Jan. 18, 1944. W. P. MUNK 2,339,748

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Filed Aug. 19, 1942 3 Sheets-Sheet 1

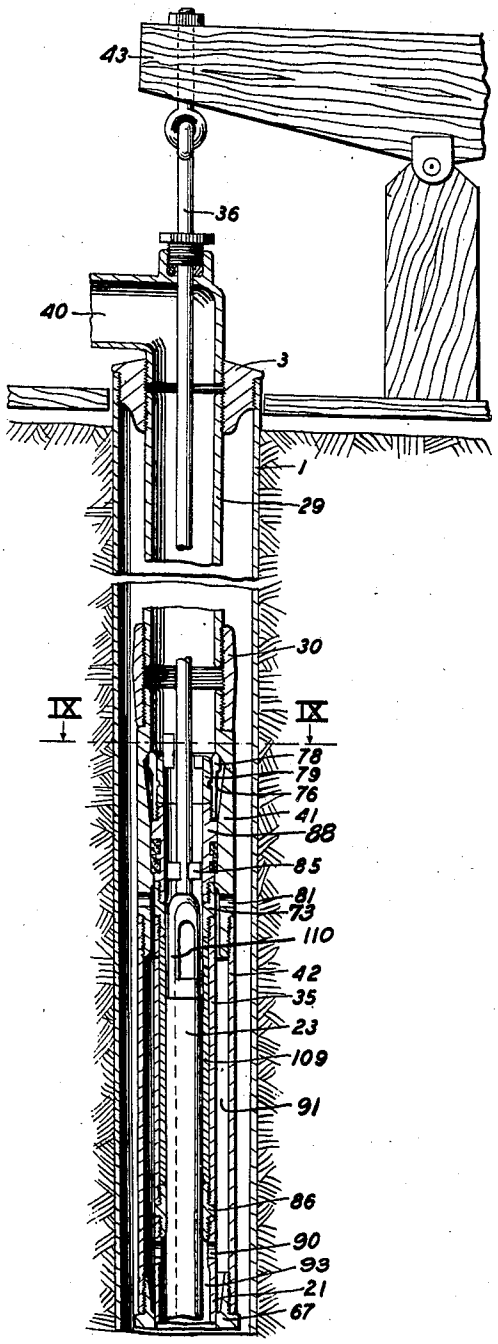


FIG. 1.

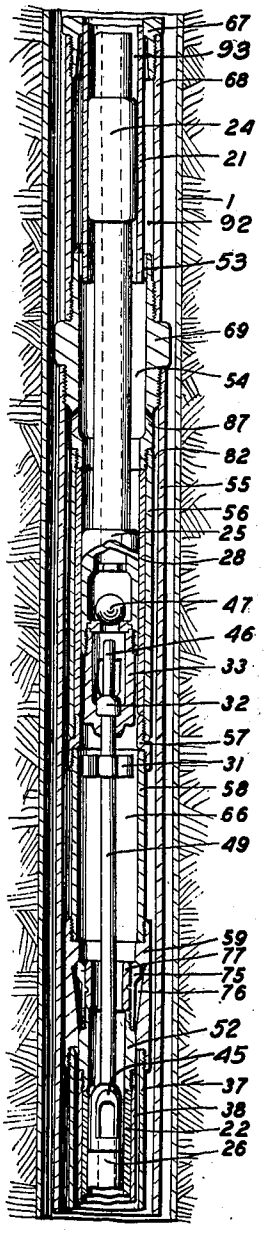


FIG. 2.

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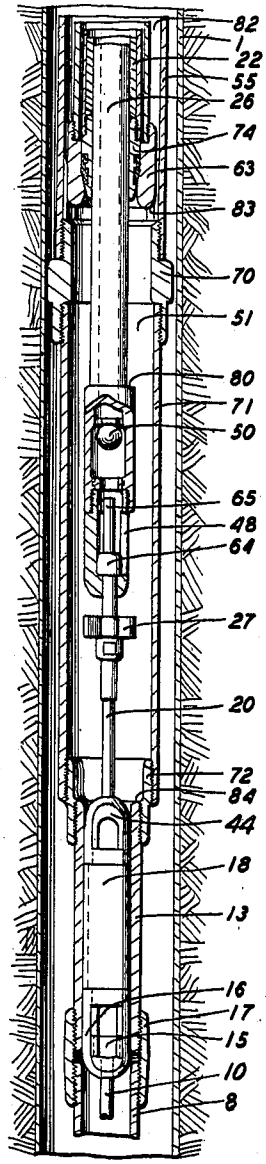


FIG. 3.

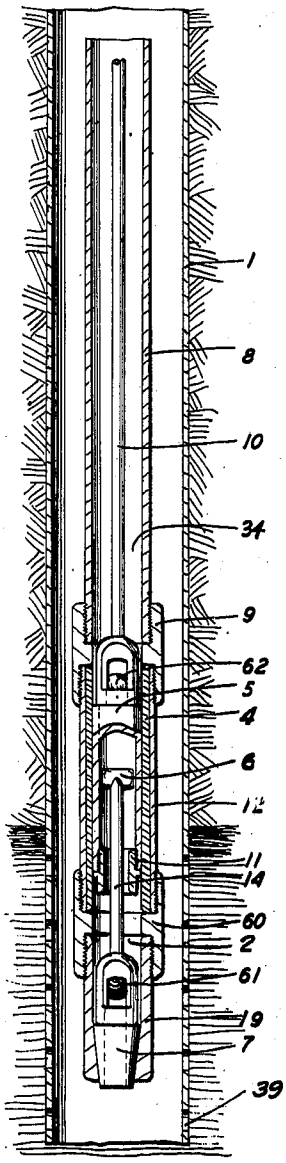


FIG. 4.

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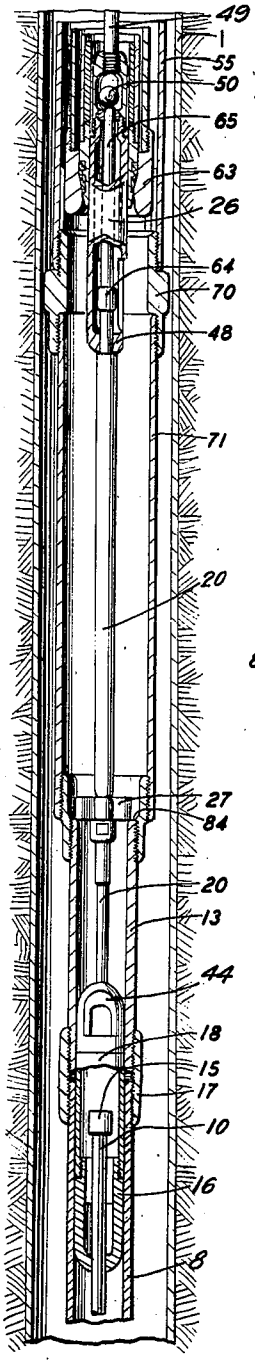


FIG. 6.

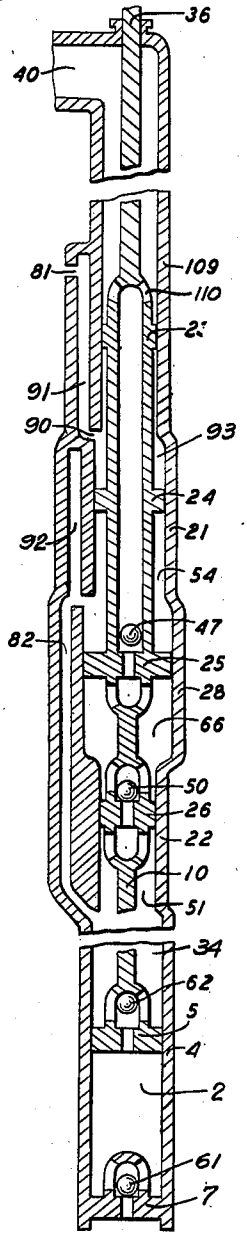


FIG. 10.

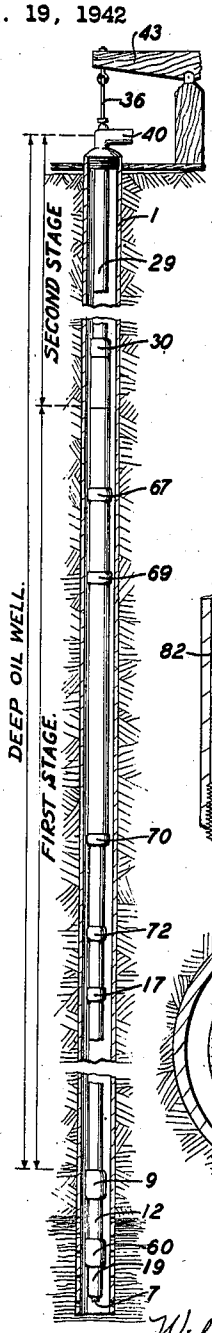


FIG. 5.

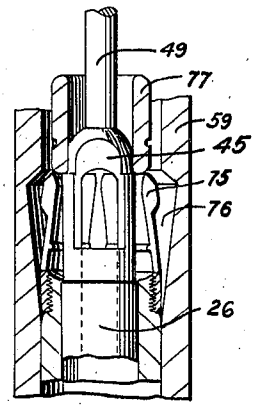


FIG. 7.

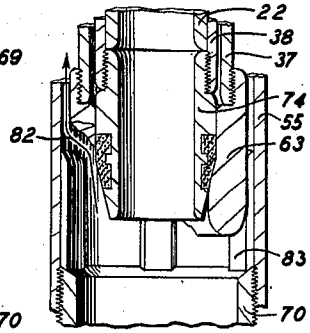


FIG. 8.

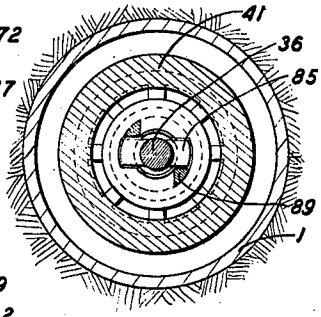


FIG. 9.

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Patented Jan. 18, 1944

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UNITED STATES PATENT OFFICE

2,339,748

PUMP

William Paul Munk, San Francisco, Calif.

Application August 19, 1942, Serial No. 455,390

23 Claims. (Cl. 103—194)

This application is filed in place of my abandoned application Serial #260,638, filed March 8, 1939, which was filed in place of my abandoned application Serial #426,973, filed February 8, 1930.

My invention relates to pumps, for the pumping of deep wells, and is particularly adapted for the pumping of deep oil wells.

In deep well pumping, with the conventional single stage pump, the long column of oil or fluid exerts great pressure on the pump, which results in excessive wear of the pump parts, brings about the early failure of the pump, and necessitates the frequent shutting down of the pump to make repairs.

In such pumps, the great weight of the long column of fluid imposes a heavy load on the rods which actuate the pump, necessitating the use of rods having large cross section to lift their own weight plus the weight of the oil or fluid. Therefore, a primary object of this invention is to provide a reciprocating pumping means in which a plurality of pumps are used to divide and raise a column of oil or fluid in a plurality of stages, thus securing reduction in pressure exerted by the column of oil or fluid being raised.

Another object of the present invention is to provide a reciprocating pumping means, in which a column of oil or fluid is raised during the downstroke, as well as during the upstroke, of the pumping means in order to allow the weight of the reciprocating pump parts to be used for actuating the pumping means to raise oil or fluid during the downstroke of the pumping means.

A further object of my invention is to provide a reciprocating pumping means in which the downward movement of the rods is restrained during the downstroke of the pumping means, the pumping means acting to use the weight of the rods during the downstroke to raise oil or fluid.

Another object of this invention is to provide storage space for, and for surging movement of, fluid to be pumped, within the pump column.

Another object is to provide, in a pump of the type described, for the prevention of sand or detritus deposits within the pump column.

Another object is to provide for concentric positioning of the parts in a pump of the nature herein disclosed, to prevent misalignment of the parts to prevent excessive wear.

A further object of this invention is to provide a reciprocating pump, of the type employing a pump column in a well, which will permit the withdrawal of the parts from the pump column at any time for the purpose of repair or replacement.

A still further object of my invention is to provide a reciprocating pump which allows the draining of oil or fluid from the pump column before pulling the removable cylinders and various pump parts therefrom.

Another object of this invention is to provide for the separation of gases from liquids in the pumping operation.

Other objects and advantages of my invention will appear as the specification proceeds.

For a better understanding of my invention, reference should be had to the accompanying drawings, in which:

Figures 1, 2, 3 and 4 illustrate consecutively the continuous column of a two-stage pump of my invention in a deep well; the pump and the well being shown in vertical section and the pump parts in the middle of an upstroke;

Figure 5 shows the completed two-stage pump of Figures 1, 2, 3 and 4, assembled in a well, the well being shown in vertical section;

Figure 6 shows in vertical section a modified form of that portion of the pump shown in Figure 3;

Figure 7 is an enlarged fragmentary vertical section of portions of the pump shown in Figures 1 and 2;

Figure 8 is an enlarged fragmentary vertical section of portions of the pump shown in Figures 3 and 6;

Figure 9 is an enlarged horizontal section taken along the line IX—IX of Figure 1; and

Figure 10 is a diagrammatic view to illustrate the operation of the pump; the pump being shown in the middle of a downstroke and certain pump parts being omitted to simplify the diagrammatic view.

While I have shown only the preferred forms of my invention, I wish to have it understood that various changes, adaptations, or modifications may be made within the scope of the claims hereto attached without departing from the spirit of the invention.

Attention is being now directed to the Figures 1, 2, 3, and 4 of the drawings, wherein a conventional deep oil well is shown having the usual well casing, designated by the numeral 1, which extends from the ground surface to the bottom of the well and which is provided with the perforations 39 (see Fig. 4) near the bottom to enable the oil or fluid to enter the casing 1 and to rise until the natural fluid or oil level has been established.

Within the well or casing 1 is positioned the pump column within which the pump structure is to be assembled, the pump column being threadedly connected through and suspended from a conventional casing head member 3 (see Fig. 1) which is suitably supported from the top of casing 1.

The pump column reading downward from top to bottom comprises the following members, each of which follows successively in the respective order and is threadedly connected to and suspended from the preceding member.

Belonging to the second stage (see Fig. 1) are the aforementioned casing head member 3, the pipe 29, coupling 30 and the member 41, which terminates the second stage and commences the first stage.

Belonging to the first stage but being parts of the second stage pump (see Fig. 1) are the aforementioned member 41, pipe 42, coupling 67, pipe 68, coupling 69 having the spacing arms 53 extending upwardly into pipe 68, pipe 55 (see Fig. 2), coupling 70 which is provided with the spacing arms 83 extending upwardly into pipe 55, pipe 71, reducer coupling 72 and the cylinder 13 (see Fig. 3).

And belonging to the first stage are coupling 17, pipe 8 (see Fig. 3), and the parts belonging to the first stage pump (see Fig. 4) are coupling 9, jacket 12, coupling 60 and the member 19, at the bottom of the pump column and below the natural oil or fluid level in the well, having the tapered bored seat therein for receiving the tapered and hollow oil or fluid inlet member 7.

The first stage pump has a hollow piston 5 slidably positioned in a stationary cylinder 4 secured in the jacket 12 by couplings 9 and 60.

The hollow and tapered fluid inlet member 7 (Fig. 4) of the first stage pump has a one-way or inlet valve 61 enclosed in an open cage, which, with valve 61 and the member 7, forms the conventional standing valve which is provided with the Garbutt rod 14 having T-head 6 loosely retained by the bushing 11 in the hollow piston 5. This in no way restricts the normal reciprocal movement of piston 5 when the member 7 of the standing valve is seated, sealed, and securely but releasably retained in the member 19, but upon upward pull of the piston 5 beyond its normal reciprocal range by rod 10, the T-head 6 on Garbutt rod 14 engages with bushing 11 to pull the standing valve member 7 free from its seat and to allow the valve 61 to be withdrawn from the pump column for the purpose of repair or replacement.

In the second-stage pump it will be noted by reference to Figures 2 and 3 of the drawings that the coupling 69, in addition to members 53, is also provided with a tubular downward extension of reduced diameter from which a tubular assembly comprising the jacket 56, coupling 57, spacer pipe 58, and parts 59, 37 and 63, is suspended in the pipe 55.

A stationary cylinder 28 (Fig. 2) for a hollow piston 25 is enclosed within the jacket 56 and is securely clamped therein by couplings 69 and 57.

The said tubular assembly is fixed in the pump column by the tubular extension of coupling 69 (see Fig. 2), and is held in concentric relation to the pump column by the tubular extension of coupling 69 and by the spacing arms 83 of coupling 70 (see Fig. 3).

A space formed between the said tubular assembly and pipe 55 communicates at its upper end, by way of ports 87 in the member 69, with the interior of the pump column, and communicates at its lower end, by way of the spaces between arms 83 (see Fig. 8), with the interior of the pump column, to provide a passage 82 to permit surging movement of oil or fluid between the storage spaces 54 and 51 indicated in Figures 2 and 3.

The part 63 is of less inner diameter than the tubular assembly to provide a seat for a cylinder removably positioned in the tubular assembly. This cylinder is comprised of an assembly of parts consisting of a cylinder 22, a jacket 38 for same and two end members 52 (see Fig. 2) and 74 (see Fig. 3) threadedly received in the jacket 38 to seal and make secure the cylinder 22 in place in the jacket 38, the end member 74 (see Fig. 8) also being tapered to fit a correspondingly tapered bore included with part 63 and thus form a seal therewith. Parts 63 and 74 also serve to hold the lower end of the cylinder 22 in concentric relation to the tubular assembly.

The end member 52 is thickened in its middle part to engage the member 59 and acts therewith to hold the upper end of the cylinder 22 assembly in concentric relation to the tubular assembly and to form a seal therewith to prevent accumulation of sand in the space between the cylinder 22 and the tubular assembly which would prevent the removal of the cylinder assembly from the tubular assembly. The end member 52 also has an extension received in a coupling for and having an annular series of spring leaves or pawls 75 rising therefrom, which are adapted to be expanded into the recess 76 formed in the face of the part 59 (see Fig. 2), by a ring 77, to latch the cylinder 22 in position in the tubular assembly. The latter ring slides into place from above (with the pumping mechanism) and is retained in position on the member 52 by the tongue and groove arrangement shown in Figure 7. The recess 76, the ring 77 and the spring leaves or pawls 75 form a latch and, when the spring leaves or pawls 75 are expanded into recess 76 by ring 77, they serve to prevent accidental loosening or unseating and unsealing of the cylinder 22.

Another assembly of parts provides cylinders removably suspended from the member 41 (see Fig. 1). This assembly of parts includes two cylinders 109 (see Fig. 1) and 21 (see Fig. 2) (the latter being of larger inner diameter), a jacket 35 for the cylinder 109, and couplings 73 and 86 threaded into the jacket for holding the cylinder 109 in place in the jacket, the cylinder 21 being suspended from coupling 86. The coupling 73 is threadedly secured to the member 88 which in turn is seated in and sealed against the member 41 and is latched in position by spring leaves or pawls 78 and latch ring 79 in the manner previously described.

The cylinder 21 is surrounded by the gas chamber 92 (see Fig. 2) and its bottom end is positioned in concentric relation to the pump column by the spacing arms 53 of the coupling 69 which allow of free intercommunication between the chambers 92 and 54. The fit between the cylinder 21 and member 67 is gas tight so as to allow gas or air to be trapped in the chamber 92.

The cylinder 109 (with its jacket) is also surrounded by a chamber 91, which communicates, at its lower end, through port 90 with chamber 93 inside of cylinder 21, and at its upper end,

through ports 81, with the space outside the pump column.

The pump column discharges through the horsehead 40 (see Fig. 1) which may be suitably connected to a storage tank or pipe line (not shown).

The reciprocating element of the two-stage pump of my invention, reading from the bottom to the top in Figures 4, 3, 2 and 1 may be described as follows:

The hollow piston 5, which has limited freedom of sliding motion relative to the standing valve, has an open cage secured to the top thereof which holds the outlet valve 62. The open cage is connected, by rod 10, with the guide 18, the rod having a head 15 slidable in the guide but adapted to bear against the inner bottom of open cage 16 at the lower end of the guide. The latter thus has a certain freedom of downward motion relative to the rod.

An open cage 44 is attached to the upper end of the guide 18 and has the rod 20 rising therefrom which latter is connected to the piston 26 by the open cage 48 and the head 64 slidable in the open cage.

The rod 20 carries a cross 27 below the cage 48 and has an extension 65 above the head 64, the extension being used to push the valve 50 off its seat for draining purposes during removal operations later described herein. The housing or closed cage enclosing the one-way or inlet valve 50 forms a shoulder 30 with the piston 26 which latter is hollow throughout the length thereof and has an open cage 45 at its upper end.

A rod 49 arises from cage 45 and connects, by head 32, with open cage 33 suspended from the hollow piston 25 which carries the one-way or outlet valve 47. The rod has a cross 31 secured thereto below cage 33 and has limited freedom of sliding motion relative to the cage 33. An extension 46 of the rod is adapted to unseat valve 47 under certain conditions for drainage purposes.

The hollow piston 25 is directly connected (as to form a continuous central fluid passage) with a hollow piston 24 directly connected with a hollow piston 23, which connects, by open cage 110, with the rod 36 attached to the walking beam 43. The rod 36 carries a cross 85 near its lower end.

It will thus be noted that the piston 5 operates in cylinder 4, the guide 18 in cylinder 13, the piston 26 in cylinder 22, piston 25 in cylinder 28, piston 24 in cylinder 21, and piston 23 in cylinder 109.

There is a clearance space commencing at member 3 and following all the way down between the pump column and the casing and the chamber 91 connects with this space through ports 81. The latter chamber connects also, through ports 90, with chamber 93 above piston 24.

A passage (not shown) through casing head 3 may be employed to connect the clearance space with the atmosphere or the usual gas pipe line (not shown), as will be readily understood.

The gas chamber 92, surrounding cylinder 21, connects, through spaces between the arms 53, with the storage space 54 above piston 25, and the latter space connects, through ports 87, with the passage 82 surrounding the structure depending from member 69. The latter passage connects, through spaces between the arms 83, with the chamber 51 which connects, through guide 18, with the chamber 34 above the first stage pump.

The entire pump column is suspended from the casing head 3 and, in normal operation, the entire reciprocating mechanism is suspended from the walking beam 43.

One of the purposes of the guide 18 is to centralize the reciprocal parts of the pump below hollow piston 26, especially when the two stage pump is employed to pump oil or fluid in off-vertical or crooked wells. In such cases if the guide 18 were not used, flexing of the portion of the piston 26 moving into and out of the cylinder 22, during reciprocation of the pump, would occur, which would hasten the wear of the piston 26 and cylinder 22. The guide 18 thus assures alignment of the reciprocating pump parts relative to the stationary pump parts at the lower end of the second stage pump. Another important feature will appear, however, in connection with the installation of pump structure in the pump column.

By providing supporting means (members 52 and 59, and 53, 67 and 83) capable of coacting with the retaining means (members 63 and 74, and 69 and 88) to hold the cylinders with the second stage pump in and in concentric relation to the pump column, lateral movement of the cylinders and pistons of the second stage pump in the pump column, which would bring about flexing of these cylinders and pistons, especially when the pump is used in off-vertical wells, is largely avoided. By avoiding flexing of the cylinders and pistons galling of such members, which would hasten wear, is largely avoided.

Before installation, the parts of the first-stage pump and the second-stage pump are assembled on the surface of the ground and adjusted to assure that they are properly proportioned for length of pump stroke and also to assure that the latch rings 77 and 79 and the ball valve dislocators 45 and 65 will function properly.

It might be said here that the usual log of the well is kept, measurements as to length and relative position of the members forming the pump column being taken and recorded, so that a log of the pump column is available when the pump column is assembled and completed within the casing 1.

The parts 19, 60, 12, 4 and 9 of the first-stage pump as a unit are now inserted in the casing 1 and other parts are added as they are fed down the well to complete the pump column up to member 17. Connection is now made between the coupling 17 and the cylinder 13 of the second stage pump (as a unit), after which the remainder of the pump column (pipe 29) is added and assembled and pipe 29 is now connected to casing head 3, which latter is then connected to casing 1.

It may be said, that in actual practice when my invention is used in an oil well, the length of the pump column for each stage of the two stage pump may be many hundreds of feet, the first stage pump being disposed near the bottom of the well and the second stage pump occupying some twenty or more feet in about the middle portion of the well, but may be above or below this point if desired.

The pump column, being properly assembled and completed within casing 1, is now ready to receive the reciprocating element of the two-stage pump together with the standing valve and Garbutt rod 14 and also the removable cylinders and their latch rings to complete the two-stage pump.

The reciprocating element of the first-stage pump with standing valve and Garbutt rod 14 depending through T-head 6 from bushing 11 of

the hollow piston 5 are now inserted into the pump column and rod 10 is added and the entire assembly lowered within the pump column, rod 10 having been adjusted for length before being connected.

The rod 10 is of such length that when this rod and hollow piston 5 are in their lowermost position in the pump column and rest on the cage of the standing valve when member 7 is seated in the member 19, the bottom of head 15 will just make contact with its seat in cage 16 when the top of the latter is flush with the bottom of cylinder 13.

Connection is now made between rod 10 and cage 16 and the entire chain of the second-stage pump is then lowered. This chain comprises the guide 18, rod 20, the hollow piston 26, rod 49 and the hollow pistons 25, 24 and 23 with rod 36. This chain also carries the cylinder 22 riding on shoulder 80 of hollow piston 26 and its latch ring 77 riding on cage 45, and cylinders 21 and 109 as well riding as a unit with coupling 36 on a shoulder provided by hollow piston 24, and also the latch ring 79 riding on rod 36. The ring 79 is disposed below cross 85 and is tied by a cord to the cross in such a manner that the cross may be freed by a twisting motion of the rod and made to pass through the ring (see Figure 9).

The lowering of the chain is continued until member 88 carrying cylinders 109 and 21 is seated in member 41. Then cross 85 forces latch ring 79 downwardly inside of spring leaves or pawls 78 until the ring seats in the manner previously described.

To release cross 35, a slight strain is taken on rod 36 to lift cross 85 off the ring 79, whereupon rod 36 is turned clockwise to break the aforementioned cord tying the ring 79 below cross 85, in order to position the cross 85 so that it may pass downwardly through the ring 79.

Next the extension 74 with cylinder 22 will reach its seat in the member 63 and the lowering of rod 36 is continued until cross 31 forces latch ring 77 into latched position with respect to the spring leaves or pawls 75 as previously described.

During this downward movement the standing valve part 7 will have reached its seat and become securely but releasably retained in its seat while the guide 18 has descended sufficiently far with respect to rod 10 as to cause the head 15 of the rod 10 to project above the inner bottom of the cage 16 as shown in Figure 6. The entire weight of rod 10, therefore, bears on standing valve member 7 for seating the same.

Horsehead 40 is now added to the pump column by connection to the casing head 3, and the reciprocating pump parts, being at rest, as shown partly in Figure 6, are then raised to function within their normal reciprocal range as shown in Figures 1, 2, 3 and 4, the rod 36 being connected to walking beam 43. The two-stage pump is now completed and ready for operation.

Thus it is seen that three operations are necessary to seat, seal and latch the insertable or removable cylinders, and to seat, seal and securely but releasably retain the standing valve part 7, of the two-stage pump in positions within the pump column; the insertable or removable cylinders 109 and 21 being seated, sealed and latched in position within the pump column by cross 85 and the entire weight of the reciprocating element of the pump; the insertable or removable cylinder 22 being seated, sealed and latched in position within the pump column by cross 31 and the weight of the reciprocating element of the second stage pump and rod 36, while the standing valve member 7 is seated, sealed and securely but releasably retained in position within the pump column by the weight of the reciprocating element of the first stage pump and rod 10, the last two operations being made possible by the lost-motion connection with guide 18.

In actual practice in oil wells the distance between the first-stage pump and the second-stage pump and the second-stage pump and the surface may easily be many hundreds of feet, and therefore, the rods 10 and 36 and the pipes 8 and 29 are made up of many sections. In view of the above and even though the members are carefully measured and proportioned for length, a variation in length of the assembled members is bound to occur so that rod 10 might be "longer" or "shorter" than pipe 8. If rod 10 were directly or threadedly connected to the guide 18, the "short" rod 10 would be prevented from exerting its weight on the standing valve member 7 to seat, seal and releasably retain the latter in position in the pump column because the "short" rod 10 would hang from the latched latch ring 77 of the insertable cylinder 22, while the "long" rod 10 would prevent the rod 36 from exerting its weight through cross 31 on latch ring 77 to seat, seal and latch cylinder 22 in the pump column because the "long" rod 10 when at rest on piston 5 and the standing valve member 7 would hold the cross 31 and rod 36 upwardly and off latch ring 77 and cylinder 22. Therefore, it is seen that by proviidng the lost-motion connection with guide 18 compensation for variation in the length of rod 10 is provided, and the proper positioning of the standing valve member 7 and of the cylinder 22 in the pump column is assured. Compensation for variation in length of the pump parts between insertable cylinders 109 and 21, and the insertable cylinder 22, is secured by the operation as described earlier herein, in connection with the seating, sealing and latching of the insertable cylinders (cylinders 109 and 21 being seated, sealed and latched by cross 85 when above the top of the normal pump stroke and cylinder 22 by cross 31 when below the bottom of the normal pump stroke), this operation assures the proper positioning or seating, sealing and latching of the insertable cylinders in the pump column.

When it is desired to withdraw the reciprocating element of the two-stage pump with attendant parts for the purpose of repair or replacement, the rod 36 is first disconnected from walking beam 43 and allowed to descend until it comes to rest. Guide 18 moves downward on rod 10 and cross 27 with rod 20 comes to rest on shoulder 84 of cylinder 13. Cage 48 comes to rest on cross 27 and ball valve 50 becomes dislodged from its seat by rod end 65 (see Figures 3 and 6). Thereafter, cross 31 with rod 49 comes to rest on ring 77, and cage 33 descends to come to rest on cross 31. Ball valve 47 is dislodged from its seat by rod end 46, after which, hollow piston 24 moves downwardly so as to pass completely out of cylinder 21 to form a continuous passage. The latter permits the oil or fluid in the pump column of the second stage to be drained downwardly through hollow pistons 23, 24 and 25, and also through chamber 66 and hollow piston 26, and upwardly through passage 82 and between piston 24 and the pump column, and further, between insertable cylinder 21 and piston 23 to and through port 90 in cylinder 21, and by way of the trap space 91 to and through port 81 in the

member 41, and downwardly in the space between casing 1 and the pump column to the bottom of the well, thus relieving the parts of the second-stage pump of the weight of the oil or fluid, and thereby enabling rod 36 to pull the reciprocating element and the insertable cylinders of the two-stage pump from the pump column with less stress to avoid the straining of rod 36.

It might be said here, that while I have shown the cylinders of the two-stage pump all of equal length in the drawings, in actual practice the cylinders, as well as the pistons, may vary in length to suit the individual requirements; for example, in the case of the cylinder 28 and the hollow piston 25 and the cylinder 109 and the hollow piston 23: the cylinder 28 and piston 25 are subject to the pressure of the oil or fluid during the downstroke only, while the cylinder 109 and piston 23 are subject to the pressure of the oil or fluid during the upstroke as well as the downstroke. Therefore, the hollow piston 23 and cylinder 109 should be of greater length than cylinder 28 and piston 25 so as to enable the pistons and cylinders to wear more evenly, and thus maintain an effective oil or fluid seal for a nearly equal period of time, as is well understood.

In actual practice the hollow piston 24 is of very reduced length so as not to require the lowering of the reciprocating element of too great a distance beyond the normal reciprocal range during the drainage of the oil or fluid because of the undesirable gas compression which might occur in the chamber 66, and guide 18 should be of such length, relative to the piston 24, as to provide sufficient clearance for head 15 and rod 10 during the seating of the cylinder 22, or during the draining of the fluid.

The horsehead 40 is uncoupled in the usual way from the member 3 and the reciprocating element of the two-stage pump together with the insertable cylinders and their latching rings, and also the standing valve, may now be withdrawn from the pump column in the following order:

The standing valve member 7 being pulled from its seat in the member 19 by Garbutt rod 14 when T-head 6 engages bushing 11, to follow upwardly with the reciprocating element.

Thereafter latching ring 77 is unlatched and pulled from within spring leaves 75 by cage 45 to enable spring leaves 75 to contract to normal position (see Figure 7) so as to allow the spring leaves 75 to become disengaged from the beveled annular recess 76 to enable extension 74 with insertable cylinder 22 to be pulled free from its tapered bored seat in the member 63 and upwardly with the reciprocating element by head 80 of hollow piston 26.

And thereafter latching ring 79 is unlatched and pulled from within spring leaves 78 by cage 110 of hollow piston 23 or cross 85 on rod 36, to enable spring leaves 78 to contract to normal position so as to allow the spring leaves 78 to become disengaged from beveled annular recess 76 to allow extension 88, with and from which insertable cylinders 21 and 109 depend, to be pulled free from its tapered bored seat in the member 41 and upwardly with the reciprocating element by hollow piston 24 engaging the coupling 86, the part 7 being pulled first, the latching ring 77 being pulled next, and then the latching ring 79 being pulled next, then insertable cylinders 21 and 109 following next, and finally insertable cylinder 22, the parts being pulled in the order shown hereabove and not all at one time so as not to strain rod 36, this being important in view of the reduced cross section of rod 36, as will be shown later herein.

To explain the operation of the pump, reference is had to Figure 10, it being assumed, for the purpose of illustration, that the pistons have the following relative areas: piston 23 equals 1.8; piston 24 equals 4; piston 25 equals 6; piston 26 equals 2; and piston 5 equals 4. The guide 18 has been omitted from Figure 10, to simplify the diagrammatic view.

The pump being full of oil and making an upward stroke, valve 61 being open and valve 62 being closed, a charge of oil is drawn, by piston 5, in through valve 61 into working pump chamber 2, which increases in volume to the extent of 4 parts. Valve 50 is open and valve 47 is closed and the latter, in conjunction with piston 23, discharges oil through the horsehead 40 proportional to the extent of 1.8 parts, the area of piston 23.

At the same time chambers 54 and 34 are decreasing in volume and a volume of oil to the extent of 2 parts is moved downward through passage 82 to mix with and increase the volume of oil to the extent of 4 parts, coming from chamber 34, to a total of 6 parts, but chambers 51 and 66, during the upstroke, are increasing in volume and 2 parts of the 6 parts are taken in by chamber 51 which increases in volume to that extent, and the remaining 4 parts pass through open valve 50 and are taken in by chamber 66 (which increases in volume to that extent).

On the downstroke of the pump, valves 61 and 50 are closed and valves 62 and 47 are open. The column of oil below valve 50 is resting on valve 61 and the hollow piston 5 descends through the oil, causing 4 parts of oil to pass from working pump chamber 2 into chamber 34, which increases in volume to that extent and which freely communicates with chamber 51. Valve 50 is closed and the oil in chamber 51 to the extent of 2 parts is transferred upwardly through passage 82 into chamber 54, which increases in volume to that extent.

At the same time working pump chamber 66 is decreasing in volume and moves oil upward for discharge through horsehead 40. The amount thus discharged is equal to the effective area of working pump chamber 66 (area of piston 25 less area of piston 26, or 6 minus 2 equals 4) minus the area of piston 23 (1.8), leaving a net discharge in volume to the extent of 2.2. parts.

It should be obvious from the description of the pump and its action that the hollow piston 26 obviates troublesome rod packing and valve difficulties encountered in multi-stage pump construction, and, together with the piston 25 provides the working pump chamber 66 adapted to increase in volume during the upstroke and to decrease in volume during the downstroke so as to pump oil or fluid into the second stage during the downstroke. The above described structure, together with the piston 23, which displaces a minor fractional volume of oil or fluid during the upstroke and a major fractional volume during the downstroke, enables reduction of oil or fluid load during the upstroke and also enables the weight of the rod 10 to be utilized to lift oil or fluid during the downstroke.

The hollow piston 24 is utilized with the pump mainly when short strokes are employed and

also when viscous oil is being pumped, and may be dispensed with in long stroke pumps, the fluid or oil rising and surging in the chambers above the working pump chamber 66, the head thus created being sufficient to assure movement of the oil or fluid from the first stage into the working pump chamber 66 of the second stage pump.

The hollow piston 24, when employed with the pump, is of special design, having a loose fit with cylinder 21, which will be determined in actual practice, to enable excess leakage oil or fluid leaking from the oil or fluid pumping members of the second-stage pump below hollow piston 24 to find egress by hollow piston 24, upwardly through chamber 93 and through port 90 in cylinder 21, and by way of trap space 91 to and through port 81 in the member 41, and downwardly between casing 1 and the pump column to the bottom of the well.

The gas chamber 92 serves to prevent "piston hammer" during the movement of the oil or fluid between the chambers positioned between pistons 5 and 24, and also serves as a storage chamber to store leakage oil or fluid leaking from the fluid elevating members of the second-stage pump during the downstroke of the pumping means until the leakage oil or fluid has an opportunity to re-enter the working pump chamber 66 or has had time to escape by relatively loose-fitting hollow piston 24.

In the example chosen, I have shown the first-stage pump as being a single-acting single-stage pump; however, the first-stage pump (Figure 4) is in reality a double-acting single-stage pump acting to raise a major fractional volume of oil or fluid during the upstroke of the pumping means and to raise a very minor fractional volume of oil or fluid during the downstroke of the pumping means.

With the first-stage pump acting to raise fluid during the downstroke as well as during the upstroke of the pumping means, and with chamber 66 of the second-stage pump increasing in volume during the upstroke of the pumping means and decreasing in volume during the downstroke of the pumping means, and with valve 50 of the second-stage pump open during the upstroke of the pumping means and closed during the downstroke of the pumping means, it will be seen that some provision must be made for the minor fractional volume of fluid being raised by the first-stage pump during the downstroke of the pumping means. This condition may be met by increasing the differential area between the hollow pistons 25 and 24 (by reducing the diameter of hollow piston 24) so that the volume of chamber 54 is large enough to store or receive a volume of fluid proportional to that of chamber 51 plus a volume of fluid proportional to the minor fractional volume of fluid being raised by the first-stage pump during the downstroke of the pumping means.

By making the volume of chamber 54 equal to that shown hereabove the chamber 54 will be able to store the volume of fluid being displaced from chamber 51 plus the minor fractional volume of fluid being raised by the first-stage pump during the downstroke of the pumping means until the following upstroke of the pumping means when valve 50 is open and chamber 66 is increasing in volume so that the volume of fluid in chamber 54 may be transferred downwardly through passage 82, one fractional volume of fluid being stored in chamber 51 while the other fractional volume of fluid (equal to the minor fractional volume raised by the first-stage pump during the downstroke) is being added to the major fractional volume of fluid being raised by the first-stage pump, the combined fractional volumes of fluid received in chamber 66 being equal to the volume of fluid drawn in through open inlet valve 61 into chamber 2. Thus it is seen that the second-stage pump may be used with either a single-acting single-stage pump or a double-acting single-stage pump for the first stage, and this is made possible by varying the differential area between hollow pistons 25 and 24 as disclosed hereabove.

During the reciprocation of the pumping means the chamber 93 will increase in volume during the downstroke of the pumping means and will decrease in volume during the upstroke of the pumping means and when no fluid is present in the chamber 93 (this being possible when the pumping means is new and is pumping fluid to the extent of only a fraction of its capacity, the column of fluid in the well being pumped down so that all the fluid entering the two-stage pump by way of inlet valve 61 is elevated in the pump column to the ground surface so that no fluid accumulates in the chamber 93), gas or air will surge back and forth between the space formed between the pump column and the casing 1 by way of port 81, trap space 91 and the port 90 in insertable cylinder 21, thus preventing the pump from becoming "gas-locked."

When fluid is present in the chamber 93 (this being possible when the pumping means has become worn and the fluid elevating members of the second-stage pump leak so that fluid leakage by hollow piston 24 also takes place, as described earlier herein) the fluid will surge back and forth between the trap space 91 and chamber 93 by way of port 90, the fluid rising and falling in the trap space 91 and the excess leakage fluid being spilled through overflow port 81 at the completion of each upstroke of the pumping means thus preventing the pumping means from becoming "liquid-locked."

It will be observed that the surging and mixing action of the oil or fluid will serve to keep sand or abrasive materials that accompany the oil constantly agitated and in motion and any such material entering the pump by way of standing valve or inlet valve 61 and the member 7 will be constantly moving upwardly, during the reciprocation of the pumping means, eventually to overflow through port 81 or through horsehead 40 at the top of the pump column and thereby be prevented from lodging in any particular spot in the pump to cause excessive wear, or to restrict the movement of the reciprocating pump parts.

In actual practice, the second-stage pump will be positioned substantially in the middle portion of the pump column, and the two pumps will act to divide the column of oil or fluid into two stages, the pressure of the column of oil or fluid in the second stage being alternately taken by the valves 50 and 47 of the second-stage pump during the upstroke and downstroke of the two-stage pumping means. Therefore, at no time, is the first-stage pump subjected to the pressure exerted by the entire column of oil or fluid, and it will be readily seen that each individual pump is less subjected to wear.

During the upstroke of the two-stage pumping means the rods 10 and 36 will lift a load equal to the weight of the column of oil or fluid being

raised through the first stage plus a load equal to the weight of the fractional volume of oil or fluid being raised through the second stage, and during the downstroke of the two-stage pumping means the second-stage pump will act to move the remaining fractional volume of oil or fluid upwardly, the weight of rod 10 and attendant pump parts aiding in this operation.

With the primary pump or the conventional single-stage pump (Figure 4) being used as the first-stage pump to raise a volume of oil through a first stage only, it will be seen that a reduction in oil load imposed on the first-stage pump is secured and the rod 10 may therefore be of smaller cross section and of less weight than heretofore.

With the double-acting multi-stage pump (Figures 1, 2 and 3) being used as the second-stage pump to raise a volume of oil through the second stage during the downstroke as well as during the upstroke, a fractional volume during the upstroke and the remaining fractional volume during the downstroke to equal the volume raised by the first-stage pump, it will be seen that a reduction in oil load imposed on rod 36 by the second-stage pump is secured and this together with reduced weight of rod 10, secured as above described, enables rod 36 to be of smaller cross section. And with the second-stage pump elevating a fractional volume of oil during the downstroke, by employing the weight of rod 10 to pull the second-stage pump downwardly, the rod 36 is relieved of the weight of rod 10 during the downstroke and rod 36 will therefore be subjected to less stretch or elongation.

Because of reduced loads imposed on the rods, and therefore less tension, there will be less vibration of the mechanism, and where wells are crooked, as is usually the case, there will be less friction and wear on the rods and the pump column.

While I have shown my apparatus as particularly applied to an oil well and have shown but two stages of pumping, it will be understood that the conventional single-stage pump for the first stage (Figure 4) may be used with any number of double-acting multi-stage pumps (Figures 1, 2 and 3) for the successive stages to pump oil from a deep well in any number of stages in order to obtain even greater all around efficiency, and fluids other than oil may be pumped with equal facility by my invention.

I desire, however, to emphasize the importance of pumping in a plurality of stages and of also employing the weight of the rods and pump parts below the pumps for the successive stages to actually pull the pistons of the pumps for the successive stages downwardly, thereby forcing oil from the pumps for the successive stages upwardly, to raise oil through the successive stages.

I do not limit myself to the particular form of latch means shown with the insertable cylinders. The latch means may be adapted for use with the rings 77 or 79 fixed to the insertable cylinders, if desired, in which case the spring or resilient action of the pawls or leaves 78 and 75 to engage same with their respective recesses may be relied upon to releasably retain the insertable cylinders in place in the pump column.

The pump hereinabove described may be used as a gas and oil pump, in combination with the conventional gas and oil separating means (not shown) disposed below the pump. The ports 81 in that case serve as vents for gas rising with the oil.

Under certain conditions, during operation of the pump in an oil well, fluid may rise in the clearance space to and above ports 81, in which case the fluid may pour through ports 81 into chamber 91 and, especially when piston 24 is not employed with the pump, separation of the gas portion from the liquid portion of the fluid may occur in chamber 91, such separated gas venting itself out through ports 81 and back into the clearance space, and such separated liquid moving downward through the chambers and passages eventually to find its way into the second stage pump, which in this case may operate as the prime pumping medium. In the pumping operation, especially when piston 23 and piston 24 as well, are not employed with the pump (ports 87 also being omitted and port 81 being placed through and adjacent to the upper end of pipe 55) separation of the gas from the oil may occur in the annular chamber formed between pipe 55, member 69, cylinder 28, parts 58, 59, 63 and 83 and cylinder 22.

When the second stage pump employs a packed rod 10 or its equivalent and an inlet valve on the cylinder 23, as a substitute for hollow piston 26 and valve 50, and the pump used for the first stage is a single-acting pump, the hollow piston 24 may be retained, and in this case its outer diameter will remain equal to that disclosed in the example given earlier herein, but piston 25 (there being no piston 26 and therefore no chamber 51 which would require the chamber 54 for surging movement of fluid as disclosed earlier herein) is therefore reduced to an outer diameter equal to the displacement area of the piston of the first stage pump. In the above mentioned case piston 5 retains the same area, as in the example disclosed earlier herein, or 4 units, piston 25 is made equal to 4 units, piston 24 equals 4 units, and piston 23 equals 1.8 units. When a double-acting first stage pump is employed with the above disclosed second stage pump the outer diameter of piston 24 should be less than that of piston 25 to provide a space of variable volume (chamber 54) to receive for storage the oil or fluid displaced upwardly by the first stage pump during the downstroke of the pumping means.

By increasing the displacement area of the piston 23 to equal that of the piston of the first stage pump during both the up and down strokes, the second stage pump may be made to act as a single-acting pump, if desired.

Making piston 26 of an outer diameter equal to or greater than that of piston 5 enables use of a stationary cylinder instead of an insertable cylinder for piston 26, yet facilitates withdrawal of the pump parts for repair or replacement, this being accomplished by varying the displacement areas of pistons 25 and 24 as disclosed in the example given earlier herein. In this case the piston 26 may be made to extend upwardly through cylinder 22, the cage 37 being directly connected to cross 31. This last mentioned condition may also be accomplished without increasing the outer diameter of piston 26, by use of a modified latch, disclosed earlier herein.

And finally, while I have here shown certain of the cylinders in the pump stationary or fixed within the pump column and certain of the cylinders removable with the rods from the pump column, I wish that it be understood that the two-stage pump may be modified so that cartridge type pumps for the first and second stages, wherein all of the cylinders may be made removable with the rods, may be employed, if desired.

I claim:

1. In a pump column for use in a well, a two-stage pumping mechanism comprising: a first stage pump having a first inlet valve and a first piston means and a first outlet valve and a first working pump chamber between said first piston means and said first valves, a second stage pump having a second inlet valve and a second piston means and a second outlet valve and a second working pump chamber between said second piston means and said second valves, and means between and to actuate said first and said second stage pumps in series; means providing a reservoir adapted for supplying fluid from and raised by said first stage pump to said second stage pump, and means including a lateral port through said pump column substantially on a level with the top of said second stage pump providing an overflow passage placing said reservoir in communication with the space exterior to said pump column.

2. In combination with a pump column for use in a well, a two-stage pumping mechanism having pump structure in said pump column comprising a first stage pump having a first inlet valve and a first piston means and a first outlet valve and a first working pump chamber between said first piston means and said first valves, a second stage pump having a second inlet valve and a second piston means and a second outlet valve and a second working pump chamber between said second piston means and said second valves, a first rod connecting the reciprocal portions of said first and said second stage pumps, and a second rod connected to the top of the reciprocal portion of said second stage pump and extending substantially to the top of said pump column and adapted to actuate the two-stage pumping mechanism, and said two-stage pumping mechanism also having other pump structure comprising means providing a reservoir adapted for supplying fluid from and raised by said first stage pump to said second stage pump, and means providing an overflow passage placing said reservoir in communication with the space exterior to said pump column, and said second working pump chamber being adapted to increase in volume and to decrease in volume during the upstroke and downstroke, respectively, of the two-stage pumping mechanism; said second stage pump also having a hollow piston, and a cylinder for said hollow piston, said hollow piston and said cylinder being positioned above and adapted to convey fluid from said second working pump chamber into the second stage, and said hollow piston and said cylinder having a fluid displacement area less than that of said second working pump chamber whereby fluid is raised in the second stage during the downstroke as well as during the upstroke of the two-stage pumping mechanism, to enable the weight of the reciprocal parts of the two-stage pumping mechanism to be utilized to actuate said second stage pump during the downstroke, in order to reduce stress on said second rod during the upstroke and the downstroke of the two-stage pumping mechanism.

3. In combination with a pump column for use in a well, a two-stage pumping mechanism having pump structure in said pump column comprising a first stage pump having a first inlet valve and a first piston means and a first outlet valve and a first working pump chamber between said first piston means and said first valves, a second stage pump having a second valve controlled inlet and a second piston means and a second valve controlled outlet and a second working pump chamber between said second piston means and said second valve controlled inlet and said second valve controlled outlet, and operating rod means between and to actuate said first and said second stage pumps in series, and said two-stage pumping mechanism also having other pump structure comprising means providing a reservoir adapted for supplying fluid from and raised by said first stage pump to said second stage pump, and means providing an overflow passage placing said reservoir in communication with the space exterior to said pump column; said second piston means comprising a first piston, a second piston above and of different fluid displacement area than said first piston, said pistons being connected to operate in series, and a cylinder for said first piston and a cylinder for said second piston, adapted to cooperate with and form a chamber between said pistons and said second valve controlled inlet and said second valve controlled outlet and of variable volume during actuation of the pumping mechanism, for providing the second working pump chamber to advance the flow of fluid from the first stage to the second stage in the pump column.

4. In combination with a pump column for use in a well, a two-stage pumping mechanism having pump structure in said pump column comprising a first stage pump having a first inlet valve and a first piston means and a first outlet valve and a first working pump chamber between said first piston means and said first valves, a second stage pump having a second inlet valve and a second piston means and a second outlet valve and a second working pump chamber between said second piston means and said second valves, and operating rod means between and to actuate said first and said second stage pumps in series, and said two-stage pumping mechanism also having other pump structure comprising means providing a reservoir adapted for supplying fluid from and raised by said first stage pump to said second stage pump, and means providing an overflow passage placing said reservoir in communication with the space exterior to said pump column; said second piston means comprising a first hollow piston, a second hollow piston above and of different fluid displacement area than said first hollow piston, said hollow pistons being connected to operate in series, said second inlet valve being associated with said first hollow piston, said second outlet valve being associated with said second hollow piston, and a cylinder for said first hollow piston and a cylinder for said second hollow piston, adapted to cooperate with and form a chamber between said hollow pistons and said second valves and of variable volume during actuation of the pumping mechanism, for providing the second working pump chamber to advance the flow of fluid from the first stage to the second stage in the pump column.

5. An inserted pump adapted to be positioned in a pump column for use in a well, comprising: a first cylinder, a second cylinder above said first cylinder, a first hollow piston in said first cylinder, a second hollow piston in said second cylinder, operating rod means between and to actuate said hollow pistons in series, means actuated by said operating rod means seating and sealing and releasably retaining said first cylinder in respect to said pump column, and means actuated by said operating rod means seating and sealing and releasably retaining said second cylinder in respect to said pump column, the two means

seating and sealing and releasably retaining said cylinders in respect to said pump column also enabling said cylinders to be spaced apart by said pump column; and a lost-motion connection in said operating rod means adapted to compensate for variations in length of the portions of the pump column and the pump related to said cylinders, in order to assure actuation of the two means, for seating and sealing and releasably retaining said cylinders in respect to said pump column, by said operating rod means.

6. An inserted pump adapted to be positioned in a pump column for use in a well, comprising: a first stationary cylinder sealed and secured in respect ot said pump column, a second cylinder positioned above said first stationary cylinder, a first hollow piston in said first stationary cylinder, a second hollow piston in said second cylinder, a standing valve below said first hollow piston and adjacent to the lower end of said first stationary cylinder, operating rod means between and to actuate said hollow pistons in series, means actuated by said operating rod means seating and sealing and releasably retaining said standing valve in respect to and adjacent to the lower end of said first stationary cylinder, and means actuated by said operating rod means seating and sealing and releasably retaining said second cylinder in respect to said pump column and enabling said second cylinder to be spaced apart by said pump column from said first stationary cylinder and said standing valve; and a lost-motion connection in said operating rod means adapted to compensate for variations in length of the portions of the pump and the pump column related to said second cylinder and said standing valve, in order to assure actuation of the two means, for seating and sealing and releasably retaining said second cylinder and said standing valve in respect to said pump column and said first cylinder, respectively, by said operating rod means.

7. An inserted pump adapted to be positioned in a pump column for use in a well, comprising: a first cylinder, a second cylinder above said first cylinder, a first hollow piston in said first cylinder, a second hollow piston in said second cylinder, operating rod means to actuate said hollow pistons in series, means actuated by said operating rod means seating and sealing and releasably retaining said first cylinder in respect to said pump column, and means actuated by said operating rod means seating and sealing and releasably retaining said second cylinder in respect to said pump column, the two means seating and sealing and releasably retaining said cylinders in respect to said pump column also enabling said cylinders to be spaced apart by said pump column; and means for compensating for variations in length of the portions of the pump and the pump column related to said cylinders, said compensating means comprising the combination of a shoulder with one of said two cylinders and an arm with said operating rod means, the combination being arranged so that said arm engages said shoulder to permit the actuation, by said operating rod means, of the means seating and sealing and releasably retaining said one of said two cylinders in respect to said pump column and the combination also being arranged so that said arm disengages said shoulder to permit the actuation, by said operating rod means, of the means seating and sealing and releasably retaining the other of said two cylinders in respect to said pump column, in order to assure actuation of the two means, for seating and sealing and releasably retaining said cylinders in respect to said pump column, by said operating rod means.

8. An inserted pump adapted to be positioned in a pump column for use in a well, comprising: a standing valve adjacent to the lower end of said pump column, a cylinder above said standing valve, a piston in said cylinder, operating rod means to actuate said piston, means actuated by said operating rod means seating and sealing and releasably retaining said standing valve in respect to said pump column, and means actuated by said operating rod means seating and sealing and releasably retaining said cylinder in respect to said pump column, the two means for seating and sealing and releasably retaining said cylinder and said standing valve in respect to said pump column also enabling said cylinder and said standing valve to be spaced apart by said pump column; and means for compensating for variations in length of the portions of the pump and pump column related to said cylinder and said standing valve, said compensating means comprising the combination of a shoulder with said cylinder and an arm with said operating rod means, the combination being arranged so that said arm engages said shoulder to permit the actuation, by said operating rod means, of the means seating and sealing and releasably retaining said cylinder in respect to said pump column and said combination also being arranged so that said arm disengages said shoulder to permit the actuation, by said operating rod means, of the means seating and sealing and releasably retaining said standing valve in respect to said pump column, in order to assure actuation of the two means, for seating and sealing and releasably retaining said cylinder and said standing valve in respect to said pump column, by said operating rod means.

9. In a pump column for use in a well, a pump adapted to raise fluid in said pump column and having a first hollow piston, a first check valve associated with said first hollow piston, a second hollow piston of relatively larger outer diameter than said first hollow piston and positioned above and connected to said first hollow piston whereby said first and said second hollow pistons operate in series, a third hollow piston of relatively less outer diameter than said second hollow piston and positioned above and directly connected to said second hollow piston, a second check valve associated with said second and said third hollow pistons, a first cylinder for said first hollow piston, a second cylinder for said second hollow piston, a third cylinder for said third hollow piston, said first and said second cylinders being connected whereby a first chamber of variable volume is formed between said first and said second cylinders and said first and said second hollow pistons and located between said valves and serving as a working pump chamber, a second chamber of variable volume formed between said second and said third pistons and said second and said third cylinders, and means enabling formation of a passage between said second and said third cylinders and said pump column and terminating with a lateral port through said pump column, said passage and said lateral port placing said second chamber of variable volume in communication with the space exterior to said pump column.

10. In a pump column for use in a well, a pump adapted to raise fluid in said pump column and

having a first hollow piston, a first check valve associated with said first hollow piston, a second hollow piston of relatively larger outer diameter than said first hollow piston and positioned above and connected to said first hollow piston whereby said first and said second hollow pistons operate in series, a third hollow piston of relatively less outer diameter than said second hollow piston and positioned above and directly connected to said second hollow piston, a second check valve associated with said second and said third hollow pistons, a first cylinder for said first hollow piston, a second cylinder for said second hollow piston, a third cylinder for said third hollow piston, said first and said second cylinders being connected whereby a first chamber of variable volume is formed between said first and said second cylinders and said first and said second hollow pistons and located between said valves and serving as a working pump chamber, a second chamber of variable volume partially formed by said first cylinder and by and below said first hollow piston, a third chamber of variable volume formed between said second and said third hollow pistons and said second and said third cylinders, and means enabling formation of a passage between said first and said second and said third cylinders and said pump column, said passage connecting said second and said third chambers of variable volume and permitting fluid to surge back and forth between said second and said third chambers of variable volume.

11. In a pump column for use in a well, a pump adapted to raise fluid in said pump column and having a first hollow piston, a first check valve associated with said first hollow piston, a second hollow piston of relatively larger outer diameter than said first hollow piston and positioned above and connected to said first hollow piston whereby said first and said second hollow pistons operate in series, a third hollow piston of relatively less outer diameter than said second hollow piston and positioned above and directly connected to said second hollow piston, a fourth hollow piston of relatively less outer diameter than said third hollow piston and positioned above and directly connected to said third hollow piston, a second check valve associated with said second and said third and said fourth hollow pistons, a first cylinder for said first hollow piston, a second cylinder for said second hollow piston, a third cylinder for said third hollow piston, a fourth cylinder for said fourth hollow piston, said first and said second cylinders being connected whereby a first chamber of variable volume is formed between said first and said second cylinders and said first and said second hollow pistons and located between said valves and serving as a working pump chamber, a second chamber of variable volume partially formed by said first cylinder and by and below said first hollow piston, a third chamber of variable volume formed between said second and said third cylinders and said second and said third hollow pistons, means enabling formation of a first pasage between said first and said second and said third cylinders and said pump column and connecting said second and said third chambers of variable volume and permitting fluid to surge back and forth between said second and said third chambers of variable volume, a fourth chamber of variable volume formed between said third and said fourth cylinders and said third and said fourth hollow pistons, and means enabling formation of a second passage between said third and said fourth cylinders and said pump column and terminating with a lateral port through said pump column, said second passage and said lateral port placing said fourth chamber of variable volume in communication with the space exterior to said pump column.

12. An inserted pump adapted to be positioned in a pump column for use in a well, comprising: a first hollow piston, a second hollow piston of relatively less outer diameter than said first hollow piston and positioned above and directly connected to said first hollow piston, a check valve associated with said hollow pistons, a first cylinder for said first hollow piston, a second cylinder for said second hollow piston, said first and said second cylinders being directly connected, a chamber of variable volume formed in said cylinders and by said cylinders and said hollow pistons, a first lateral port through said first cylinder and positioned substantially on a level with the top of said chamber of variable volume, means seating said cylinders in respect to said pump column, means sealing said first cylinder in respect to said pump column, means sealing said second cylinder in respect to said pump column, and means releasably retaining said cylinders in respect to said pump column; and a passage formed between the two sealing means provided for said cylinders and between said cylinders and said pump column and connecting said first lateral port with a second lateral port through said pump column, said passage and said first and said second lateral ports placing said chamber of variable volume in communication with the space exterior to said pump column.

13. An inserted pump adapted to be positioned in a pump column for use in a well, comprising: a first hollow piston, a second hollow piston of relatively less outer diameter than said first hollow piston and positioned above and directly connected to said first hollow piston, a first cylinder provided for said first hollow piston, a second cylinder provided for said second hollow piston, said first and said second cylinders being directly connected, a chamber of variable volume formed in said cylinders and by said cylinders and said hollow pistons, a first lateral port through said first cylinder and positioned substantially on a level with the top of said chamber of variable volume, means seating said cylinders in respect to said pump column, means sealing said first cylinder in respect to said pump column, means sealing said second cylinder in respect to said pump column, and means releasably retaining said cylinders in respect to said pump column; and a passage formed between the two sealing means provided for said cylinders and between said cylinders and said pump column and connecting said first lateral port with a second lateral port through said pump column, said passage and said first and said second lateral ports placing said chamber of variable volume in communication with the space exterior to said pump column.

14. An inserted pump adapted to be positioned in a pump column for use in a well, comprising: a cylinder and a piston in said cylinder, means within said pump column and with said cylinder adjacent to its upper end seating and sealing said cylinder in respect to said pump column, and an annular recess within said pump column and positioned adjacent to the first mentioned means within said pump column; and resilient means, adapted for surrounding said cylinder adjacent to its upper end and adapted for engaging said

recess, latching said cylinder in respect to said pump column.

15. An inserted pump adapted to be positioned in a pump column for use in a well, comprising: a cylinder and a piston in said cylinder, means within said pump column and with said cylinder seating said cylinder in respect to said pump column, means within said pump column and with said cylinder adjacent to its upper end sealing said cylinder in respect to said pump column, means within said pump column and with said cylinder adjacent to its lower end sealing said cylinder in respect to said pump column, and an annular recess within said pump column and positioned adjacent to the second mentioned means within said pump column; and resilient means, adapted for surrounding said cylinder adjacent to its upper end and adapted for engaging said recess, latching said cylinder in respect to said pump column.

16. An inserted pump adapted to be positioned in a pump column for use in a well, comprising: a first stationary cylinder sealed and secured in respect to said pump column, a first hollow piston positioned in said first stationary cylinder, a second hollow piston of relatively less outer diameter than said first hollow piston and positioned above and connected to said first hollow piston whereby said hollow pistons operate in series, a second cylinder provided for said second hollow piston, and means seating and sealing said second cylinder in respect to said pump column; and means latching said second cylinder in respect to said pump column.

17. An inserted pump adapted to be positioned in a pump column for use in a well, comprising: a first stationary cylinder sealed and secured in respect to said pump column; a first hollow piston positioned in said first stationary cylinder, a first check valve with said first hollow piston, a second hollow piston above and of relatively less outer diameter than said first hollow piston, a second check valve with said second hollow piston, said hollow pistons being connected to operate in series, a second cylinder provided for said second hollow piston, means seating and sealing and releasably retaining said second cylinder in respect to said pump column, and a chamber of variable volume between said cylinders and said hollow pistons and said valves, said chamber of variable volume serving to advance the flow of fluid in said pump column.

18. In a well pump, a pump column, a pump located in said pump column and comprising: a first hollow piston, an inlet valve associated with said first hollow piston, a second hollow piston of different outer diameter than said first hollow piston and positioned above said first hollow piston, an outlet valve associated with said second hollow piston, operating rod means to connect and to actuate said hollow pistons in series, a first cylinder for said first hollow piston, and a second cylinder for said second hollow piston, said cylinders being connected and with said hollow pistons form a chamber of variable volume acting as a working pump chamber; said pump also having means providing a lost-motion connection with the operating rod means between said first and said second hollow pistons and adapted to dislodge said outlet valve from its seat, and means below said first piston enabling said inlet valve to be dislodged from its seat.

19. An inserted pump adapted to be positioned in a pump column for use in a well, comprising: a cylinder, a hollow piston extending through said cylinder, means seating and sealing and releasably retaining said cylinder in respect to said pump column, and means with and at the top of said hollow piston providing a shoulder engageable with the upper end of said cylinder during and to facilitate actuation of the means seating and sealing and retaining said cylinder in respect to said pump column; and means, with and at the bottom of said hollow piston and comprising a closed cage of greater outer diameter than said hollow piston and a check valve in said closed cage, providing a shoulder engageable with the lower end of said cylinder during and to facilitate releasing and unseating and unsealing of said cylinder in respect to said pump column.

20. In a well, a pump column provided with a closure adjacent to its lower end preventing the downward movement of fluid in said pump column, a pump located in said pump column above said closure, retaining means at the top of said pump to hold said pump in said pump column, said pump having an inlet valve, hollow piston means, an outlet valve, and a first chamber of variable volume in said pump and between said hollow piston means and said valves and serving as a working pump chamber, and a second chamber below said pump and between said pump and said pump column and said closure and communicating at its upper end with said inlet valve; supporting means below said retaining means and between said pump and said pump column, said supporting means and said retaining means coacting to substantially prevent misalignment of said pump in respect to said pump column, a third chamber serving as an oil and gas separation chamber positioned between said retaining means and said supporting means and said pump and said pump column and substantially on a level above said first chamber, and a passage between said supporting means and said pump and said pump column, said passage affording communication between the bottom of said third chamber and the top of said second chamber, and lateral openings through said pump column and positioned substantially on a level with the top of said third chamber and placing said third chamber in communication with a space between said pump column and the well whereby oil and gas entrained in the oil are admitted from said space to said third chamber and gas is vented from said third chamber to said space.

21. In a well, a pump column provided with a closure adjacent to its lower end preventing the downward movement of fluid in said pump column, a pump located in said pump column above said closure and having an inlet valve, hollow piston means, an outlet valve, and a first chamber of variable volume in said pump and between said hollow piston means and said valves and serving as a working pump chamber, a second chamber below said pump and between said pump and said pump column and said closure and communicating at its upper end with said inlet valve, a first retaining means positioned at the top of said pump to hold said pump in said pump column, and a second retaining means positioned intermediately between the top and the bottom of said pump and between said pump and said pump column, said second retaining means also being provided to hold said pump in said pump column; a first supporting means

between said first and said second retaining means and said pump and said pump column, a third chamber serving as an oil and gas separation chamber between said first retaining means and said first supporting means and said pump and said pump column, a second supporting means positioned below said second retaining means and between said pump and said pump column, said first and said second retaining means and said first and said second supporting means coacting to substantially prevent misalignment of said pump in respect to said pump column, and a passage between said first and said second supporting means and said second retaining means and said pump and said pump column, said passage affording communication between the bottom of said third chamber and the top of said second chamber, and lateral openings through said pump column and positioned substantially on a level with the top of said third chamber and placing said third chamber in communication with a space between said pump column and the well whereby oil and gas entrained in the oil are admitted from said space to said third chamber and gas is vented from said third chamber to said space.

22. In a pump column for use in a well, a surge pump comprising the combination of: an inlet valve, hollow piston means, an outlet valve, a first chamber of variable volume in said pump and between said hollow piston means and said valves and serving as a working pump chamber, a second chamber about said pump, a third chamber about said pump and positioned substantially on a level above said second chamber, at least one of the last mentioned two chambers being adapted to be varied in volume during operation of the pump, and retaining means to hold said pump in said pump column; supporting means between said pump and said pump column, said supporting means and said retaining means coacting to substantially prevent misalignment of said pump in respect to said pump column, and a passage between said pump and said supporting means and said pump column, said passage placing said last mentioned two chambers in communication to permit fluid to surge back and forth between said last mentioned two chambers.

23. In a pump column for use in a well, a surge pump comprising the combination of: an inlet valve, hollow piston means, an outlet valve, a first chamber of variable volume in said pump and between said hollow piston means and said valves and serving as a working pump chamber, a second chamber of variable volume about said pump and positioned substantially on a level above said first chamber of variable volume, a third chamber of variable volume about said pump and positioned substantially on a level below said first chamber of variable volume, and retaining means to hold said pump in said pump column; supporting means between said pump and said pump column, said supporting means and said retaining means coacting to substantially prevent misalignment of said pump in respect to said pump column, and a passage between said pump and said retaining means and said supporting means and said pump column, said passage connecting said second and said third chambers of variable volume and permitting surging movement of fluid between said second and said third chambers of variable volume.

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