Jan. 15, 1935. W. T. WELLS 1,987,919

OIL WELL TOOL

Filed Sept. 6, 1932

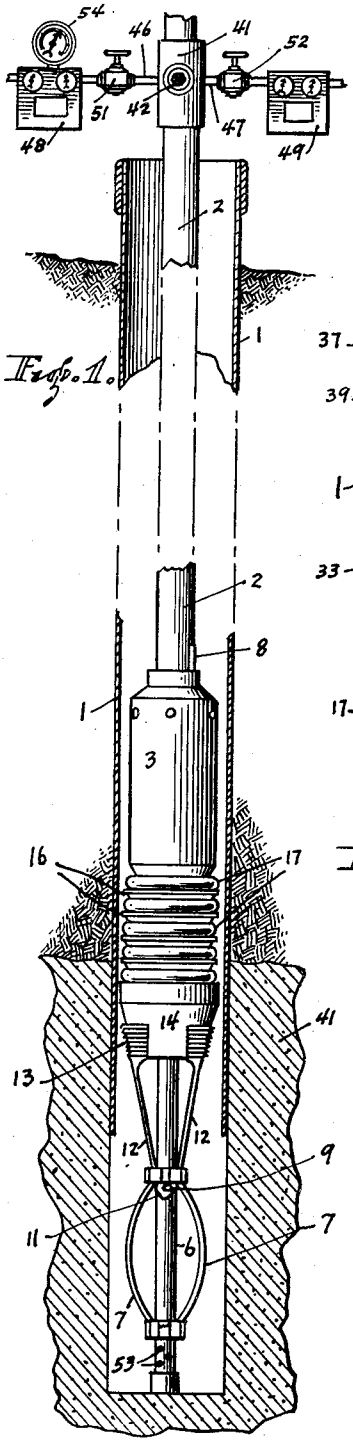


Fig. 1.

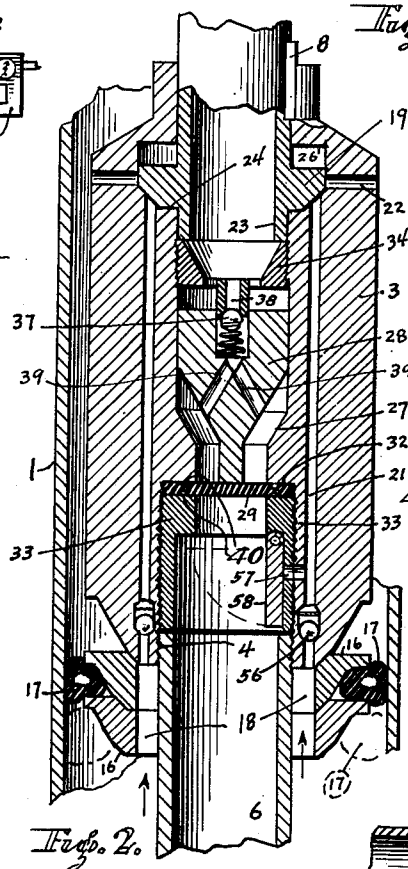


Fig. 2.

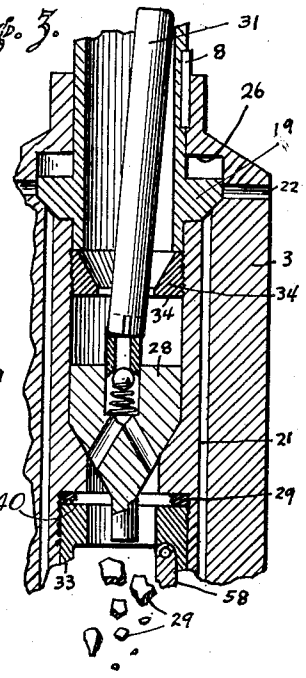


Fig. 3.

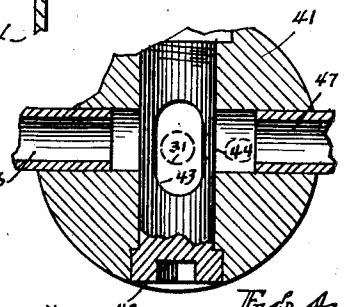


Fig. 4.

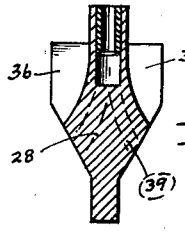


Fig. 5.

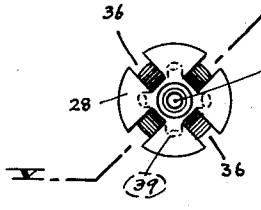


Fig. 6.

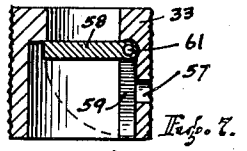


Fig. 7.

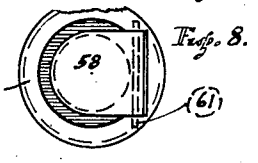


Fig. 8.

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1,987,919

OIL WELL TOOL

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Application September 6, 1932, Serial No. 631,781

12 Claims. (Cl. 166—1)

The present invention is an improved oil well tool and has relation to a packer of the type shown and described in my co-pending application for Packer, Patent No. 1,925,016, issued August 29, 1933.

The device hereinafter described is shown in conjunction with said packer, and, while it in no way restricts the operation thereof, it greatly increases its utility for various operations, some of which have heretofore been possible only by the employment of heavy, complicated, and expensive equipment.

My invention contemplates an attachment, for connection with a packer of the character described, the use of which is optional, whereby hydrostatic pressure in a well casing filled with drilling mud, or other fluid, can be dammed at any desired level and communication established with the zone below the point at which the packer is set, after said zone has been relieved of said hydrostatic pressure within the casing.

As examples of the utility of my invention, it can be successfully operated in various testing operations customarily resorted to in determining deep well conditions either in producing wells or in formation before the well is placed on production.

It can be used to determine the existence of leaks in or around a casing, and the volumetric flow or fluid characteristics thereof be determined by entrapping a sample, which when relieved of hydrostatic pressure, enters the tubing string and is entrapped and brought to the surface for examination.

Means are provided whereby fluid under pressure can be introduced from the top through the tubing string to which my device is attached, either for continuous circulation, to flush the zone below the packer, or to create hydraulic pressure in said zone and thereby dislodge the equipment should it prove difficult to remove.

In the accompanying drawing, Figure 1 is a diagrammatic view of a well casing, with my device therein associated with a tubing string and packer, and shows means at the top for gaging flow through said string,

Figure 2 is a central section of a head member connecting said packer and said tubing string, portions of both of which are shown,

Figure 3 is a fragmentary section, similar to Figure 2, and illustrates the effect of the impact of a falling weight employed to open the tubing string at the bottom after the packer has been set as shown in Figure 2.

Figure 4 is a sectional view of a plug-valve, Figures 5 and 6 are, respectively cross-sectional and top views of a piston-valve, the section of Figure 5 being indicated by the line V—V of Figure 6, and Figures 7 and 8 are, respectively, vertical cross-sectional and bottom plan views of a sleeve member in which is mounted a flapper valve.

Referring to the drawing, Figure 1, the numeral 1 indicates a well casing into which is lowered a string of tubing 2, to the lower end of which is attached the head member 3 of my invention.

Threaded at 4, Figures 2 and 3, into the bottom end of said head member is a tubular support member 6, which is the central support member of a hook wall packer shown and described in my co-pending application for Letters Patent, Serial No. 614,731, filed June 1, 1932.

The tube 6 carries a spring cage, slidable thereon and, when the device is run in, springs 7 frictionally engage the inner wall surface of casing 1.

The tubing string 2 is provided with a limited degree of longitudinal movement relative to the head member 3, as shown in Figures 2 and 3, and a key 8 provides a means whereby said longitudinal movement is possible and at the same time makes it possible to impart rotative movement to head 3, and tube 6 secured thereto, when said tubing is rotated from the top of the well.

When so rotated, a stud 9 secured to tube 6 is disengaged from a hook 11, integral with said spring cage. Slips 12, provided with serrations 13, are secured to said spring cage and are spread outwardly into engagement with casing 1 by the downward movement of a cone member 14.

When said slips are so engaged, further downward movement of tubing string 2 causes compression between the anchored cone 14 and head member 3 and this force compresses expansion rings 16 and the conic surfaces of said rings expand packing rings 17 radially into engagement with casing 1. The packer is now set and said casing divided into upper and lower zones having no communication except through said packer and head 3.

The expansion rings 16 are provided with complementary confronting surfaces which form a metal-to-metal seal, one ring fitting the adjacent ring, and the top ring fitting the tapered bottom of head 3. Fluid can pass only through

an annular by-pass 18, Figure 2, surrounding tube 6 or through said tube.

The by-pass 18 is normally closed, as shown in Figures 2 and 3, by the weight of tubing string 2. However, if said tubing be lifted, a valve member 19, integral with the lowermost member of tubing string 2 moves upward and uncovers passages 21 which then connect by-pass 18 with ports 22 leading through head 3 to the space between casing 1 and tubing string 2.

When said valve 19 is lifted, fluid is prevented from entering tubing string 2 by a skirt 23 (the lowermost portion of said tubing) which is provided with a sliding fit within head 3, rising as valve 19 leaves its seat 24, and until said valve encounters a stop shoulder 26, Figure 3.

Head member 3 is centrally bored to connect tube 6 with the tubing string 2 and said bore is reduced and tapered near the middle of its length, as indicated at 27, to form a seat for a piston-valve 28.

Valve 28 is shown in detail in Figures 5 and 6, and in unseated and seated positions, respectively in Figures 2 and 3.

It is often desirable to run the tubing string in "dry." That is to say, with the lower end closed against the admission thereto of drilling mud, or for other reasons to be given later.

This is accomplished by means of a barrier disc 29, of bakelite, cast iron, or any other suitable fragile material which is effective to resist fluid pressure and yet of a nature to be easily shattered, to open the passage it obstructs, by the impact of a go-devil 31 dropped through the tubing string 2 when the packer has been set and the device is ready to function.

Disc 29 is inserted in the bore of head 3 and held against the shoulder 32 by a collar 33 threaded in ahead of tube 6. The lower reduced portion of piston-valve 28 rests on said disc, as shown in Figure 2, and the reduced top of said valve is centered in an opening in a sleeve 34 against the top of said valve.

Sleeve 34 also serves, later, as a stop to limit the upward movement of said piston-valve 28.

The effect of the impact of the go-devil 31 is illustrated in Figure 3. Disc 29 is shattered and pressure from the zone below the packer lifts piston-valve 28 till it is stopped by collar 34. Flow from tube 6 passes through grooves 36 in said piston, through collar 34 and upward through the tubing string 2.

It will be noted that grooves 36 are so formed as to be closed by shoulders 27 when piston-valve 28 is in seated position (Figure 3).

In order to make it possible to circulate the fluid, under pressure, downward through the tubing string 2 and upward through by-pass 18, passages 21, ports 22, and upward through the casing, I provide a check-valve 37 which controls a passage 38 in the center of piston-valve 28. Quadrilaterally disposed ports 39 communicate with passage 38.

When fluid, under pressure is directed downward in tubing string 2, piston-valve 28 seats on shoulder 27, closing grooves 36. Said pressure unseats check-valve 37, passes through ports 39, through the broken disc 29 and down tube 6. This admission of fluid under pressure may be to formation or, by lifting the tubing 2 (and valve 19) it may be for circulation, as for instance, to remove drilling mud from formation.

In case it is the latter, said fluid is discharged from, or near, the bottom of tube 8 and fluid enters by-pass 18, and goes up through passages 21 and 22 to the casing 1.

Operation

In Figure 1, I show my device assembled and run in to the bottom of casing 1. The packer is set, as heretofore described, near formation 41. Assuming that the well is about to be placed on production and that casing 1 is filled with drilling fluid through which the device has been lowered, that the hydrostatic pressure of said mud has been cut off and is now supported above the packer rings 17, that fluid in formation is no longer under pressure therefrom, and that the tubing string 2 has been run in dry, or empty, go-devil 31 is dropped through the tubing string 2.

As a safeguard against the well getting out of control, should it prove to be a flowing well, I provide at, or near, the top a sub 41 in which is a plug-valve 42 of well-known type, in common use in well practice because of its compact form and adaptability to slender cylindrical parts.

In Figure 4 I show a cross-section of said sub and plug-valve. Said valve 42 has a gate 43, which, in the position shown in Figure 4, admits therethrough the go-devil 31. Said valve is then rotated ninety degrees and said gate then is in position to direct flow from tubing string 2, through a port 44, thence laterally to pipes 46 and 47 leading, respectively, to a fluid meter 48 and a gas meter 49. Valves 51 and 52 govern pipes 46 and 47.

When the go-devil 31 contacts piston-valve 28, resting on barrier 29, said barrier is shattered, as indicated in Figure 3, opening tubing string 2 to normal formation pressure.

Fluid from formation enters tube 6 of the packer through perforations 53, and lifts piston-valve 28 from its seat 27, uncovering slots 36, and passes into tubing string 2, rising therein to a level determined by the degree of formation pressure.

Said fluid entering tubing string 2 displaces air in the dry drill stem and the force and duration of said displacement is measured by the operators at the top as it passes through gas or oil meters 48 and 49, either or both of which are equipped with pressure gages 54. If the formation yields oil or gas and if the well continues to flow, suitable preparations are made to take care of the flow.

However, should the formation pressure be insufficient to lift a column of liquid to the top, and this fact be evidenced at the top of the tubing string by subsidence of flow therefrom, it becomes necessary to entrap, in said string, such fluid as is accumulated therein in order to determine its characteristics and volume.

When pressure has subsided in tubing string 2 said tubing is lifted. The first upward movement of said string lifts valve 19 and hydrostatic pressure from casing 1 enters port 22, and passage 21 which is closed at the bottom by a check-valve 56, and is directed through a port 57 against the back of a flapper-valve 58 in a recess 59 in the wall of sleeve 53, Figures 2, 7, and 8.

Said valve is pivoted on a pintle 61, and when said hydrostatic pressure encounters the back of said valve it is swung out of recess 59 and to a position indicated in dotted lines in Figure 2 and in full lines in Figures 7 and 8.

The upward movement of tubing string 2 disengages the bottom of head member 3 from its seat in the uppermost of expansion rings 16, and

the sudden equalization of hydrostatic pressure above and below the packer causes a jar or impact sufficient to dislodge the packer from the wall of casing 1.

Hydrostatic pressure, after this equalization, in tube 6 exceeds that of the entrapped sample in the tubing string and is effective to hold the flapper-valve 58 against its seat as the tubing string moves upward.

When said string of tubing is raised to a level where the level of the sample therein is higher than that of the fluid in casing 1, and pressure within the tubing string overbalances that of the casing, piston-valve 28 seats against shoulder 27 and positively locks the entrapped sample of fluid within the tubing string 2, and valve 58 drops back to its original position in recess 59.

While I have elected, for the purposes of better illustration, to show in the drawing my invention as applied to a well casing and hook wall packer, it is obvious that the device is equally applicable to, and as useful for, conditions where no casing is provided. It will operate equally as well in connection with a packer of so-called formation, or open hole packer, as with a rat-hole, or plug type packer. The fragile disc 39 can be provided with a weakened section, as indicated at 40 in the drawing, to cause it to fracture in a manner which will form an opening of predetermined shape.

This can be done when said disc is cast or moulded, or afterward by machining or scarifying said disc, depending upon whether said disc be made of bakelite, glass or metal.

I claim:

1. A well tool comprising a tubing string, a packer adapted, when set in a fluid-filled well, to divide said well into upper and lower zones, means whereby said tubing string can be run into said well and kept empty until said packer has been set, means for opening said tubing string to passage therethrough of fluid from the zone below said packer, means, responsive to hydrostatic pressure in said well for entrapping, within said tubing string, a sample of fluid from below said packer and means, actuated by the weight of said sample, for preventing its escape when the tubing string is lifted.

2. A well tool comprising a tubing string, a packer adapted, when set in a well containing fluid, to divide said well into upper and lower zones, means for excluding fluid from said tubing string until after said packer has been set, means for opening said tubing string to passage therethrough of fluid from the zone below said packer, and means, responsive to hydrostatic pressure in said well, for entrapping, within said tubing string, a sample of fluid from below said packer, and gravity actuated means, automatically effective, when said hydrostatic pressure from said well is exceeded by that of said fluid sample, for holding said sample entrapped within said tubing.

3. In combination, a tubing string, a packer adapted, when set in a well, to divide said well into upper and lower zones, said packer provided with independent flow channels therethrough, a head member constituting one of a pair of relatively movable members adapted, when compressed, to set said packer, said head provided with independent flow passages therethrough registering with the channels of said packer, means, responsive to movement of said tubing string, for selectively opening and closing the passages in said head, closure means for keeping said tubing string empty until said packer has been set, means, yieldable to the impact of a falling weight, for rendering said closure means inoperative, a valve, automatically movable to seated position upon removal of said closure means, adapted to entrap within said tubing string a sample of fluid from the zone below said packer, and a supplemental valve, automatically operative by hydrostatic pressure in said well when said tubing string is lifted, to close said tubing string against loss of said entrapped sample, as long as said well pressure exceeds that of said sample.

4. In a well tool a housing, provided with a passage therethrough, valve seats in said passage in spaced-apart relation to each other, a piston valve, movable between said seats, provided with surfaces on its opposite ends complementary to adjacent surfaces on said seats, by-pass means providing a fluid passage through said valve, open when said valve contacts one of said seats, and closed when it contacts the other of said seats, and frangible means for closing the passage through said housing and suspending therein said piston valve, in inoperative position.

5. In combination, a tubing string, a packer associated with said tubing string, adapted, when set in a well, to divide the well into upper and lower zones, fluid passages extending through said packer communicating with the upper and lower zones, a tubular head member slidably retained on the lower end of the tubing string, an annular valve seat formed within the bore of said tubular head adjacent the lower end of the tubing, fluid passages extending longitudinally through said head below said valve seat and communicating with the passages in said packer, check valves in said passages to prevent fluid from passing downwardly therethrough, lateral fluid passages in said head above said valve seat communicating with the upper well zone outside of said head, valve means adapted to close the passage through said tubular head member actuated by fluid pressure from the upper zone transmitted through the longitudinal fluid passages in the head, frangible means for sealing the passage through said tubular head member, a piston valve in the tubular head member above said frangible member and adapted to bear thereon, an annular valve seat in the passage through said tubular head member co-acting with said piston valve, a longitudinal fluid passage through said piston valve adapted to be closed by said valve seat when the piston valve is in its lowermost position, a second longitudinal fluid passage through said piston valve communicating with the fluid passage through said tubular head below said valve, and a check valve in the last named fluid passage adapted to prevent fluid from flowing upwardly therethrough.

6. A device as described in claim 5 in which the valve means on the lower end of the tubing string is provided with a circular, downwardly depending skirt, and the tubular head member is provided with a bore adapted to receive said downwardly depending skirt to effect a slidable, telescoping seal between the tubing and head.

7. The combination, with a tubing string and a packer with a by-pass therethrough, of a pair of valve seats occurring in spaced-apart relation within said tubing string, a piston valve, movable between said seats, controlling move-

ment of fluid through said tubing string, a frangible closure, adapted to exclude fluid from said string when it is immersed, and means, operable through said tubing string for breaking open said closure and seating said valve.

8. The combination with a tubing string and a packer incorporating means for balancing the pressures above and below the packer upon initiating withdrawal thereof, of check valve at the lower portion of the tubing string arranged to close against the flow of fluid from the interior thereof, a frangible closure for said tubing string, means operable through said tubing string and said check valve to break said closure and valve means operatively connected with said pressure balancing means to close said tubing string against further entrance of fluid upon instigating withdrawal of the tubing string.

9. The combination with a tubing string, of a valve seat and stop occurring in spaced apart relation within said tubing string, a piston valve moveable between said seat and stop for controlling movement of fluid through said tubing string, a frangible closure adapted to exclude liquid from the string when immersed, and means operable through said tubing string for breaking open said closure and seating said valve.

10. The combination with a tubing string and a packer of a body incorporated in the upper end of the packer, and having a bore communicating with the interior of the tubing string, a spaced apart valve seat and stop within said bore, a piston valve moveable between said seat and stop for controlling movement of fluid through said tubing string, a frangible closure adapted to exclude liquid from the string when immersed, and means operable through said tubing string for breaking open said closure and seating said valve.

11. The combination with a tubing string, of a check valve seat in the lower portion of said tubing string, a frangible closure below said check valve seat for initially sealing said tubing string, a check valve for said valve seat initially supported by said closure off said seat, and means for impacting said check valve whereby the check valve is caused to break said closure and subsequently to coact with said seat and entrap fluid within the tubing string.

12. The combination with a tubing string, of a check valve seat in the lower portion of said tubing string, a closure below said check valve seat for initially sealing said tubing string, a check valve for said valve seat initially supported by said closure off said seat, and means operable through said check valve to open a passage through said closure.

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