July 4, 1944. A. T. FERRIS 2,352,700

OPEN HOLE REMOVABLE PACKER

Filed Jan. 28, 1942

Fig 1

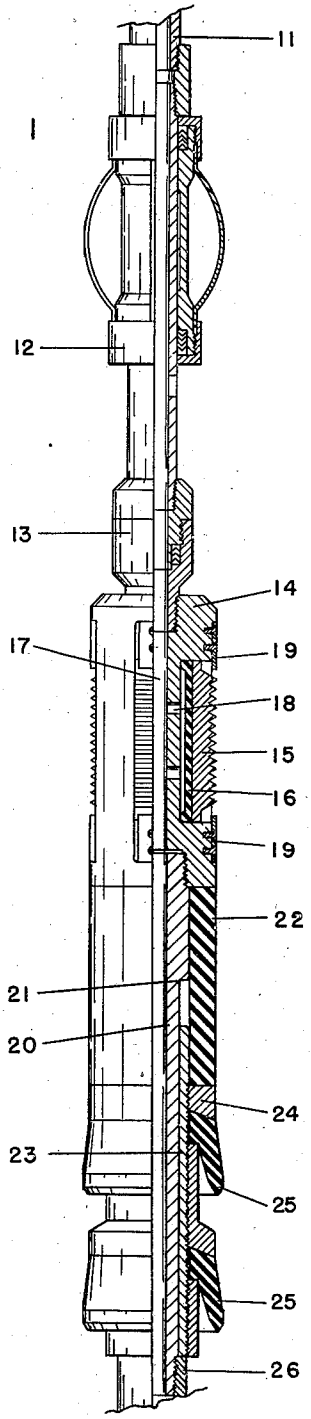
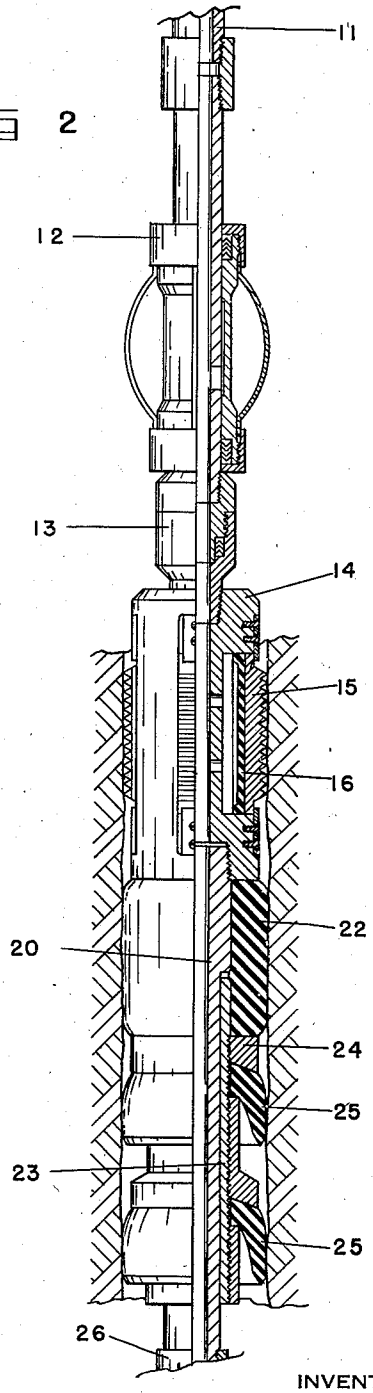


Fig 2



INVENTOR

AUTTIE T. FERRIS

BY

Earl Babcock

Patented July 4, 1944

2,352,700

UNITED STATES PATENT OFFICE

2,352,700

OPEN HOLE REMOVABLE PACKER

Auttie T. Ferris, Flora, Ill., assignor to Halliburton Oil Well Cementing Company, Duncan, Okla.

Application January 28, 1942, Serial No. 428,563

1 Claim. (Cl. 166—12)

This invention relates to packers adapted for use in oil wells, and more particularly to packers adapted to be secured in the open or uncased portion of an oil well to effect a seal therein and to prevent fluid under pressure from moving past the same.

It is often desirable in making an oil well to provide a packer in the open hole which will hold fluid under pressure. Thus, where the well is being cemented by what is known as a "squeeze job" in which the cement is forced under high pump pressure down through tubing and off into the formation of the well, it is necessary to prevent the cement from flowing upwardly on the outside of the tubing. As commonly practiced heretofore, the cement has been prevented from moving upwardly on the outside of the tubing by means of a cement retainer set by means of slips to casing in the well. It is sometimes desirable, however, to cement off a formation some distance below the shoe of the casing while preventing the flow of cement into another formation below the shoe of the casing but above the formation being cemented. The present arrangement, wherein the packer is set and secured in the open hole beneath the shoe of the casing and so arranged as to withstand considerable pressure, is intended to solve this problem.

Packers of the type herein shown and described may also be used to advantage in connection with the acidizing of oil wells. They are particularly adapted for use in connection with combination acidizing and cementing operations of the type shown, described and claimed in the United States patent to William D. Owsley, et al., No. 2,163,449, for "Method of treating a well," granted June 20, 1939.

In the United States patent to O'Donnell, No. 2,204,378, granted June 11, 1940, an open hole packer similar to that of the present arrangement is shown and described, but the O'Donnell packer has certain disadvantages in that it requires the use of an anchor pipe which rests on the bottom of the well to support the lower shoe of the packer, and in that it cannot be removed from the well once it is set, except by drilling it up.

The present invention relates to improvements in open hole packers such as that disclosed in the O'Donnell patent referred to, by which the above-mentioned disadvantages are eliminated. The anchor pipe is entirely eliminated and slips are employed to grip the wall of the well and provision is made for releasing the slips when desired. The wickers of the slips are especially designed to engage the wall of the well in an uncased portion thereof and special means is provided for effecting a seal beneath the slips.

Accordingly, it is one object of the invention to devise a novel combination of elements which co-act in such a way as to provide an open-hole packer which can be set and released so that it may be removed from the well without the necessity of drilling it up.

It is a further object of the invention to devise novel means for setting and holding a packer in an uncased part of an oil well, which means can be so manipulated that the packer can be released at any time, such as after cement has been placed and hardened therebeneath, so that the packer can be removed from the well or moved to another point in the well.

Other objects and advantages reside in certain novel features of the arrangement and construction of parts, as will be apparent from the following description taken in connection with the accompanying drawing, in which;

Figure 1 is a vertical quarter-sectional view of an open hole packer constructed in accordance with the principals of the present invention, the view showing the relative position of the parts when the packer is not set and as it is being lowered into a well; and

Figure 2 is a vertical quarter-sectional view of the same apparatus as that shown in Figure 1, but with the parts in the position which they take when the packer is set.

Referring to the drawing in detail, it will be seen that an oil well tubing is shown at 11, upon which the apparatus of the present invention is adapted to be lowered into an oil well. Between the tubing 11 and the packer assembly, a circulating valve or sub 12 is provided. As illustrated, this sub may be the same as that shown and described in the patent to Halliburton, No. 2,235,318, granted March 18, 1941.

Connected to the lower end of the circulating sub by the safety joint coupling 13, there is a slip body 14, upon which especially designed slips 15 are mounted for limited radial movement in recesses contained in the slip body 14. Inserted in the recesses behind the slips are slip pads 16. These pads are, in general, rectangular in shape and have a depression or cupped portion on one face. They may be made of rubber reinforced with fabric. These slip pads act as packing and prevent any fluid from passing around the slip pad and by the slips.

As illustrated, the center of the slip body 14 contains a longitudinally extending passage 17

which is connected through the coupling 13 and the circulating sub 12 to the tubing 11. There are ports 18 in the slip body 14 which connect the passageway 17 to the recesses beneath the pads 16. Thus, by pumping a fluid down through the tubing, pressure may be transmitted into the space behind the slip pads and if the pressure on the outside of the slip body is less than that on the interior, the slip pads will act as pistons to force the slips out against the wall of the bore hole.

Leaf springs 19 connected by screws to the slip body 14 provide means for holding the slips in the retracted position shown in Figure 1, while the apparatus is being lowered into the well and also serve to urge the slips back into the slip body after they have been forced outwardly whenever the pressure on the interior and exterior of the slip body is equalized.

The slips 15 are especially designed to adapt them to engage and hold in open hole formations in oil wells. The wickers of the slips are larger and have sharper edges than those of slips commonly used in oil wells for engaging casing or the like and it has been discovered that if the formation opposite the slips is relatively hard, such as limestone, these slips will serve to hold the tool against movement in the well.

A hollow mandrel 20 is threaded into the lower end of the slip body 14. The upper portion of the mandrel 20 is of slightly larger diameter than the lower portion thereof, so as to provide a shoulder 21.

Slidably mounted on the upper portion of the mandrel and abutting against the lower surface of the slip body 14, there is a rubber wall packer sleeve 22. As shown in Figure 1, this sleeve normally extends downwardly some distance below the shoulder 21.

A slidable operating sleeve 23 is telescoped upon the lower portion of the mandrel 20, with its upper portion inside of the wall packer sleeve 22. Integral with this operating sleeve is a lower shoe 24 for the wall packer sleeve and also one or more rubber swab cups 25 mounted in inverted position.

The rubber wall packer sleeve and the rubber swab cups may be of the construction commonly employed in oil wells and in which the rubber may be reinforced with fabric or the like.

To limit movement of the operating sleeve 23 longitudinally upon the mandrel 20 and also to prevent it from falling off of the mandrel, a collar 26 is threaded onto the lower end of the mandrel. The lower end of the collar 26 is threaded so that a tail pipe may be connected thereto, if desired, so that fluid may be discharged from the tool at any desired distance beneath the tool when the packer is set.

To operate the assembly shown in the drawing in carrying out a cementing operation, the tool is lowered into the well on the tubing 11, with the parts in the position shown in Figure 1. With the parts in this position there is no tendency for the slips to engage the wall of the hole or for the wall packer sleeve to expand, because the pressure above and below the swab cups 25 is substantially the same, due to the fact that the circulating sub 12 is open, so that fluid can flow from a point beneath the tool upwardly through the mandrel 20, the passage 17 in the slip body 14, the safety joint 13 and out through the ports in the circulating sub or on up into the tubing 11. In this way the hydrostatic head inside the tubing 11 is the same as that on the outside.

When the tool has been lowered to the desired point in the well where it is desired that a seal be effected, the circulating sub 12 is closed by merely picking up or lifting the tubing 11 a short distance. Fluid is then pumped down through the tubing 11 and through the entire tool, discharging through the collar 26.

The swab cups 25 are incapable of forming a complete seal with the wall of the bore hole but they do offer sufficient impedance to the flow of fluid upwardly around the outside of the tool to maintain a slight pressure differential and as a result, hydrostatic pressure is transmitted to the slip pads 16, which causes the slips to expand and contact the wall of the bore hole.

At about the same time, the swab cups 25 are forced upwardly, the motion being transmitted to the shoe 24 through the operating sleeve 23 and causing the wall packer sleeve 22 to expand and make a tight seal with the wall of the well. In general, this seal will only be maintained and the slips 15 will remain set only so long as pressure is being applied to the fluid in the tubing 11. If the tubing 11 is filled with mud, as is normally the case in a cementing operation, it is necessary to remove the mud before squeezing cement into the formation beneath the tool. This can be done by releasing the fluid pressure in the tubing 11, so that the packer and slips collapse, then lowering the tubing slightly to open the circulating sub 12. Cement slurry can then be forced down through the tubing 11 with the mud ahead of it being displaced and moving out through the circulating sub 12. When the cement slurry is down nearly to the depth of the tool, the circulating sub may be closed and pressure applied. The application of pressure will again set the slips and packer as described above, and cause the cement to be squeezed into the formation beneath the tool. As soon as the cement slurry is in place, circulation of mud in the reverse direction, that is, down on the outside of the tubing and up through the interior, may be brought about.

If the circulating sub is held closed, reverse circulation of mud will wash out the tool, the mud flowing downwardly past the slips, the packer 22 and the swab cups 25 and up through the interior of the tool into the tubing. This action is possible because as soon as the pressure on the exterior of the tool is the same as that on the interior, the slips and wall packer sleeve take the retracted or collapsed position shown in Figure 1.

As mentioned above, the apparatus shown and described may also be used with success in carrying on acidizing operations in oil wells where it is desired to effect a seal at a particular point in the uncased part of the well.

To explain this operation, a typical instance of the use of the tool in Illinois will be described. The well was equipped with casing cemented at a depth of approximately 3,390 feet. The total depth of the well was reported to be 3,440 feet and plugged back to a depth of 3,478 feet. The amount of open hole was calculated to be approximately 50 feet, the production being in limestone which it was desired to treat with 1,000 gallons of 15% hydrochloric acid. The apparatus shown and described herein was set in the well opposite a hard lime section at a depth of 3,425 feet. A perforated pipe 11 feet long was connected to the coupling 26, being located at a depth of 3,427 to 3,438 feet, which was reported to be the location of the producing McClosky lime formation. The well was filled with oil with the circulating sub open, and the oil was then displaced out of the tubing with acid, after which

the slips and packer were set. Acid was then pumped into the McClosky lime formation at an initial pressure of 500 pounds per square inch. After 1 hour and 20 minutes, 500 gallons of acid had been pumped into the formation and the pump pressure had increased to 1,000 pounds per square inch. The pressure continued to increase until it reached 2,000 pounds per square inch when the 1,000 gallons of acid had been pumped into the formation. The total time of the acid displacement was 3 hours and 45 minutes.

The annular space between the tubing and the wall of the hole, both in the cased and uncased portion thereof, was maintained full of oil during the time that pressure was maintained in forcing the acid into the formation.

On completion of the acidizing operations, the pressure was equalized and the tubing and the tool removed from the well.

While only one embodiment of the invention has been shown and described herein, it is obvious that various changes may be made in the arrangement and construction of parts, without departing from the spirit of the invention or the scope of the annexed claim.

I claim:

An open hole removable packer for oil well or the like, adapted to be lowered into a well on tubing, including a hollow mandrel adapted to be connected to the tubing, a set of slips means for mounting said slips for limited radial movement on said mandrel near its upper end, means operable hydraulically for actuating said slips to move the same outwardly to engage the wall of the bore hole and prevent movement of the mandrel in the hole, a cylindrical wall packer sleeve mounted on said mandrel beneath said slips and means operable hydraulically for expanding said sleeve to cause the same to engage the wall of the bore hole and effect a seal between it and the mandrel, said means for expanding said packer sleeve, including an operating member slidably mounted on said mandrel beneath said packer sleeve, a lower shoe for said packer sleeve fixed to said member and an inverted swab cup fixed to said member beneath said lower shoe.

AUTTIE T. FERRIS.