Nov. 29, 1938. E. P. HALLIBURTON 2,138,157

REMOVABLE PACKER FOR WELLS

Filed March 5, 1937 2 Sheets-Sheet 1

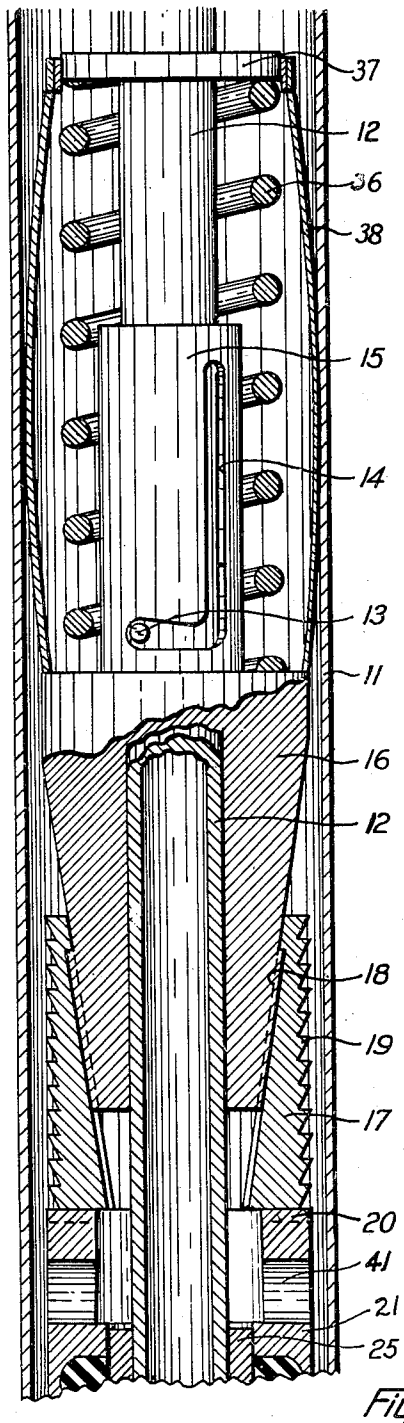

Fig. 1.

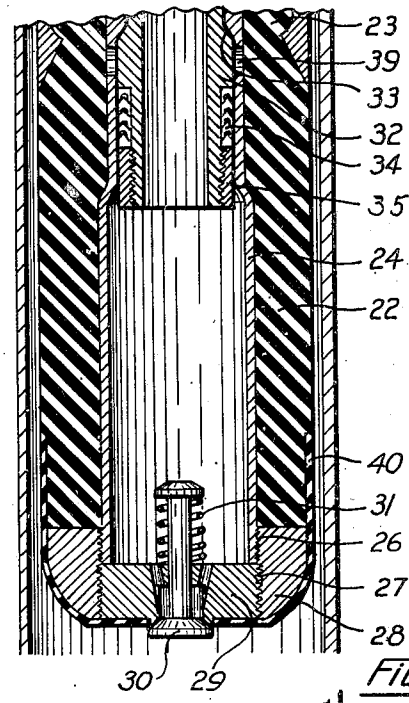

Fig. 2.

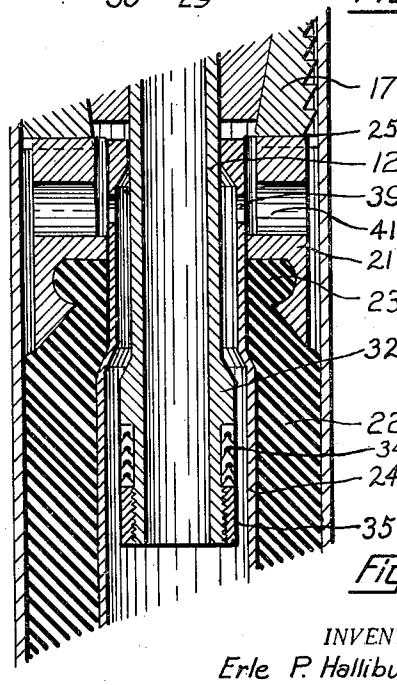

Fig. 3.

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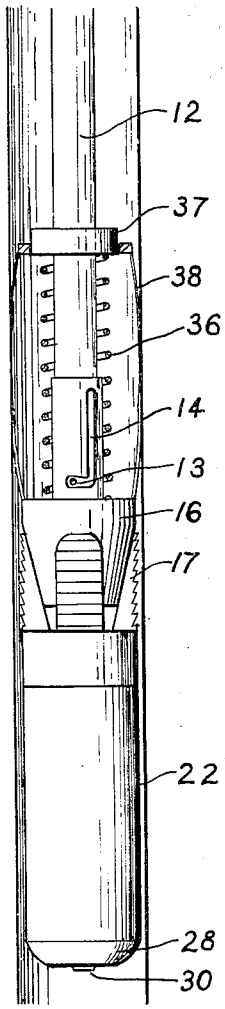

Fig. 4.

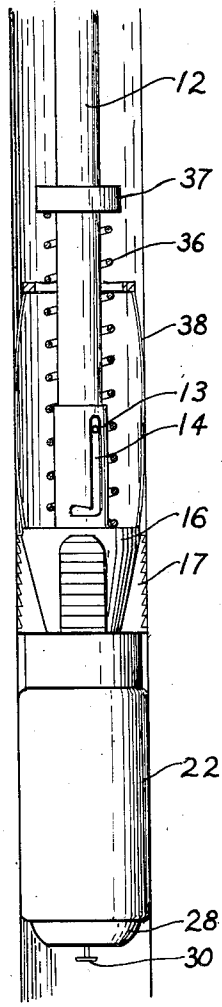

Fig. 5.

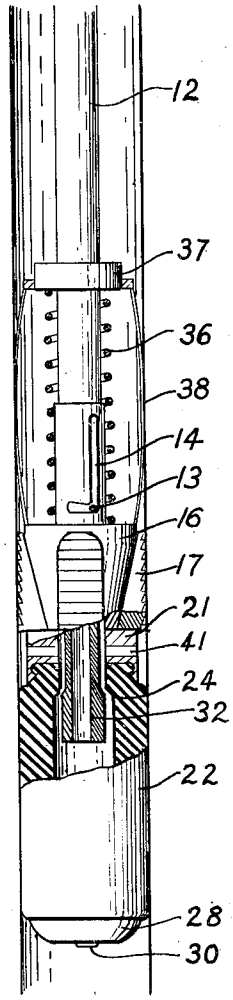

Fig. 6.

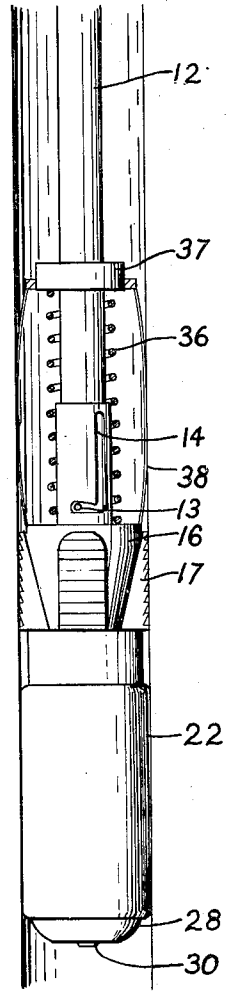

Fig. 7.

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2,138,157

REMOVABLE PACKER FOR WELLS

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Application March 5, 1937, Serial No. 129,205

11 Claims. (Cl. 166—12)

This invention relates to apparatus adapted for use in oil wells or the like and more particularly to packers and means for removably securing the same to the casing of a well.

It is often desirable to fix and seal a valve or other structure to the casing of an oil well. If it is known prior to the time the casing is placed in the well that a valve is to be needed or used therein, a collar or a shoe may be made up with the casing and may contain the valve, but many occasions arise where it is necessary to fix a valve or the like to the casing while the casing is in the well.

The present invention relates to apparatus and methods for fixing and sealing structures in wells and is particularly suitable for use in certain classes of cementing operations.

A well is sometimes cemented by forcing the slurry down into the well through tubing and into the formation of the well under extremely high pressure. In the trade, this is called a "squeeze job."

Because the pressure is extremely high, it is desirable and often necessary to secure the bottom of the tubing to the casing, for otherwise the tubing would move upwardly and "corkscrew" or collapse.

It is also desirable to maintain an efficient seal between the bottom of the tubing and the casing to prevent the slurry, under high pressure, from passing upwardly therebetween instead of into the formation.

In the structure at the bottom of the tubing also has a "back-pressure valve" therein, pressure can be maintained on the cement slurry until it hardens, even though the pressure on the pumps at the surface is relieved.

The apparatus of the present invention is so constructed and arranged that it can function to effectively meet the above mentioned requirements. In addition, the apparatus presents many features of novelty and utility which will now be explained.

Prior to the present invention it has been proposed to secure packers in wells and cement beneath them, but it is believed that no one heretofore has ever attempted to remove the packer after the cement has hardened.

The usual procedure has been to fix the valve and packer to the casing to retain the cement and leave it there. It is then necessary, if further drilling operations are required, to drill out the packer, the slips which hold the packer, the valve and all the associated parts, most of which are made of iron or other metal and some of which (the slips, for example) are usually case hardened. The drilling of this material is so difficult that the drills sometimes go through the casing rather than through the cement retaining assembly left in the well. Even where successfully drilled out, the practice is troublesome, time-consuming and expensive, the cement retaining assembly being destroyed.

It is an important object of the present invention, therefore, to devise means for retaining cement or other fluid in place in a well and to so construct and arrange the same that it can readily be removed from the well after the cement has hardened or at any other time. The cement retaining assembly or at least some parts thereof may then be used again in another well.

It is a further object of the invention to devise a novel packer for sealing tubing to the casing of a well and to devise novel and practical means for setting the packer and for releasing and removing it from the well.

It is another object of the invention to devise a packer assembly particularly adapted for "squeeze jobs" of well cementing or other types of cementing where tubing is used, and in which the tubing and casing may be washed out above the packer after the cement is in place.

It is another object of the invention to devise means, controllable at will, for setting slips in a casing and for subsequently disconnecting the same from the casing.

It is still another object of the invention to devise a novel method of cementing and conditioning an oil well or the like.

Other objects and advantages reside in certain novel features of the arrangement and method as will be more apparent from the following description taken in connection with the accompanying drawings, in which:

Fig. 1 is a vertical cross-sectional view of the upper portion of a packer assembly constructed in accordance with the principles of the present invention.

Fig. 2 is a vertical cross-sectional view of the lower portion of the same apparatus;

Fig. 3 is a vertical cross-sectional view of a portion of the apparatus shown in Fig. 2, but illustrating a different relative position of the parts; and

Figs. 4 to 7, inclusive, are diagrammatic showings of the apparatus of Figs. 1 and 2 illustrating the operation thereof.

In the drawings it is to be understood that Figs. 1 and 2 show complementary or adjacent portions of the same apparatus, the upper por-

tion of Fig. 2 being contiguous to the lower portion of Fig. 1.

The arrangement shown in the drawings includes a portion of the casing 11 of an oil well, the apparatus of the present invention being mounted therein.

The apparatus shown is intended to be mounted on the lower end of drill stem or tubing (not shown) by means of a suitable mandrel 12 which is hollow and provides a conduit from the tubing through a major portion of the packer assembly. For supporting the packer assembly the mandrel carries one or more pins 13 of any suitable size and shape which are adapted to cooperate with a J-slot or bayonet joint structure 14 formed in a sleeve 15 mounted for longitudinal movement on the mandrel 12.

Integral with the sleeve 15 is a cone or wedge-shaped member 16 a lower or tapered portion of which is dovetailed to a number of slip segments 17 as shown at 18. It will be noted that the slips 17 have their inner-faces inclined to correspond with the inclination on the cone or wedge member 16 so that the cone may ride up and down therein. If the cone moves downwardly the slips are expanded radially and press against the casing 11. If the cone is pulled upwardly the slips are removed from the casing, being pulled inwardly by the dovetails 18.

The slips are provided with teeth 19 which may be of known construction as, for example, case hardened steel, so as to bite into the casing. It is to be noted that the teeth are so formed as to extend upwardly, thus preventing upward movement of the apparatus beneath the slips when the teeth are set.

By means of a dovetailed connection 20, the lower end of the slips 17 are secured for sliding radial movement to the upper shoe 21 of the packer 12. The upper shoe 21 may be of usual construction and consist of a cylindrical metallic body having a groove 23 therein so that it may be secured to the upper end of the packer.

Radially extending wash out ports 41 may be provided in the shoe 21 or the water used in washing out may be caused to flow upwardly through the shoe 21 after flowing through the ports 39, and then outwardly between the slip segments 17.

The packer 22 may be made of rubber or other material and is normally of the shape shown in Fig. 2. Within the packer there is a sleeve 24 the upper end of which has an inwardly extending flange 25 and the lower end of which is screw-threaded, as shown at 26, to cooperate with screw-threads 27 on the lower shoe 28 of the packer. The lower shoe 28 carries a valve seat member 29 to which the valve 30 is secured. The valve 30 is of such a nature that the spring 31 thereof tends to close the same upwardly. Thus fluid can flow downwardly through the sleeve 24 but not upwardly. The valve 30 closes whenever the pressure beneath the shoe 28 is substantially equal to or greater than that inside of the sleeve 24.

While the main body of the packer may be of known construction, it is preferably provided with a thin sleeve 40 around its lower portion. This sleeve 40 is of tough elastic rubber and covers not only the lower portion of the packer 22 but also the lower shoe 28 and a portion of the valve seat member 29, as shown in Fig. 2.

The purpose of the sleeve 40 is twofold. It helps to prevent the creepage of cement slurry up around the packer (which would tend to cement the packer to the casing) and it covers the lower shoe 21 thus making it easier to pull that shoe loose from the cement after the cement has hardened.

When the packer is removed from the well, the sleeve 40 may remain therein.

The lower end of the mandrel 12 is provided with an enlargement 32 and this has a seat 33 which cooperates with a seat on the flange 25 of the sleeve 24 to maintain a seal between the mandrel and sleeve when the parts are in the position shown in Fig. 2. Suitable packing 34 may also be provided on the mandrel as shown. The packing may be compressed by means of the gland nut 35. Just beneath the flange 25 the sleeve 24 is provided with a number of ports 39, the purpose of which will be explained hereinafter.

The parts are maintained in the relative positions shown in Figs. 1 and 2 while the apparatus is being lowered into the well. This is accomplished in part by means of the coil spring 36 resting on the top of the cone 16 and held in place by means of a collar 37 fixed to the mandrel 12. The cone 16 also has drag springs 38 of usual construction integral therewith.

It is to be noted that except for the latching means (pins 13 and slot 14) the cone 16 is free to move downwardly on the mandrel 12 under the influence of the spring 36.

The mandrel is also free to move downwardly through the sleeve 24 and the packer 22, the parts then taking the relative positions shown in Fig. 3.

The operation of the apparatus for cementing a well is as follows:

With the parts in the relative positions shown in Figs. 1, 2 and 4, the packer assembly is lowered to the desired point in the well. The drill stem and mandrel 12 are then rotated to the left a sufficient amount to bring the pin 13 into the longitudinally extending portion of the J-slot 14. The cone 16 is prevented from rotating at this time by the drag springs 38. As soon as the pin 13 is in the longitudinal portion of the J-slot the spring 36 acts to throw the cone 16 downwardly and this causes the slips 17 to engage the casing and take an initial set therein. The drill stem and mandrel 12 are then lifted. The pin 13 moves farther up in the slot 14 at this time and the packer is compressed to maintain an effective seal with the casing, the upward movement of the mandrel 12 being transmitted to the lower shoe 28 by the sleeve 24. Both the lower shoe 28 and the sleeve 24 thus move upwardly with respect to the upper shoe 21 when the packer is set. The slips having taken their initial set, the upper shoe 21 cannot move upwardly at this time and as the lower shoe is lifted not only is the packer set but the slips are caused to be firmly pressed in place on the casing, the lifting force being transmitted from the lower shoe to the upper shoe and slips by the packer, the parts then taking the position shown in Fig. 5.

The slips and packer now having been set, tension is maintained on the drill stem or tubing and cement is pumped down therethrough. The cement flows through mandrel 12 and outwardly through the valve 30 (shown open in Fig. 5). After a sufficient quantity of cement has been pumped into the well in this manner, the fluid pressure in the drill stem is removed and the valve 30 immediately closes. The drill stem is now lowered slightly to the position shown in Fig. 6. The mandrel 12 moves downwardly a

sufficient amount to bring it into the position shown in Figs. 3 and 6.

As previously mentioned, when the mandrel 12 is lifted up to set the packer, the sleeve 24 rides upwardly with respect to the upper shoe 21 thus moving the ports 39 therein up sufficiently to bring the ports 39 and 41 into alignment to allow fluid to flow from inside the sleeve 24 to the outside of the shoe 21. Therefore, when the mandrel 12 is moved down to the position shown in Figs. 3 and 6, water may be pumped downwardly through the mandrel and flow upwardly between the lower end thereof and the sleeve 24 outwardly through the ports 39. The water may then flow either outwardly through the ports 41 or upwardly between the sleeve 24 and the upper shoe 21 and outwardly between the slip segments 17 and thence back to the surface between the drill stem and the casing 11. This water will wash out any cement which may have found its way up around the slips.

After the cement has hardened the drill stem will be lowered further (if necessary) and rotated to the right to bring the pin 13 back into the horizontal portion of the J-slot 14 as shown in Fig. 7. Then by lifting up on the drill stem the cone 16 will be pulled upwardly. This will cause the slips 17 to disengage from the casing 11 and move inwardly, this action being due to the dovetail 18. The dovetail 18 has a stop at its lower end so that after the slips have been disengaged further upward movement of the cone 16 will move the upper shoe 21 upwardly, this pull being transmitted through the slips 17 and dovetail 20. The packer 22 will thus be contracted and the entire apparatus may then be removed from the well, leaving only the hardened cement and perhaps some or all of the rubber sleeve 40 in the well.

While only one embodiment of the invention has been shown herein and the description has been limited to the use of the apparatus in a particular kind of cementing operation, it is obvious that both the apparatus and method are adaptable to a wide variety of application, and that various changes may be made without departing from the spirit of the invention or the scope of the annexed claims.

I claim:

1. Apparatus adapted for use in the cementing of cased oil wells or the like and comprising a mandrel adapted to be secured to the lower end of drill pipe or tubing, a one-way valve structure carried by said mandrel for preventing the flow of fluid upwardly therethrough, a packer for sealing the valve structure to the casing of the well, slips for gripping the casing to prevent upward movement of the packer and valve structure and means controllable from the surface of the well for setting the slips and packer and then releasing the slips and packer whereby the slips, packer, valve structure and mandrel may be removed from the well after the same have been used therein to supply and hold cement in place in the well.

2. Apparatus for cementing wells comprising means for securing a conduit to the casing of the well, means for sealing the conduit to the casing, means for supplying cement to the well at a point beneath the sealing means, a one-way valve structure associated with said conduit to hold the cement in place until it hardens and means for releasing said securing means and said sealing means from the casing after the cement has hardened, whereby the conduit, securing means, sealing means and valve structure may be removed from the well.

3. The combination with the casing and tubing of an oil well or the like of an arrangement for releasably securing conduit means associated with the tubing against upward movement with respect to the casing, said arrangement including slips having upwardly directed teeth, spring means for setting the slips and means operable in response to an upward pull on the tubing for releasing said slips.

4. Apparatus adapted for use in the cementing of a cased oil well, said apparatus including a string of tubing, a mandrel carried by the tubing, one-way valve means carried by the mandrel for preventing the flow of fluid upwardly therethrough when the securing and packing means is set, securing and packing means carried by the mandrel for fastening and sealing the mandrel to the casing of the well, and control means operable by movement of the tubing and mandrel to either set or release said packing and securing means.

5. Apparatus adapted for use in the cementing of a cased oil well, said apparatus including a string of tubing, a mandrel carried by the tubing, one-way valve means carried by the mandrel for preventing the flow of fluid upwardly therethrough when the securing and packing means is set, securing and packing means carried by the mandrel for fastening and sealing the mandrel to the casing of the well, and control means operable by movement of the tubing and mandrel to either set or release said packing and securing means, said control means being operable to release said securing and packing means in response to an upward pull on the tubing.

6. Apparatus adapted for use in the cementing of a cased oil well or the like, said apparatus including tubing for supplying cement to the well under pressure, means for holding the tubing against upward movement with respect to the casing during the period of time the cement is being supplied to the well and until the cement has hardened, packing means for sealing the tubing to the casing during the same period and means for removing the holding means and the packing means from the well after the cement has hardened.

7. Apparatus adapted for use in the cementing of a cased oil well or the like, said apparatus including tubing for supplying cement to the well under pressure, means for holding the tubing against upward movement with respect to the casing during the period of time the cement is being supplied to the well and until the cement has hardened, packing means for sealing the tubing to the casing during the same period, back-pressure valve means associated with said tubing for holding pressure on the cement until it hardens, means for washing out the casing and tubing above said packing means during the time the cement is hardening and means for removing the holding and packing means from the well after the cement has hardened.

8. Apparatus adapted for use in the cementing of a cased oil well or the like, said apparatus including tubing for supplying cement to the well under pressure, means for holding the tubing against upward movement with respect to the casing during the period of time the cement is being supplied to the well and until the cement has hardened, packing means for sealing the tubing to the casing during the same period, said holding means being located above said packing

means, means for washing out around said holding means during the time that the cement is hardening and means for removing the holding means from the well after the cement has hardened.

9. A removable packer adapted for use in the cementing of oil wells or the like, said packer having a main body portion adapted to be expanded to effect a seal with the casing of the well and a sleeve of flexible material surrounding said main body portion to protect the main body portion from cement.

10. The method of sealing a portion of a well with cement by the use of tubing carrying a back-pressure valve, securing means and a packer on its lower portion, which method includes the steps of lowering the tubing into the well, setting the securing means to hold the tubing against upward movement in the well, setting the packer to seal the tubing to the well, pumping the cement at high pressure into the well beneath the sealing means while the tubing is secured, relieving the pressure in the tubing to allow the back-pressure valve to close, washing the tubing and securing means above the back-pressure valve and packer to prevent cement from sticking the same, allowing the cement to harden and subsequently removing the tubing, the securing means, the packer and the back-pressure valve from the well.

11. The method of sealing a portion of a well with cement which involves first setting slips in the casing of the well, placing a packer below the slips, pulling up on the lower portion of the packer to expand the same against the slips, placing cement below the packer, allowing the cement to harden and then removing the slips from the well.

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