

July 2, 1957

P. S. BLODOFF

2,797,642

2-ZONE PUMP

Filed May 2, 1955

4 Sheets-Sheet 1

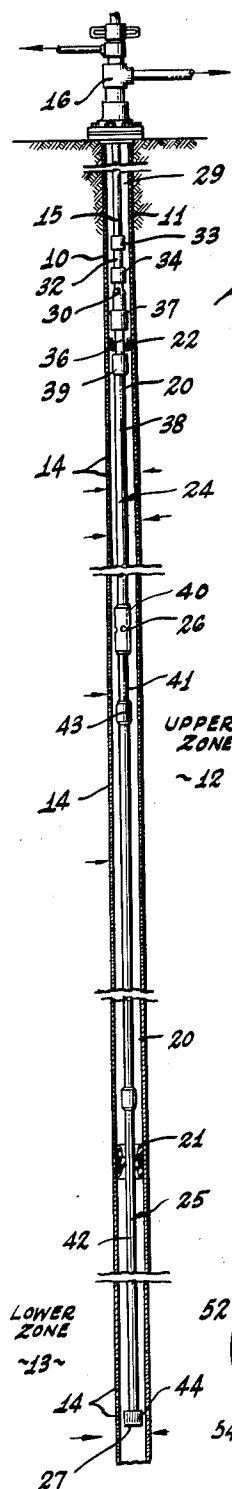


Fig. 1

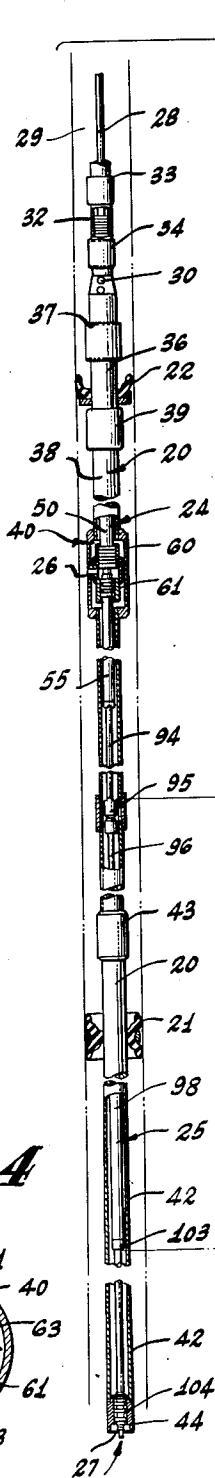


Fig. 2

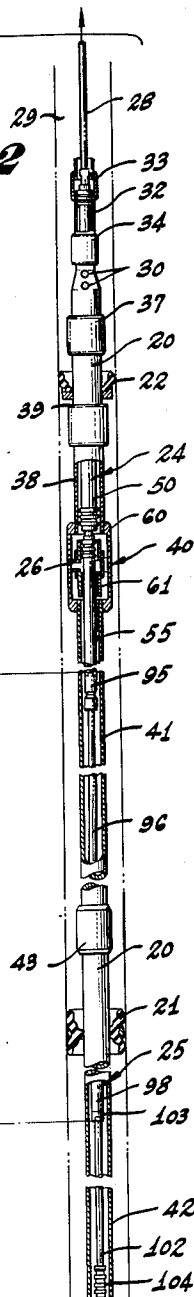
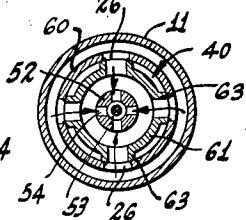


Fig. 4



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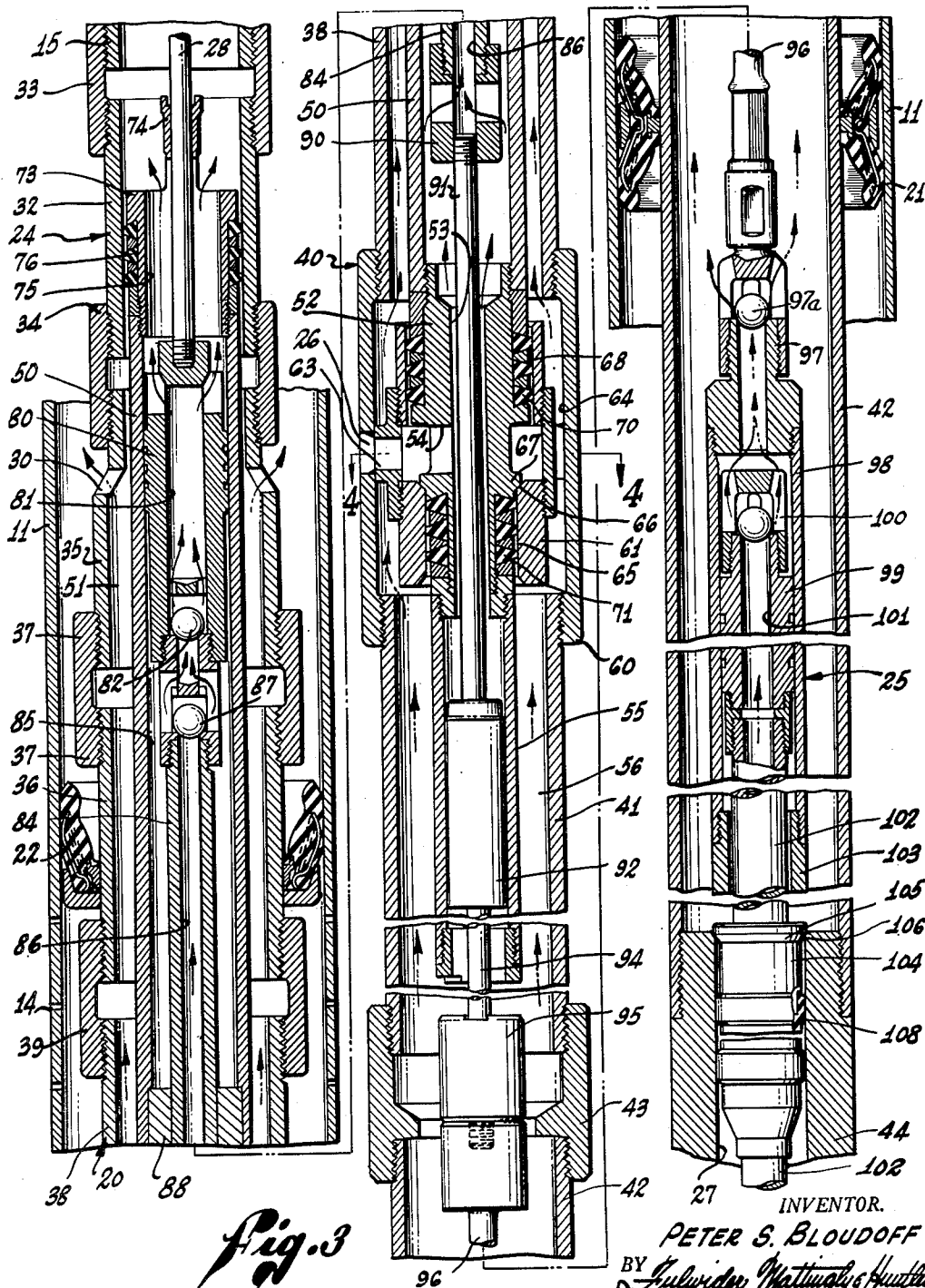
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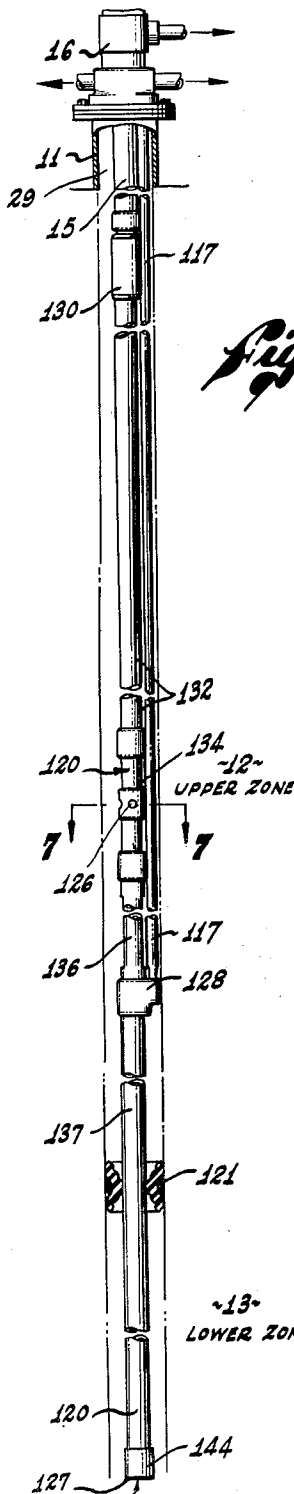


Fig. 5

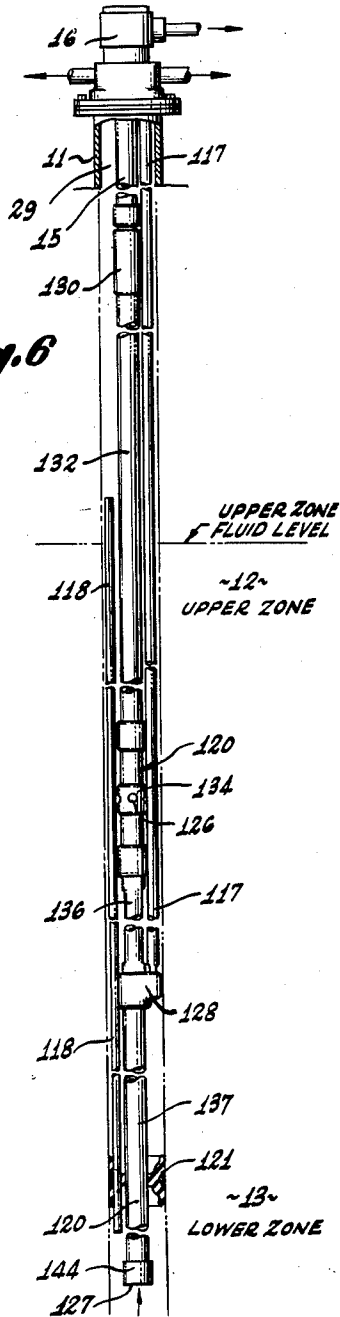


Fig. 6

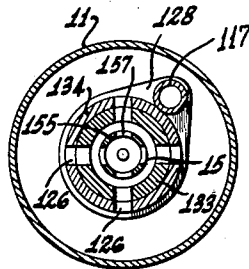


Fig. 7

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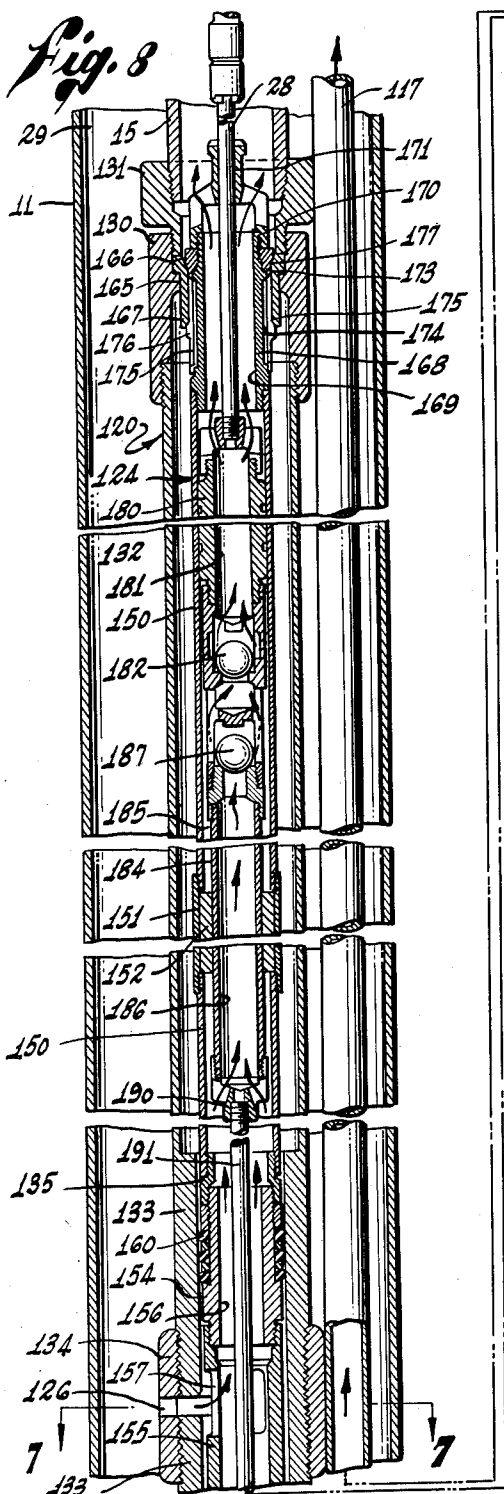
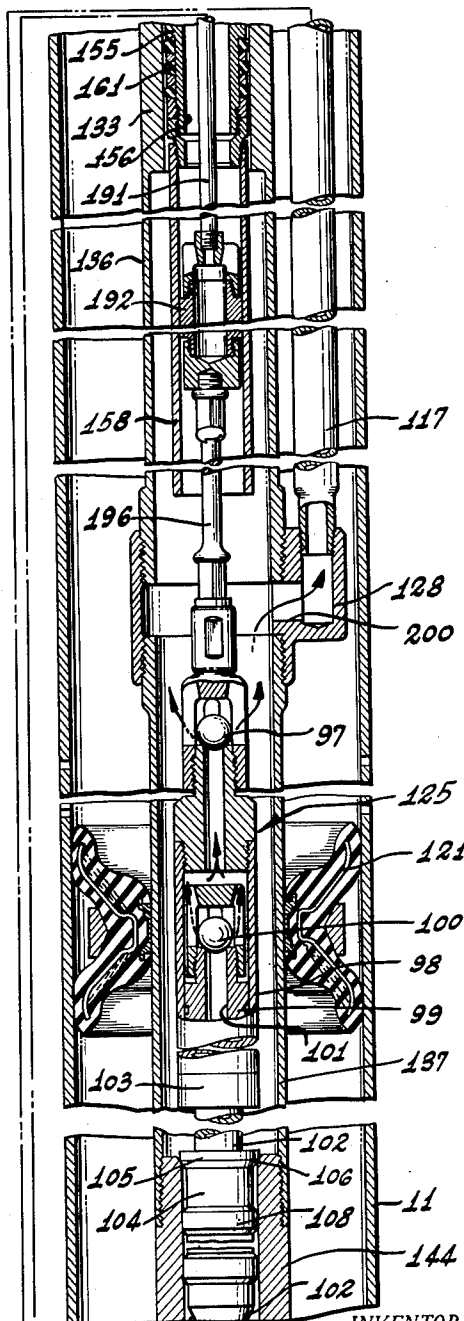
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2-ZONE PUMP

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Application May 2, 1955, Serial No. 505,348

13 Claims. (Cl. 103—4)

This invention relates generally to reciprocating pumps for pumping fluids from a well bore, and more particularly to a form of pump for separately pumping fluids from upper and lower production zones.

Many oil wells penetrate through two zones or strata from which oil may be produced. In some areas production is closely regulated, and daily quotas or allowances are established for each of the different zones. This requires that the fluids produced from each of the zones be kept separate through all of the cycles of production.

Special pumps for pumping both zones have been proposed and have found some use. These pumps while capable of the primary pumping function, are of complex construction and are difficult to install and service. One of the main objections is the difficulty in replacing the working or wearing parts of the pump.

An embodiment of the present invention provides a pump of the so-called insert type wherein the pump may be run into the well or removed by insertion or removal of the string of sucker rods which are used to operate the pump. All of the working parts of the pump including plungers, barrels, liners, and valves are included within the assembly which can be inserted or removed in this manner, and it is not necessary to remove the tubing string from the well in order to repair the pump. At the same time, the pump assembly includes two pump units which are so arranged that the production therefrom is kept entirely separate throughout its travel from the producing zones to the well head. The invention thus provides a great saving in time and operating costs over prior pumps used for this purpose.

With the foregoing in mind it is a major object of this invention to provide a two zone pump wherein all of the working parts subjected to operating wear are insertable and removable from the well with the sucker rod string.

An equally important object of the invention is to provide a pump which without modification of its internal structure can be installed in a variety of different piping systems for use with different well conditions.

It is another object of the invention to provide a two zone pump wherein lifting of all of the working parts is accomplished simply by pulling upwardly on the sucker rods and no connecting or disconnecting problems are involved.

A further object of the invention is to provide a two zone pump wherein anchoring of the pump assembly can be accomplished by means of the static pressure of a column of fluid within the well bore without the necessity for any mechanical lock.

It is also an object of the invention to provide anchoring means including differential area sealing means adapted to exert a downwardly directed force on the pump through the application of fluid pressure thereagainst.

It is another object of the invention to provide a two zone pump adapted for use with a piping installation which is particularly advantageous for use with wells

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producing a considerable amount of free gas from either one or both of the production zones.

A still further object of the invention is to provide a two zone pump having an upper pump unit sealed within a cavity member in such a manner that a lower pump unit can be removed upwardly along with the upper unit.

An additional object of the invention is to provide a two zone pump having an upper pump unit formed with a plunger which carries both the traveling and standing values and is designed to have a desirable compression ratio within the pumping chamber for handling high gas oil ratio fluids.

Yet another object of the invention is to provide a two zone pump wherein static pressure is utilized to lighten the pump loads.

A further object of the invention is to provide a two zone pump of sturdy construction having a minimum diameter for ease of installation and which can be manufactured in pumps of different stroke length and sizes without design changes.

These and other objects and advantages of the invention will become apparent from the following detailed description of preferred and modified forms thereof, and from an inspection of the accompanying drawing in which:

Figure 1 is an elevational view showing the installation of the preferred form of pump within a well bore;

Figure 2 is a pair of partial elevational views showing the relative movement of the pump elements upon lifting of the pump;

Figure 3 is a detailed longitudinal section taken through the preferred form of pump;

Figure 4 is a cross section taken along the line 4—4 of Figure 3;

Figure 5 is an elevational view showing a parallel string installation of a modified form of pump;

Figure 6 is an elevational view showing an alternate triple string installation of the modified pump;

Figure 7 is a cross section taken along the line 7—7 of Figures 5 and 8; and

Figure 8 is a detailed longitudinal section taken through the modified form of pump.

Referring now to the drawings and particularly to Figure 1 thereof, the installation of a preferred form of pump within a well bore is illustrated. As is conventional, a well bore 10 is provided with a casing 11 which normally extends from the bottom to the surface of the well. Opposite an upper producing zone 12 and a lower producing zone 13, casing 11 is provided with perforated sections 14 which allow the well fluids from the producing zones to enter within the casing. As is also conventional, the well is provided with an elongated string of tubing 15 which is suspended from a well head fitting 16 at the surface and extends downwardly to the producing zones. It will be understood, that the tubing 15 as illustrated, is greatly foreshortened, and that in an actual installation it will extend downwardly into the well bore for many thousands of feet. For this reason it may be easily understood that the setting and removal of tubing 15 is a major job involving considerable time and expense.

Secured upon the lower end of tubing 15 is a tubular extension or pump jacket 20 which is itself of elongated shape and is of a length to extend through both upper zone 12 and lower zone 13. In construction, the extension 20 is made up of suitable lengths of pipe coupled together in fluid tight relationship so that the extension functions as a cavity means defining an elongated internal cavity which is separated from the well bore and is open thereto only through particularly established intake ports as will hereinafter be described.

Tubing extension 20 is provided with externally

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mounted packer means which are adapted to seal against the wall of casing 11. In this form of the pump two packers are provided, a lower packer 21 which is set in place between upper and lower zones 12 and 13, and an upper packer 22 which is set above the upper zone just below the bottom of tubing string 15. Mounted within extension 20 are two pumping units, an upper pump unit 24 and a lower unit 25 which are spaced apart approximately opposite the producing zones 12 and 13, respectively. Upper zone intake ports 26 are positioned in extension 20 to admit well fluids to upper pump unit 24 and a lower zone intake port 27 in the bottom of extension 20 serves to admit well fluid to lower pump unit 25.

Pump units 24 and 25 are of the reciprocating type and are operatively connected together and actuated by an upper string of sucker rods 28 as is best seen in Figures 2 and 3. The sucker rods 28 extend to the surface through tubing 15 and are moved in the conventional manner by a suitable pump jack and engine (not shown). In this embodiment of the invention well fluid is pumped to the surface from the upper pump unit 24 through tubing 15 and is pumped from the lower pump unit 25 through the tubing-casing annulus 29 after passing upwardly through extension 20 and out through a set of discharge ports 30 which are positioned near the top of the extension. In flowing through extension 20 the fluid from lower pump unit 25 is kept separated from the fluid within upper pump unit 24.

Considering the position of packers 21 and 22 it will be seen that lower packer 21 serves to separate the well fluids entering from zones 12 and 13 so that upper zone fluid must enter extension 20 through ports 26 while lower zone fluid must enter through port 27. Upper packer 22 is positioned just below the discharge ports 30 for the lower pump unit 24, and thus maintains the pumped fluid from the lower zone separate from the intake fluid from the upper zone. The pumped fluid from the upper zone is, of course, confined by the tubing 15 until it reaches the surface so that the production from the two zones is thus kept separated throughout the complete pumping operation.

The internal construction of the pump units 24 and 25 may best be seen in detail by an examination of Figure 3. This view, tracing from left to right and downwardly along the various sections, is representative of the major portions of the pump units 24 and 25 and the outer pump jacket or tubing extension 20. At its top, tubing extension 20 has a sealing nipple 32 which is threadedly engaged in a tubing coupling 33 connected to the bottom of tubing 15. A coupling collar 34 connects sealing nipple 32 with an outwardly swaged nipple 35 that has formed therein the previously mentioned ports 30 for discharging pumped lower zone fluid into the tubing casing annulus 29. Nipple 35 is in turn joined to a cylindrical packer support 36 by a collar 37. The packer support 36 has mounted thereon the upper packer 22 which is of conventional design. Below the packer support 36 an elongated cylindrical pipe section 38 is connected thereon by a collar 39. Pipe section 38, which may be designated as the upper pipe section is cut to length in accordance with the depth of the upper producing zone 12 and is terminated at a point lying somewhere adjacent the perforated casing 14 provided for the upper zone.

Secured to the bottom of upper pipe section 38 is a crossover connection 40 which is of special construction as will later be described in detail. The upper zone ports 26, serving to admit fluid to the upper pump unit 24, are formed in crossover connection 40, and are arranged so as to prevent the mixing of this fluid with that pumped by lower pump unit 25. Crossover connection 40 engages with an intermediate pipe section 41 that is in turn joined to a lower elongated pipe section 42 by a collar 43. Packer 21 is mounted on lower section 42, and the length of these sections will be determined in accordance with the spacing between the upper and lower production

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zones 12 and 13. On the bottom of lower pipe section 42 is a seating shoe 44 which completes the extension 20 and is formed with the previously mentioned lower zone port 27 therein for admitting well fluid from the lower zone to the lower pump unit 25.

Upper pump unit 24 has an outer elongated barrel 50 which fits slidably through sealing nipple 32 and is spaced inwardly from the extension upper pipe section 38 to define therewith an annular chamber or passageway 51 which is open to the lower zone fluid discharge ports 30. The lower end of barrel 50 is threadedly connected to a heavy-walled tubular seating body 52 which is formed with an axially extending bore 53 therethrough and a plurality of radially directed side ports 54 opening into the bore. Body 52 is adapted to seat within crossover connection 40 and carries a downwardly projecting skirt or cylinder 55 which completes the upper pump unit barrel assembly. Cylinder 55 is spaced inwardly considerably from the extension lower pipe section 41 and defines therewith an annular longitudinally extending passageway 56 which opens downwardly into the extension lower pipe section 42 and is adapted to carry upwardly the fluid pumped by the lower zone pump unit 25.

The crossover connection 40 is provided with an outer collar or shoe 60 having the upper zone intake ports 26 therein and surrounding an inner sleeve or seating nipple 61 in spaced relationship but rigidly supporting the latter. As is best seen in Figure 4, seating nipple 61 is provided with a plurality of radially projecting bosses 63 which join shoe 60 in the region of each of the fluid intake ports 26 and are rigidly secured to the collar by welding or the like. Each of bosses 63 is hollow so as to communicate ports 26 with the interior of nipple 61, and ports 54. Once the fluid from the upper zone has entered within nipple 61 it can be seen that it may flow through body ports 54 into axial bore 53 and thence upwardly into the interior of pump barrel 50. The space between shoe 60 and sleeve 61 not covered by bosses 63 provides longitudinally or vertically extending passageways 64 which serve to communicate the lower annular passageway 56 with the upper annular passageway 51 surrounding barrel 50 for carrying upwardly fluid pumped by the lower pump unit 25. Attention is also directed to the fact that lower zone fluid flowing through passageways 41, 64 and 51 is kept entirely separated from the upper zone fluid which enters the interior of barrel 50 through ports 26.

In order to support pump barrel 50 against downward movement, seating nipple 61 has a lower portion below bosses 63 having a reduced bore 65 formed by an inwardly thickened wall on the top of which is formed an upwardly facing annular beveled seat 66. Seating body 52 has a corresponding reduced lower portion which defines a shoulder 67 adapted for close fitting engagement upon seat 66. The upper portion of nipple 61 has a bore 68 which is of considerably larger diameter than bore 65 and it should be noted that the corresponding portions of body 52 have substantial clearance with both of these bores. The previously mentioned lower barrel skirt or cylinder 55 is of a diameter to pass freely through the bore 65 of nipple 61 so that the entire barrel assembly may be removed upwardly. It might also be pointed out that all of the working parts of lower pump unit 25 as will subsequently be described, are likewise of a diameter to pass through seating nipple 61 and thus may be removed upwardly along with upper pump unit 24.

In order to provide a sealing fit between body 52 and seating nipple 61, sets of sealing rings are mounted thereon. These rings provide the additional important function of anchoring the upper pump unit 24 against upward movement. Such an anchoring means is necessary to hold the stationary portion of the pump to prevent its movement when the reciprocating element is moved during normal pumping operations and must of course be releasable when it is desired to remove the pumps from the well. One set of sealing rings or cups 70 is fitted between

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the lower end of barrel 50 and body 52 for sealing engagement with the wall of bore 68. These sealing rings 70 project outwardly beyond body 52 providing upwardly facing surfaces and are of resilient deformable construction for making high pressure sealing engagement with the sealing nipple 61. Since sealing rings 70 are above intake ports 26 and 54 they act to prevent any mixing of the incoming upper zone fluid with the pumped lower zone fluid flowing through passageway 51. A second set of sealing rings or cups 71 is fitted between the lower end of body 52 and cylindrical skirt 55 for sealing engagement with the wall of reduced bore 65 and to provide downwardly facing surfaces in the space between the body and bore wall. This latter set of sealing rings 71 is of considerably smaller diameter and surface area than is the set of rings 70 in accordance with the difference in size between bores 65 and 68. Since rings 71 are below intake ports 26 and 54 they act to prevent any mixing of the incoming upper zone fluid with the pumped lower zone fluid flowing through passageway 56.

Because of the cooperative relationship between the upper set of sealing rings 70 and the lower set 71 they may appropriately be designated as differential area anchoring means. As will be remembered, the pumped lower zone fluid within passageways 51 and 56 is flowing upwardly through the interconnecting passageways 64 and after leaving upper passageway 51 is discharged through ports 30 into the tubing-casing annulus 29 where it is pumped upwardly to the surface. Accordingly, this entire column of lower zone pumped fluid creates a static head or pressure which exerts a downward force of considerable magnitude on the fluid at the bottom of the well. The fluid within both passageways 51 and 56 is under such a high static head, and the pressures therein are substantially equal due to the interconnecting passageways 64. The fluid pressure within passageway 51 acts downwardly upon the upwardly facing surfaces of rings 70 through the space between nipple bore 68 and body 52, and the fluid pressure within passageway 56 acts upwardly against the downwardly facing surfaces of rings 71 through the space between the body and lower bore 65. However, considerably more surface area of the upper rings 70 is subjected to downward pressure than is the surface area of rings 71 subjected to upward pressure. The resultant force thus acts downwardly and tends to hold body 52 and the entire upper pumping unit 24 seated within the cross-over connection. This force is sufficient to hold the pumping unit barrel assembly stationary during normal operation of the pump so that there is no unseating of the pump stationary parts due to frictional engagement with the reciprocating elements or working parts. It can be appreciated, however, that this hold-down or anchoring force can be overcome by exerting a sufficient upward lifting force when it is desired to remove the pump barrel. This is done by the sucker rods 28 and through engagement between cooperating lifting means carried by the pump units as will subsequently be described.

At its upper end barrel 50 is threadedly connected to a sucker rod guide member having a tubular outer body 73 connected with a central hub 74 by open webbing so as to define an open ended passageway 75 which permits the upward flow of fluid from barrel 50 into tubing string 15. Hub 74 provides slidable bearing support for the lower sucker rod 28 which extends therethrough for actuating plunger means within the barrel. The fluid which is pumped into tubing 15 from barrel 50 is the upper zone fluid and this pumping action creates a column of fluid in the tubing which extends from the pump to the well surface. As can be understood, this column of fluid likewise exerts a high static head or pressure acting downwardly.

In order to prevent leakage of the fluid within tubing 15 downwardly around barrel 50 a set of sealing rings 76 is mounted on the exterior of the barrel between the upper end of the barrel and member 70. The sealing rings 76

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are similar to the previously described lower rings and are adapted to make high pressure sealing engagement with the wall of the sealing nipple 32. The fluid within tubing 15 acts downwardly against rings 76 and resists the lifting force exerted upon the rings by the fluid within passageway 51.

The lower end of sucker rod 28 is threadedly connected to an upper plunger 80 which is of the size to fit slidably within barrel 50 and forms a section of an elongated reciprocating plunger assembly. Plunger 80 is of tubular shape and has a vertical port 81 extending therethrough and adapted to be closed at the bottom end by a ball valve 82. The latter is the so-called traveling valve of the pump and has a ball confined within a cage structure which is longitudinally open through an upwardly facing seat in the usual manner.

Connected into the bottom of plunger section 80 is an elongated reduced lower plunger section 84 having substantial clearance with barrel 50 and defining therewith an annular pumping chamber 85. The smaller plunger section 84 is likewise tubular and has a central vertical port 86 extending therethrough and open at the bottom into the lower portion of barrel 50. At the top of plunger section 84 is a ball valve 87 having a seat and cage structure of usual construction and adapted to close the upper end of port 86. The valve 87, while being completely carried by the movable plunger assembly, may nevertheless be appropriately designated as the standing valve of the pump in accordance with customary pump terminology. Fluid entering through valve 87 from port 86 passes into pumping chamber 85 and from thence through valve 82, the upper plunger port 81, and into tubing 15 during the operation of the pump. Mounted within the lower portion of barrel 50 is an elongated sleeve or liner 88 which closes the bottom of chamber 85 and makes a close sliding fit with the smaller plunger section 84. The top of chamber 85 is of course closed by plunger section 80, and it can thus be seen that the volume of the chamber is increased or decreased in accordance with the relative movement of the plunger assembly within the working barrel.

Upon the upstroke of the pump, both plungers 80 and 84 move upwardly and this increases the volume of pumping chamber 85. The accompanying reduction in pressure within chamber 85 causes valve 87 to unseat and allows upper zone fluid to fill the pumping chamber through port 86, the lower portion of barrel 50, passageways 53 and 54 and the fluid intake ports 26 in cross-over shoe 40. Also upon the upstroke of the pump, valve 82 is closed by the downward pressure of the column of fluid standing thereon and all of the fluid within barrel 50 is pushed upwardly into tubing 15 by the movement of plunger 80.

Upon the downstroke of the pump the pressure of the well fluid within chamber 85 is increased and this fluid pressure acts downwardly upon valve 87 to close port 86 and prevent any downward or backflow of the fluid. At the same time, the fluid pressure within chamber 85 acts upwardly to lift valve 82 from its seat and allow fluid flow through the upper plunger port 81. Thus, upon continued downward movement of upper plunger 80 the fluid within chamber 85 is all forced above valve 82 to be lifted with the plunger upon the next upstroke of the pump. Subsequent up and down strokes of pump continue the cycles of pump operation in the manner just described. It should be noted that when plunger 80 is at the bottom of its down stroke the volume within pump chamber 85 is very small in comparison to the total volume of plunger displacement during the pump stroke. This low clearance volume to plunger displacement volume gives the pump a very high compression ratio which is quite advantageous for handling well fluids having a high gas oil ratio without loss of pumping efficiency.

The lower end of plunger 84 is connected through an adapter 90 with an elongated connecting rod 91 which

extends loosely through passageway 53 and downwardly into cylinder 55. The bottom end of rod 91 is connected to a sealing piston or plunger 92 which fits closely within cylinder 55 in tight sealing engagement. The loose fit of rod 91 within bore 53 permits the free upward flow of fluid into barrel 50 from the upper zone intake ports 26, and the function of piston 92 is to prevent any flow of lower zone well fluid into the upper zone pump unit. Since the bottom end of piston 92 is open to the lower zone pumped fluid having a high static head thereon, it will also be appreciated that this fluid pressure is utilized to aid in lifting the upper zone plunger assembly during its upward or working stroke.

Piston 92 is connected to a rod extension 94 which joins to a lifting collar 95 adapted for lifting the upper pump unit from the well as will subsequently be described. Collar 95 is in turn joined to a lower zone pump connecting rod 96 which actuates the lower zone pump unit 25. The latter is of the traveling barrel type in the pump as illustrated, having a reciprocating outer barrel 98 and a normally stationary inner plunger 99. Barrel 98 is connected to rod 96 through an upper traveling ball valve assembly 97 having a ball valve 97a which serves to control the flow of fluid from the interior of barrel 98 to the space in extension pipe 42 surrounding the pump unit. It should also be noted that barrel 98 is of the same external diameter as cylinder 55 so that it may follow the latter upwardly through seating nipple 61 upon removal of the pump.

Plunger 99 fits slidably within barrel 98, and has an upper standing ball valve 100 which serves to control the flow of fluid through a port 101 extending longitudinally of the plunger.

The bottom end of plunger 99 is connected to an elongated tubular tailpipe 102 which extends out the bottom of barrel 98 and downwardly through the shoe 44 provided on the lower end of extension 20. At the bottom of barrel 98 an inwardly projecting annular member 103 is threadedly secured therein, and forms a lifting shoulder for engaging with plunger 99. Tailpipe 102 also carries an enlarged footpiece 104 which is formed with a downwardly facing shoulder 105 adapted to engage with a seat 106 formed in shoe 44. Below seat 106 footpiece 104 is provided with a set of sealing rings 108 which are adapted to make tight sealing contact with the wall of shoe 44 and prevent any downward flow of fluid from pipe section 42. Tailpipe 102 is open to fluid from the lower zone through the previously mentioned shoe intake port 27.

Fluid from the lower zone is thus free to enter into tailpipe 102 and pass upwardly into plunger 99, and thence into barrel 98. Footpiece 104 acts as an anchoring means for holding plunger 99 in normal stationary position since the fluid within pipe section 42 which is under a high static head acts downwardly against the footpiece.

During the normal operation of the pump and upon the upstroke thereof, the volume of the chamber within barrel 98 above plunger 99 is increased due to the relative upward movement of the barrel. Standing ball valve 100 is opened, and fluid from the lower zone flows into barrel 98 through port 101 and tailpipe 102. At the same time, the fluid within extension pipe 42 acts downwardly on traveling ball valve 97a to seat the latter and prevent any back flow of fluid into barrel 98 from the space around it.

On the downstroke of the pump, the pressure of fluid above plunger 99 causes standing valve 100 to close and traveling ball valve 97a to open. The fluid within barrel 98 is thus forced upwardly and outwardly into pipe section 42. The flow path of the lower zone fluid from pipe section 42 upwardly through crossover connection 40 and ultimately into the tubing-casing annulus 29 has previously been described. Therefore, it may now be appreciated that the pump fulfills its primary function of pump-

ing fluids from the two production zones, and maintaining these fluids separate during the entire pumping operation.

As will be remembered, an important object of the invention is to provide a pump wherein all of the working parts subject to rapid wear and deterioration are easily removed and replaced with the sucker rods and without the necessity of removing the tubing. The present pump provides this advantageous construction for both the upper pump unit 24 and lower unit 25. It should be noted that these two units include all of the pump valves as well as the reciprocating and relatively stationary working members. In upper pump unit 24, the working barrel 50 is held in place during the normal pump strokes by the differential area anchoring or hold down means seated within crossover connection 40 as was previously described. In lower unit 25 the stationary plunger 99 is similarly held down by the foot piece 104 engaging within shoe 44 during normal pump strokes.

When it is desired to remove the pump units 24 and 25 from the well, sucker rods 28 are simply pulled upwardly beyond the normal upward pump stroke. This causes lifting collar 95 to engage against the bottom end of cylinder 55 in the manner shown in Figure 2, wherein the two views show the parts in normal operating position and lifting position. Continued upward movement of the sucker rods 28 causes cylinder 55 to be lifted, moving working barrel 50 upwardly to unseat the sets of sealing rings 70, 71 and 75 from within the extension 20.

At the same time, lifting shoulder 103 engages against the bottom of plunger 99 causing the footpiece 104 to be moved upwardly to unseat rings 108 from shoe 44 so that the entire lower pump unit 24 is free to move upwardly through bore 65 in the upper pump seating nipple 61. The reason for controlling the diameter of all of the lower pump parts to the same or smaller size than that of cylinder 55 can now be fully understood, for it is essential that these parts be capable of passing through bore 65.

Once both pump units 24 and 25 are free of extension 20 it is apparent that they can be pulled to the surface quite easily by continuing to pull upwardly on the sucker rod string 28. As will be noted from the description of the lifting operation, there is no necessity to make any connections or to disconnect any parts in order to remove both pump units from the well. The time and expense for making repairs or servicing of the pump units is thus maintained at a minimum.

The modified form of pump embodying the invention is generally similar to the preferred form but is designed for somewhat different types of installations. These installations are for wells wherein the formations produce a considerable amount of free gas apart from the well fluids which may also contain some proportion of gas trapped with the oil or other liquids therein. In such wells, it is highly advantageous to provide a separate passageway to the surface for the free gas apart from the flow path for either the upper or lower zone fluids. This increases the pumping efficiency and at the same time avoids a separation problem as would occur if all of the free gas were mixed into the pumped fluid columns which are under a high static head.

Figures 5 and 6 are illustrative of such piping installations adapted for use with the modified form of pump. Figure 5 shows an installation suitable for use with a well in which there is a large quantity of free gas produced by the upper production zone. Figure 6 shows a further variation of Figure 5 which is advantageous for use in a well wherein both upper and lower production zone produce a large quantity of free gas. Figure 5 may be termed a parallel string installation, and Figure 6 a triple string installation.

Considering first the parallel string installation shown in Figure 5, it is seen that the well is provided with the usual casing 11 extending downwardly to the upper production zone 12 and lower zone 13. The tubing string

15 is also provided, being suspended from the well head 16. In addition to the usual tubing 15 this installation provides an auxiliary or second string of tubing 117 which also extends from the surface of the well down to the producing formations. Tubing 117 is adapted to carry the lower zone fluid to the surface in contrast to the previously described installation wherein the tubing-casing annulus 29 was used for this purpose. Therefore, in this installation the tubing-casing annulus is available to flow the free gas to the surface separate and apart from either the upper or lower zone fluids.

To accomplish this result a modified tubing extension 120 is secured to the lower end of tubing 15. Extension 120 is provided with packer means in the form of a single packer 121 which is set in place to engage sealingly with casing 11 between producing zones 12 and 13. Thus the tubing casing annulus 29 is open directly to the upper zone 12 and any free gas which flows from this zone is able to pass directly up to the well surface without being mixed with the well fluids from either of the zones, or passing through the pump assembly. Extension 120 is provided with upper zone intake ports 126 and a bottom port 127 for admitting fluid from the lower zone. In addition, extension 12 is provided with a parallel connecting collar 128 which joints tubing 117 with the extension below upper zone intake ports 126. The connection 128, as will later be described in detail, serves to divert the pumped lower zone fluid into tubing 117 so that it does not pass upwardly around the upper pump unit as in the installation for the preferred pump, nor does it interfere with the flow of free gas in the tubing-casing annulus 29.

Before considering the internal construction of the modified pump in detail, it is desirable to consider the triple string installation shown in Figure 6. This latter installation includes all of the parts of the installation shown in Figure 5, and provides additional means for venting free gas from the lower production zone 13. As shown, a third string of tubing 118 is placed in the well in a position to extend from the lower zone through packer 121 to a point above the upper zone fluid level. If desired, the tubing 118 could be extended to the surface but this will normally not be necessary as the free gas from the lower zone may be mixed with the free gas from the upper zone under usual conditions. The bottom and top of tubing string 118 are both open so that the lower zone free gas has a straight passage through the upper zone fluid without being taken into either the upper or the lower zone pump units. With the exception of the difference just pointed out, the parallel and triple string installations are identical, and the following detailed description of the modified pump assembly thus applies to both of these installations.

Referring now to Figure 8, the internal construction of the modified pump is shown in detail. As before, the pump assembly comprises two units, an upper pumping unit 124 adapted to pump upper zone fluid and a lower pumping unit 125 for pumping lower zone fluid. Both of the pump units 124 and 125 are mounted within the previously mentioned extension 120 which is of sufficient length to extend through both of the production zones. In this form of the device, extension 120 has an upper seating and anchoring shoe 130 which is threadedly connected to tubing 15 by a coupling collar 131.

Below shoe 130 is an elongated tubular pipe section or jacket 132 which joins a sealing nipple 133 at its lower end. Sealing nipple 133 may be formed in sections joined together by a collar 134 which contains therein the upper zone fluid intake ports 126. Both of the nipple sections 133 have an internal wall of straight cylindrical shape defining an elongated bore 135 extending therethrough. The bottom end of sealing nipple 133 is in turn joined to an intermediate extension pipe section 136 that connects into the parallel string coupling collar

128. Extended below coupling collar 128 is a lower pipe section 137 which has mounted thereon the packer 121. On the bottom of pipe section 137 is a seating shoe 144 which has therein the lower zone fluid intake port 127, and completes the extension structure.

Upper pump unit 124 has an elongated tubular working barrel 150 which may be formed in sections joined together by an intermediate collar 151 and an inner liner 152. Barrel 150 fits within extension 120 in spaced relationship to the pipe 132. The lower end of barrel 150 is connected to a sealing body which is formed of an upper tubular section 154 and lower section 155 threadedly connected together. Both of the sealing body sections have a longitudinal passageway 156 extending therethrough and opening upwardly into barrel 150, and lower section 155 has a plurality of transverse ports 157 positioned opposite the upper zone fluid intake ports 126. As can thus be seen, upper zone fluid may flow inwardly through ports 126 and 157, passageway 156, and into barrel 50.

Projecting downwardly from the bottom end of lower body section 155 is a cylinder or skirt 158 which lies below sealing nipple 133. Cylinder 158 is also open to passageway 156 at its upper end, and is of an external diameter to pass slidably through bore 135. It should be noted that since bore 135 has the same diameter throughout its length, cylinder 158 may be made of larger diameter than the cylinder 55 in the preferred form of pump.

Mounted on the exterior of sealing body sections 154 and 155 are sets of sealing rings 160 and 161, respectively, which are adapted for tight sealing engagement with the wall of bore 135 in sealing nipple 133. The upper set of sealing rings 160 prevent any back or downward flow of upper zone fluid around barrel 150, and the lower set of rings 161 prevents any downward flow of upper zone fluid, or upward flow of lower zone fluid around cylinder 158. The sole function of the rings 160 and 161 in this form of the pump is to provide sealing engagement and they do not have the anchoring function of the corresponding rings in the preferred pump.

In order to seat and hold upper unit pump barrel 150 within the well in this form of pump, seating and anchoring means are provided at the upper end of the barrel. These means take the form of a mechanical locking device which provides a positive and yet releasable anchoring structure. Shoe 130 is provided with an internal seating ring 165 which is secured between the shoe and collar 131, and has a top upwardly facing annular beveled seat 166 and a lower outwardly recessed shoulder 167. A tubular seating mandrel 168 is secured to the upper end of barrel 150 and has a large internal bore 169 for the upward passage of well fluid from barrel 150. The upper end of mandrel 168 is connected to a sucker rod guide 170 formed with an outer cage-like structure which supports a central bearing hub 171 bored to slidably receive a sucker rod 28 therethrough. Sucker rod guide 170 is longitudinally open so as to permit the upward flow of fluid from mandrel bore 169 into tubing 15.

Secured in place between mandrel 168 and guide 170 is an anchoring sleeve 173 which extends downwardly around mandrel 168 and is spaced from the central portion of the mandrel by an annular recess 174 formed on the latter. Sleeve 173 has a plurality of longitudinally extending slots spaced around the periphery thereof to define a plurality of flexible fingers 175 which are adapted to move radially inwardly into recess 174 upon compression. Each of the fingers 175 has an outwardly projecting locking lug 176 formed thereon for locking beneath the shoulder 167 formed on seating ring 165. At the top of sleeve 173 is a projecting beveled shoulder 177 which is adapted to engage against seat 166.

When the upper pump unit is lowered into place both mandrel 168 and sleeve 173 pass through seating ring 165. The engagement of lugs 176 against the wall of the

ring, compresses fingers 175 inwardly so that the lugs may pass through the ring. As lugs 176 reach shoulder 167 they snap outwardly under the shoulder and hold the pump unit against upward movement. At the same time, the projecting shoulder 177 reaches seat 166 and engages against it to hold the pump unit against further downward movement. When it is desired to remove the pump unit an upward lifting force on mandrel 168 will force fingers 175 inwardly to release lugs 176, but normally the pump unit is held quite firmly in the well.

The internal plunger assembly of the upper zone pump 124 is quite similar to that of the preferred form previously described. An upper plunger 180 is connected to the lower end of sucker rod 28 and fits slidably within barrel 150. Plunger 180 has a vertical port 181 extending therethrough and is provided with a ball valve 182 for controlling the flow of fluid through the port. Connected into the bottom of plunger 180 is an elongated reduced lower plunger 184 having substantial clearance with barrel 150 and defining therewith an annular pumping chamber 185. The reduced plunger section 184 has a central vertical port 186 extending therethrough and opening at the bottom into lower portion of barrel 150. At the top of plunger section 184 is ball valve 187 having a cage structure of usual construction and adapted to close the upper end of port 186. Valve 187 functions as the standing valve of the pump while the upper valve 182 acts as the traveling valve.

The previously mentioned sleeve or liner 152 is mounted in the lower portion of barrel 150 and makes close sliding fit with the plunger section 184 so as to close the bottom of chamber 185. The top of chamber 185 is, of course, closed by the plunger section 180. Upon the upstroke of the pump the plungers move upwardly and increase the volume of pumping chamber 185. Fluid then flows into the chamber 185 from the upper zone intake ports 126 past the standing valve 187. During this upstroke, traveling valve 182 is closed and all of the fluid above it within barrel 150 is pushed upwardly into tubing 15 by the movement of plunger 180. Upon the downstroke of the pump, standing valve 187 closes and traveling valve 182 opens so that the fluid within chamber 185 passes upwardly through plunger port 181 to a position above plunger 180. Upon the subsequent upstroke of the pump the fluid which is then above plunger 180 is lifted into tubing 15.

The lower end of plunger 184 is connected through an adapter 190 with an elongated connecting rod 191 which extends loosely through body passageway 156 and downwardly into cylinder 158. The bottom end of rod 191 is connected to a sealing piston or plunger 192 which fits closely within cylinder 158 in sealing engagement. The loose fit of rod 191 within bore 156 permits the free upward flow of fluid into barrel 150 from the upper zone intake ports 126 and the function of piston 192 is again to prevent any flow of lower zone well fluid into the upper zone pump unit. Since the bottom end of piston 192 is open to the lower zone fluid which has a communicating column of fluid standing thereon within the auxiliary tubing string 117, the static head or fluid pressure within this body of fluid is utilized to aid in lifting the upper zone plunger assembly during its upward or working stroke.

Piston 192 is joined directly to a lower zone pump connecting rod 196 in this form of the invention. No lower lifting collar is provided as in the preferred upper pump unit, but instead the upper end of plunger 180 is formed to engage against the bottom of sealing mandrel 168 upon upward movement of the plunger beyond its normal stroke. Once plunger 180 has engaged against mandrel 168, further upward movement of the sucker rod string 28 will cause the barrel and other normally stationary portions of the upper pump unit to be lifted out of extension 120.

The connecting rod 196 connects to the lower pump unit 125 for actuating the same. Pump unit 125 may have completely similar parts to the previously described lower pump unit 25 and is so illustrated herein. For simplicity, all of the corresponding parts of pump unit 125 are given the same reference numerals as those used in unit 25, and it is to be understood that the mode of operation is exactly the same in both units. In this form of pump, unit 125 pumps fluid into the extension 10 lower pipe section 137. From the pipe section 137 the lower zone fluid flows through a side port 200 formed in parallel connection 128 and into the lower end of the auxiliary tubing string 117.

While as stated, lower pump unit 125 has all similar parts to lower pump unit 25, the construction of the modified pump assembly permits the pump unit 125 to be of relatively larger diameter. In the preferred pump assembly the lower unit 25 had necessarily to be of an external diameter no larger than the reduced bore 65 of the seating nipple 61 in order that it could be removed with the upper pump unit 24. Bore 65 was necessarily smaller than bore 68 and the upper pump unit barrel 50 for the proper functioning of the differential area anchoring means. In the modified pump, the lower sealing nipple 133 has only the single bore 135 extending therethrough, and this bore has the same diameter as the upper pump unit barrel 150. Accordingly, the lower pump unit 125 may have the same external diameter as the upper pump unit 124 and still be removable with the latter by passing through bore 135. This permits the lower pump unit 125 to have relatively more pumping capacity than the lower pump unit 25, and may be more advantageous for certain well conditions.

As was previously mentioned, the modified form of pump may be installed in either the parallel or triple string piping installations as illustrated. While I have also shown preferred and modified forms of the pump as having certain differences in construction, it is to be understood that the features of the different pump can be combined to provide pumps for meeting special well conditions, and that other changes of design and construction may be made without departing from the scope of the invention. Therefore, I do not wish to be restricted to the foregoing detailed description except as defined in the appended claims.

I claim:

1. In a structure for anchoring pumps in tubing in a well: an extension supported upon said tubing and defining an inner cylindrical chamber having an internal projection therein; a reciprocating pump having a normally stationary cylindrical member adapted to fit within said chamber and to be held against downward movement by said projection; sealing means including sealing elements mounted upon said member for engagement with the wall of said extension, the upwardly facing surface of the top sealing element having a larger area than the downwardly facing surface of the bottom sealing element; and means for communicating well fluid under hydrostatic pressure against said upwardly and downwardly facing surfaces.
2. In a structure for anchoring pumps in tubing in a well: an extension supported upon said tubing and defining an inner cylindrical chamber having an internal seat therein; a reciprocating pump insertable in said chamber and having a normally stationary cylindrical member formed with an upper portion of enlarged diameter and a lower portion of reduced diameter, said member being adapted to engage on said seat and being open at the bottom to admit well fluid therein, and said pump having a relatively movable member open at the top to discharge fluid into said tubing; and sealing means having a pair of sealing elements mounted on said normally stationary member for sealing engagement with the wall of said extension, one of said sealing elements being mounted on said enlarged portion and the other on said reduced portion and being of smaller surface area, both of said elements being exposed to well fluid within said extension.

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3. A well pump assembly for separately pumping fluids from upper and lower production zones which includes: a tubing extension adapted to be secured upon the lower end of a tubing string and having a packer for engagement with the well casing to separate said upper zone from said lower zone, said extension providing a seat for an upper pump unit and a lower pump unit and having a port for admitting fluid from said upper zone and a separate bottom port for admitting fluid from said lower zone; an upper pump unit having a plunger adapted for operative connection with a sucker rod string and a barrel removably seated in said extension, said barrel having an enlarged upper portion above said seat spaced from the wall of said extension and a reduced lower portion projecting below said seat; a lower pump unit having a traveling barrel and a standing plunger removably seated in said extension and in fluid communication with the lower zone port; means connecting the upper plunger with the lower barrel for operation by said sucker rod string, said means having a sealing plunger slidably engaged in the reduced portion of said upper barrel for blocking the flow of fluid into said upper pump unit; sealing means including a pair of sealing elements mounted on said upper pump unit barrel for sealing engagement with the inner wall of said extension, the upper one of said elements being on the enlarged portion of said barrel and the lower one of said elements being on the reduced portion thereof and of smaller surface area; and passageway means in said extension for directing the fluid from said lower pump upwardly around said upper barrel and against the top surface of said upper sealing element.

4. A well pump assembly for separately pumping fluids from upper and lower production zones which includes: a tubing extension adapted to be secured upon the lower end of a tubing string and having a packer for engagement with the well casing to separate said upper zone from said lower zone, said extension providing a seat for an upper pump unit and a lower pump unit and having a port for admitting fluid from said upper zone and a separate bottom port for admitting fluid from said lower zone; an upper pump unit having a plunger adapted for operative connection with a sucker rod string and a barrel removably seated in said extension, said barrel having an enlarged upper portion above said seat spaced from the wall of said extension and a reduced lower portion projecting below said seat; a lower pump unit having a traveling barrel and a standing plunger removably seated in said extension and in fluid communication with the lower zone port; means connecting the upper plunger with the lower barrel for operation by said sucker rod string, said means having a sealing plunger slidably engaged in the reduced portion of said upper barrel for blocking the flow of fluid into said upper pump unit; sealing means including a pair of sealing elements mounted on said upper pump unit barrel for sealing engagement with the inner wall of said extension the upper one of said elements being on the enlarged portion of said barrel and the lower one of said elements being on the reduced portion thereof and of smaller surface area; passageway means in said extension for directing the fluid from said lower pump upwardly around said upper barrel and against the top surface of said upper sealing element; and lifting means in said upper pump unit and said lower pump unit, said lifting means having engaging surfaces on the respective plungers and barrels for lifting both of said pump units with said sucker rod string.

5. A well pump assembly for separately pumping fluids from upper and lower production zones which includes: a tubing extension adapted to be secured upon the lower end of a tubing string and having a packer for engagement with the well casing to separate said upper zone from said lower zone, said extension providing a bottom seat for a lower pump unit and being open at the bottom for admitting fluid from said lower zone, the top of said extension being open into said tubing string and the upper

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side wall thereof having discharge ports opening into the tubing-casing annulus; a crossover connection in said extension providing a seat for an upper pump unit and having transverse ports for admitting fluid from said upper zone and spaced non-communicating passageways extending longitudinally therethrough; an upper pump unit having a plunger adapted for operative connection with a sucker rod string and a barrel removably fitted in said extension and seated in said connection with the interior of said barrel open to said transverse ports, said barrel having an enlarged upper portion sealing with said extension above said discharge ports and spaced from the side wall of said extension, and said barrel having a reduced lower portion projecting downwardly below said seat, said longitudinal passageways opening upwardly into the space between said extension and said upper enlarged portion; a lower pump unit having a plunger and a barrel, said lower unit being removably seated in said extension and in fluid communication with the lower zone port, said pump unit discharging into said extension below said upper pump unit; means connecting the upper plunger with the lower barrel for operation by said sucker rod string, said means having a sealing plunger slidably engaged in the reduced portion of said upper barrel for blocking the flow of fluid into said upper pump unit; sealing means including a pair of sealing elements mounted on said upper pump unit barrel for sealing engagement with the inner wall of said extension, the upper one of said elements being on the enlarged portion of said barrel and the lower one of said elements being on the reduced portion thereof and of smaller surface area; and lifting means in said upper pump unit and said lower pump unit, said lifting means having engaging surfaces on the respective plungers and barrels for lifting both of said pump units with said sucker rod string.

6. A well pump assembly for separately pumping fluids from upper and lower production zones which includes: a tubing extension adapted to be secured upon the lower end of a tubing string and having a packer for engagement with the well casing to separate said upper zone from said lower zone, said extension providing a top seat for an upper pump unit and a bottom seat for a lower pump unit, the top of said extension being open into said tubing string and the bottom thereof having a port open to said lower zone, and said extension having an intermediate port opening into said upper zone; an upper pump unit having a plunger and a barrel removably seated in said extension and in fluid communication with the upper zone port, said plunger being adapted for operative connection with a sucker rod string; a lower pump unit having a traveling barrel and a standing plunger removably seated in said extension and in fluid communication with the lower zone port; means connecting the upper plunger with the lower barrel for operation by said sucker rod string, said means having a sealing plunger and a cylinder connected to said upper unit barrel and cooperating to block the flow of fluid into said upper pump unit from the lower portion of said extension; sealing means for sealing said upper unit barrel with said extension between said ports, said sealing means having an apertured member connected to said extension and permitting the passage of said lower unit barrel therethrough; a secondary tubing string suspended in the tubing casing annulus and connected to said extension below said sealing means for bypassing fluid from said lower pump unit through said upper zone; and lifting means in said upper pump unit and said lower pump unit, said lifting means having engaging surfaces on the respective plungers and barrels for lifting both of said pump units with said sucker rod string.

7. A well pump assembly for use with a tubing string and a sucker rod string separately pumping fluids from the upper and lower production zones of a well bore, which includes: a tubular extension depending from the lower end of said tubing string; packer means interposed between said extension and the walls of said well

bore separating said upper zone from said lower zone; an upper pump unit removably seated in said tubular extension and connectible with said sucker rod string; a lower pump unit removably seated in said tubular extension; connecting means connecting said lower pump unit with said upper pump unit for operation by said sucker rod string; sealing means for sealing said upper pump unit with respect to said tubular extension, said sealing means having an apertured member in said extension permitting the passage of said lower pump unit therethrough; and lifting means carried by said upper pump unit and said lower pump unit for concurrently lifting both of said pump units with said sucker rod string.

8. A well pump assembly for use with a tubing string and a sucker rod string separately pumping fluids from the upper and lower production zones of a well bore, which includes: a tubular extension depending from the lower end of said tubing string, said extension having a port for admitting fluid from said upper zone and a separate port for admitting fluid from said lower zone; packer means interposed between said extension and the walls of said well bore separating said upper zone from said lower zone; an upper pump unit removably seated in said tubular extension and operatively connectible to said sucker rod string; a lower pump unit removably seated in said tubular extension; connecting means connecting said lower pump unit with said upper pump unit for concurrent operation by said sucker rod string; sealing means for sealing said upper pump unit with said tubular extension between said ports, said sealing means having an apertured member in said extension permitting the passage of said lower pump unit therethrough; passageway-defining means associated with said tubular extension to bypass the fluid from said lower pump unit upwardly through said upper zone; and lifting means carried by said upper pump unit and said lower pump unit for concurrently lifting both of said pump units with said sucker rod string.

9. A well pump assembly for use with a tubing string and a sucker rod string in separately pumping fluids from the upper and lower production zones of a well bore, which includes: a tubular extension depending from the lower end of said tubing string; packer means interposed between said extension and the walls of said well bore separating said upper zone from said lower zone; a port formed in said extension for admitting fluid from said upper zone; a separate port formed in said extension for admitting fluid from said lower zone; an upper pump unit removably seated in said tubular extension, said unit being connectible with said sucker rod string; a lower pump unit removably seated in said tubular extension; connecting means connecting said lower pump unit with said upper pump unit for concurrent operation by said sucker rod string; sealing means interposed between said extension and said upper pump unit for sealing said upper pump unit with said extension between said ports, said sealing means having an apertured member disposed in said extension to permit the passage of said lower pump unit therethrough; passageway-defining means associated with said tubular extension for bypassing the fluid from said lower pump unit upwardly through said upper zone; lifting means carried by said upper pump unit and said lower pump unit for concurrently lifting both of said pump units with said sucker rod string; and an upwardly facing surface associated with said upper pump unit and exposed to the head of the fluid being pumped whereby such head will exert a downwardly directed fluid pressure on said upper pump unit to hold said pump units in said cavity during the normal pump operating strokes of said sucker rod string.

10. A well pump assembly for use with a tubing string and a sucker rod string separately pumping fluids from the upper and lower production zones of a well bore, 75

which includes: a tubular extension depending from the lower end of said tubing string; means on said extension engaging said well bore to separate said upper zone from said lower zone, said extension being formed with a seat for an upper pump unit and a lower pump unit and having a port for admitting fluid from said upper zone and a separate bottom port for admitting fluid from said lower zone; an upper pump unit having a plunger and a barrel removably seated in said extension and in fluid communication with the upper zone port, said plunger being adapted for operative connection with a sucker rod string; a lower pump unit having a plunger and a barrel, said lower unit being removably seated in said extension and in fluid communication with the lower zone port; connecting means connecting the upper plunger with said lower pump unit for concurrent operation by said sucker rod string and having a sealing plunger blocking the flow of fluid into said upper pump unit; sealing means for sealing said upper unit barrel with said extension between said ports, said sealing means having an apertured member connected to said extension and permitting the passage of said lower unit barrel therethrough; and lifting means in said upper pump unit and said lower pump unit, said lifting means having engaging surfaces on the respective plungers and barrels for concurrently lifting both of said pump units with said sucker rod string.

11. A well pump assembly for use with a tubing string and a sucker rod string in separately pumping fluids from the upper and lower production zones of a well bore, which includes: a tubular extension depending from the lower end of said tubing string; packer means on said extension engaging the walls of said well bore to separate said upper zone from said lower zone; seat means on said extension for an upper pump unit and a lower pump unit; a port in said extension admitting fluid from said upper zone; a separate bottom port in said extension admitting fluid from said lower zone; an upper pump unit having a plunger and a barrel removably seated in said extension and in fluid communication with the upper zone port, said plunger being adapted for operative connection with said sucker rod string; a lower pump unit having a traveling barrel and a standing plunger removably seated in said extension and in fluid communication with the lower zone port; means connecting the upper plunger with the lower barrel for concurrent operation by said sucker rod string, said means having a sealing plunger and a cylinder connected to said upper unit barrel and cooperating to block the flow of fluid into said upper pump unit from the lower portion of said extension; sealing means for sealing said upper unit barrel with said extension between said ports, said sealing means having an apertured member connected to said extension and permitting the passage of said lower unit barrel therethrough; passageway-defining means associated with said extension for bypassing the fluid from said lower pump unit upwardly through said upper zone; lifting means in said upper pump unit and said lower pump unit, said lifting means having engaging surfaces on the respective plungers and barrels for lifting both of said pump units with said sucker rod string; and means holding said pump units downwardly in said cavity during the normal pump operating reciprocating strokes of said sucker rod string.

12. A well pump assembly for use with a tubing string and a sucker rod string separately pumping fluids from the upper and lower production zones of a well bore, which includes: a tubular extension depending from the lower end of said tubing string; packer means interposed between said extension and the walls of said well bore separating said upper zone from said lower zone; a seat formed in said extension for an upper pump unit and a lower pump unit; a port formed in said extension for admitting fluid from said upper zone; a separate bottom port formed in said extension for admitting fluid from said lower zone; an upper pump unit having a barrel

removably seated in said extension and in fluid communication with the upper zone port and a plunger adapted for operative connection with a sucker rod string, said plunger having an enlarged hollow upper section provided with a traveling valve and a reduced hollow lower section provided with a standing valve mounted therein, said barrel having a liner in the lower portion thereof engaged with said lower plunger section and an annular chamber defined around said lower plunger section and below said upper section and in communication with said upper zone port through said lower plunger section; a lower pump unit having a traveling barrel and a standing plunger removably seated in said extension and in fluid communication with the lower zone port; means connecting the upper plunger with the lower barrel for concurrent operation by said sucker rod string, said means having a sealing plunger and a cylinder connected to said upper unit barrel and cooperating to block the flow of fluid into said upper pump unit from the lower portion of said extension; sealing means for sealing said upper unit barrel with said extension between said ports, said sealing means having an apertured member connected to said extension and permitting the passage of said lower unit barrel therethrough; passageway-defining means associated with said extension for bypassing the fluid from said lower pump unit upwardly through said upper zone; lifting means in said upper pump unit and said lower pump unit, said lifting means having engaging surfaces on the respective plungers and barrels for lifting both of said pump units with said sucker rod string; and means holding said pump units downwardly in said cavity during the normal pump operating reciprocating strokes of said sucker rod string.

13. A well pump assembly for use with a tubing string

and a sucker rod string separately pumping fluids from the upper and lower production zones of a well bore, which includes: a tubular extension depending from the lower end of said tubing string; packer means interposed between said extension and the walls of said well bore separating said upper zone from said lower zone; seat means formed in said extension for an upper pump unit and a lower pump unit; port means in said extension for admitting fluid from said upper zone; separate bottom port means in said extension for admitting fluid from said lower zone; an upper pump unit having a plunger and a barrel removably seated in said extension and in fluid communication with said upper zone port means, said plunger being connectible with said sucker rod string; a lower pump unit having a plunger and a barrel, said lower unit being removably seated in said extension and in fluid communication with said bottom port means; connecting means connecting the upper plunger with said lower pump unit for operation by said sucker rod string and having a sealing plunger blocking the flow of fluid into said upper pump unit; sealing means mounted on said upper pump unit barrel engaging the inner wall of said extension, said sealing means having an upwardly exposed surface of larger area than the downwardly exposed surface; passageway-defining means in said extension for directing the fluid from said lower pump upwardly around said upper barrel and against said upwardly exposed surface; and lifting means in said upper pump unit and said lower pump unit, said lifting means having engaging surfaces on the respective plungers and barrels for concurrently lifting both of said pump units with said sucker rod string.

No references cited.