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METHOD AND MEANS FOR CEMENTING OIL WELLS

APPLICATION FILED JUNE 26, 1920.

1,369,891. **Patented Mar. 1, 1921.**

Fig. 1

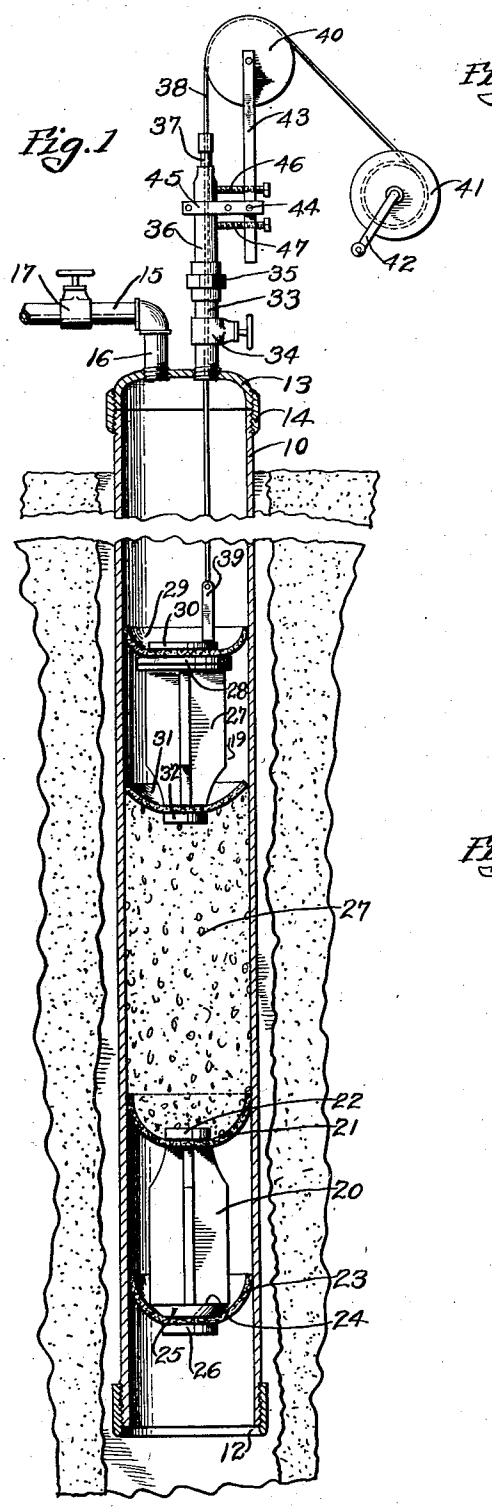


Fig. 3

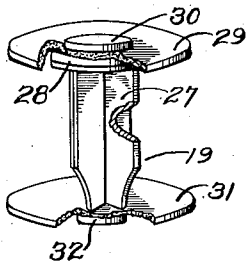


Fig. 4

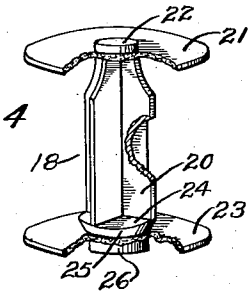
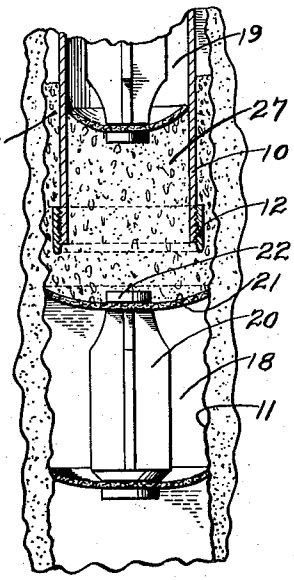


Fig. 2



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UNITED STATES PATENT OFFICE.

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METHOD AND MEANS FOR CEMENTING OIL-WELLS.

1,369,891. Specification of Letters Patent. Patented Mar. 1, 1921.

Application filed June 26, 1920. Serial No. 391,980.

To all whom it may concern:

Be it known that I, ERLE P. HALLIBURTON, a citizen of the United States, residing at New Wilson, in the county of Carter and State of Oklahoma, have invented a certain new and useful Improvement in Methods and Means for Cementing Oil-Wells, of which the following is a full, clear, concise, and exact description, reference being had to the accompanying drawings, forming a part of this specification.

This invention relates to an improved method of and means for cementing oil wells.

It is well known to those skilled in the art of oil well drilling that one of the greatest obstacles to successful development of oil bearing lands has been the encountering of large quantities of liquid mud water and the like during and after the process of drilling the wells. Scientific investigation has shown that where the water is permitted to enter the oil bearing sands, the water drives the oil away from the well. Methods to cope with these difficulties have met with scant success, and while thoroughly good results have been obtained in some cases where water was encountered, entirely satisfactory results with prior methods have been lacking.

Those experienced in the occupation of drilling oil wells have discovered after experiment that while the land into which the well had been sunk was capable of giving fairly satisfactory results, the delivery of oil from the well has been hampered by water getting into the oil bearing sands from above the same thus necessitating the expense of pumping off many barrels of water with the oil. This has caused the abandonment of many wells which otherwise would have developed a profitable output.

After numerous experiments with different materials, cement has been resorted to as the only thing which will effectively close off a well from water. However, difficulties have been attendant upon the use of cement for this purpose; particularly that of the proper introduction of the cement into the well and the application of the cement in its proper place between the well casing and the earth wall of the bore. This has been successfully accomplished in a small way, but it has been expensive and difficult to insure the cement reaching its proper "set" or crystallization, so that it will be capable of withstanding the external pressure exerted thereon resultant upon bailing the well.

It is customary in cementing oil wells to drill the well to a greater depth than the depth of the well casing, as after oil is "struck" it is desirable to go deeper to discover whether the well will deliver oil in commercial quantities. This means that the well must later be filled with some material to the point at where the casing is to be set before cementing. This necessitates the drilling the oil sands after cementing. If the well is making oil and gas in any large quantities, it is practically impossible to cement the casing with the other methods now employed.

With the difficulties and the objections to the prior methods in view, I have designed the method described in detail later which, briefly, consists in forcing cement into the well casing between two plug members, it being understood that the well casing as customary is anywhere between the bottom of the well and any distance off the bottom. The lowermost of the plug members is expansible so that as the same is forced under pressure beyond the end of the casing, the same expands into contact with the wall of the bore and plugs up the well temporarily, at the same time deflecting the cement upwardly and around the outside of the well casing in which position it is held until hardened. Some of the cement is permitted to remain in the well casing, as it is not desirable to force all of the cement out of the casing. The cement left in the casing is bailed out later and the plug member drilled through. During the forcing of the cement into the well I measure, by means of an improved measuring device, the depth to which the cement has been forced, so that the depth to which the cement has been forced is known at all times. During the forcing of the cement into the casing, the lowermost plug member necessarily forces water and the other foreign contents of the well, such as "rotary mud" water and the like from the well. The rotary mud is trapped for use on the same cementing job.

While I shall describe in detail a structural embodiment of my invention which I prefer to employ in connection with the improved method which I have designed, it is to be understood that it is a method which I am particularly concerned with and, I,

therefore, reserve the right to make such modifications in the structural embodiment as becomes necessary in the refinement of the device for commercial use.

A more thorough understanding of my invention may be obtained from the following detailed description and the appended claims, taken in connection with the accompanying drawings:

Figure 1 is a vertical fragmentary sectional view of my invention;

Fig. 2 is a similar view of the same in another position;

Fig. 3 is a fragmentary perspective view of one of the plug members; and

Fig. 4 is a similar view of the other plug member.

In the reduction to practice of my invention, an example of the same being shown in assembly in Fig. 1, the casing 10 is lowered into the well bore 11 to say about 2200 feet, the well having been drilled to for example about 2300 feet. The casing 10 is of less diameter than that of the bore of the well, and is provided with a conventional shoe 12 on the lower end thereof. The upper end of the casing is closed by a cap 13, a threaded collar 14 securely engaging the cap 13 with the upper end of the casing 10, and preventing the escape of the hydraulic medium to be maintained in the casing during the cementing process. A pipe 15 is connected into the top of the casing at 16 and is controlled by a valve 17, said pipe serving to deliver to the interior of the casing, a fluid, for instance rotary mud or water under pressure. The pipe 15 serves also for introduction of cement in semi-liquid form into the casing prior to the introduction of the rotary mud or other hydraulic power means.

In introducing the cement into the casing, I provide a pair of plug members 18 and 19, the plug member 18 which forms a retainer for the cement consisting of a body portion 20 formed of two wooden planks arranged at right angles, said body carrying a flexible composition washer 21 secured on the body by means of a washer 22. A similar flexible washer 23 is mounted on the opposite end of the body 20, a disk 24 being interposed between the body 20 and the washer 23 and having the beveled peripheral edge 25. A washer 26 secures the flexible washer 23 in place. The plug 18 is known and will be referred to hereinafter as the dead end plug or retainer and when inserted into the casing, the washers 21 and 23 will be distorted as shown in Fig. 1. The cement 27 is inserted in semi-liquid form between the measuring line plug or follower 19 and the dead end plug 18. The plug 19 is constructed somewhat similarly to the plug 18, having a body portion 27 constructed similarly to the body portion 20 of the plug 18. The body portion 27 carries a pair of circular wooden washers 28 on its upper end and a flexible composition washer 29, secured to first said washers by means of a plate 30. The lower end of the plug 19 carries a composition flexible washer 31 secured in place by disk 32. This plug is known as a measuring line plug or follower and will be so referred to later.

A pipe 33 is connected into the casing 10 through the cap 13 and extends vertically therefrom, a gate valve 34 being arranged in said pipe 33. The pipe 33 is joined by means of a union 35 with a second pipe 36, said pipe having a packing gland 37 in the upper end thereof. A wire cable 38 known as the measuring line extends through the packing gland 37 and carries a weight 39 on the free end thereof, said cable passing over a sheave 40 and drum 41, the drum 41 being operable by a crank 42. The sheave 40 is mounted in a suitable support arm 43, said arm being pivoted at 44 in a bracket 45 clamped around the pipe 36, the screws 46 and 47 passing through said arm 43 and abutting said pipe in order to adjust the angle of the arm 43 to avoid friction at the packing gland when lowering away on the weight. Insertion of the weight is possible through the pipe 33 by closing the valve 34 and screwing the extension 36 into place. Then the valve 34 is opened and the weight will sink through the mud until it rests on a support in this case the follower 19. The weight is adapted to rest by gravity on the top of the measuring line plug 19.

The cementing process of my invention with the structure described is accomplished as follows:

The cap 13 is removed from the casing, it being understood that the casing is suitably supported in place. The dead end plug 18 is now inserted into the casing at the position shown and the cement 27 is introduced on top of this. The cement must have the proper consistency to cause it to flow readily. The quantity of cement used depends on the size of well and well casing, quality of cement and the area of the wall of the well which it is desired to cement. The cap 13 is replaced and cement is then fed into the casing through the pipe 15. The cap is later removed to insert the upper plug. The measuring line plug 19 is now placed in the casing, and the cap 13 secured in place. The gage valve 34 is opened and weight 39 and cable 38 inserted into the casing until the weight rests upon the plug 19. The pipe 36 is screwed into the union 35 and the well is now ready for cementing.

Pressure, hydraulic in the present instance, is introduced into the casing through the pipe 15 above the plug 19, thereby forcing the cement and dead end plug together with plug 19 downwardly in the casing

As the plug 19 descends the weight 39 will also descend and the operator can tell at a glance at the measuring line by suitable markings thereon, or by suitable registering device, just how much of the measuring line has been paid out and consequently the depth to which the plug 19 has gone. As the pressure is maintained the plug 18 passes downwardly in the casing until forced beyond the shoe 12 of said casing. As the dead end plug 18 leaves the casing, the flexible washers 23 and 21 expand successively into contact with the walls of the well bore 11. As soon as the washers 21 and 23 engage the wall of the bore, the plug is arrested against further downward movement because of the liquid trapped in the bore below it and the cement being under continuous pressure is caused to flow out of the casing and up around the sides thereof to the required distance. It will be obvious that the cement will flow out of the casing and up around the end of the same since no amount of pressure on the plug 18 can force it further into the well. During the movement of the body of cement and the plug members downwardly in the casing any water or rotary mud, or mixture of water and oil, will be forced up around the casing and out of the well. When the drilling operation is stopped the hole still contains liquid which may be for instance water, mud, or oil. This I trap as the same leaves the top of the well and use it as a medium for supplying pressure to the casing. In Fig. 2, the cement is shown forced up along the side of the casing as indicated at 50, and it will be noted that the strongest part of the seal formed by the cement is at and around the shoe 12. This is very desirable as it is usually around this point that leakage occurs with the other methods employed.

The device of my invention as used in the methods involved therein is not intended to force all of the cement out of the casing. It is very desirable that some of the cement be left in the casing, usually about 5% of the total amount of cement originally placed therein, as the cement on the top of the column is always a lighter aggregate (known as washed cement) and is not suitable for the purpose of sealing the well against entrance of water. This is due to the fact that this cement will never set and will not crystallize sufficiently to be of any value. It is better that it be left in the casing and later bailed out.

After the cement has been forced up and around the casing to the desired point, the valve 17 is closed and the cement maintained under pressure until hardened.

While in the foregoing description I have referred to a method of cementing and described specific means for carrying out the method, I desire it to be understood that I do not limit myself to the parts shown, nor to the exact manner of setting up the casing or applying pressure to the cement. This pressure could be applied to the cement and the same held in position until hardened by mechanical as well as by hydraulic means. Neither do I limit myself to the use of water, and, in fact, find it preferable to use mud fluid as this substance is always available for the purpose, whereas in many cases the water in quantity is not always available. It is well recognized that better results have been obtained with a mud laden substance than with water, and such a substance is almost always available. In view of the foregoing, I reserve the right to make certain changes in the invention when reducing to practice as do not depart from the spirit of the invention and scope of the claims.

I claim:

1. In combination with a well casing, retaining means adapted to be placed in the casing for retaining a body of cement, means for forcing said retaining means downwardly and lineal measuring means for determining the depth to which the body of cement has been forced.

2. In combination with a well casing, retaining means adapted to be guided in the casing for retaining above it a body of cement, means for forcing said retaining means downwardly, lineal measuring means for measuring the depth to which the body of cement has been forced, and means resting on the body of cement forming a stop for the lineal measuring means.

3. The method of cementing oil wells with cement or other plastic material in semi-liquid form, which consists in forcing the cement in a body downwardly through the casing and simultaneously carrying with said body of cement a lineal depth indicator until a desired depth is reached and then maintaining an equal static pressure upon all sides of the cement until the cement hardens.

4. The method of cementing oil wells, which consists in introducing into the well casing cement or other plastic material in semi-liquid form, and separating the cement from the contents of the well by a suitable separator, then applying pressure to the cement to force the same and said separator into the well, then maintaining pressure until said barrier engages the wall of the well to deflect the cement upwardly and around the outside of the well casing and out of contact with the bottom of the well.

5. The method of cementing oil wells, which consists in introducing into the well casing cement or other plastic material in semi-liquid form between two plugs, then applying hydraulic pressure to one of the

plugs to force the cement and the other of said plugs from the casing to cause the last mentioned plug to engage the wall of the well to maintain the cement off the bottom of the well and deflect the same upwardly and around the outside of the well casing.

6. The method of cementing oil wells which comprises introducing a retaining member into the well casing, introducing cement behind said member then introducing a follower member behind the cement then applying hydraulic pressure to the cement and to said members to force the cement and said members downwardly in the casing until said first member is forced beyond the end of the casing and simultaneously carrying an indicating member downwardly with the follower member and continuing said hydraulic pressure to force a predetermined portion of the cement as determined by said indicator around the end of the casing then maintaining the pressure on the cement substantially stationary until the cement hardens around the end of the casing.

7. In combination, a well and well casing therein terminating short of the bottom of the well, an expansible retaining member in said well casing, a follower member in said casing, said members supporting cement in semi-liquid form therebetween, and means for applying hydraulic pressure to the second member to force the first member beyond the end of the well casing to permit the same to expand into contact with the wall of the well.

8. In combination, a well and well casing therein terminating short of the bottom of the well, an expansible retainer member in said well casing, a follower member in said casing, said members supporting and conveying cement in liquid form therebetween, means for applying hydraulic pressure to the second member to force the cement and first said member beyond the end of the well casing to permit the first said member to expand into contact with the wall of the well to form a deflector, and means for measuring the depth of the cement throughout its path of travel into the well casing and well.

9. In combination, a well and well casing therein terminating short of the bottom of the well, an expansible plug in said well casing, a second plug in said casing, said plugs supporting and conveying cement in liquid form therebetween, means for applying hydraulic pressure to the second plug for forcing the cement into the casing, first said plug serving to force the contents of the well upwardly and outwardly around the outside of the well casing and being adapted to expand when leaving the casing into engagement with the wall of the well to form a deflector for causing the cement to expand up and around the outside of the well casing away from the bottom.

10. The method of cementing oil wells, which consists in forcing a body of cement into the well casing and around the outside of the casing, and in excluding the cement from the bottom of the well.

11. The method of cementing oil wells, which consists in forcing cement under hydraulic pressure into the well between two suitable members, then forcing the contents of the well out around the side of the well casing and replacing the same with cement, then maintaining the pressure until the cement is hardened around the outside of the well casing, and then excluding the cement during the cementing process from the bottom of the well.

12. The method of cementing oil wells, which consists in introducing cement into the well casing thereof between two suitable barriers, maintaining this pressure until one of the barriers and the cement is forced beyond the end of the well casing but short of the bottom of the well to deflect the cement up and around the outside of the casing, the entrance of cement forcing the contents of the well up and around the outside of the well casing, holding the cement in position by pressure until hardened.

13. The combination with a well casing and means for conveying cement into the casing to a predetermined depth, of means for directly indicating the depth of the cement throughout its passage along the well casing.

14. The combination with a well casing and means for conveying cement into the casing to a predetermined depth, of a measuring line for indicating the depth of said cement in the casing said line extending outside the casing for indicating externally of the casing the depth of the cement in the casing.

15. The method of cementing a casing in the hole of an oil well which consists in forcing a body of cement in the casing above a movable septum to a point immediately below the end of the casing expanding the septum into contact with the walls of the hole and forcing the cement out of the casing to a predetermined depth to cause the cement so expelled to lie about the end of the casing.

16. The method of cementing a casing in the hole of an oil well which comprises forcing a body of cement down through the casing and when the cement arrives below the end of the casing closing off the hole immediately below the casing to exclude the cement from the bottom of the hole and then expelling the cement from the casing into the space about the end of the casing

until the cement stands at a predetermined lineal distance below the top of the casing.

17. In combination a well casing an upper plug and a lower expansible plug movable within the casing and being adapted to be separated from each other at all times solely by a body of cement and a depth measuring member carried by the upper plug.

18. In combination means for carrying a body of cement to the lower end of a well casing and a depth indicating device carried by said means for indicating the depth to which the cement has been forced, said carrying means including a device for excluding the cement from the hole beyond a point immediately below the well casing.

In witness whereof I hereunto subscribe my name this 22nd day of June, 1920.

ERLE P. HALLIBURTON.