May 15, 1962 D. E. HERMANSON 3,034,440

TWO-IN-ONE PUMP ASSEMBLY

Filed June 24, 1959 3 Sheets-Sheet 1

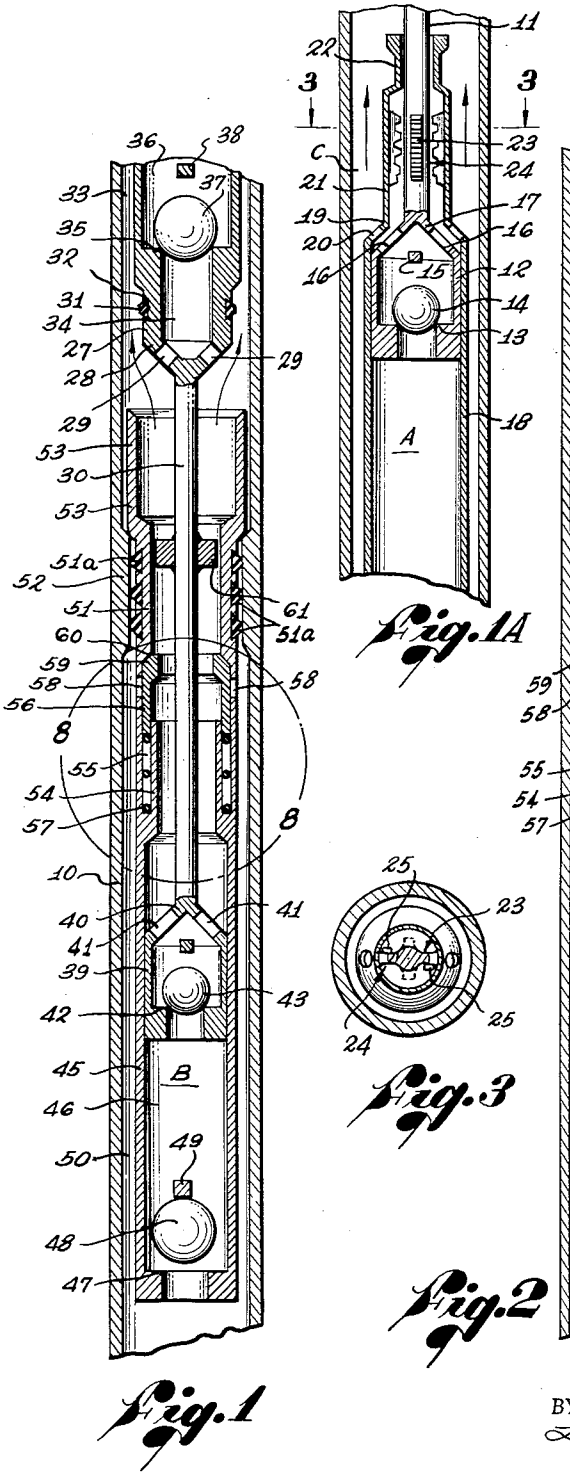

Fig. 1

Fig. 1A

Fig. 3

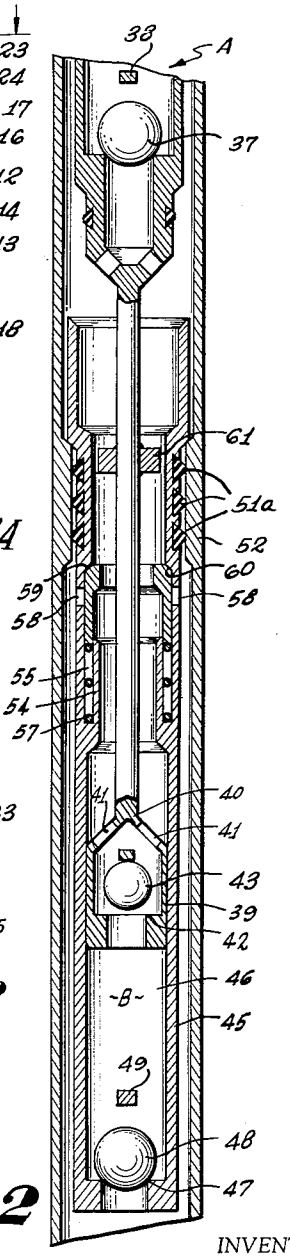

Fig. 2

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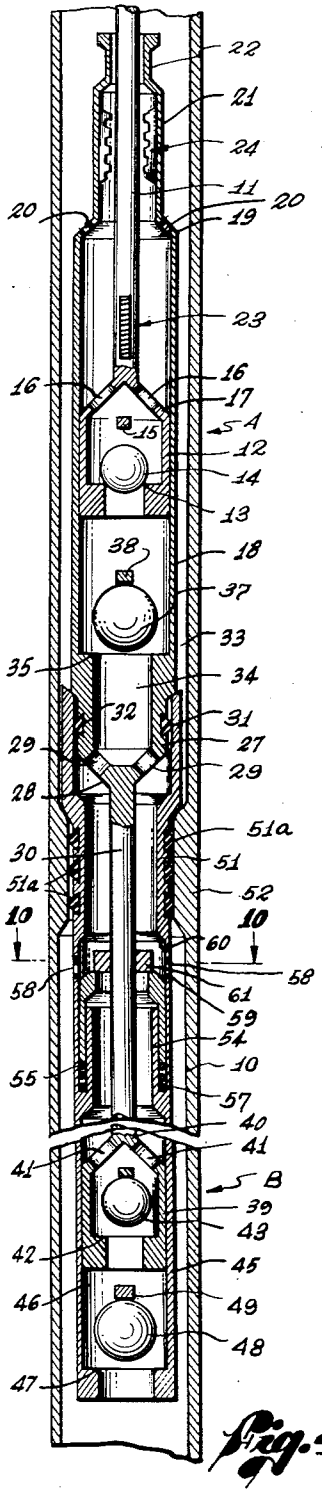

Fig. 4

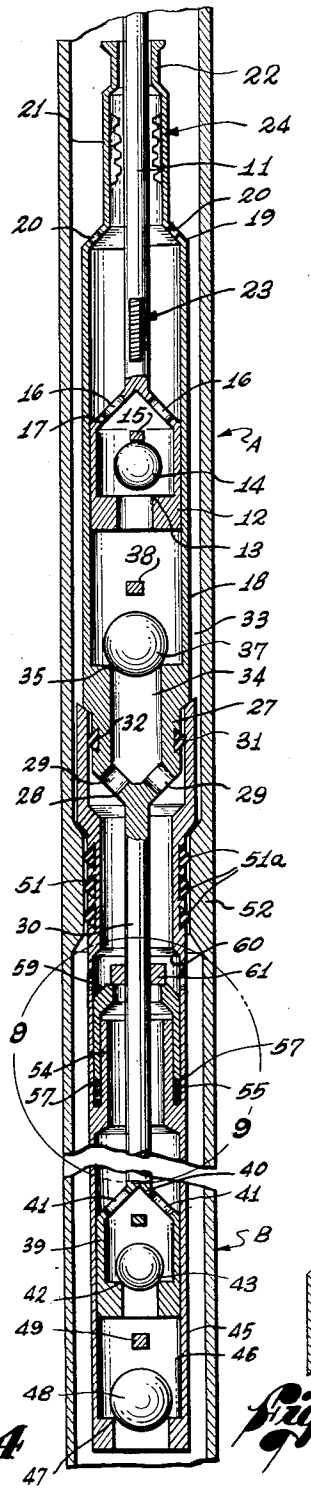

Fig. 5

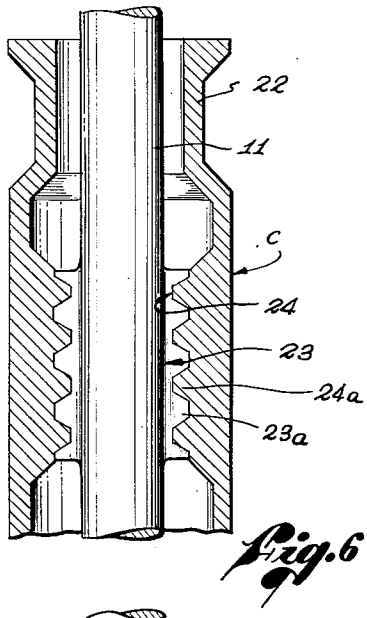

Fig. 6

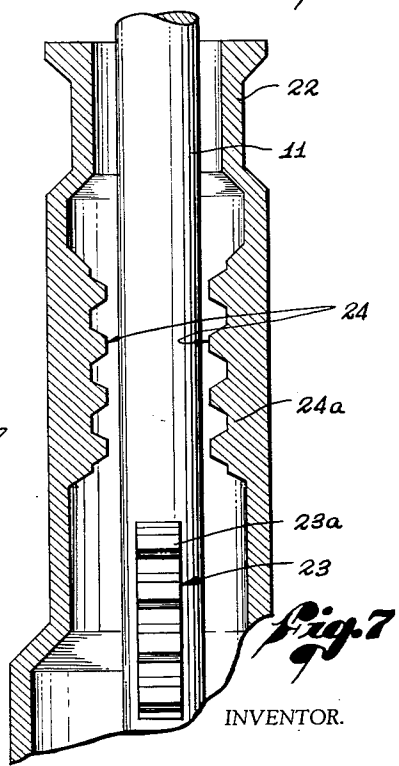

Fig. 7

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TWO-IN-ONE PUMP ASSEMBLY

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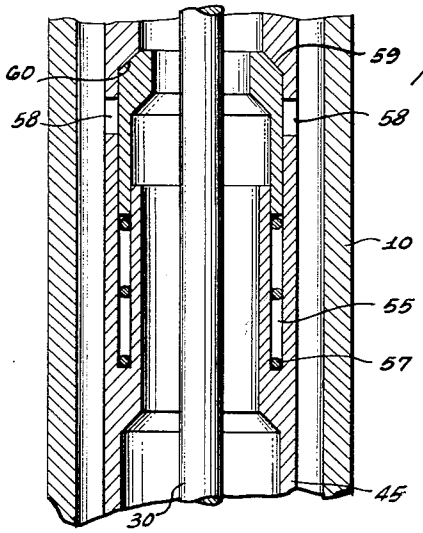
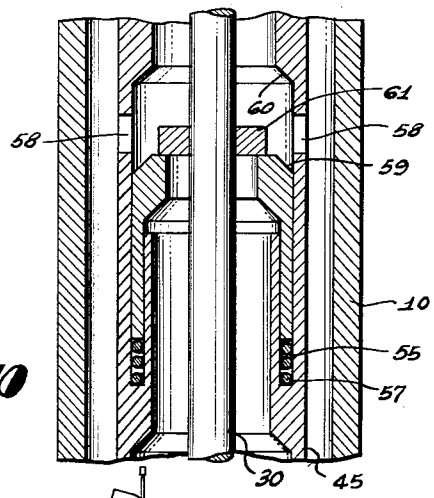


Fig. 8

Fig. 9



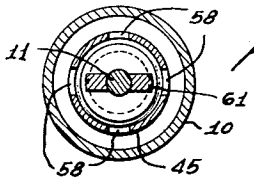


Fig. 10

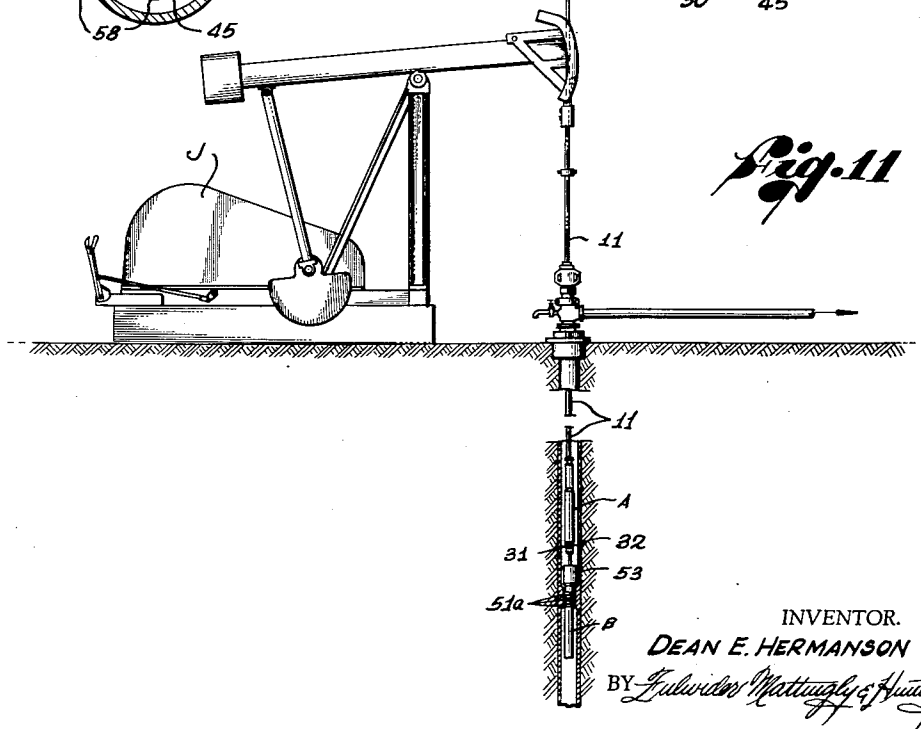


Fig. 11

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TWO-IN-ONE PUMP ASSEMBLY

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4 Claims. (Cl. 103—4)

This invention relates generally to pumps for pumping fluids from a well bore and more particularly to a mechanically connected pump assembly in which one pump acts as a stand-by and may be activated from the surface when the other pump becomes inoperative through wear or otherwise.

It is standard procedure to seat a single well pump barrel in a tubing string or well bore in the production zone of the well and reciprocate a pump plunger therein. A string of attached sucker rods depends into the well and connects a conventional surface pump jack and the pump plunger.

The pump barrel usually contains a ball controlled fluid inlet valve commonly referred to as a standing valve. The pump plunger is normally equipped with a similarly constructed valve conventionally called a traveling valve. The cooperating standing and traveling valves in connection with the reciprocated pump plunger operate to continuously elevate the fluids to the well surface.

Well bore pumps undergo rugged usage and wear out or become defective for many reasons. Any pump failure means an expensive pulling operation. This operation includes lifting of the pump from its seat and pulling the pump and the attached sucker rod string to the well surface. Oil production is stopped during the pulling and new pump reseating operations.

It is a primary object of this invention to save the cost of one pump pulling operation by providing mechanically connected pumping assemblies, so arranged that one pump is placed in the well in an initially inactive condition and thereafter activated remotely from the well surface at the same time that the other pump is de-activated.

Another object of the invention is to provide upper and lower connected pump assemblies, in which the upper pump is initially mounted in inactive condition and operates as a link or section of the sucker rod string to actuate the lower pump until the latter is de-activated, the upper pump then being activated from the well's surface and placed in operative communication with the well fluids.

A further object of the invention is to provide a connection between the barrel and plunger assemblies of a pair of reciprocating pumps, whereby one pump will be initially locked to the sucker rod string and rendered inactive or stand-by to provide actuating means for the other pump until the latter becomes inoperative, the stand-by pump then being actuated from the well's surface into operative well fluid communication.

A still further object of the invention is to provide a sucker rod connected operative and stand-by pump assembly with releasable well bore anchoring means that permits lifting of all of the working parts simply by pulling upwardly on the sucker rods.

Still another object of the invention is to provide sucker rod connected operative and stand-by pump assemblies with releasable well bore seats, so arranged that the operative pump is initially seated, and when de-activated, simultaneously becomes a seat for the activated stand-by pump.

It is another object to provide a pump assembly of the class described wherein valve means are provided and operable from the surface to by-pass the inoperative pump when placing the stand-by pump in operation.

These and other objects and advantages of the invention will become apparent from the following detailed description of a preferred embodiment thereof and from an inspection of the accompanying drawings in which:

FIGURES 1 and 1–A are vertically contiguous portions of a longitudinal section taken through the pumps when initially seated in the well bore;

FIGURE 2 is a partial longitudinal section of the pumps showing the lower pump in down-stroke position;

FIGURE 3 is a cross section taken on the line 3—3 of FIGURE 1–A;

FIGURE 4 is a detailed longitudinal section taken through the connected pumps after activation of the upper pump and with the latter in up-stroke position;

FIGURE 5 is a detailed longitudinal section similar to FIGURE 4 with the upper pump in down-stroke position;

FIGURE 6 is an enlarged sectional view of the upper pump barrel and sucker rod in locked position;

FIGURE 7 is a sectional view of the upper pump barrel and sucker rod in released position;

FIGURE 8 is a sectional view of the sleeve valve mechanism with the upper pump in stand-by position;

FIGURE 9 is a sectional view of the sleeve valve mechanism with the upper pump in active position;

FIGURE 10 is a cross-sectional view taken on the line 10—10 of FIGURE 4; and

FIGURE 11 is an elevational view showing the installation of the preferred form of pump within a well bore.

Referring to the drawings, it will be seen that applicant's sucker rod and connected pump assembly is shown in operative releasable seated position within an oil-well tubing at the producing level. The well bore, casing, well head, pump jack, and power means, as well as attached sucker rod string, and tubing string, are deemed so conventional as to permit merely a general disclosure including the lower end of the tubing 10 and the lowermost rod 11 of the sucker rod string which normally extends downwardly into the well bore many thousands of feet.

An upper pump assembly A, initially mounted in inactive condition by linkage to the sucker rod 11, has a rod connection with a well bore seated lower operative pump assembly B.

Formed integrally with the lower end of the lowermost sucker rod 11 (FIGURE 1–A) is a cylindrical reciprocating plunger 12 for the upper pump A. The plunger 12 has a longitudinally open upwardly facing seat 13 upon which a ball valve 14 trapped at 15 operates in a manner conventional to so-called traveling valves. Spaced fluid ports 16 are formed in the tapered upper end 17 of the plunger 12 and the tapered end 17 provides the integral plunger connection with the lowermost sucker rod 11. The rod string, not shown in detail, is operated in a reciprocal manner by a conventional pump jack at the well surface.

An elongated cylindrical upper pump barrel 18 has sliding engagement with the plunger 12, the upwardly tapered portion 19 thereof having fluid ports 20 similar to the ports 16 in plunger 12. The reduced upper extension 21 of barrel 18 forms a cylindrical housing for lock parts to be described, and a hub 22 has slidable engagement with the rod 11. Hub 22 is formed to permit operating engagement with a fishing tool if necessary.

Within the cylindrical extension 21 is located a releasable locking mechanism C for the upper barrel 18 and the sucker rod 11. The locking mechanism C comprises complementally threaded pairs of lugs 23 and 24, the inner pair 23 of which is secured to the sucker rod 11 and the other pair 24 of which is secured to the interior of the extension 21. The mating threads 23(*a*) and 24(*a*) on the respective lugs are formed along the edges of the

lugs, thus to form an interrupted thread joint which can be locked or unlocked by rotating one pair of lugs through approximately 90 degrees. FIGURES 3, 6, and 7 best disclose the barrel locking and releasement mechanism. As shown in FIGURE 3, diagonally disposed stops **25** on the outer lugs **24** limit and secure the inter-fitting locking elements in position, permitting only a partial rotation of the sucker rod **11** to the right for release of the locking action and free reciprocal movement of sucker rod **11** as shown in FIGURE 7.

The lower end of the pump barrel **18** is reduced to form a secondary seating boss **27**, tapered at **28**, ported at **29** and merging into an integral connecting rod **30**. The secondary seating boss **27** has one or more sealing rings or cups **31**, disposed in circular recesses **32** therein and having deformable metal seating edges thereof projecting therefrom.

The upper pump barrel **18** is spaced from the tubing **10** sufficiently to provide an annular fluid passageway **33**. The seating boss **27** has a bore **34** providing fluid communication between the ports **29** and a standing valve seat **35** within a cavity **36** of barrel **18**. A ball valve **37** and trap **38** in connection with the valve seat **35** complete an upper standing valve assembly in the lower end of the upper pump barrel **18**. The upper pump barrel **18** contains in operative association the lower conventional fluid inlet or standing valve assembly and the standard discharge or traveling valve assembly carried by the plunger **12**.

The depending connecting rod **30** has a lower plunger **39** formed thereon with a valve seat **42** and traveling valve **43** organized and operating in the same manner as the plunger and valve in the upper pump A.

The lower pump B includes an elongated cylindrical pump barrel **45** which receives the plunger **39** and depends substantially therebelow in a manner to support a lower standing valve in a cavity **46**. The standing valve comprises an upwardly facing longitudinally open seat **47**, ball valve **48**, and trap **49**. The lower pump barrel **45** is spaced inwardly from tubing **10** to form an annular fluid passageway **50**. In the upper end of the lower pump barrel **45** is formed a seating collar **51** which carries a series of outwardly projecting standard sealing rings or cups **51**(*a*) that fit tightly into an inwardly projecting seating nipple **52** formed on the interior of tubing **10** and anchor the entire pump assembly therein. The seating of the lower pump barrel **45** in the nipple **52** provides a secure anchoring of the lower pump assembly against reciprocal movement induced by sucker rod action, but the lower pump mechanism as well as the upper pump assembly are still releasable and removable to the well surface when a pulling job is required.

The open upper end of the lower pump barrel **45** is flared outwardly to form a seating nipple **53** adapted to receive and releasably anchor the previously described seating boss **27** in a manner and at a time later to be described.

Within the lower pump barrel cavity **46** and above the plunger **39**, an upwardly extending inner cylinder **54** is formed or secured in spaced relationship with the barrel **45** and forms an annular recess **55** for a sleeve valve **56**, normally urged upwardly by a helical compression spring **57** to a closed position with respect to spaced fluid ports **58** formed in the lower pump barrel **45**. The sleeve valve **56** has a tapered upper shoulder **59** adapted to engage a similarly formed seat **60** in the barrel **45** to limit the sleeve valve **56** in its upward closed position. The shoulder **59** of sleeve valve **56** extends inwardly around the connecting rod **30** in such manner that it will be engaged by lugs **61** on the connecting rod **30** when the latter moves downwardly beyond the lower limit of its reciprocation in operating the lower pump B. The sleeve valve **56** and associated mechanism is shown in closed position in FIGURES 1, 2, and 8 and in open position in FIGURES 4, 5, and 9.

The operation normally starts with an initial well surface locking of the upper pump barrel **18** and the sucker rod **11**. This is accomplished by rotating the lugs **23** into locking engagement with the lugs **24** as shown in full line in FIGURE 3 and also in FIGURE 6. When the pump barrel **18** has been locked to the lowermost sucker rod **11**, the upper pump assembly A is rendered completely inactive and in a stand-by condition with the plunger mechanism therein rigidly secured to the upper pump barrel.

The upper pump barrel **18** now becomes a link or section of the sucker rod string and is directly connected through rod **30** to the plunger **39** in the lower pump assembly which is supported during insertion in the well bore by the engagement of the plunger **39** with the inner circular sleeve valve shoulder **54** in lower pump barrel **45**. In other words, the lower pump barrel **45** is loosely supported and carried by the lower pump plunger **39** during well insertion. Removal of the pump barrel **45** from the well bore at any time is also accomplished by engagement of the plunger **39** with the inner cylinder **54**.

When the connected reciprocating upper and lower pump assemblies have been lowered to the fluid producing zone of the well, the multiple sealing rings **51** (A) on the lower pump barrel **45** engage the conventional tubing nipple **52** on the tubing **10** and are pressed into pressure-tight releasable seated engagement. The downward movement of the barrel **18** seats the boss **27** on the secondary seating nipple **53**.

With the lower pump barrel **45** firmly seated, the sucker rod string, including the locked upper pump barrel **18**, is withdrawn slightly to an operative detached position. Because there are a greater number of seating rings **51** (A) on the tubing nipple **52** than on the seating boss **27**, withdrawal of the upper pump barrel **18** is permitted.

With the lower pump assembly anchored and the upper stand-by pump withdrawn to a position where it merely becomes a section of the sucker rod assembly to reciprocate the plunger **39** in the lower pump barrel **45**, the well fluid pumping operation may be initiated.

The above-described operations and methods have all been manual or at least manually controlled at the surface initially, and thereafter remotely controlled from the well surface. Now, the sucker rod string, not shown in detail, is connected to a power operated pump jack J, and reciprocation of plunger **39** in the lower anchored pump barrel **45** begins with consequent elevation of the well fluids to the surface in the usual manner.

During operation of the lower pump B, the fluid passes around the upper pump A through the annular passage **33** and little or no fluid passes through the upper pump since in the absence of a restriction in the annulus **33** there is insufficient pressure to raise the valves **14** and **37**.

As stated before, as long as the lower pump assembly functions satisfactorily, the above operation continues, but when the lower pump becomes ineffective for reasons beyond manual surface control, such for example as wear or sanding up, the stand-by upper reciprocating pump assembly A may be thrown into operation to save the expense of a pulling operation.

To activate the upper stand-by pump A, the reciprocal movement of the sucker rod string is stopped and manual surface controlled operation thereof is commenced. First, the sucker rod string is advanced to a point where the secondary seating boss **27** and the attached sealing rings **31** are again anchored in the secondary seating nipple **53** of the lower pump barrel **45**. This downward movement of the upper pump barrel **18** operates simultaneously to engage the lugs **61** on connecting rod **30** against the sleeve valve **56** to move the same to an open position as shown in FIGURES 4, 5, and 9.

The anchoring of the upper pump barrel **18** renders the plunger **39** inactive in the lower pump barrel **45** and the lower pump B now becomes in effect fluid isolated. Fluid flow is now established through the annular fluid

passageway 50, through the sleeve valve ports 58 into the upper barrel cavity 36 through ports 29 and bore 34. Final activation of the upper pump assembly A is accomplished by manual surface controlled rotation of the sucker rod 11 through approximately 90 degrees to the right and to a completely unlocked position with the lugs 24 released from the complemental lugs 23.

Complete activation of the stand-by upper pump assembly having been accomplished remotely from well surface position, the sucker rod string is again connected to the power driven reciprocating mechanism, not shown, and pumping of fluid from the same producing zone is accomplished without the expense of a pulling operation. The fluid flow to the anchored upper pump barrel 18 has been described and the actual pumping operation thereafter is conventional insofar as the standing valve 37 and traveling valve 14 are concerned in that the fluid is elevated to the well surface in tubing 10 through the ports 16 in upper plunger 12 and the ports 20 in tapered extension 19 of the upper pump barrel 18.

The initial seating of the lower pump assembly has been described including the slight withdrawal of the secondary seat from the lower pump barrel seating nipple. The final permanent seating of the upper pump barrel in the secondary seat upon de-activation of the lower pump assembly has also been explained. Nevertheless, it is important to emphasize that under any circumstances and at any time it is possible to manually remove the connected pumping assemblies from the well bore because the connected barrel and plunger assemblies are fashioned and arranged for secure anchoring during operation, but still are susceptible of a pulling operation from the well surface.

While the form of the invention shown and described is fully capable of achieving the objects and providing the advantages hereinbefore stated, it will be realized that variations are possible without departure from the spirit of the invention. For this reason it is not intended to limit the invention to the form shown and described but rather to the scope of the appended claims.

I claim:

1. A well pump assembly for use with well tubing in the fluid producing zones of a well bore, which includes: a sucker rod string; mechanically connected upper and lower pump assemblies, said upper assembly comprising an upper barrel annularly spaced from the well tubing to define therewith a first fluid passageway, a plunger in said upper barrel connected to the lowermost sucker rod, a seating boss on said supper barrel, and an actuating rod depending from said upper barrel; said lower pump assembly comprising a lower barrel annularly spaced from the well tubing to define therewith a second fluid passageway, means on the exterior of said lower barrel for releasably anchoring said lower barrel in the well tubing and thereby blocking direct fluid communication between said first and second passageways, means on said lower barrel providing a third fluid passageway establishing direct fluid communcation from said second passageway to said upper pump assembly, a plunger in said lower barrel connected to said actuating rod, a sleeve valve mechanism in said lower barrel normally preventing flow through said third passageway, and a seating nipple on said lower barrel; means for locking said upper barrel to said sucker rod string to initially render said upper pump assembly inactive; and surface controlled means responsive to longitudinal movement of said sucker rod string into the well bore for de-activating said lower pump assembly by anchoring said upper barrel boss in said nipple and actuating said sleeve valve mechanism to establish such communication; said upper barrel being releasable from said sucker rod string by virtue of rotation of the latter, the upper pump assembly being thereby actuated.

2. A well pump assembly for use in the fluid-producing zones of an oil well, which includes: upper and lower axially alined reciprocating pump assemblies, each of said assemblies having an individual barrel and an individual plunger; a stem extending upwardly from the plunger of said first assembly; releasable interlocking means on said stem and the barrel of said upper assembly releasably holding them against relative reciprocation; releasable means for holding the individual barrels of said assemblies against relative reciprocation; a connecting rod between said upper barrel and the plunger of said lower assembly, there being a port through the wall of the lower barrel; a sleeve valve normally closing said port; and means carried by said rod and operable by descent thereof to open said valve.

3. A well pump assembly for use in the fluid-producing zones of an oil well, which includes: upper and lower, axially alined reciprocating pumps, each of said pumps having an individual barrel assembly including a standing valve, and an individual plunger assembly including a traveling valve; a stem extending upwardly from and axially alined with the plunger assembly of said upper pump; releasable interlocking means on said stem and on the barrel assembly of said upper pump releasably holding them against relative reciprocation; a connecting rod between said upper barrel assembly and the plunger assembly of said lower pump; selectively operable releasable means sealingly interconnecting the two barrel assemblies to hold them against relative reciprocation; and a bypass valve in the lower barrel assembly operable, when the said barrel assemblies are so held, to establish a bypassage around the valves of said lower pump.

4. A well pump assembly for use in well tubing in the fluid producing zones of an oil well, which includes: upper and lower, axially aligned reciprocating pumps, each of said pumps having an individual barrel assembly including a standing valve, and an individual plunger assembly including a traveling valve and having a work stroke confined to the extent of its barrel; means on the barrel assembly of said lower pump adapted to sealingly and releasably anchor said last mentioned barrel assembly in the well tubing; a stem extending upwardly from and axially aligned with the plunger assembly of said upper pump; means operatively connected to said stem for imparting reciprocatory motion to the plunger assembly of said upper pump; releasable interlocking means on said stem and on the barrel assembly of said upper pump releasably holding them against relative reciprocation; a connecting rod between the barrel assembly of said upper pump and the plunger assembly of said lower pump; selectively operable releasable means interconnecting the two barrel assemblies to hold them against relative reciprocation; and a bypass valve in the lower barrel assembly operable when the barrel assemblies are so held to establish a bypassage around the valves of said lower pump.

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