July 27, 1954 W. J. SUTTON 2,684,639

WELL PUMP

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Fig. 1

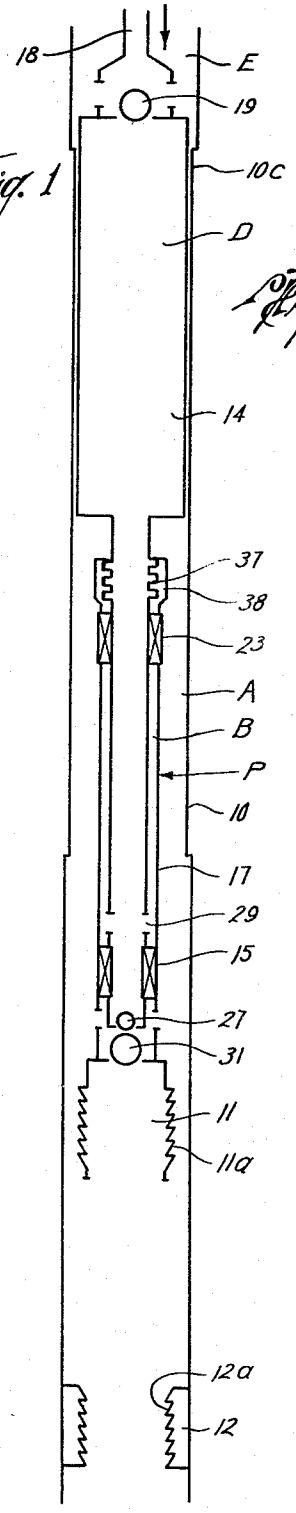


Fig. 2

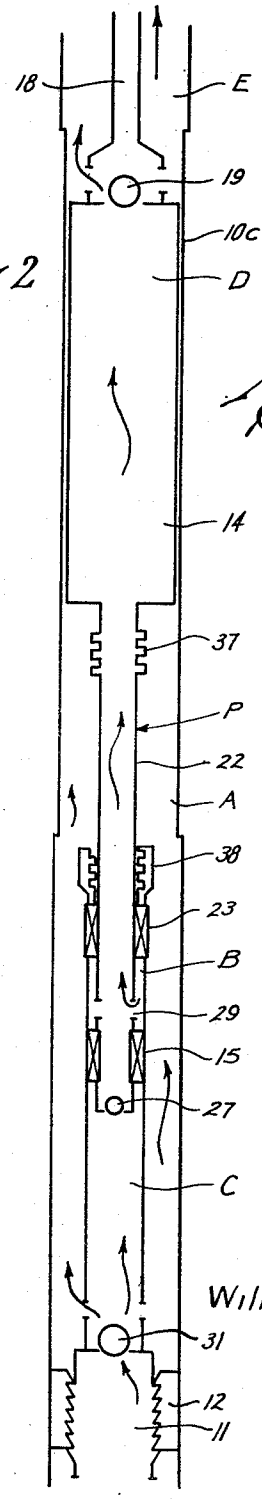
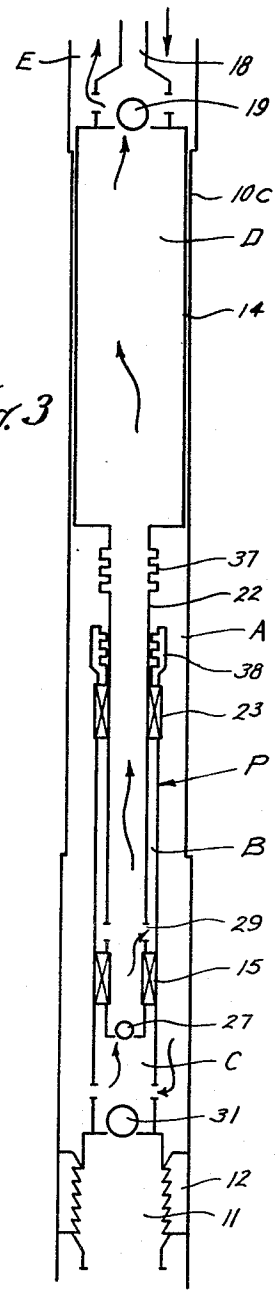


Fig. 3



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WELL PUMP

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Fig. 4

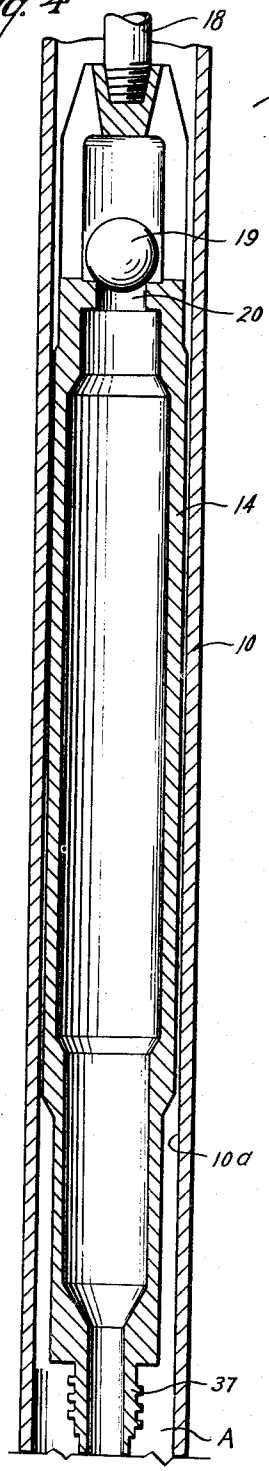


Fig. 4A

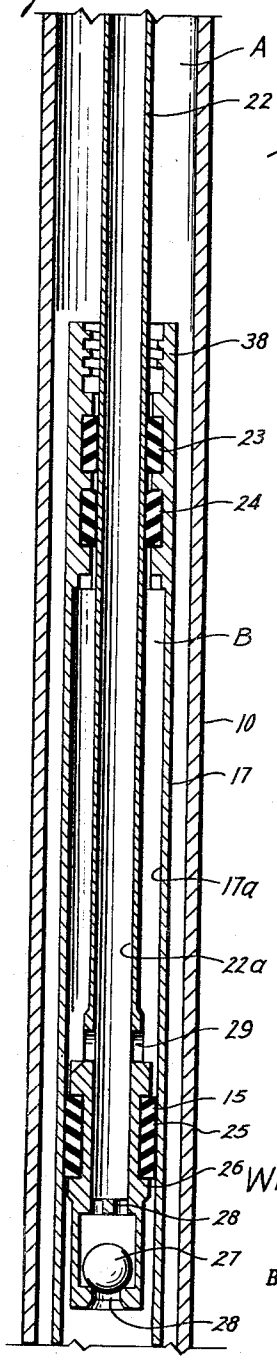
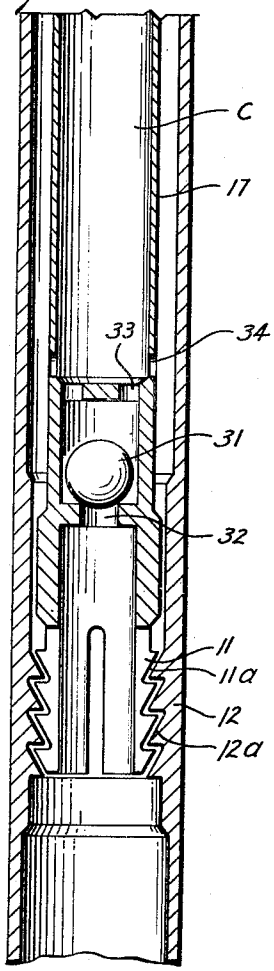


Fig. 4B



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Fig. 5

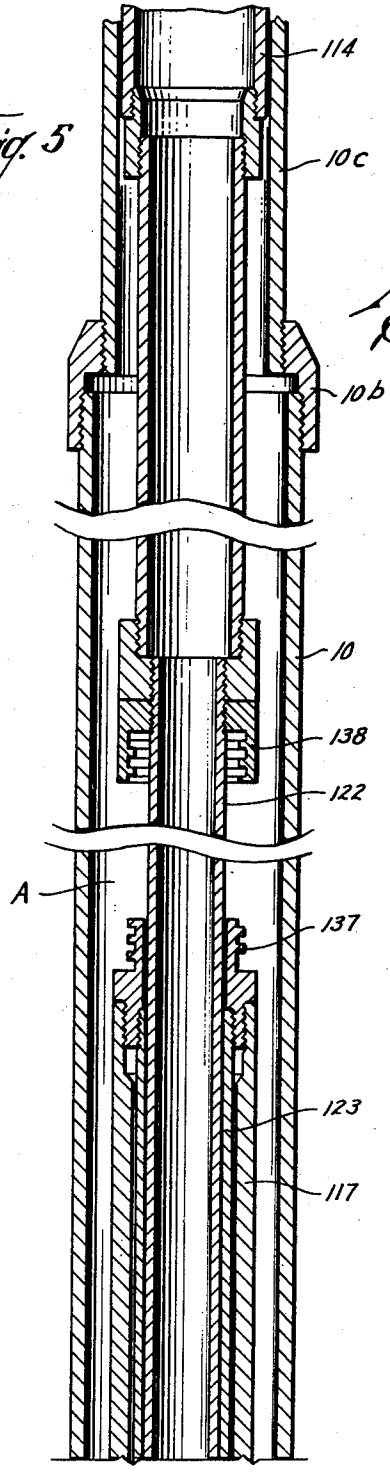
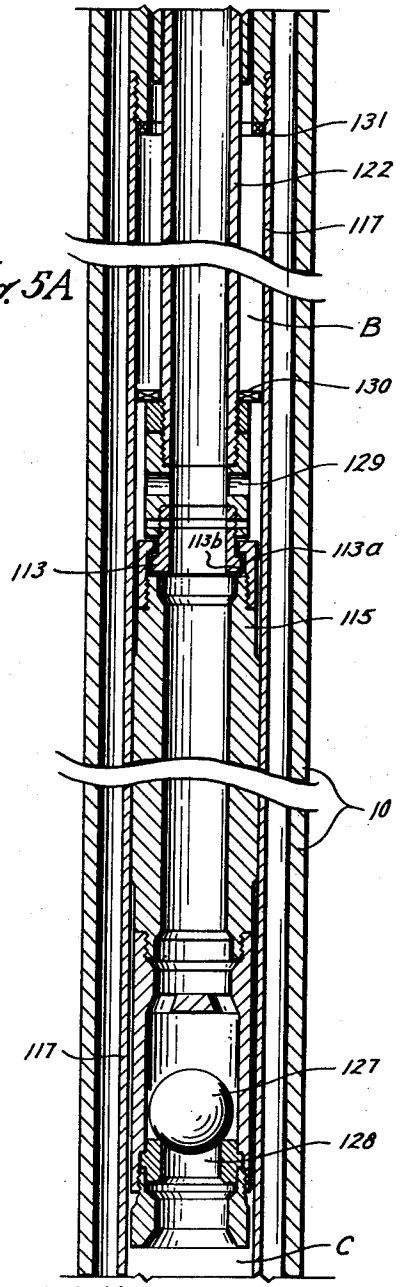


Fig. 5A



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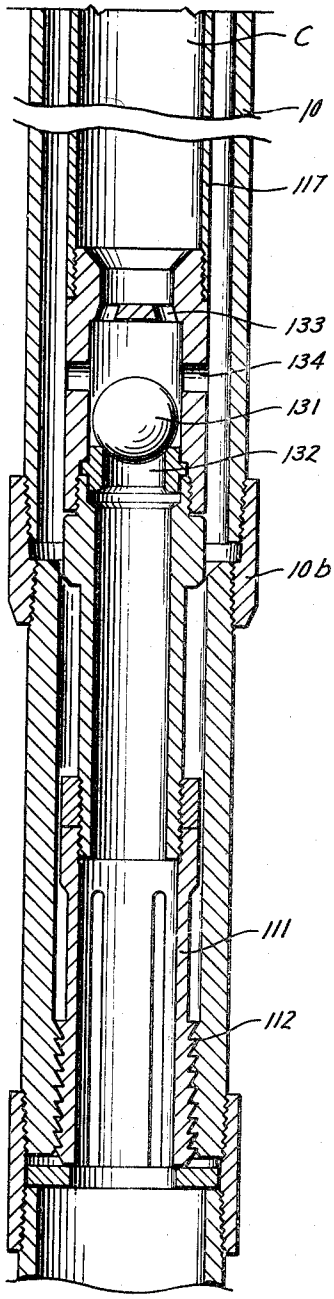
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Fig. 5B



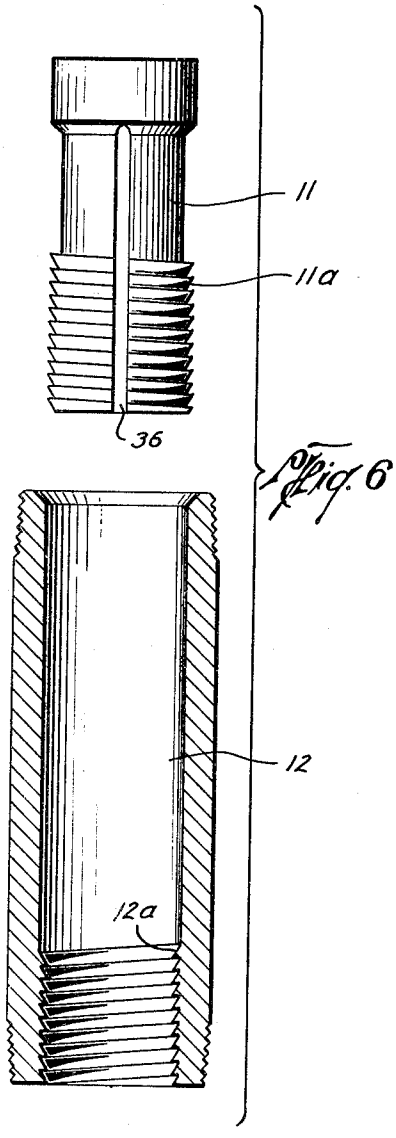


Fig. 6

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WELL PUMP

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Application March 3, 1952, Serial No. 274,608

8 Claims. (Cl. 103—181)

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This invention relates to new and useful improvements in well pumps.

This application is filed as an improvement upon the well pump disclosed in my co-pending application, Serial No. 208,381, filed January 29, 1951.

As pointed out in said co-pending application, the conventional single stroke well pump has definite limitations as to stroke length and pumping speed which results in limiting the volume of fluid which can be displaced from the well. The construction shown in my co-pending application provides a double plunger and cylinder arrangement which produces advantages over the usual single stroke pump; however, the use of two cylinders does increase the cost of the unit.

It is therefore an object of this invention to provide a well pump having all of the advantages of the pump shown in my co-pending application and in addition having the advantage of requiring only a single cylinder, as compared to the dual cylinder illustrated in such application.

A particular object of this invention is to provide a well pump having a double plunger wherein the lower plunger operates within the cylinder or lower working barrel, with the upper plunger reciprocating within a working barrel in the well tubing string, whereby the construction is simplified.

Another object of this invention is to provide a subsurface pump having a pump chamber and a booster chamber, wherein the pump chamber and booster chamber are both filled upon the upstroke of the pump plungers, and wherein fluid is pumped upwardly above the pump from the booster chamber upon the downstroke of the plungers.

Another object of this invention is to provide a well pump having an inner working barrel and double pump plunger, together with means for securing the pump in position by a releasable latch means; said pump also having means on the plunger for actuating the latch means to effect insertion and removal of the pump from the tubing string.

The construction designed to carry out the invention will be hereinafter described together with other features thereof.

The invention will be more readily understood from a reading of the following specification and by reference to the accompanying drawings forming a part thereof, wherein an example of the invention is shown, and wherein:

Figure 1 is a diagrammatic view of the pump of this invention as it is being inserted into the tubing,

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Figure 2 is a diagrammatic view of the pump of this invention, illustrating the relationship of the parts and the fluid flow upon the upstroke of the pump,

Figure 3 is a diagrammatic view of the pump of this invention, illustrating the relationship of the parts and the fluid flow upon the downstroke of the pump,

Figures 4, 4A and 4B together are a longitudinal sectional view illustrating one embodiment of the pump of this invention, Figure 4 illustrating the upper portion thereof, Figure 4A illustrating the central portion thereof, and Figure 4B illustrating the lower portion thereof,

Figures 5, 5A and 5B together are a longitudinal sectional view of another embodiment of the pump of this invention, Figure 5 illustrating in part the upper portion thereof, Figure 5A illustrating the central portion thereof, and Figure 5B illustrating the lower portion thereof, and

Figure 6 is an exploded view, partly in section and partly in elevation, of the coupling members of the releaseable anchor of this invention.

In the drawings the numeral 10 designates a tubing which extends longitudinally from the earth surface downwardly into the well bore. A pump P which comprises the present invention is adapted to be positioned with the tubing string nearer its lower portion and said pump is secured in operating position by the engagement of a threaded collar 11 located at the lower end of the pump P within a threaded sleeve 12 connected in said tubing string. The collar 11 and the sleeve 12 together form an anchor means for the pump P, and such anchor means will be hereinafter described in detail.

The pump P includes an upper plunger 14 and a lower plunger 15, the upper plunger 14 being of considerably larger diameter than the lower plunger 15. During operation the upper plunger 14 reciprocates within an upper working barrel 10c which is of the same nominal size as the tubing; actually, a nominal size working barrel is slightly less in bore diameter than the same nominal size tubing so that the bore of the upper working barrel is less than the bore of the tubing; however, from a practical standpoint, the upper working barrel forms a part of the tubing string. The lower plunger 15 reciprocates within a cylindrical lower working barrel 17 positioned below the upper plunger 14, this barrel 17 being of considerably reduced diameter as compared with the tubing 10. Since the upper plunger 14 operates within a barrel forming part of the tubing string and of substantially the same diameter,

and since the lower plunger 15 is the only plunger operating within the lower barrel 17, said lower barrel can be of relatively short length. It is this feature in particular which makes the pump of this invention more economical and more simplified than the pump disclosed in my aforementioned co-pending application.

As is clearly shown in Figures 4, 4A and 4B, wherein the preferred embodiment of the pump of this invention is illustrated, the pump P is supported by and operated by the usual pump rod 18 connected to the upper plunger 14. Above the upper plunger 14 is a check valve 19 which is adapted to close the opening 20 in the plunger 14. As can be seen, the plunger 14 is of substantially the same diameter as the bore 10a of the tubing 10, and it normally operates within the upper working barrel 10c of the tubing string. It will be appreciated, of course, that the working barrel 10c may form part of the tubing string 10 if desired.

The upper plunger 14 is connected to the lower plunger 15 through a tube 22 of reduced diameter as compared to the pump plunger 14. The tube 22 extends within the working barrel 17 for the lower plunger 15. Near the upper end of the cylindrical barrel 17, packers 23 and 24 are employed to thereby separate the chamber A in which the upper plunger 14 operates from the chamber B in which the lower plunger 15 operates. It will be appreciated that the packers 23 and 24 could be consolidated to one single packing or a large number of smaller packings if desired.

The lower plunger 15 includes a plurality of flexible members 25 mounted on a sleeve 26. These flexible members 25 engage the inner bore 17a of the working barrel 17 in the reciprocation of the lower plunger 15 therein. Below the plunger 15 is a check valve 27 seated upon an opening 28 in the lower portion of the plunger 15. When the check valve 27 is opened, the fluid is permitted to pass upwardly through the opening 28 into the bore 22a of the tube 22, with some of the fluid passing outwardly through the passages 29 in the tube 22. The flow of fluid during the pumping operation will be described more in detail hereinafter. At the lower end of the sleeve or working barrel 17 is a check valve 31 which is seated over an opening 32. When the check valve 31 is open fluid may pass upwardly through the passages 33 into the chamber C below the plunger 15, with some of the fluid passing through the openings 34 into the chamber A, the flow of fluid being described more in detail hereinafter.

The releaseable anchor means at the lower end of the pump P includes the collar 11 and the sleeve 12, the collar 11 having teeth 11a thereon and the collar 12 having mating teeth 12a thereon. As can be seen particularly in Figure 6, the threads 11a and 12a are left hand threads. Longitudinal slots 36 are provided in the collar 11 to provide for flexing of the collar 11 so that in the insertion of the pump P into the tubing 10 the collar 11 may simply be speared or forced downwardly into the sleeve 12, whereby the teeth 11a and 12a engage. It will be observed in Figures 4 and 4A that there is positioned below the plunger 14 a threaded sleeve 37 which is engageable with a threaded box 38 on the upper portion of the cylinder 17. The threaded sleeve 37 and the threaded box 38 together form a latching means and the threads are preferably right hand threads. In any event, the threads on the latching means should have an opposite handedness to the threads on the releaseable anchor means at the lower portion of the pump P. Thus, in the insertion of the pump P into the tubing 10 the sleeve 37 and the box 38 are joined or threaded into each other, whereby the barrel 17 is held in fixed relationship to the upper plunger 14. As the pump P is lowered into the tubing 10 on the pump rods 18, the parts are in the relationship as shown particularly in Figure 1. The movement of the pump P is continued downwardly to seat the pump and the collar 11 is set straight down into the seating sleeve 12. After the anchor means 11, 12, is secured so that the pump P is secured in the tubing 10, the pump rods 18 are rotated to the left to disengage the latch means 37, 38, by rotating the sleeve 37 out of the box 38. Since the threads on the anchor means are left hand threads they will not disengage upon the rotation to the left, whereas the threads on the latch means will disengage since they are right hand threads. It will be appreciated that these threads on the latch means and the anchor means may have their pitch reversed if desired and still the same result can be accomplished. This rotation of the pump rods 18 to the left separates the pump plunger 14 from the barrel 17 and the pump P is then in position for its normal pumping operation in the well. When it is desired to remove the pump P from the tubing 10, the latch means 37, 38, are reassembled by rotation of the pump rods 18 to the right until the threads 37 are completely seated in the box 38. Continued rotation to the right then unthreads the threads 11a from the threads 12a since these are lefthanded threads, and it is thereby possible to completely unthread the collar 11 from the sleeve 12 for removal of the pump assembly P.

The operation of the pump P with the collar 11 engaged with the sleeve 12 and the threads 37 released from the box 38 can be seen in Figures 2 and 3. In Figure 2 the relationship of the parts and the flow of the fluid are illustrated when the plungers 14 and 15 are on the upstroke. On such upstroke the well fluid enters from the well bore passing the check valve 31, and filling the chambers A and C. Assuming that the chamber B and the tube 22 and chamber D of the plunger 14 had previously been filled with fluid, the upstroke of the pump would force such fluid in the chamber B upwardly so that the portion of the fluid is delivered above the check valve 19 into the tubing space E above the pump.

The downstroke of the pump is illustrated in Figure 3. On such downstroke the plunger 14 forces the fluid in the chamber A into the chamber C. The check valve 27 is forced open whereby the fluid from the chamber A passing into the chamber C may thence pass upwardly into the chamber B to fill same. Since the tube 22 had previously been filled with fluid, that fluid is forced upwardly into the chamber D and above the valve 19 into the space E. It can therefore be seen that on both the upstroke and the downstroke well fluid is pumped upwardly above the pump into the tubing space E.

In Figures 5, 5A and 5B, a modified form of the pump of this invention is illustrated. In this form the tubing 10 is shown as composed of several sections and it may have a section 10c of reduced diameter connected to the other section through a collar 10b. The section 10c of reduced diameter may be the portion in which the plunger 14 operates. It will be appreciated, of

course, that the section 10c may be of the same diameter as the rest of the tubing 10 if desired. In the modifications of Figures 5, 5A and 5B, the various parts are substantially the same as illustrated in Figures 4, 4A and 4B. It will be observed that the box 138 is positioned on the tube 122 and the threaded sleeve 137 is positioned on the working barrel 117. Thus, the box and the sleeve of the latching means are reversed as compared to the modification shown in Figures 4, 4A and 4B, but it will be appreciated that either form of the latching means may be used in either of these modifications. Between the barrel 117 and tube 122 is a metal-to-metal packing 123 which serves to define the upper end of the chamber B. The lower plunger 115 is of somewhat different construction that the modification shown in Figures 4, 4A and 4B, since the plunger 115 is a metal plunger, whereas the plunger 15 was of a flexible construction having the flexible elements 25. Also, since the plunger 115 is constructed of metal, it is desirable to have an alignment coupling 113 to obtain proper axial alignment of the plunger 115 in the working barrel 117. This alignment coupling includes an overhanging collar 113a and a shoulder 113b which is engaged by the overhanging collar 113a. Above the alignment collar 113 are openings 129, which are similar to the openings 29 in the modification of Figures 4, 4A and 4B. Flexible elements 130 are mounted on the tube 122 and serve to contact the flexible members 131 at the top of the travel of the elements 130. At the lower portion of the plunger 115 is the check valve 127 mounted over the opening 128.

At the lower end of the cylindrical barrel 117 is the check valve 131 seated over the opening 132, with the inlet passages 134 and 133 thereabove. At the lower end of the pump P is the collar 111 secured in the sleeve 112 by the threads constructed in the same manner as the collar 11 and the sleeve 12 of Figures 4, 4A and 4B.

The operation of the modification of Figures 5, 5A and 5B is identical with the operation of the modification shown in Figures 4, 4A and 4B, which operation has been described above and is illustrated in particular in Figures 1 to 3.

With respect to the pressures acting on the plungers 14 and 15 (or 114 and 115 in the modification) these pressures are unbalanced during the upstroke. Because of the lifting of fluids in the tubing during the upstroke the pressure acting on the upper surface of plunger 14 and that acting on the upper surface of plunger 15 is relatively high due to the load; however, the pressures acting on the lower surfaces of the plungers is relatively low since fluid is being drawn in through standing valve 31. However upon the downstroke the valve 27 is unseated and when this occurs the areas above and below the plungers are all placed in communication with each other so that equalization of pressures across both plungers during the downstroke is effected. This prevents placing the pump rods under compression and makes possible the efficient displacement of an increased volume of fluid. The many advantages of the equalization of plungers on the downstroke is set forth in my co-pending application heretofore referred to.

The foregoing disclosure and description of the invention is illustrative and explanatory thereof and various changes in the size, shape and materials, as well as in the details of the illustrated construction may be made, within the scope of

the appended claims, without departing from the spirit of the invention.

What is claimed is:

1. A sub-surface pump for pumping well fluids upwardly within a well tubing and including, an upper working barrel connected in the well tubing and having a diameter substantially equal to the tubing diameter, a lower working barrel of lesser diameter than the upper barrel and disposed axially within the tubing below the upper barrel, the lower end of the lower working barrel having a valve-fluid inlet, an upper tubular plunger reciprocable in the upper barrel and having the upper end of its bore in communication with the area above the plunger, a lower tubular plunger reciprocable within the lower barrel, a tubular connecting element connecting the plungers and establishing communication between the bores of said plungers, means establishing communication between the lower end of the connecting element and the area above the lower plunger, packing means in the upper portion of the lower working barrel sealing around the exterior of the connecting element, a downwardly closing valve in the lower portion of the lower plunger, operating means extending from the surface of the well for reciprocating the plungers relative to their respective barrels, and means for establishing communication between the lower surfaces of both plungers whereby when the valve in the lower portion of the lower plunger is open pressure communication may occur through the tubular plungers and tubular connecting element to the areas above and below said plungers so that pressures across said plungers are equalized during downward movement of the plungers relative to their respective barrels.

2. A sub-surface pump as set forth in claim 1, together with a detachable connection between the connecting element and the upper end of the lower working barrel, whereby the upper plunger, lower plunger and lower barrel may be lowered into the tubing as a unit after which the element may be detached from said lower barrel to permit reciprocating of the lower plunger within said lower barrel.

3. A sub-surface pump as set forth in claim 1, together with a downwardly closing valve in the upper end of the upper plunger.

4. A sub-surface pump as set forth in claim 1, together with a releasable anchor secured to the lower end of the lower working barrel for releasably securing said inner working barrel in position within the tubing.

5. A sub-surface pump for pumping well fluids upwardly within a well tubing and including, an upper working barrel connected in the well tubing and having a diameter substantially equal to the tubing diameter, an upper plunger reciprocable within said upper barrel and comprising an elongate cylindrical member which provides a fluid chamber therein, a downwardly closing valve in the upper end of the plunger controlling flow to and from the chamber, a lower working barrel of lesser diameter than the upper barrel and disposed in the well tubing below the upper plunger, said lower barrel having a well fluid inlet in its lower end, a downwardly closing valve controlling flow through the inlet, a lower tubular plunger reciprocable within the lower working barrel, a downwardly closing valve in the lower end of the bore of the lower plunger, a tubular element physically connecting the upper

and lower plungers and establishing communication between the bore of the lower plunger and the chamber of the upper plunger, and packing means in the upper end of the lower barrel and sealing around the tubular connecting element, said connecting element having an opening which establishes communication between the bore of said element and the interior of the lower working barrel above the lower plunger, the lower end of the lower working barrel having an opening disposed between the well fluid inlet and the lower end of the lower plunger for establishing communication between the interior of the lower working barrel and the area outside said working barrel.

6. A sub-surface pump as set forth in claim 5, together with a releasable anchor secured to the lower end of the lower working barrel for releasably securing said inner working barrel in position within the tubing.

7. A sub-surface pump for pumping well fluids upwardly within a well tubing and including, an upper working barrel connected to the well tubing and having a diameter substantially equal to the tubing diameter, a lower working barrel of lesser diameter than the upper barrel disposed axially therebelow, an upper plunger reciprocable within the upper working barrel, a lower plunger reciprocable within the lower working barrel, a connecting element having a flow passage therethrough connecting the upper and lower plungers whereby said plungers reciprocate simultaneously within their respective barrels, packing means within the upper end of the lower barrel for sealing off around the connecting element, the lower end of the lower working barrel having a valved fluid inlet, means located between the valved inlet and the lower plunger for establishing communication between the lower end of the interior of the lower working barrel and the area exteriorly thereof, a downwardly closing valve in the lower end of the lower plunger, and means for establishing communication between the passage of the connecting element and the interior of the lower working barrel above the lower plunger.

8. A sub-surface pump as set forth in claim 7, together with a detachable connection between the connecting element and the upper end of the lower working barrel, whereby the upper plunger, lower plunger and lower barrel may be lowered into the tubing as a unit after which the element may be detached from the lower barrel to permit reciprocating of the lower plunger within the lower barrel.

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