the lower end of the spear is guided into the passage 89 by recessing the upper end of the landing head, as at 140, with the bottom of the recess inclined toward the upper end of said passage 89.

When the landing spear has been inserted into the passage 89 to a position whereat the flange 101 is seated at the upper end of the landing head, the finger 92 locks the spear in position.

Oil from the zone above the packer passes through the cross-bores 114 and into the passage 115 of the landing spear and thence upwardly into the passage 124, flow of oil upwardly in this manner is permitted by the ball valves 117 and 122 but reverse flow is prevented by the seating of said ball valve. It is the upper zone pump 71 which draws the oil from this upper zone and the oil from the passage 124 flows through the crossbores 125 into the annular chamber or recess defined by the grooves 95 and 105 and thence the oil passes through the crossover passage 97 into the recess or groove 14. From this groove the oil is drawn through the crossbores 24 and into the bore 21 in the extension 20 of the cylinder 19 of the upper zone pump.

The oil from the upper zone is drawn upwardly into the lower end of the cylinder 19 when the piston 70 of the upper zone pump moves upwardly. When the piston 70 moves downwardly the oil in the lower end of the cylinder will pass through the openings 75, passage 74, and into the passage 73 of the piston. The ball valve 77 will be unseated during this stroke of the pump and will be limited in its upward movement by a stop member 141. When the piston 70 has reached its lowermost position and starts on its return stroke the valve 77 will close and oil in the cylinder 19 above the piston 70 will be forced upwardly out of the upper end of said piston by way of the openings 31 and will thence be forced up through the primary string 135 to the surface.

Should it be desired to remove the upper and lower pumps, the rod 78 will be pulled upwardly to a point whereat the flange 63 of the lower zone pump piston 62 will engage the under side of the piston 49 and further upward movement of the rod will effect release of the fingers 54 of the flange 51 of the piston rod 50.

Referring to FIG. 4, there is shown an alternative arrangement. The upper and lower zone pumps and the landing spear are the same as in the arrangement hereinabove described.

In FIG. 4 there is a vent to the surface for gas from the region immediately below the packer, indicated at 41a.

This vent comprises a pipe 150 having its lower end received in an opening provided therefor in the packer 41a. The upper end of the pipe 150 is secured by any suitable means, such as screw threads, not shown, in a bore 151 of the landing head. From the bore 151 there extends a passage 152 to the recess 94 which is connected to the secondary parallel string 130 by the annular groove 104 and cross-bores 133.

The upper end of the passage 89 in the body of the landing head is counterbored, as at 154, and the lower reduced diameter end 155 of a socket member 156 is secured in said counterbore by any suitable means, such as screw threads, not shown.

The socket member 156 is provided with an internal flange 157 and the upper free edge of said socket member is flared at 158 to provide a seat. A third parallel string 160 extends from the surface downwardly and is provided adjacent its lower end with an inwardly inclined part 161 which is adapted to seat on said seat 158. A seal of any suitable character, not shown, may be provided at the seat for sealing the connection the socket and third parallel string to prevent the escape of oil therepast. From the part 161 of the parallel string there are a plurality of annularly spaced depending fingers 162 which are resilient and which have notches 163 in the outer surfaces thereof for reception of the flange 157 to thereby releasably lock the lower end of the parallel string 160 in said socket member 156. It is to be noted that the lower ends of the fingers are downwardly and inwardly inclined, as at 164, to form cam surfaces so that said fingers will be forced inwardly to pass the flange 157 when the third parallel string is lowered into the socket member.

The annulus, or annular space 165, between the second and third parallel string, provides a passage for the upward flow of oil or other fluid from the lower zone pump, the passage 96 from the counterbore 16 connecting with said annulus at one 166.

Thus the arrangement shown in FIG. 4 provides for the pumping of oil from two zones upwardly to the surface and also provides for a gas or other vent from the lower zone to the surface.

It is believed that the invention and its attendant advantages will be understood from the foregoing description and that it will be apparent that various changes may be made in the form, construction and arrangement of the parts of the invention without departing from the spirit and scope thereof or sacrificing its material advantages, the embodiments hereinbefore described being merely for the purposes of illustration.

I claim:

1. Dual zone pumping apparatus for installation within casings of oil wells, comprising: a landing head having a smaller external diameter than the internal diameter of said well casing, said landing head comprising a crossover body having a pair of longitudinally extending parallel passages therethrough, one of said passages being of larger diameter than the other; a primary string secured to the crossover body in alignment with the larger passage through said body; a tubular member secured to the lower end of the body in alignment with said larger passage and having an annular internal flange adjacent the upper end and an internal annular flange in downwardly spaced relation therewith, said tubular member extending downwardly to the lower zone; a packer in said casing separating the upper and lower zones and having an opening through which said tubular member extends; an upper pump cylinder having a depending tubular extension with a wall at the lower end thereof, said wall having an axial bore therethrough; a plurality of annularly spaced releasable latching fingers secured to the lower end of said extension, the free ends of said fingers releasably engaging the lower internal edge of the upper flange of said tubular member; a lower pump piston having a depending tubular piston rod; an annular external flange at the lower end of said rod, having a plurality of annularly spaced depend-

ing latching fingers releasably engaging the lower internal annular flange in said tubular member, said piston rod and piston having a longitudinally extending passage therethrough; a standing valve at the upper end of said bore of the piston, said valve permitting upward flow of fluid but preventing reverse flow through the passage in the piston; an upper pump piston in said upper pump cylinder, said upper pump piston having a longitudinal passage therethrough; a check valve controlling said passage permitting upward flow of fluid through said passage and preventing reverse flow therethrough; a pump rod connected to the upper end of said upper pump piston and adapted to be operably connected to pumping mechanism at the surface; a pump rod connected to the lower end of said piston and extending downwardly through said extension and bore through the lower wall thereof; a lower pump cylinder operably receiving the lower pump piston, the upper end of said cylinder being connected to the lower end of the second mentioned pump rod, said cylinder having a wall closing the upper end thereof and having an outlet port therein; a valve controlling said outlet port permitting upward flow of fluid therethrough but preventing reverse flow; a cylindrical flange carried by the second mentioned pump rod in downwardly spaced relation to the latch means at the lower end of the extension of the upper pump cylinder and adapted to disengage the fingers thereof from the flange at the upper end of the tubular member when the pump rod is moved upwardly to a predetermined point to effect release of said fingers; a landing spear disposed in the smaller passage through the landing head, said spear having a flange at the upper end seating on the upper end of said landing head and a strainer at the lower end below the landing head and having an external annular groove at the upper end of said strainer; a locking sleeve secured to the crossover body in alignment with the smaller passage therethrough; flexible latching fingers at the lower end of said sleeve, said latching fingers being annularly spaced apart and releasably received in the annular groove at the upper end of the strainer to thereby releasably lock the landing spear in said smaller passage; said landing spear having a passage extending upwardly therein and closed at the upper end; check valves controlling the flow of fluid through the upwardly extending passage of said landing spear to permit upward flow of fluid therein but preventing reverse flow, there being crossover passageway means between the upwardly extending passage in said landing spear and the interior of said extension of the upper pump cylinder for the flow of fluid therethrough, into the passage through the upper pump piston and upwardly into the primary string, there also being a passage extending downwardly in the upper end of said landing spear and closed at its lower end, said crossover body having crossover passage means for the flow of oil from the upper end of the tubular member to the upper end portion of the landing spear which has means providing a connection for the flow of oil into the upper passage in said landing spear; and a secondary parallel string extending upwardly from the upper end of the landing spear, said secondary string having a passage therethrough connected with the passage in the upper end of said landing spear whereby oil pumped by the lower zone pump will be transmitted to the surface independently of the oil pumped to the surface by the upper zone pump.

2. Dual zone pumping apparatus for installation within casings of oil wells, comprising: a landing head comprising a crossover body having a pair of longitudinally extending parallel passages therethrough, one of said passages being of larger diameter than the other; a primary string secured to the upper end of said crossover body in alignment with the larger passage therethrough; a tubular member secured to the lower end of the body in alignment with said passage, said tubular member having one internal flange adjacent its upper end and a second internal flange spaced downwardly therefrom; an upper pump

cylinder having a depending tubular extension with a wall at the lower end thereof, said wall having an axial bore therethrough; a latching means at the lower end of said extension releasably engaging said one internal flange of said tubular member; a lower pump piston having a depending tubular rod; latching means on said tubular rod releasably engaging said second internal annular flange of said tubular member, said piston rod and piston having a longitudinally extending bore therethrough; a standing valve at the upper end of said bore of the piston, said valve permitting upward flow of fluid but preventing reverse flow through said piston bore; an upper pump piston in said upper pump cylinder, said upper pump piston having a longitudinal passage therethrough; a check valve controlling said passage permitting upward flow of fluid through said passage and preventing reverse flow therethrough; a pump rod connected to the upper end of said upper pump piston and adapted to be operably connected to pumping mechanism at the surface; a pump rod connected to the lower end of said piston and extending downwardly through said extension and bore through the lower wall thereof; a lower pump cylinder operably receiving the lower pump piston, the upper end of said cylinder being connected to the lower end of the second mentioned pump rod, said cylinder having a wall closing the upper end thereof and having an outlet port therein; a valve controlling said port permitting upward flow of fluid therethrough but preventing reverse flow; a cylindrical flange carried by the second mentioned pump rod in downwardly spaced relation to the latch means at the lower end of the extension of the upper pump cylinder and adapted to effect release of the latching means at the lower end of said extension when the pump rod is moved upwardly to a predetermined position; a landing spear disposed in the smaller passage through the landing head, said spear having a strainer at the lower end below the landing head; a lock sleeve secured to the crossover body in alignment with the smaller passage therethrough; locking means on said lock sleeve releasably locking the landing spear in said smaller passage; said landing spear having a passage extending upwardly therein and closed at the upper end; check valves controlling the flow of fluid through the upwardly extending passage of said landing spear to permit upward flow of fluid therein but preventing reverse flow, there being passageway means between the upwardly extending passage in said landing spear and the interior of said extension of the upper pump cylinder for the flow of fluid therethrough, into the passage through the upper pump piston, and upwardly into the primary string, there also being a passage extending downwardly in the upper end of said landing spear and closed at its lower end, said crossover body having a passage for the flow of oil from the upper end of the tubular member to the upper end portion of the landing spear which has means providing a connection for the flow of oil into the upper passage in said landing spear; and a secondary parallel string from the upper end of the landing spear, said secondary string having a passage therethrough connected with the passage in the upper end of said landing spear whereby oil pumped by the lower zone pump will be transmitted to the surface independently of the oil pumped to the surface by the upper zone pump.

3. Dual zone pumping apparatus for installation within casings of oil wells, comprising: a crossover body having a pair of longitudinally extending parallel passages therethrough; a primary string secured to the crossover body in alignment with one of said passages through said body; a tubular member secured to the lower end of the body in alignment with said passage, said tubular member having an upper interior flange and a lower interior flange and an exterior flange in the region of said lower interior flange; an upper pump including a cylinder having a depending tubular extension with a wall at the lower end thereof, said wall having an axial bore therethrough; the lower end of said extension for releasably engaging the

upper flange; a lower pump piston having a longitudinally extending bore therethrough; latching means connected to said piston for releasably engaging said lower interior flange; a check valve at the upper end of the bore of said piston, said valve permitting upward flow of fluid but preventing reverse flow through said piston bore; an upper pump piston in said upper pump cylinder, said upper pump piston having a longitudinal passage therethrough; a check valve controlling said passage permitting upward flow of fluid through said passage and preventing reverse flow therethrough; an upper pump rod connected to the upper end of said upper pump piston and adapted to be operably connected to pumping mechanism at the surface; a lower pump rod connected to the lower end of said piston and extending downwardly through said extension and bore through the lower walls thereof; a lower pump cylinder operably receiving the lower pump piston, the upper end of said cylinder being connected to the lower end of the lower pump rod, said cylinder having a wall closing the upper end thereof and having an outlet port therein; a check valve controlling said port permitting upward flow of fluid therethrough but preventing reverse flow; latch release means carried by the lower pump rod in downwardly spaced relation to the latch means at the lower end of the extension of the upper pump cylinder and adapted to effect release of said latch means from said interior flange; a landing spear disposed in the other passage through the landing head; latch means responsive to a predetermined upward pull on said spear, releasably latching said spear in said other passage; a strainer at the lower end of said spear and below the landing head, said spear having a passage extending upwardly therein from said strainer and closed at the upper end; check valve means controlling the flow of fluid through the upwardly extending passage of said landing spear to permit upward flow of fluid therein but preventing reverse flow, there being passageways, including a crossover passage, between the upwardly extending passage in said landing spear and the interior of said extension of the upper pump cylinder for the flow of fluid therethrough and into the passage through the upper pump piston whereby oil pumped by said upper pump is pumped into the primary string, there also being a passage extending downwardly in the upper end of said landing spear, said crossover body having a passage for the flow of oil from the upper end of the tubular member to the upper end portion of the landing spear which has means providing a connection for the flow of oil into the upper passage in said landing spear; and a secondary parallel string extending from the upper end of the landing spear, said secondary string having a passage therethrough connected with the passage in the upper end of said landing spear whereby oil pumped by the lower zone pump will be transmitted to the surface.

4. In dual zone pumping apparatus for installation within casings of oil wells: a crossover body having a pair of longitudinally extending parallel passages therethrough; an upwardly extending primary string connected to said body in axial alignment with one of said passages therein; a depending tubular member connected to the lower end of said body in axial alignment with said one passage; an upper zone pump comprising a fixed cylinder and a longitudinally movable piston having a flow passage therethrough; a check valve controlling said flow passage and permitting upward flow of fluid but preventing reverse flow through the piston flow passage; means releasably securing said upper cylinder in said one passage in the crossover body; a lower zone pump comprising a fixed piston having a flow passage therethrough; a check valve controlling flow of fluid through said passage through the lower zone pump piston permitting upward flow of fluid but preventing reverse flow; latch means releasably latching said lower zone pump piston in the tubular member; a lower pump cylinder operably receiving the lower pump piston, said cylinder having a wall closing the upper end thereof and having an outlet

port therein; a check valve controlling the outlet port of the lower zone pump cylinder, said check valve permitting upward flow of fluid but preventing reverse flow; an upper pump rod having its lower end connected to the piston of the upper zone pump; a lower zone pump rod having its upper end connected to the piston of the upper zone pump and having its lower end connected to the cylinder of the lower zone pump; means on the lower pump rod for effecting release of the latching means for the upper zone pump cylinder when the pump rods are moved upwardly to a predetermined position; a landing spear in the other of said parallel passages through the crossover body, said landing spear having an upper longitudinally extending passage and a lower longitudinally extending passage, said passages being separated from each other; latching means responsive to a predetermined upward pull on the landing spear for releasably securing said landing spear in said other passage; a strainer at the lower end of said landing spear, said strainer being connected to the lower passage in said landing spear; check valve means controlling flow of fluid through said lower passage of the landing spear, said check valve means permitting upward flow of fluid but preventing reverse flow; and a secondary parallel string extending upwardly from said landing spear and having a flow passage therethrough connected with the upper passage in said landing spear, there being passageway means, including crossover passages, connecting the discharge end of the lower zone pump with the upper passage in the landing spear; and passageway means, including a crossover passage in the crossover body, connecting the lower passage in the landing spear with the inlet end of the cylinder of the upper zone pump.

5. In dual zone pumping apparatus for installation within casings of oil wells: a crossover body having a pair of longitudinally extending parallel passages therethrough; an upwardly extending primary string connected to said body in axial alignment with one of said passages therein; a depending tubular member connected to the lower end of said body in axial alignment with said one passage; an upper zone pump comprising a fixed cylinder and a longitudinally movable piston having a flow passage therethrough; a check valve controlling said flow passage and permitting upward flow of fluid but preventing reverse flow through the piston flow passage; means releasably securing said upper cylinder in said one passage in the crossover body; a lower zone pump comprising a fixed piston having a flow passage therethrough; a check valve controlling flow of fluid through said passage through the lower zone pump piston permitting upward flow of fluid but preventing reverse flow; latch means releasably latching said lower zone pump piston in the tubular member; a check valve controlling the outlet port of the lower zone pump cylinder, said check valve permitting upward flow of fluid but preventing reverse flow; a lower pump cylinder operably receiving the lower pump piston, said cylinder having a wall closing the upper end thereof and having an outlet port therein; an upper pump rod having its lower end connected to the piston of the upper zone pump; a lower zone pump rod having its upper end connected to the piston of the upper zone pump and having its lower end connected to the cylinder of the lower zone pump; means on the lower pump rod for effecting release of the latching means for the upper zone pump cylinder when the pump rods are moved upwardly to a predetermined position; a landing spear in the other of said parallel passages through the crossover body, said landing spear having upper and lower fluid flow passages therein; latching means responsive to a predetermined upward pull on the landing spear for releasably securing said landing spear in said other passage; a secondary parallel string extending upwardly from said landing spear and having a flow passage therethrough connected with one of the flow passages in said landing spear, there being passageway means connecting the discharge end of

the lower zone pump with the upper passage in the landing spear; passageway means connecting the lower passage in the landing spear with the lower end of the cylinder of the upper zone pump, and check valve means for controlling the flow of fluid through last mentioned passageway means, said check valve permitting upward flow of fluid through the upper zone pump but preventing reverse flow therethrough.

6. In dual zone pumping apparatus for installation within casings of oil wells: a crossover body having a pair of longitudinally extending parallel passages therethrough; an upper zone pump operably associated with one of said passages, said pump having an inlet and an outlet; a depending tubular member connected to the lower end of said body in axial alignment with said one passage; valve means controlling fluid flow through said pump; locking means releasably securing said pump to the crossover body; a lower zone pump operably associated with said one passage, said pump having an inlet and an outlet; valve means controlling flow of fluid through said lower zone pump; latch means releasably latching said lower zone pump to said tubular member; an upper pump rod having its lower end connected to a pumping part of the upper zone pump; a lower zone pump rod having its upper end connected to said pumping part of the upper zone pump and having its lower end connected to a pumping part of the lower zone pump; means on the lower pump rod for effecting release of the locking means for the upper zone pump when the pump rods are moved upwardly to a predetermined position; a landing spear in the other of said parallel passages through the crossover body; latching means responsive to a predetermined upward pull on the landing spear in said other passage; and a secondary parallel string extending upwardly from said crossover body and having a flow passage therethrough, there being passageway means, including a crossover passage connecting the outlet of the lower zone pump with the flow passage in the secondary string; and passageway means, including a crossover passage in the crossover body and a passage in said landing spear connecting the end of the landing spear with the inlet of the upper zone pump; and valve means for controlling the last mentioned passageway means.

7. Dual zone pumping apparatus for installation within casings of oil wells and the like, comprising: a crossover body having a pair of parallel passages extending therethrough; a primary string extending upwardly from said crossover body and having its lower end connected to the upper end of said body in axial alignment with one of the passages therethrough; a depending tubular member having its upper end secured to said crossover body, said tubular member being in axial alignment with said one passage; an upper pump comprising a stationary cylinder and a reciprocating piston having a flow passage therethrough; a check valve controlling said flow passage and permitting upward flow of fluid therethrough but preventing reverse flow; means releasably locking the upper pump cylinder against movement; a lower pump comprising a stationary piston having a flow passage therethrough and a reciprocating cylinder having an outlet port at its upper end; means releasably locking the piston of the lower pump against movement and being released by predetermined upward pull on said piston; a check valve controlling the flow of fluid through the passage of the lower pump piston, said check valve permitting upward flow of fluid but preventing reverse flow; a check valve controlling the outlet port of the lower pump cylinder permitting upward flow through said port but preventing reverse flow therethrough; an upper pump rod having its lower end connected to the piston of the upper pump; a lower pump rod having its upper end connected to the upper pump piston and having its lower end connected to the lower pump cylinder; unlocking means on the lower pump rod, said unlocking means being adapted to effect unlocking of the locking means for the upper pump

cylinder when said unlocking means has been moved upwardly a predetermined distance; a landing spear in the other passage of said crossover body; means releasably securing the landing spear in said other passage, said means releasing said landing spear upon a predetermined upward pull thereon; a vent string connected to the upper end of said landing spear and extending upwardly therefrom, said vent string having a vent passage therethrough; a strainer at the lower end of said landing spear; an upwardly extending parallel string about the vent string and defining with said vent string an annular upwardly extending flow passage; means releasably locking said parallel string to the upper end of the crossover body; a vent conduit having its upper end connected to the lower end of the crossover body, said vent conduit extending downwardly to communicate with the upper end of the lower zone in the casing; a packer secured in the casing and receiving the lower end of the vent conduit, said packer having an opening therein for operable reception of the tubular member; passageway means including a crossover passage, connecting the discharge end of the lower pump with the annular upwardly extending passage of the parallel string; passageway means connecting the lower end of the upper pump with the strainer of said landing spear; check valve means permitting flow from the strainer to the upper pump but preventing reverse flow; and passageway means connecting the upper end of the vent conduit with the vent passage of the vent string.

8. Dual zone pumping apparatus for installation within casings of oil wells and the like, comprising: a crossover body having a pair of parallel passages extending therethrough; a primary string extending upwardly from said crossover body and having its lower end connected to the upper end of said body in axial alignment with one of the passages therethrough; a depending tubular member having its upper end secured to said crossover body, said tubular member being in axial alignment with said one passage; an upper pump having an inlet and an outlet and operably connected to said crossover body and disposed in said primary string; valve means controlling fluid flow through said upper pump; means releasably locking the upper pump to said crossover body in operable position; a lower pump in said tubular member and having an inlet and an outlet; means releasably latching the lower pump in said tubular member; said latching means being released by predetermined upward pull on a part of the lower pump; valve means controlling the flow of fluid through the lower pump; an upper pump rod having its lower end operably connected to the upper pump; a lower pump rod having its upper end connected to the upper pump and having its lower end operably connected to the lower pump; unlocking means on the lower pump rod, said unlocking means being adapted to effect unlocking of the locking means for the upper pump when said unlocking means has been moved upwardly a predetermined distance; a landing spear in the other passage of said crossover body, said spear having an inlet passage; means releasably securing the landing spear in said other passage, said means releasing said landing spear upon a predetermined upward pull thereon; a vent string connected to the upper end of said landing spear and having a vent passage therethrough; an upwardly extending parallel string about the vent string and defining with said vent string an annular upwardly extending flow passage; means releasably locking said parallel string to the upper end of the crossover body; a vent passage having its inlet at the lower end of the crossover body and connected to said vent string by passageways, including passageway means in a part of said landing spear; passageway means including a crossover passage, connecting the outlet of the lower pump with the annular upwardly extending passage of the parallel string; passageway means connecting the inlet of the upper pump with the inlet passage of said landing spear;

13

and valve means permitting fluid flow to the upper pump but preventing reverse flow.

9. Dual zone pumping apparatus for installation within casings of oil wells and the like, comprising: a crossover body having a pair of parallel passages extending therethrough and a vent inlet at its lower end; an upper pump releasably locked to said crossover body and operably related to one of said parallel passages in said body; a lower pump having an operable connection with said upper pump; means releasably latching the lower pump to said crossover body, said latching means being released by predetermined upward pull on a part of said lower pump; unlocking means carried by the operable connection between the lower pump and the upper pump for unlocking of the locking means for the upper pump when said unlocking means has been moved upwardly a predetermined distance; a landing spear releasably latched in the other passage of said crossover body and released upon a predetermined upward pull on said spear, said landing spear having an inlet; a vent string connected to the upper end of said landing spear; an upwardly extending parallel string about the vent string and defining with said vent string an annular upwardly extending flow passage, said parallel string being releasably latched to said crossover body and released by a predetermined upward pull on said parallel string; passageway means including a crossover passage in said crossover body, connecting the discharge end of the lower pump with the annular upwardly extending passage of the parallel string; passageway means connecting the inlet end of the upper pump with the inlet of said landing spear; and passageway means connecting the vent inlet with the vent string.

10. In dual zone pumping apparatus for installation within casings of oil wells and the like, including: a crossover body; interconnected upper and lower zone pumps releasably connected to said body in operable relationship therewith; a landing spear releasably connected to said crossover body; a vent string operably connected to said landing spear; a parallel string releasably connected to said crossover body and disposed about the vent string to define therewith an annular upwardly extending flow passage, there being vent passageway means connecting the vent string with the lower end of the crossover body, passageway means including a crossover passage in the crossover body, connecting the outlet of the lower pump with the annular upwardly extending passage of the parallel string, and passageway means, including a part in said landing spear connecting the inlet of the upper pump with the lower end of said body.

11. In dual zone pumping apparatus for installation within casings of oil wells for separately pumping fluids from a plurality of longitudinally spaced production zones: a crossover body having a pair of longitudinally extending parallel passages therethrough; an upwardly extending primary string connected to said body in axial alignment with one of said passages therein; a depending tubular member connected to the lower end of said body in axial alignment with said one passage; an upper zone pump comprising a fixed cylinder and a longitudinally movable piston having a flow passage therethrough; a check valve opening upon downward movement of said piston and controlling said flow passage and permitting upward flow of fluid but preventing reverse flow through the piston flow passage; means releasably securing said upper cylinder in said one passage in the crossover body; a lower zone pump comprising a fixed piston having a flow passage therethrough; a check valve controlling flow of fluid through said passage through the lower zone pump piston, permitting upward flow of fluid but preventing reverse flow; latch means releasably latching said lower zone pump piston in the tubular member; a lower pump cylinder operably receiving the lower pump piston, said cylinder having an outlet port at the upper end thereof; a check valve controlling the outlet port of the lower zone pump cylinder, said check valve permitting

14

upward flow of fluid but preventing reverse flow; an upper pump rod having its lower end connected to the piston of the upper zone pump; a lower zone pump rod having its upper end connected to the piston of the upper zone pump and having its lower end connected to the cylinder of the lower zone pump; means on the lower pump rod for effecting release of the latching means for the upper zone pump cylinder when the pump rods are moved upwardly to a predetermined position; a landing spear in the other of said parallel passages through the crossover body, said landing spear having flow passages therein; latching means responsive to a predetermined upward pull on the landing spear for releasably securing said landing spear in said other passage; a secondary parallel string extending upwardly of said crossover body and having a flow passage therethrough, there being passageway means connecting the discharge end of the lower zone pump with the flow passage of said secondary parallel string; passageway means connecting a passage in the landing spear with the lower end of the cylinder of the upper zone pump; and check valve means controlling flow of fluid through the last mentioned passageway means permitting upward flow of fluid therethrough but preventing reverse flow.

12. In dual zone pumping apparatus for installation within casings of oil wells for separately pumping fluids from a plurality of longitudinally spaced production zones: a crossover body having a pair of longitudinally extending parallel passages therethrough; an upwardly extending primary string connected to said body in axial alignment with one of said passages therein; a depending tubular member connected to the lower end of said body in axial alignment with said one passage; an upper zone pump comprising a fixed cylinder and a longitudinally movable piston having a flow passage therethrough; a check valve opening upon downward movement of said piston and controlling said flow passage and permitting upward flow of fluid but preventing reverse flow through the piston flow passage; means releasably securing said upper cylinder in said one passage in the crossover body; a lower zone pump comprising a fixed piston having a flow passage therethrough, one end of said passage being the inlet and the other end the outlet; a check valve controlling flow of fluid through said passage through the lower zone pump piston, permitting upward flow of fluid but preventing reverse flow; latch means releasably latching said lower zone pump piston in the tubular member; a lower pump cylinder operably receiving the lower pump piston, the upper end of said cylinder being connected to the lower end of the upper pump piston, said cylinder having a wall closing the upper end thereof and having an outlet port therein; a check valve controlling the outlet port of the lower zone pump cylinder, said check valve permitting upward flow of fluid but preventing reverse flow; an upper pump rod having its lower end connected to the piston of the upper zone pump; means on the lower pump rod for effecting release of the latching means for the upper zone pump cylinder when the pump rods are moved upwardly to a predetermined position; a landing spear in the other of said parallel passages through the crossover body, said landing spear having flow passages therein; latching means responsive to a predetermined upward pull on the landing spear for releasably securing said landing spear in said other passage; a secondary parallel string extending upwardly of said crossover body and having a flow passage therethrough, there being passageway means connecting the discharge end of the lower zone pump with the flow passage of said secondary parallel string; passageway means connecting a passage in the landing spear with the lower end of the cylinder of the upper zone pump; and check valve means controlling flow of fluid through the last mentioned passageway means permitting upward flow of fluid therethrough but preventing reverse flow.

13. In dual zone pumping apparatus for installation

15

within casings of oil wells for separately pumping fluids from a plurality of longitudinally spaced production zones: an upper zone pump comprising a fixed cylinder and a longitudinally movable piston having a flow passage therethrough; a check valve controlling said flow passage and openable upon the down stroke of the piston so as to permit upward flow of fluid but preventing reverse flow through said piston flow passage; passageway means for connecting the lower end of said fixed cylinder with one production zone; check valve means controlling flow of fluid to said cylinder, permitting fluid flow to said cylinder but checking reverse flow through said passageway means; conduit means for conducting fluid pumped by said upper zone pump to the upper end of said well; a lower zone pump comprising a fixed piston having a flow passage therethrough for connection with another production zone; a check valve controlling flow of fluid through said passage through the lower zone pump piston, permitting upward flow of fluid through said passage but preventing reverse flow therethrough; a lower pump cylinder operably receiving the lower pump piston, said cylinder having a wall closing the upper end thereof and having an outlet port therein; means connecting the

16

lower pump cylinder with the piston of the upper pump for simultaneous pumping movement therewith; a check valve controlling the outlet port of the lower zone pump cylinder, said check valve permitting upward flow of fluid but preventing reverse flow; conduit means connecting fluid pumped by the lower zone pump to the upper end of said well separately of the first mentioned conduit means; and a pump rod having its lower end connected to the piston of the upper zone pump.

References Cited in the file of this patent

UNITED STATES PATENTS

2,281,899	White	May 5, 1942
2,513,869	Hoffer	July 4, 1950
2,522,825	Hoffer	Sept. 19, 1950
2,625,882	Davis	Jan. 20, 1953
2,642,803	Morris	June 23, 1953
2,668,500	Hoffer	Feb. 9, 1954
2,797,642	Bloudoff	July 2, 1957
2,903,066	Brown	Sept. 8, 1959
2,966,119	Boydston	Dec. 27, 1960
2,973,035	Brown	Feb. 28, 1961
2,991,721	Foster	July 11, 1961