Aug. 6, 1963 J. REGAN 3,100,015

METHOD OF AND APPARATUS FOR RUNNING EQUIPMENT INTO AND OUT OF WELLS

Filed Oct. 5, 1959 3 Sheets-Sheet 1

FIG. 1.

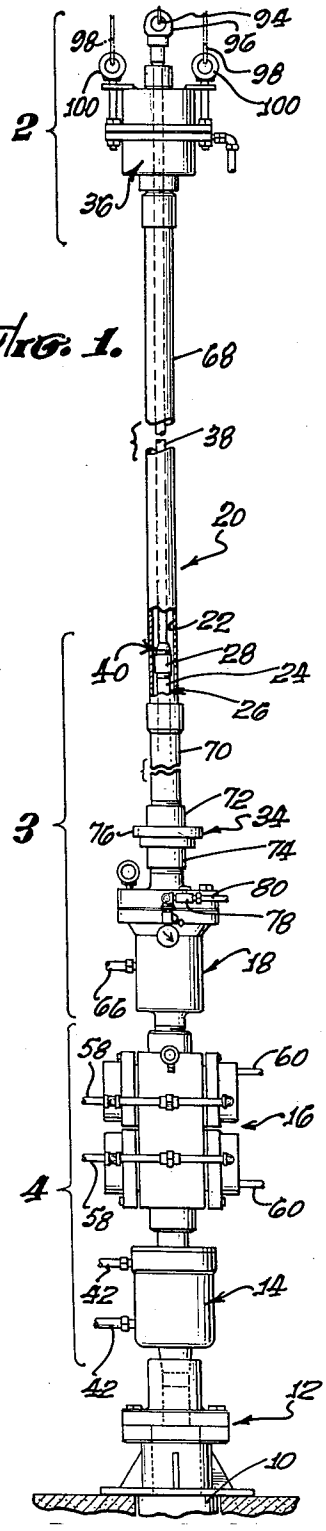
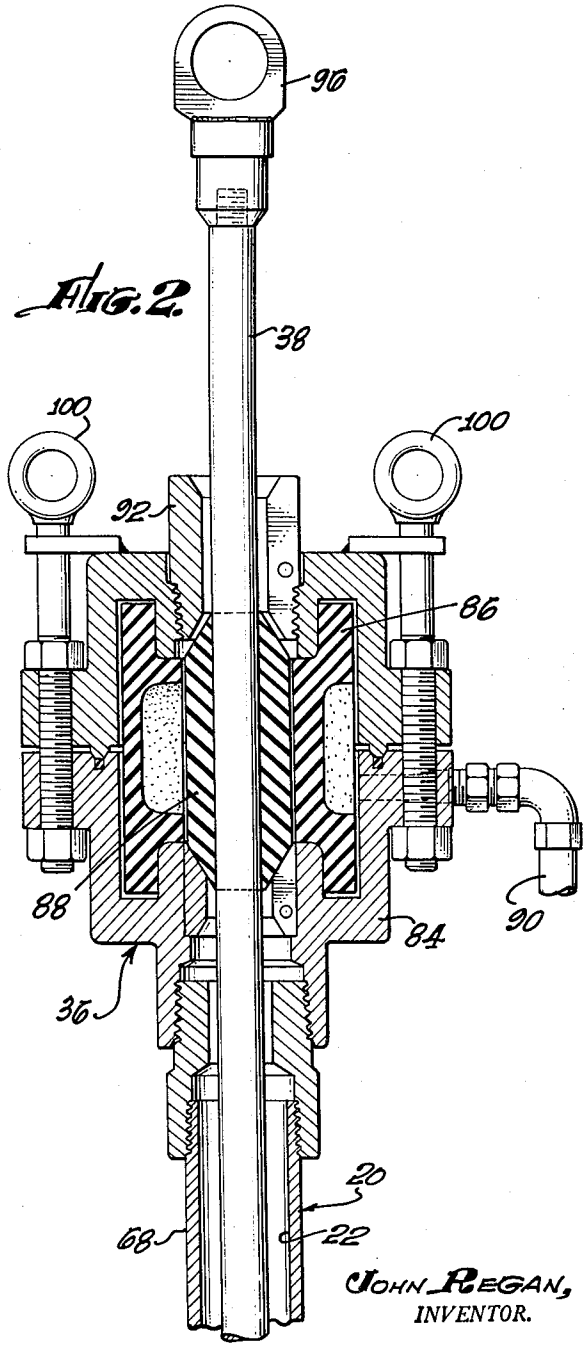


FIG. 2.



JOHN REGAN,
INVENTOR.

BY HIS ATTORNEYS.

HARRIS, KIECH, RUSSELL & KERN.

Aug. 6, 1963 J. REGAN 3,100,015

METHOD OF AND APPARATUS FOR RUNNING EQUIPMENT INTO AND OUT OF WELLS

Filed Oct. 5, 1959 3 Sheets-Sheet 2

Fig. 3.

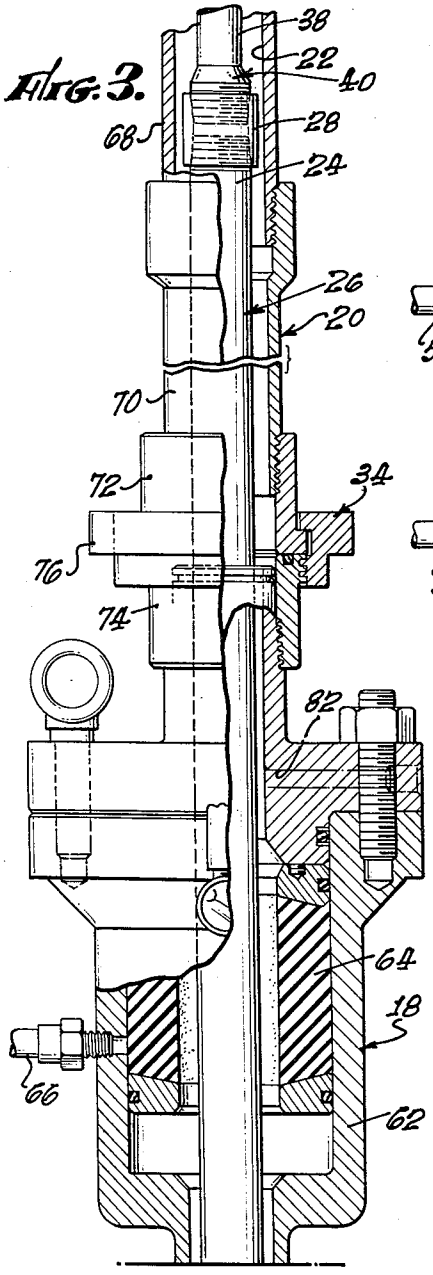
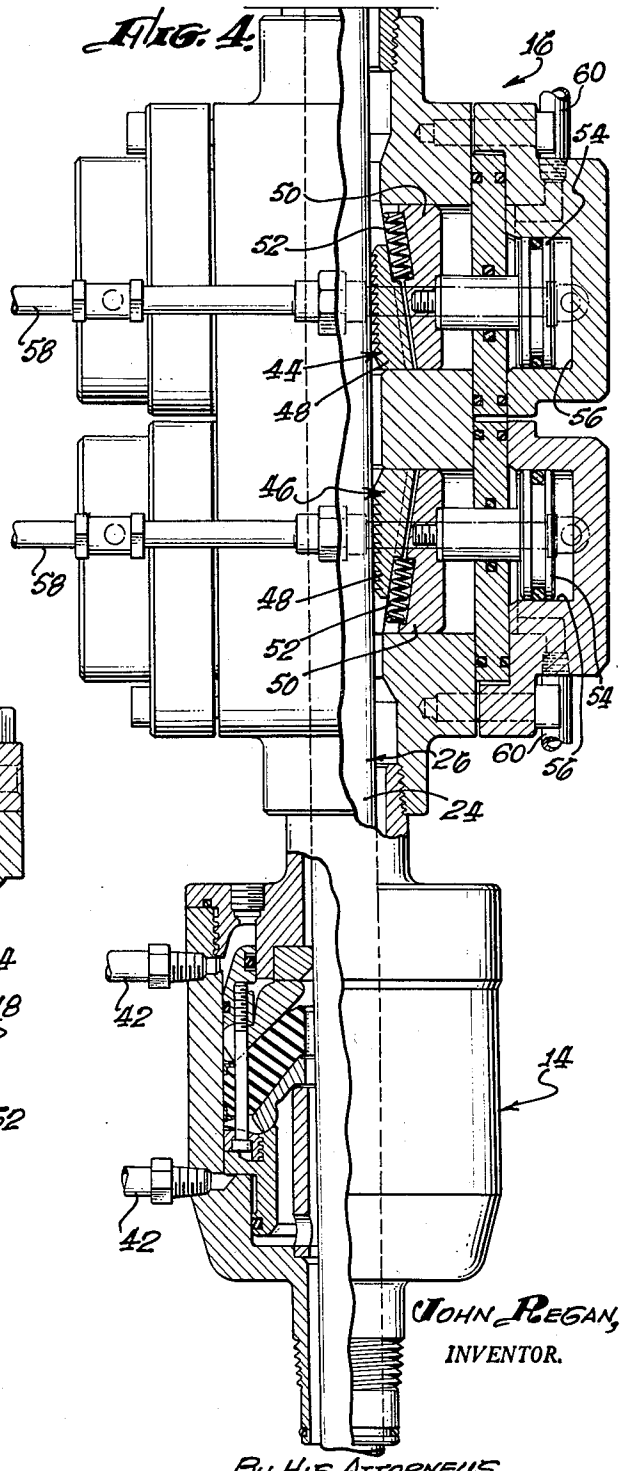


Fig. 4.



JOHN REGAN,
INVENTOR.

By His Attorneys.
HARRIS, KIECH, RUSSELL & KERN.

Aug. 6, 1963 J. REGAN 3,100,015

METHOD OF AND APPARATUS FOR RUNNING EQUIPMENT INTO AND OUT OF WELLS

Filed Oct. 5, 1959 3 Sheets-Sheet 3

FIG. 5.

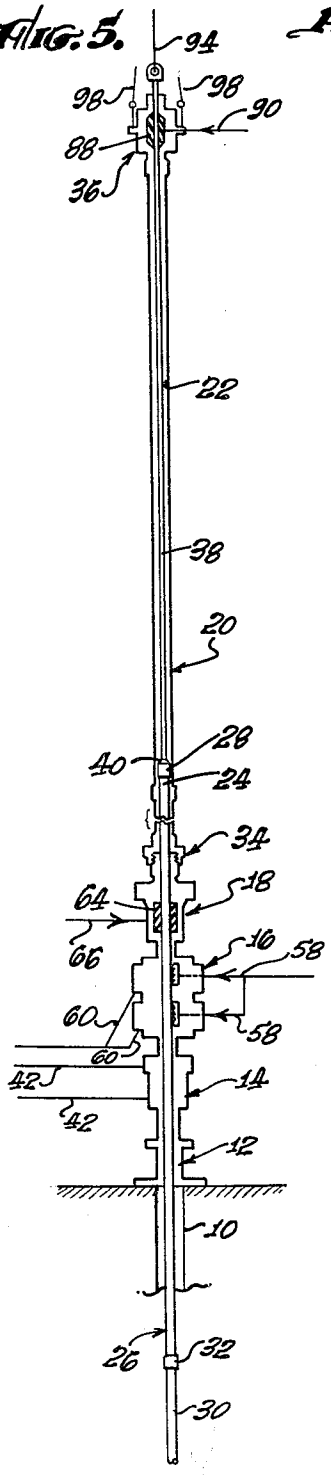


FIG. 6.

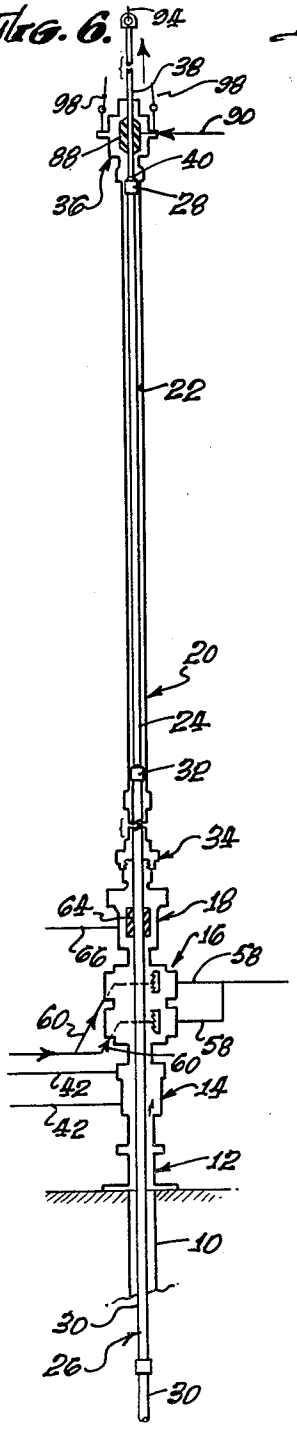
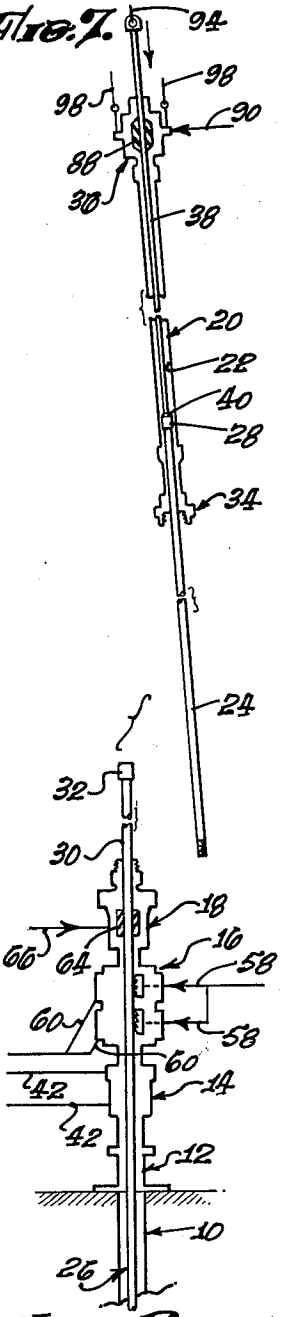


FIG. 7.



JOHN REGAN,
INVENTOR.

BY HIS ATTORNEYS.

HARRIS, KIECH, RUSSELL & KERN.

United States Patent Office 3,100,015 Patented Aug. 6, 1963

3,100,015
METHOD OF AND APPARATUS FOR RUNNING EQUIPMENT INTO AND OUT OF WELLS

John Regan, Rolling Hills, Calif., assignor to Regan Forge and Engineering Company, San Pedro, Calif., a corporation of California

Filed Oct. 5, 1959, Ser. No. 844,427
10 Claims. (Cl. 166—46)

The present invention relates in general to an apparatus for running equipment into or out of a well under pressure and a primary object of the invention is to maintain the upward pressure force applied to the equipment at a value not substantially in excess of the weight of the equipment, and preferably at a value less than the weight of the equipment, particularly when running the equipment into the well. Consequently, control of the equipment is maintained at all times, which is an important feature of the invention.

More particularly, the invention relates to an apparatus which is commonly known as a lubricator and, for convenience, the invention will be considered herein as applied to a lubricator for running a sectional tubing string into or out of a well under pressure. However, it will be understood that the invention is susceptible of other applications and is not limited to a tubing string lubricator.

As background, a tubing string lubricator includes the following elements: tubular housing means positionable generally vertically over the well and providing an elongated lubricator chamber of a size to receive at least one section of the tubing string therein, the tubular housing means including coupling means, preferably at its lower end, for opening the lubricator chamber to provide for access to the tubing string joints; an energizable lower packer below the tubular housing means, the lower packer, when energized, being engageable with the tubing string to confine the well pressure; an upper packer connected to the upper end of the tubular housing means; tubing-string supporting means, preferably a polished rod, extending downwardly through the upper packer into the lubricator chamber and having at its lower end attachment means connectible to the tubing string, the upper packer being engageable with the polished rod; and energizable slip means below the tubular housing means and engageable with the tubing string to prevent upward or downward movement thereof, the lower packer and the slip means being connectible to the top of the well.

Assuming that a lubricator of the foregoing type is being utilized to run a sectional tubing string out of the well, the uppermost section of the tubing string is moved upwardly into the lubricator chamber with the slip means and the lower packer deenergized so that they are out of engagement with the tubing string. Under such conditions, the well pressure is confined in the lubricator chamber by the upper packer in engagement with the polished rod, or equivalent. Once the uppermost section of the tubing string is within the lubricator chamber, the lower packer is energized to confine the well pressure and the slip means is energized to prevent either upward or downward movement of the tubing string. Then, the coupling means mentioned is opened to open the lubricator chamber, whereupon the uppermost tubing section may be disconnected from the tubing section therebeneath and may also be disconnected from the polished rod. The uppermost tubing section is then removed from the lubricator chamber and the lower end of the polished rod is connected to the next tubing section. Thereupon, the lubricator chamber is closed by the coupling means mentioned and the foregoing events are repeated to remove the next section of the tubing string.

As successive sections of the tubing string are removed from the well in the foregoing manner, the tubing string becomes progressively lighter until, eventually, the upward pressure force applied to the tubing string by the pressure in the well exceeds the weight of the tubing string with the result that the well pressure tends to force the tubing string upwardly out of the well. In accordance with the teachings of the prior art, various snubbing devices are utilized under such conditions to keep the tubing string under control, such snubbing devices also being utilized in running the tubing string into the well until such time as the weight of the tubing string exceeds the upward pressure force applied thereto. The use of snubbers to run the tubing string into the well, or to maintain control over the tubing string in running it out of the well, is quite hazardous and involves considerable risk of damage to the well installation and injury to personnel, the reason being that failure of any component of the snubbing equipment can result in complete loss of control of the tubing string.

As previously indicated, the present invention overcomes the foregoing problems by maintaining the upward pressure force applied to the tubing string at a value not substantially in excess of the weight of the tubing string even when running the tubing string out, the upward pressure force being maintained at a value less than the weight of the tubing string when running the tubing string in. Thus, no snubbing devices of any kind are necessary and the weight of the tubing string is utilized at all times to maintain control thereof.

An important object of the invention is to maintain the desired relation between the weight of the tubing string and the upward pressure force applied thereto by changing the diameter of the polished rod, or other supporting means for the tubing string, as the weight of the tubing string varies. More particularly, the invention contemplates using polished rods of progressively decreasing diameters as the weight of the tubing string decreases in running the tubing string out of the well, this procedure being reversed in running the tubing string in. Expressed differently, the invention contemplates using a polished rod having a cross sectional area sufficient to support the weight of the tubing string, but insufficient to produce an excessive upward pressure force.

Another object of the invention is to locate the slip means below the lower packer so that the slip means is always exposed to well pressure. Consequently, the operating conditions to which the slip means is exposed are constant, which is an important feature.

The foregoing objects, advantages, features and results of the present invention, together with various other objects, advantages, features and results thereof which will be evident to those skilled in the art in the light of this disclosure, may be attained with the exemplary embodiment of the invention described in detail hereinafter and illustrated in the accompanying drawings, wherein:

FIG. 1 is an elevational view of a well head installation which incorporates the lubricator of the invention;

FIG. 2 is an enlarged vertical sectional view taken in the region of FIG. 1 which is spanned by the bracket 2;

FIG. 3 is an enlarged view, partially in elevation and partially in vertical section, which is taken in the region of FIG. 1 spanned by the bracket 3;

FIG. 4 is an enlarged view, partially in vertical section and partially in elevation, which is taken in the region of FIG. 1 spanned by the bracket 4; and

FIGS. 5, 6 and 7 are semidiagrammatic views of the well head installation illustrating the operation of the invention.

Referring particularly to FIG. 1 of the drawings, the numeral 10 designates a well casing provided at its upper

end with the usual casing head 12, or the like. As is conventional, a blowout preventer 14 is located above and is connected to the casing head 12. An energizable slip means 16 is located above and is connected to the blowout preventer 14, and above and connected to the slip means is an energizable lower packer 18. Above the lower packer 18 and connected at its lower end to such packer is a tubular housing means 20 which provides an elongated, upright lubricator chamber 22 of a size to receive therein at least one section 24, FIG. 6, of a sectional tubing string 26, the tubing section 24 having a coupling 28 at its upper end and being connected to the next tubing section 30 by a coupling 32. The tubular housing means 20 includes coupling means 34, preferably at the lower end thereof, for opening the lubricator chamber 22 to provide access to the couplings connecting the sections of the tubing string 26, such as the couplings 28 and 32. Connected to the upper end of the tubular housing means 20 is an energizable upper packer 36 and extending downwardly through such upper packer into the lubricator chamber 22 is a tubing-string supporting means, shown as a polished rod 38, having at its lower end attachment means 40 connectible to the couplings of the tubing string 26, such as the coupling 28.

As shown in FIG. 1 of the drawings, the blowout preventer 14, the slip means 16, the lower packer 18, the tubular housing means 20 and the upper packer 36 are all aligned with the well casing 10 so that each section of the tubing string 26 may move upwardly from the well casing through the blowout preventer, the slip means and the lower packer into the lubricator chamber 22 as the tubing string is run out of the well. Conversely, when running the tubing string 26 into the well, each section thereof is moved downwardly from the lubricator chamber 22 through the lower packer 18, the slip means 16 and the blowout preventer 14 into the well casing 10.

Considering the foregoing generally-designated components in more detail, the blowout preventer 14 may be of any suitable type, the one illustrated in FIG. 4 of the drawings being substantially identical to that disclosed in Patent No. 2,846,178, granted August 5, 1958 to Burt Stanley Minor. The blowout preventer 14 shown is hydraulically energizable through lines 42 connected to any suitable source, not shown, of pressure fluid. As will be understood, the blowout preventer 14 is adapted to engage the tubing string 26 in a fluid-tight manner to prevent the well from blowing out.

The slip means 16, which is shown in FIG. 4, may also be of any suitable constructon and is preferably double acting, i.e., is preferably capable of preventing both upward and downward movement of the tubing string 26. To achieve this, the slip means 16 is provided with two sets of slips 44 and 46, the set of slips 44 being adapted to prevent upward movement of the tubing string and the set of slips 46 downward movement thereof. The slips 44 and 46 are preferably self energizing so that they grip the tubing string 26 more tightly in response to upward and downward movement thereof. To accomplish this, each slip 44 and 46 includes a wedge-shaped jaw 48 carried by a complementary jaw holder 50, each jaw being biased toward a retracted position by a spring 52. The slip means 16 is hydraulically energizable and deenergizable, the slips 44 and 46 having connected thereto pistons 54 reciprocable in cylinders 56. In order to energize the slip means 16, pressure fluid is admitted to the outer ends of the cylinders 56 through lines 58, as best shown in FIG. 4 of the drawings. To deenergize the slip means 16, pressure fluid is admitted to the inner ends of the cylinders 56 through lines 60, as also shown in FIG. 4 of the drawings. The lines 58 and 60 may be connected to any suitable source, not shown, of pressure fluid.

An important feature of the present invention is that the slip means 16 is located below the lower packer 18, instead of above such packer as in prior lubricators.

Consequently, the slip means 16 is always subjected to the well pressure to provide constant operating conditions.

The lower packer 18 is suitably connected to the upper end of the slip means 16 and may be of any suitable type. For example, the lower packer 18 may have the construction disclosed in Patent No. 2,945,665, granted July 19, 1960 to Louis M. Regan and Darrell L. Sims. Basically, the lower packer 18, as shown in FIG. 3, comprises a housing 62 having therein an elastomeric sleeve 64 adapted to be displaced radially inwardly into fluid-tight engagement with the tubing string 26 by fluid pressure applied thereto through a line 66. The latter is connected to any suitable source, not shown, of pressure fluid.

The tubular housing means 20 forming the lubricator chamber 22 may have any desired structure. In the construction shown, the tubular housing means 20 comprises two threadedly interconnected tubes 68 and 70. The tube 68 is threadedly or otherwise connected to the upper packer 36 and the tube 70 is threadedly or otherwise connected to the coupling means 34.

Any easily connectible and disconnectible coupling may be utilized for the coupling means 34. Referring to FIG. 3, in the particular construction illustrated, the coupling means 34 is of the union type and includes fittings 72 and 74 connectible by a gland 76 seated against a shoulder on the fitting 72 and threaded onto the fitting 74. The fitting 72 is threaded onto the tube 70 of the tubular housing means 20 and the fitting 74 is threadedly connected to the lower packer housing 62.

As will be explained in more detail hereinafter, the coupling means 34 is disconnected to open the lubricator chamber 22 after energizing the lower packer 18 so that the lower packer confines the well pressure. However, fluid at the well pressure is trapped in the lubricator chamber 22 upon energizing the lower packer 18, and such pressure must be dissipated prior to disconnecting the coupling means 34. In the construction illustrated, this is accomplished by opening a valve 78, FIG. 1, in the line 80 communicating with the interior of the lower packer housing 62 above the elastomeric sleeve 64. Such communication is indicated by the broken line passage 82 in FIG. 3 of the drawings.

The upper packer 36, shown in FIG. 2, which may be of the type shown in Patent No. 2,746,709, issued May 22, 1956 to Burt S. Minor, includes a housing 84 having therein an elastomeric sleeve 86 which is hydraulically movable radially inwardly into engagement with an elastomeric bushing 88 on the polished rod 38 to cause the bushing 88 to engage the polished rod in a fluid-tight manner. Pressure fluid from any suitable source, not shown, is applied to the elastomeric sleeve 86 through a line 90. The elastomeric bushing 88 is held in place by a retainer 92 which may be disconnected from the housing 84 to permit removal of the elastomeric bushing. Thus, when the polished rod 38 is replaced by one of a different diameter, as hereinafter described in more detail, the elastomeric bushing 88 may also be replaced by one of a diameter corresponding to that of the substituted polished rod.

The attachment means 40 at the lower end of the polished rod 38 may simply comprise a threaded connection between the lower end of the polished rod and one of the couplings, such as the couplings 28 and 32, of the tubing string 26. The attachment means 40 is preferably large enough in diameter to prevent passage thereof through one of the lower components of the installation, such as the packer 18, or the slip means 16, so as to prevent loss of the tubing string 26 into the well in the event of failure of the polished rod 38. Preferably, the attachment means 40 engages the tubing string 26 in a fluid-tight manner to prevent the build up of pressure in the tubing string below the attachment means, thereby minimizing the volume of fluid to be bled off from the lubricator chamber 22 prior to opening same.

The weight of the tubing string 26 may be supported by a cable 94, FIGS. 1 and 5 to 7, connected to an eye 96

threadedly connected to the upper end of the polished rod. When the coupling means 34 is disconnected, the tubular housing means 20 and the upper packer 36 may be supported by cables 98 connected to eyes 100 attached to the upper packer housing 84.

Operation

In considering the operation of the invention, it will be assumed that the tubing string 26 is being run out and the steps involved in removing the tubing section 24 from the well will be described.

Initially, the tubing string 26 is in the position shown in FIG. 5 of the drawings and the slip means 16 and the lower packer 18 are energized, the former preventing either upward or downward movement of the tubing string and the latter confining the well pressure. With the tubular housing means 20 connected to the lower packer 18 by the coupling means 34 as shown in FIG. 5, the upper packer 36 is energized and the lower packer 18 is deenergized, whereupon the upper packer confines the well pressure. At this point, the slip means 16 is deenergized and the tubing string 26 is moved upwardly by means of the cable 94 until the tubing section 24 is entirely within the lubricator chamber 22, as shown in FIG. 6 of the drawings. It will be understood that the well pressure acting on the tubing string 26 assists in the upward movement of the tubing string, the upward pressure force preferably being maintained at a value less than the weight of the tubing string in the manner hereinafter explained. It will also be understood that upward flow through the tubing string 26 itself is prevented in any suitable manner, as shown, for example, in Patents Nos. 1,895,132 and 2,758,654, respectively issued January 24, 1933 and August 14, 1956 to Burt S. Minor and Drury M. Simmons.

With the tubing section 24 within the lubricator chamber 22, the slip means 16 and the lower packer 18 are again energized, whereby the slip means prevents movement of the tubing string and the lower packer confines the well pressure. The well pressure in the lubricator chamber 22 is then bled off by opening the valve 78, whereupon the coupling means 34 is disconnected to open the lubricator chamber. This accomplished, the upper packer 36, which is preferably deenergized at this stage, and the tubular housing means 20 are moved upwardly by means of the cables 98 so that the tubing section 24 may be disconnected from the tubing section 30 at the coupling 32, as shown in FIG. 7 of the drawings. Then, the tubing section 24 and the polished rod 38 are lowered relative to the upper packer 36 and the tubular housing means 20 to provide access to the connection between the attachment means 40 and the coupling 28 to permit disconnecting the tubing section 24 from the polished rod 38. The polished rod is then connected to the tubing section 30 by connecting the attachment means 40 to the coupling 32, not shown, and the tubular housing means 20 is reconnected to the lower packer 18 by the coupling means 34. The foregoing steps are then repeated to withdraw the next tubing section 30 from the well.

In running the tubing string 26 into the well, the procedure is essentially the reverse of that described above. Consequently, a detailed explanation is not necessary.

It will be apparent that as the tubing string 26 is run out of the well, its weight is eventually reduced to a value approaching the upward force applied to the tubing string by the pressure in the well, the upward pressure force being the product of the cross sectional area of the polished rod 38 and the difference between the well pressure and atmospheric pressure. At this point, the polished rod 38 is replaced by a smaller polished rod, i.e., one having a smaller diameter. At the same time, the elastomeric bushing 88 is replaced by a correspondingly smaller one. As will be apparent, substituting a smaller polished rod reduces the upward pressure force acting on the tubing string 26 by reducing the cross sectional area exposed to the difference between the well pressure and atmospheric pressure.

Normally, several polished rods of progressively smaller diameter are utilized as the tubing string 26 is run out of the well, a smaller polished rod being substituted each time the upward pressure force acting on the tubing string approaches the weight of the tubing string remaining in the well. For example, polished rods ranging in diameter from 1¼ inches down to ½ inch may be utilized in the course of running out the tubing string 26, although this range of diameters will vary with variations in the size and length of the tubing string and is intended as illustrative only. For example, the polished rod 38 may be a wire line having a diameter of less than 0.10 inch with very little pipe in the hole.

As hereinbefore indicated, the upward pressure force acting on the tubing string 26 is preferably maintained at a value less than the weight of the tubing string so that there is always a net downward force applied to the string. However, in running the tubing string out, it is not essential that the polished rod diameter be decreased before the upward pressure force exceeds the weight of the tubing string, so long as the difference between the weight of the tubing string and the upward pressure force does not become so large as to make control of the tubing string difficult. It will be understood that, under such conditions, the tubing string is permitted to move upwardly a section at a time as the result of the upward pressure force acting thereon. However, in running the tubing string in, the upward pressure force is preferably maintained at a value less than the weight of the tubing string at all times so that the weight of the tubing string always acts to move the tubing string downwardly in the well. Thus, in progressively increasing the diameter of the polished rod 38 in running the tubing string 26 in, a larger diameter polished rod is not substituted until the weight of the tubing string is high enough to exceed the upward pressure force with the substituted polished rod in place.

Considering the invention from a more general point of view, the invention never permits the upward pressure force applied to the tubing string to exceed the weight of the tubing string by an amount which cannot be controlled safely with the slip means 16. Even if the upward pressure force is permtited to exceed the weight of the tubing string, particularly in running the tubing string out, the force differential can be maintained low enough, by going to progressively smaller polished rods, that the tubing string can always be stopped with the slip means 16, or even with the lower packer 18. Thus, the tubing string is always kept under complete control and this result is achieved without the use of snubbing devices, or the like.

Although an exemplary embodiment of the invention has been disclosed herein for purposes of illustration, it will be understood that various changes, modifications and substitutions may be incorporated in such embodiment without departing from the spirit of the invention as defined by the claims which follow.

I claim:

1. In combination: tubular housing means positionable generally vertically over a well and providing an elongated chamber of a size to receive at least one section of a sectional tubing string therein, said tubular housing means including coupling means for opening said elongated chamber to provide for access to the tubing string; a contractible lower packer connected to the lower end of said tubular housing means, said lower packer, when contracted, being engageable with the tubing string and being connectible to the top of the well; means for contracting said lower packer onto the tubing string; an upper packer connected to the upper end of said tubular housing means; and supporting means extending downwardly through said upper packer into said elongated chamber and engageable by said upper packer and having at its lower

end attachment means connectible to the tubing string, that portion of said supporting means which is within said elongated chamber being smaller than and out of engagement with the periphery of said elongated chamber throughout the entire length of said elongated chamber so that the pressure within said elongated chamber is uniform from one end thereof to the other, whereby said supporting means and the tubing string are hydraulically balanced in the vertical direction, except for the cross sectional area of said supporting means extending upwardly through said upper packer and exposed to atmospheric pressure.

2. In combination: tubular housing means positionable generally vertically over a well and providing an elongated chamber of a size to receive at least one section of a sectional tubing string therein, said tubular housing means including coupling means for opening said elongated chamber to provide for access to the tubing string; a contractible lower packer connected to the lower end of said tubular housing means, said lower packer, when contracted, being engageable with the tubing string and being connectible to the top of the well; means for contracting said lower packer onto the tubing string; a contractible upper packer connected to the upper end of said tubular housing means; supporting means extending downwardly through said upper packer into said elongated chamber and engageable by said upper packer and having at its lower end attachment means connectible to the tubing string, that portion of said supporting means which is within said elongated chamber being smaller than and out of engagement with the periphery of said elongated chamber throughout the entire length of said elongated chamber so that the pressure within said elongated chamber is uniform from one end thereof to the other, whereby said supporting means and the tubing string are hydraulically balanced in the vertical direction, except for the cross sectional area of said supporting means extending upwardly through said upper packer and exposed to atmospheric pressure; and means for contracting said upper packer onto said supporting means.

3. In combination: tubular housing means positionable generally vertically over a well and providing an elongated chamber of a size to receive at least one section of a sectional tubing string therein, said tubular housing means including coupling means at the lower end of said elongated chamber for opening said elongated chamber to provide for access to the tubing string; a contractible lower packer connected to the lower end of said tubular housing means, said lower packer, when contracted, being engageable with the tubing string and being connectible to the top of the well; means for contracting said lower packer onto the tubing string; a contractible upper packer connected to the upper end of said tubular housing means; supporting means including a polished rod extending downwardly through said upper packer into said elongated chamber and engageable by said upper packer and having at its lower end attachment means connectible to the tubing string, said supporting means being smaller than and out of engagement with the periphery of said elongated chamber throughout the entire length of said elongated chamber so that the pressure within said elongated chamber is uniform from one end thereof to the other, whereby said supporting means and the tubing string are hydraulically balanced in the vertical direction, except for the cross sectional area of said polished rod extending upwardly through said upper packer and exposed to atmospheric pressure; and means for contracting said upper packer onto said polished rod.

4. In an apparatus connectible to the top of a well in alignment therewith for running a sectional tubing string, or the like, into or out of the well under pressure, the combination of: tubular housing means positionable generally vertically over the well and providing an elongated chamber of a size to receive at least one section of the tubing string therein, said tubular housing means including coupling means for opening said elongated chamber to provide for access to the tubing string; a contractible lower packer connected to the lower end of said tubular housing means, said lower packer, when contracted, being engageable with the tubing string; means for contracting said lower packer onto the tubing string; an upper packer connected to the upper end of said tubular housing means; supporting means extending downwardly through said upper packer into said elongated chamber and engageable by said upper packer and having at its lower end attachment means connectible to the tubing string, that portion of said supporting means which is within said elongated chamber being smaller than and out of engagement with the periphery of said elongated chamber throughout the entire length of said elongated chamber so that the pressure within said elongated chamber is uniform from one end thereof to the other, whereby said supporting means and the tubing string are hydraulically balanced in the vertical direction, except for the cross sectional area of said supporting means extending upwardly through said upper packer and exposed to atmospheric pressure; means for contracting said upper packer onto said supporting means; and slip means below and connected to said lower packer, said slip means being engageable with the tubing string and being directly connectible to the top of the well.

5. In an apparatus connectible to the top of a well in alignment therewith for running a sectional tubing string, or the like, into or out of the well under pressure, the combination of: tubular housing means positionable generally vertically over the well and providing an elongated chamber of a size to receive at least one section of the tubing string therein, said tubular housing means including coupling means for opening said elongated chamber to provide for access to the tubing string; a contractible lower packer connected to the lower end of said tubular housing means, said lower packer, when contracted, being engageable with the tubing string; means for contracting said lower packer onto the tubing string; an upper packer connected to the upper end of said tubular housing means; supporting means extending downwardly through said upper packer into said elongated chamber and engageable by said upper packer and having at its lower end attachment means connectible to the tubing string, that portion of said supporting means which is within said elongated chamber being smaller than and out of engagement with the periphery of said elongated chamber throughout the entire length of said elongated chamber so that the pressure within said elongated chamber is uniform from one end thereof to the other, whereby said supporting means and the tubing string are hydraulically balanced in the vertical direction, except for the cross sectional area of said supporting means extending upwardly through said upper packer and exposed to atmospheric pressure; means for contracting said upper packer onto said supporting means; and slip means below and connected to said lower packer, said slip means being engageable with the tubing string and being directly connectible to the top of the well, and said slip means having oppositely oriented slips respectively adapted to prevent upward and downward movement of the tubing string.

6. In combination: tubular housing means providing an elongated chamber and including coupling means for opening said elongated chamber; a contractible lower packer connected to the lower end of said tubular housing means; means for contracting said lower packer; an upper packer connected to the upper end of said tubular housing means; and supporting means extending downwardly through said upper packer into said elongated chamber and engageable by said upper packer and having attachment means at its lower end, that portion of said supporting means which is within said elongated chamber being smaller than and out of engagement with the periphery of said elongated chamber throughout the en-

tire length of said elongated chamber so that the pressure within said elongated chamber is uniform from one end thereof to the other, whereby said supporting means is hydraulically balanced in the vertical direction, except for the cross sectional area of said supporting means extending upwardly through said upper packer and exposed to atmospheric pressure.

7. In combination: tubular housing means providing an elongated chamber and including coupling means at its lower end for opening said elongated chamber; a contractible lower packer connected to the lower end of said tubular housing means; means for contracting said lower packer; a contractible upper packer connected to the upper end of said tubular housing means; supporting means including a polished rod extending downwardly through said upper packer into said elongated chamber and engageable by said packer and having attachment means at its lower end, said supporting means being smaller than and out of engagement with the periphery of said elongated chamber throughout the entire length of said elongated chamber so that the pressure within said elongated chamber is uniform from one end thereof to the other, whereby said supporting means is hydraulically balanced in the vertical direction, except for the cross sectional area of said polished rod extending upwardly through said upper packer and exposed to atmospheric pressure; and means for contracting said upper packer onto said polished rod.

8. A method of running equipment which varies in weight into or out of a well under pressure, characterized by the use of a supporting means for the equipment, and including the steps of: enclosing a portion of the supporting means and at least a portion of the equipment in an elongated upright chamber which communicates with the well; sealing the upper end of said chamber around said supporting means; raising or lowering the supporting means and the equipment relative to said chamber and the well; coupling or uncoupling a portion of the equipment carried by the supporting means so as to increase or decrease the weight of the equipment carried thereby; and substituting larger-area or smaller-area supporting means to increase or decrease the cross sectional area of said supporting means with increases or decreases in the weight of the equipment supported by said supporting means.

9. A method of running equipment which varies in weight into or out of a well under pressure, characterized by the use of a supporting means for the equipment which includes a polished rod, and including the steps of: enclosing a portion of the polished rod and at least a portion of the equipment in an elongated upright chamber which communicates with the well; sealing the upper end of said chamber around said polished rod; raising or lowering the supporting means and the equipment relative to said chamber and the well; coupling or uncoupling a portion of the equipment carried by the supporting means so as to increase or decrease the weight of the equipment carried thereby; and substituting larger or smaller polished rods for the polished rod first mentioned as the weight of the equipment increases or decreases.

10. A method of running equipment which varies in weight into or out of a well under pressure, characterized by the use of a supporting means for the equipment having a net upwardly-facing area exposed to atmospheric pressure, and characterized in that the supporting means and the equipment collectively have a net downwardly-facing area equal to said upwardly-facing area and exposed to the well pressure, said method including the steps of: lowering the equipment into or raising it out of the well on the supporting means and simultaneously respectively coupling or uncoupling a portion of the equipment carried by the supporting means so as to increase or decrease the weight of the equipment carried by the supporting means; and substituting larger-area or smaller-area supporting means so as to increase or decrease said net upwardly-facing and downwardly-facing areas with increases or decreases, respectively, in the weight of the equipment supported by the supporting means.

References Cited in the file of this patent

UNITED STATES PATENTS

1,852,717	Grinnell et al.	Apr. 5, 1932
1,895,132	Minor	Jan. 24, 1933
1,910,762	Grinnell et al.	May 23, 1933
2,555,145	McKinney	May 29, 1951
2,600,848	Collins et al.	June 17, 1952
2,721,614	Simmons	Oct. 25, 1955
2,758,654	Simmons	Aug. 14, 1956

UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 3,100,015 August 6, 1963

John Regan

It is hereby certified that error appears in the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 9, line 17, before "packer" insert -- upper --.

Signed and sealed this 3rd day of March 1964.

(SEAL)
Attest:

ERNEST W. SWIDER
Attesting Officer

EDWIN L. REYNOLDS
Acting Commissioner of Patents