

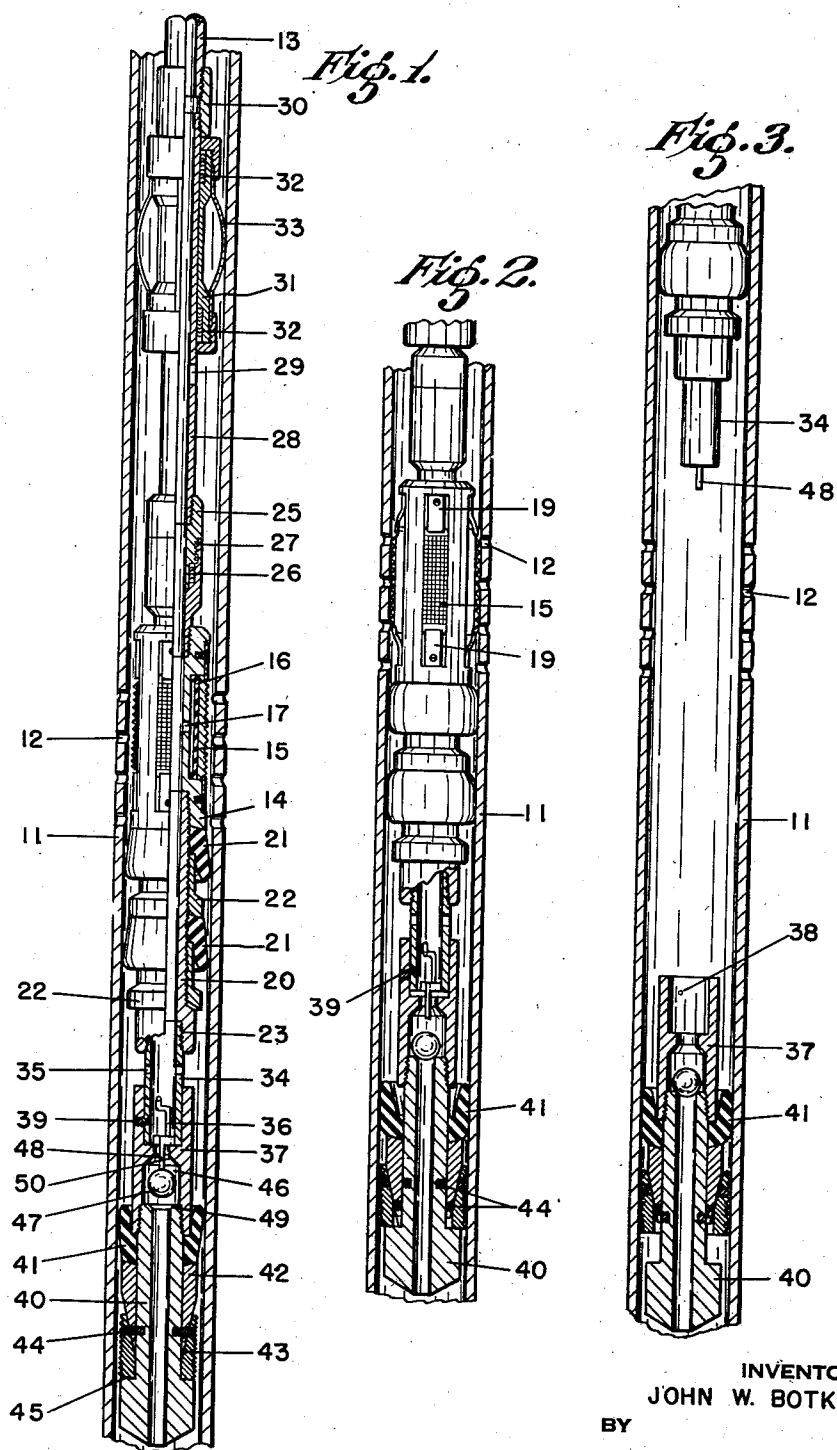
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APPARATUS FOR CEMENTING WELLS

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APPARATUS FOR CEMENTING WELLS

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1 Claim. (Cl. 166—1)

This invention relates to apparatus adapted for use in cementing oil wells and more particularly to means for forcing cement through perforations in the casing in a well.

In the cementing of oil wells it is common practice to perform what is known as a "squeeze job." By this is meant that a cement slurry or other sealing fluid is forced or squeezed by pressure into or against a permeable formation or through perforations in casing and liners for the purpose of shutting off water or reducing gas-oil ratio or for other purposes.

The apparatus of the present invention is adapted to be used for squeeze jobs through perforations and in certain respects may be regarded as an improvement or modification of the apparatus of the following U. S. applications and patents:

Patent to Erle P. Halliburton, No. 2,235,318, for "Apparatus for cementing wells," granted March 18, 1941.

Patent to A. D. Stoddard, No. 2,274,940, for "Squeeze cementing of wells," granted March 3, 1942.

Patent to S. R. Robinson et al., No. 2,239,295, for "Cementing tool," granted April 22, 1941.

Patent to S. R. Robinson, No. 2,239,296, for "Cementing tool," granted April 22, 1941.

Patent to H. F. Boggs et al., No. 2,244,354, for "Cementing tool," granted June 3, 1941.

Application of M. M. Verheul et al., Ser. No. 335,494, filed May 16, 1940, for "Apparatus for introducing fluid into an opening."

Application of W. R. McClendon, Ser. No. 370,190, filed December 14, 1940, for "Removable packers."

As mentioned in some of these applications, in squeeze cementing it is customary, and usually desirable, to fix and seal a tubing or other conduit to the casing above the point where the cement slurry is to be squeezed. For this purpose slips and a packer are utilized. The Stoddard application and the McClendon apparatus are of this type.

In many cases, oil well casing has been perforated opposite a number of formations at different levels and then later it is desirable to squeeze cement into one or another of these formations. It is then necessary to set packers both above and below that set of perforations.

In the arrangements of the prior art, bridge plugs and cement retainers have been used for this purpose, and more recently, as exemplified by the art cited above, it has been pro-

posed to provide removable equipment for this purpose.

In accordance with the present invention, it is proposed to provide cementing equipment for the purpose mentioned, and like uses, in which the lower or bridge forming packer is detachable from the remainder of the assembly, so that it may be set and left in the well to be drilled up when the well is completed.

In some cases this presents considerable advantages over prior known arrangements. It avoids the limitation as to fixed spacing between the upper and lower packers common to certain of the prior systems, and thus permits greater flexibility of use. On the other hand it eliminates the difficulties of drilling up large bodies of iron and rubber, experienced when the old types of cement retainers were used.

Accordingly, it is one object of the present invention to supply a bridge plug which may be run in connection with a removable packer and be set below perforations in a casing through which cement is to be squeezed.

It is another object of the present invention to provide a bridge plug which may be run in connection with a removable packer to be used in squeeze cementing, said bridge plug being easy to set and easy to detach from a removable packer assembly after said plug is secured to the walls of the casing.

Another object of this invention is to provide a bridge plug which may be run in an oil well on the same trip that the removable packer is run into the well to perform a squeeze job, thus eliminating the necessity of an additional round trip of the tubing, which is a considerable saving of both time and expense.

Another object is to provide a novel combination of packers and cementing equipment for wells in which one packer may be set and another moved upwardly therefrom any desired distance, so that cement may then be squeezed in between the two.

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

Figure 1 is a view partly in side elevation and partly in cross-section of apparatus constructed in accordance with the invention, the parts being shown in the position they occupy as the apparatus is being lowered into the well;

Figure 2 is a similar view of part of the as-

sembly of Figure 1, showing the relation of the parts as the bridge plug is being set below the perforations in the well casing and before the bridge plug is detached from the removable packer; and

Figure 3 is a view of the bridge plug set below the perforations in the casing and the removable packer above the said perforations; the apparatus now being ready to perform a squeeze job.

Referring to the drawing in detail, it will be seen that an oil well casing is illustrated at 11, this being provided with perforations 12. Within this casing is a string of tubing, the lower end of which is shown at 13. To this tubing is connected an apparatus for securing and sealing the tubing to the casing. For purposes of illustration, the apparatus shown here is a removable packer similar to the one described and claimed in the co-pending application of W. R. McClendon, Serial No. 370,190, mentioned above. Releasably secured to the lower end of the apparatus is a bridge plug which constitutes a particular feature of the present invention, as described hereinafter.

As herein shown, the removable packer assembly includes a slip body 14 carrying slips 15, the latter being mounted for limited radial movement in a recess contained in the slip body. Inserted in these recesses behind the slips are slip pads 16 made of rubber reinforced with fabric. The slip pads act as packing rings so that by pumping fluid through ports 17 in the slip body, the slips are pumped out like a piston until they engage the walls of the casing 11. Springs 19 bolted to the slip body 14 provide means for holding the slips 15 in position and for urging them back into the slip body.

A mandrel 20 is threaded into the lower end of the slip body 14 and it carries two flexible swab cups 21 directed downwardly as illustrated. The swab cups 21 may be made of rubber or fabric and are held in position by thimbles 22 threaded onto the mandrel. Fluid may flow downwardly between the cups and the casing, but not upwardly by them. The lower end of the mandrel 20 is threaded as shown at 23.

To support the slip body 14 and the mandrel 20, the upper end of the slip body is connected to a safety joint 25 provided with packing 26 and with a left hand back-off thread 27.

The safety joint 25 is in turn connected to a circulation sub consisting of a pipe 28, connected to the tubing 13 by a collar 30, and a sleeve 31 provided with packing as shown at 32 and drag springs as shown at 33. An opening 29 in the pipe 28 provides a valve port covered or uncovered by the sleeve 31.

The apparatus so far described is essentially the same as that described in the McClendon application cited above.

In accordance with the present invention a tubular member 34 is threaded into the lower end of the mandrel 20. This member 34 is provided with ports 35 and a J slot 36, by which the bridge plug is releasably connected to the mandrel 20. The bridge plug includes a coupling 37 at its upper end, said coupling having a pin 38 therein which rides in the J slot 36 and is held therein by a shear pin 39. Coupling 37 is threaded to the upper end of the bridge plug mandrel 40. On this mandrel a flexible cup 41 made of rubber, fabric or the like is carried. This cup is of known construction and is directed upwardly and acts as a

packer or swab. Fluid may flow upwardly and by-pass between the cup and casing, but not downwardly thereby in the annular space between the tubing and casing. This cup 41 may be secured to the casing by wedge member 42, which is slidably mounted on the mandrel 40 and by a set of slips 43, the wedge 42 and slips 43 being connected to the mandrel by shear pins 44. There is an abutment shoulder 45 provided for these slips at the lower end of the mandrel 40.

The coupling 37 is provided with an enlarged chamber 46 which acts as a valve cage for the ball 47, and the tubular member 34 is provided with a depending rod 48 which holds the ball 47 down, off of its upper seat until the members 34 and 37 are separated. After separation, the ball 47 acts as a back pressure valve. As illustrated, the ball 47 acts as a valve in two directions. As long as the tubular member 34 is in the position illustrated in Figures 1 and 2, fluid may pass in an upwardly direction through the mandrel 40, but when fluid tries to pass downwardly therethrough, the ball 47 engages the seat 49 on the mandrel 40 and prevents the flow of the fluid in a downwardly direction therethrough. When the tubular member 34 has been disconnected from the bridge plug and moved upwardly therefrom as illustrated in Figure 3, the ball 47 acts as a valve in both an upwardly and downwardly direction, it then being possible for it also to engage seat 50 in the coupling 37.

The operation of the tool illustrated will be apparent from the following example given by way of illustration. Assuming that the operator wishes to carry out a squeeze cementing operation through perforations 12 in the casing 11, the procedure may be as follows:

The apparatus is lowered into the hole with the parts as shown in Figure 1. As it is lowered, part of the fluid in the hole will flow upwardly through the bridge plug and part will flow upwardly around the bridge plug, through the ports 35 and through the removable packer assembly. The ports 29 in the circulation sub are also open at this time, so that all the swab cups are by-passed. When the tool reaches the position shown in Figure 1, that is, when the bridge plug and the cups on the removable packer are below the perforated section which is to be squeezed, the removable packer and bridge plug are set by raising the tubing slightly to cause the sleeve 31 to cover the ports 29, and applying pump pressure. When the pump pressure is applied the ball 47 engages the seat 49 and thus confines the pressure between the bridge plug and the removable packer. Fluid is forced out through the ports 35 and pressure is applied to the cup 41. As this pressure is exerted downwardly on the cup, the pins 44 shear and the slips 43, wedge 42, and cup 41 take the position shown in Figure 2, so as to fix the cup 41 and mandrel 40 to the casing.

As an alternative method of operation, the bridge plug may be set by merely lifting up on it, thus allowing the hydrostatic pressure, due to the fluid above the cup 41 to shear the pins 44, instead of shearing them by pump pressure.

After the bridge plug has taken the position shown in Figure 2 it may be disconnected from the removable packer by lifting up the tubing to shear the pins 39 and rotating the same to the left until the pin 38 is turned out of the J slot 36. The removable packer may then be moved up the well until it is above the perforations 12, as shown in Figure 3, where it is in position to perform a squeeze job by forcing cement down through the

assembly and discharging the same through the member 34. As cement is discharged and forced through the perforations, the bridge plug prevents flow downwardly in the well.

The operation of the removable packer assembly is the same as described in the McClendon application mentioned above. The tubing can be raised or lowered to control the sleeve valve 31 to circulate mud or other fluid in advance of the cement, or after the cement has been deposited to remove any excess. With the valve 31 closed, pump pressure temporarily sets the slips 15 and holds the cups 21 in position so that no fluid can flow upwardly through the annular space between the tubing and casing above the perforations 12.

After the squeeze job has been completed the removable packer may be removed from the bore of the well, and the bridge plug may be left in the bore of the well as a permanent plug, or since the mandrel, slips, packer and associated parts of the bridge plug are made of drillable material, they may be drilled up during the process of completing the well, thus leaving the bore of the well unobstructed.

Only one embodiment has been illustrated and described herein but it is obvious that the inven-

tion may be carried out in a wide variety of ways and may be adapted to various purposes other than those mentioned.

Materials other than cement may be used as a sealing fluid. The apparatus can also be used for acidizing oil wells. Various changes may be made in the arrangement or construction of the parts without departing from the spirit of the invention or the scope of the annexed claim.

I claim:

Apparatus adapted for use in squeeze cementing through perforations in casing in a well, comprising a conduit, a circulation sub operable by manipulation of said conduit to connect the interior to the exterior of said conduit if desired, a back-off safety joint in said conduit below said circulation sub, a packer assembly secured to said conduit beneath said safety joint and adapted to be removed from the well with said conduit, a bridge plug located beneath said packer assembly and adapted to be fixed to the casing, said bridge plug having means associated therewith for setting the same hydraulically, and means temporarily securing said bridge plug to said packer assembly.

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