TWO-IN-ONE PUMP ASSEMBLY

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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 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 making of the new pump assembly.

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 time that the other pump is deactivated.

Another object of the invention is to provide an 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 activate the lower pump until the latter is deactivated, the upper pump then being deactivated from the well's surface and placed into 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 inactivated to the sucker rod string and rendered inoperative 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 deactivated, 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 a well rod-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 operative 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 and the lowermost rod of the sucker rod string which normally extends downward 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 reciprocating 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 threading 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 release mechanism. As shown in FIGURE 3, diagonally disposed slots 25 on the outer lugs 24 limit and secure the inter-fitting locking element 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 26, ported at 20 and engaged into the inter-fitting internal lugs 21. The secondary seating boss 27 has one or more sealing rings or cups 31, disposed in circular recesses 32 therein and having deformable metal sealing 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 therein 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 fluid passageway 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 52 and 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 reciprocating 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 55 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 travel. 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 reciprocating motion operating the lower pump B. The sleeve valve 56 and associated mechanism is shown in detail in 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 a series of conically inter-engaged fluid passages 54 to 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 lower 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 operational detached position. Because there are a greater number of sealing 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 momentarily 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 lower rod action within the lower pump, 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 reciprocating 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 51 are again anchored in the secondary seating nipple 53 of the lower most sucker rod 11. When the lower most sucker rod 11 is engaged 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 as shown in FIGURES 3, 6, and 8 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 approximately 90 degrees to the right and to a completely unlocked position with the lugs 24 released from the complementary 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 zones 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 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 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.

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 barrel and a seating boss on said upper 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 communication 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 inactively; and surface contact rod 11 through approximately 90 degrees to the left and to a completely unlocked position with the lugs 24 released from the complementary lugs 23.

2. A well pump assembly for use in the fluid-producing zones of an oil well, which includes: upper and lower axially aligned 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 for 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 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; a stem extending upwardly from and axially aligned with the plunger assembly of said upper pump; releasable interlocking means on said stem and 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 selectively 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 bypass 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 releasable 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 bypass around the valves of said lower pump.

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