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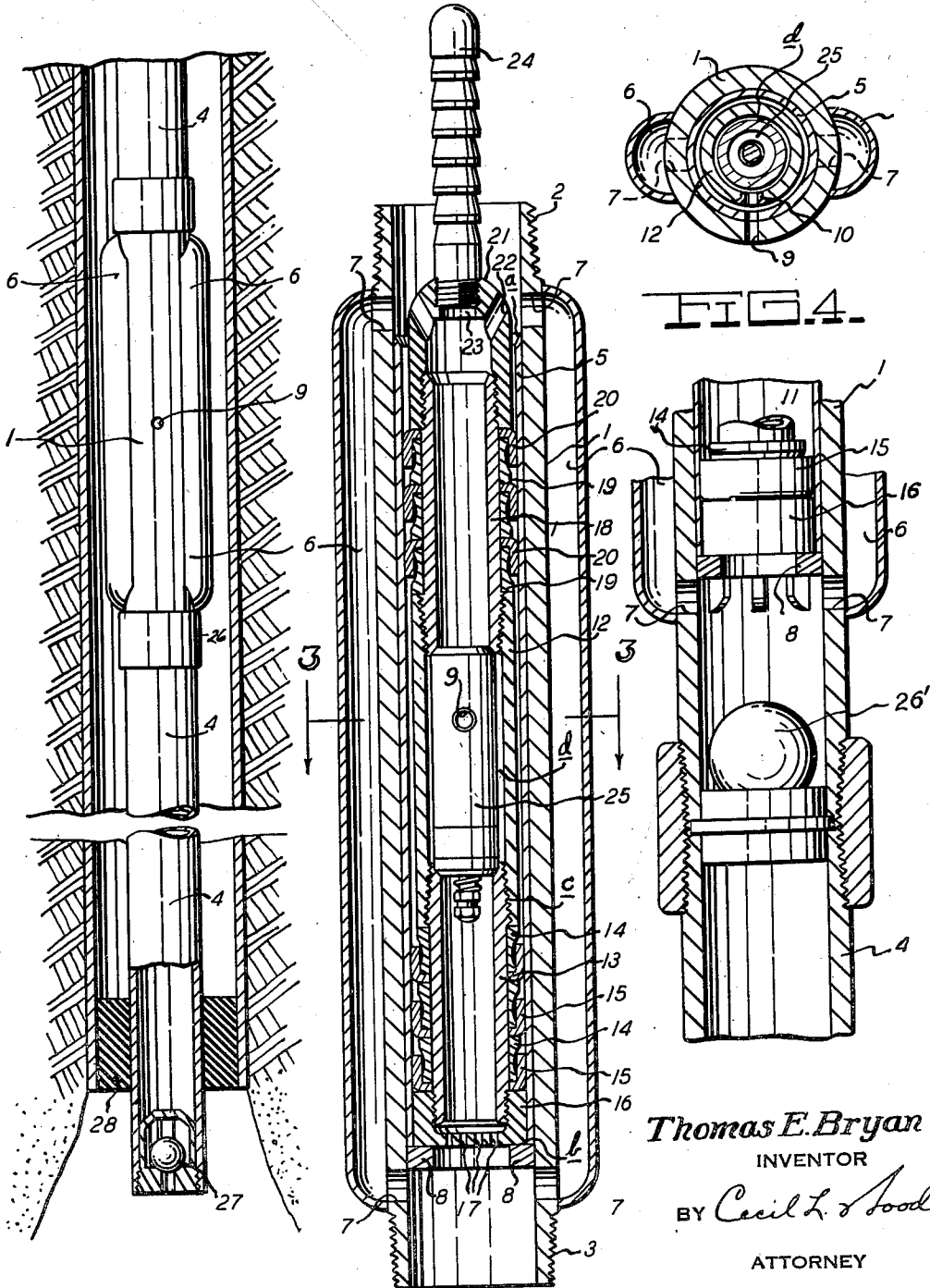
REMOVABLE GAS LIFT APPARATUS IN OIL WELLS

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FIG. 1.

FIG. 2.

FIG. 3.



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REMOVABLE GAS LIFT APPARATUS IN OIL WELLS

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8 Claims. (Cl. 103—232)

This invention relates to equipment and apparatus for removing fluid from wells, or the like, and more especially to the removal of oil from oil wells whereby such oil can be lifted by gas or air under pressure and relates to applicant's co-
 pending applications Serial No. 103,824, filed October 3, 1936, patented November 22, 1938, No. 2,137,441; Serial No. 117,082, filed December 21, 1936, patented February 7, 1939, No. 2,145,918, and Serial No. 182,764, filed December 31, 1937, and it has particular reference to such equipment or apparatus capable of installation and removal, without pulling the tubing from the well, and its principal object resides in providing such an equipment as will afford greater economy in production in eliminating much of the usual time and effort expended in pulling and replacing the tubing when making such installations or when repairs are necessary to the proper operation of the device.

For the purposes of the following specification and claims, the term "gas" will be used as meaning any gaseous substance suitable for the purpose set forth, whether said substance be of that class of gases known as "natural gas," or whether it be atmospheric air or some other composition.

In the past oil has been removed from oil wells and other liquids from similar wells by means of introducing into the well first a casing, the lower end of which may be positioned at some desired point either above or below the liquid level in the well, and a tubing within said casing, which tubing is lowered to a point substantially below the liquid level in the well.

Various arrangements have been resorted to for supplying the gas under pressure to the inside of the casing in an apparatus thus set up, and this gas under pressure has been utilized in a variety of ways for causing the liquid to rise from the bottom of the well through the tubing to the top of the well. Perhaps the simplest arrangement to this end has been that employed in some instances where the gas has simply been allowed to exert a pressure upon the upper surface of the liquid within the well, and thus cause the liquid to rise within the tubing. This, however, is very limited in its application for a number of reasons, and various types of valves have been employed for admitting the gas under pressure through the walls of the tubing at various points so that such gas might aerate the liquid standing within the tubing and make the standing column of liquid lighter. In many instances it is possible to make the liquid sufficiently lighter

so that the formation pressure within the well will be enabled to lift the column of liquid from the well hole through the tubing. Such valves as this are commonly known as "kick-off valves."

In still other instances, these valves have been so constructed that a large quantity of gas will be admitted to the tubing at a point below the liquid level therein so as to form a slug or piston composed of gas under high pressure, and to continue the admission of such gas until the piston expands and causes the liquid above it to be forced out of the well.

All of the foregoing arrangements have their advantages and most of them have certain disadvantages. It is an object of this invention to provide an arrangement utilizing a combination of the last two forms of apparatus for the purpose of eliminating certain disadvantages inherent in each, while retaining the advantages of both.

In the past also it has been customary to provide the valves such as above mentioned, and to permanently attach them to the tubing before it is lowered into place within the well. However, many wells do not require the use of these valves until the well has been in production for a considerable period of time. Furthermore, where only a single valve is used for admitting a slug of gas to the tubing to force the liquid therefrom, this valve will in use become worn and may be damaged in various ways so as to become no longer useful. Under those circumstances, it has previously been necessary to pull the entire tubing from the well so that the valve adjacent the lower end thereof might be removed and repaired or replaced.

It is an object of this invention to provide a means whereby a valve for admitting gas to a tubing may be removed from or replaced in the tubing without the necessity of removing the tubing from the well.

It is a further object to provide a housing for such a valve which may be removed and replaced without removing the tubing from the well.

It is a further object to provide a means within a tubing for removably seating a valve device so that it may be removed from or replaced in the tubing without the necessity of withdrawing the tubing from the well, and so that when in place within the well it will control communication between the outside and the inside of the tubing.

It is a further object to provide a combination for accomplishing the objects above set forth in which the gas about the tubing will be prevented

from exerting any pressure upon the upper surface of the liquid within the well.

Other objects and advantages of the apparatus herein described will become apparent from the following description taken in connection with the accompanying drawing. It is to be understood that said drawing and description are by way of illustration and example, and that the apparatus herein shown and described is to be limited only by the prior art and by the terms of the appended claims.

Figure 1 is an elevational view showing the preferred form of the apparatus herein described connected in a string of tubing in an oil well and illustrating a check valve in the lowermost end of the tubing.

Figure 2 is a cross-sectional view of the apparatus illustrating the fluid passages and the valve element.

Figure 3 is a lateral cross-sectional view of the device taken on lines 3—3 of Figure 2.

Figure 4 is a fragmentary view of the lowermost end of the apparatus showing, in modification, a check valve secured thereto.

It is desirable to employ apparatus having, primarily, a substantially cylindrical casing 1 having exteriorly threaded portions 2 and 3 at its upper and lower ends, as shown in Figure 2, whereby the device can be connected into a conventional string of tubing 4 adjacent the lower end thereof and well below the usual level of the fluid in the well.

The casing 1 presents a smooth inner surface, which is preferably lined with a non-corrosive material in the form of a liner or cylinder 5 within which the valve assembly, hereinafter described, is slidably fitted as illustrated in Figure 2. The casing 1 is provided with fluid passages 6 arranged longitudinally thereof and on opposite sides and such passages may be integral with the main body of the casing 1 or secured thereto in any suitable manner such as by welding, or the like. The passages 6 extend the full length of the casing 1 and are closed at each end, communicating with the interior of the casing 1 at both their ends through ports 7 through the walls of the casing 1 near the bases of the threaded portions 2 and 3 thereon.

The liner or cylinder 5 is formed with a smooth internal surface and is slightly beveled at its upper end at *a* so that a body dropped from above will be guided into the interior thereof. At its lower end the liner is provided with an integral internally projecting annular flange 8 providing a shoulder *b* for a purpose presently to be explained. Intermediate their ends, the casing 1 and the liner 5 are tapered at one or more points about their circumference to provide openings 9 therethrough. Sleeves or nipples 10 are arranged through a portion of the openings 9 and will be presently described more in detail.

Within the casing 1 there is provided a valve housing 11, as illustrated in Figure 2, adapted to seat within the casing 1 in the manner illustrated when dropped into the tubing from above. The housing 11 consists of a tubular body section 12 internally threaded at each end at *c* and into the lowermost end of the body section 12 there is threaded a sleeve 13 carrying a series of rings 14 so formed as to receive and properly retain a plurality of sealing cups 15. The lowermost of the cups 15 is secured in position upon the sleeve 13 and all of the cups 15 and the rings 14 are secured together by means of a tail cap 16 having openings 17 through which fluid may pass into

the interior of the sleeve 13 and the body member 12.

Threaded into the upper end of the body member 12 is a second sleeve 18 similar to the sleeve 13 and likewise carrying rings 19 and a series of cups 20. These sealing cups 20 and rings 19 are secured in position by means of a head cap 21, the upper end of which has upwardly and outwardly directed openings 22 for the purpose of permitting fluid to escape from the housing, and a threaded opening 23 adapted to receive a spear 24. The spear 24 is so formed as to receive an overshot for the purpose of removing the housing, including the rings and cups 14, 15, 19, and 20, just described from the well.

Within the tubular body 12 there is mounted a valve housing 25 which is secured in position between the uppermost end of the lower sleeve 13 and the lowermost end of the sleeve 18. Within the body 25 there are assembled two valve and valve seat elements (not shown), in a manner disclosed in above noted copending patents.

It is apparent, by reference to Figure 2, that the internal diameter of the tubular section 12 is somewhat greater than the external diameter of the valve housing 25 thus affording an annular space *d* around the latter. The advantage of this arrangement is manifest in that it provides a chamber or space through which external gas or air pressure may pass upon entering the housing 1 through the openings 9 and the nipples 10 in the walls thereof, it being an obvious advantage should the valve housing 25 be installed in such a manner as to cause the ports 9 to be out of register or when several of the ports 9 may be provided through the walls of the casing 1 and the tubular section 12. The sleeves or nipples 10 are provided in order that the openings, in which these members are arranged can be varied in diameter.

As previously pointed out, the primary object of the device herein referred to is that of simplifying its installation which can be accomplished without molesting the tubing already set in the well. The casing 1 having been installed in the string of tubing by means of collars 26, the liner 5 having been previously inserted thereinto and made secure, the assembly is lowered into the tubing from the earth's surface by means of a wire line, or the like (not shown), attached to an over shot, or similar tool, into the casing 1.

The sealing cups 15 and 20 tightly, although slidably, engage the inner walls of the liner 5, and are guided thereinto by the beveled upper rim *a* previously described. In order to properly seat the device in the casing 1 it may be necessary, on occasions, to jar the same downwardly so that its lowermost end can be urged against the shoulder *b* of the flange 8. The cups 15 and 20 afford a frangible connection between the assembly and the inner walls of the liner 5 as well as to create a seal therearound. Obviously, the removal of the assembly is accomplished simply by running an over shot or other tool, into the well and grappling the spear 24, pulling upwardly thereon to disengage the assembly from the housing 1.

By reason of the passages 6 the fluid can pass freely upwardly through the device entering the interior thereof through the uppermost of the ports 7 and thence to the earth's surface. Gas pressure exteriorly of the housing 1 is admitted through the valve assembly enclosed within the housing 25 to aerate the liquid and aid in lifting the same. The valve assembly within the hous-

ing 25 is of the type intermittently actuated by the differential in fluid pressures both inside and outside the tubing 4 and while a portion of the liquid may flow through the valve assembly 25, the function of this member is that of controlling the flow of motivating fluid through the assembly to lift the liquid column which flows upwardly around and through the passages 6, as previously stated. Obviously, no great volume of liquid could pass through the valve assembly 25, and this member is intended to function only to control the lifting fluid which aerates the column after the liquid passes upwardly above the assembly and urges the same to the earth's surface.

The apparatus may also be provided, if desirable, with a ball check valve 26 which can be secured to the lowermost end thereof in the manner shown in Figure 4. This arrangement will shut off the downward flow of the fluid above the device while that contained within the upper portion of the tubing above the valve assembly, is discharged by the external gas pressure admitted through the valve assembly within the housing 25.

It will be seen, by reference to Figure 1, that the lower end of the tubing 4 is provided with a check valve 27 of any conventional construction adapted to prevent the liquid column from being moved downwardly back into the formation. Also, a packing 28 is provided between the tubing and the lower end of the well casing 29, so that the space between the tubing and the casing provides a closed chamber for gas under pressure which is to be supplied to the tubing, but prevents this gas from coming into contact with the surface of the liquid in the well.

If it is considered desirable to utilize a series of other valves, such as may be conventionally referred to as "kick-off" valves, these may be installed in the string of tubing above the installation of the housing 1 of the apparatus herein described. The valve assembly can be lowered into the tubing and installed without interference from these other valves.

Through the foregoing, it will be seen that an apparatus has been provided whereby a valve or other device for controlling intermittent admission of gas into or under a column of liquid may be removed from a well and replaced without necessity for removal of the tubing from the well and without necessity for any expensive and time-consuming operation.

It will further be apparent that a means has been provided for insuring the maximum efficiency in a device of the general character set forth and that all of the objects and advantages sought by this invention may be realized by the apparatus just described.

What is claimed is:

1. A gas lift valve for oil wells, in combination with a string of tubing and casing, a fitting interposed within the said tubing having a passage therethrough of the same internal diameter as the said tubing, integral portions providing external fluid passages communicating interiorly of the said fitting with said passage at each end thereof, a port providing a communication through the walls of the said fitting between the exterior and interior intermediate its ends, a removable valve assembly having a cylindrical housing supported within the said fitting, means on the said housing forming frangible sealed connections with the internal walls of the said fitting on each side of the said port, a communication

through the walls of the said housing in the vicinity of the said port providing passage for gas pressures into the said fitting and the said tubing thereabove, and valve elements supported within the said housing interrupting the said communication actuated by liquid pressures within the said tubing and by gas pressures without the latter.

2. In a gas lift valve for producing oil in an oil well, in combination with a string of tubing and casing, a fitting adapted to be interposed in the said tubing having an uninterrupted passage therethrough of a diameter equal to that of the said tubing, fluid conduits integral with and externally of the said fitting communicating at each end thereof with the said passage, a port in the said fitting intermediate its ends providing communication between the interior and exterior of the said tubing, a removable valve assembly including a housing disposed within the said fitting, a communication through the said housing disposed normally in the vicinity of the said port providing passage for gas pressures exteriorly of the said fitting into the said tubing through the said valve assembly, means on the said housing forming a seal therearound interiorly of the said fitting above and below the said port and communication and valve elements adapted to interrupt the flow of gas pressures through the said port and the said communication into the said tubing, the said elements being operated by a preponderance of liquid pressures internally of the said tubing and adapted to be closed when such pressures reach a predetermined minimum value.

3. A gas lift valve for producing oil in an oil well, in combination with a string of tubing and casing, a fitting interposed within the said tubing having an internal bore of the same diameter as that of the said tubing and having integral portions providing passages exteriorly thereof and communicating with the said bore near each end, a removable valve assembly including a cylindrical housing open to the tubing thereabove and supported within the said fitting, sealing means carried by the said housing frangibly engaging the interior walls thereof forming an annular chamber, a port providing communication through the walls of the said fitting between the exterior thereof and the said annular chamber, valve elements operatively disposed within the said housing in the vicinity of the said port adapted to interrupt gas pressures flowing through the said port and the said chamber into the said housing and adapted to be actuated by liquid pressures internally of the said tubing and by gas pressures externally thereof.

4. In a fitting adapted to be installed in a string of oil well tubing for supporting a gas lift valve, the said fitting including a cylindrical portion forming a continuous passage through the said tubing and having a seat for the said valve secured therein, a gas lift valve removably disposed in said cylindrical portion, integral passages on said fitting arranged exteriorly of the said cylindrical portion communicating with its interior at each end thereof above and below the said valve, open communications between the said valve and the tubing thereabove for the passage of fluid pressures therethrough and communications through walls and intermediate the ends of the said cylindrical portion adjacent the said valve admitting fluid pressures to the said tubing through the said valve when the latter is opened.

5. In combination with a string of tubing and casing in an oil well, a fitting adapted to be installed within the said tubing and including a cylindrical portion providing a continuous passage through the said tubing, integral passages on said fitting exteriorly of the said cylindrical portion communicating interiorly thereof at each end providing a by-pass for substance flowing through the said tubing, a gas lift valve removably disposed within the said fitting between the ends of the said passages, the said valve having open communication with the tubing above the said fitting and open ports in the walls of the said fitting adjacent the said valve admitting gas pressures into the said tubing through the said valve.

6. In combination, a string of tubing for an oil well, a gas lift valve and a fitting adapted to be installed in the said tubing supporting the said valve, the said fitting including a central cylindrical body forming a continuous passage through the said tubing, integral passages on said fitting exteriorly of the said body communicating at each end with the interior thereof, a gas lift valve removably arranged within the said body between the said communications and open to the tubing above the said fitting and ports intermediate the ends of the said body adjacent the said valve admitting gas pressures into the said tubing above the said fitting through the said valve when the latter is operated.

7. In combination, a well casing and a string of tubing, a fitting having a cylindrical body interposed within the said tubing adapted to receive a gas lift valve, a valve removably disposed within the said fitting and means on the said valve providing a seal therearound, open communication between the said valve and the tubing thereabove, passages providing a by-pass for fluid around the said valve and through the said fitting, the said passages communicating with the interior of the said fitting at both ends and ports arranged in the walls of the said fitting and valve between the said sealing means admitting gas pressures into the said tubing through the said valve.

8. In combination, a fitting for supporting a gas lift valve within a string of tubing having a cylindrical main body providing a continuous passage therethrough of the same diameter as the said tubing, a removable gas lift valve supported within the said fitting and open to the tubing thereabove, means integral with the said fitting by-passing fluid flowing through the said tubing around the said valve, means on the said valve creating a seal therearound within the said fitting and ports in the walls of the said fitting and valve between the said sealing means admitting gas pressures to the said tubing above the said valve when the latter is actuated.

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