Oct. 20, 1931. E. V. CROWELL 1,828,100

METHOD OF CEMENTING WELLS

Original Filed March 1, 1927

Fig. 1.

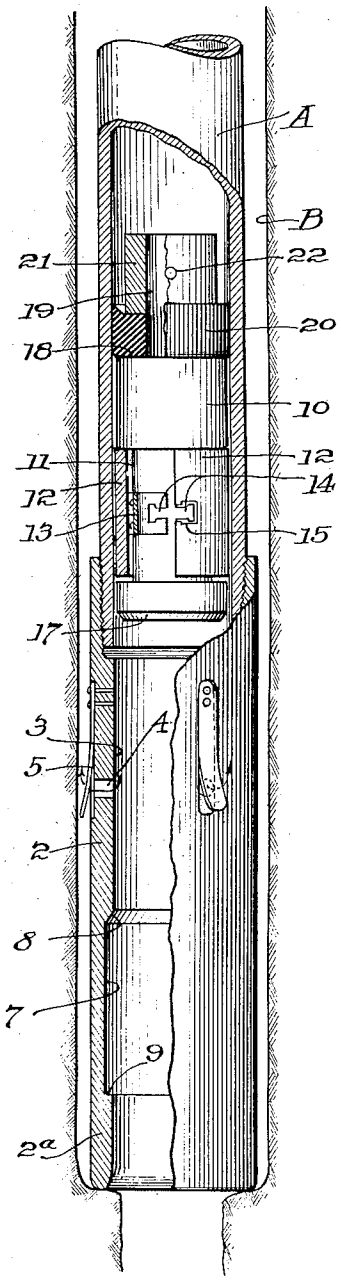


Fig. 2.

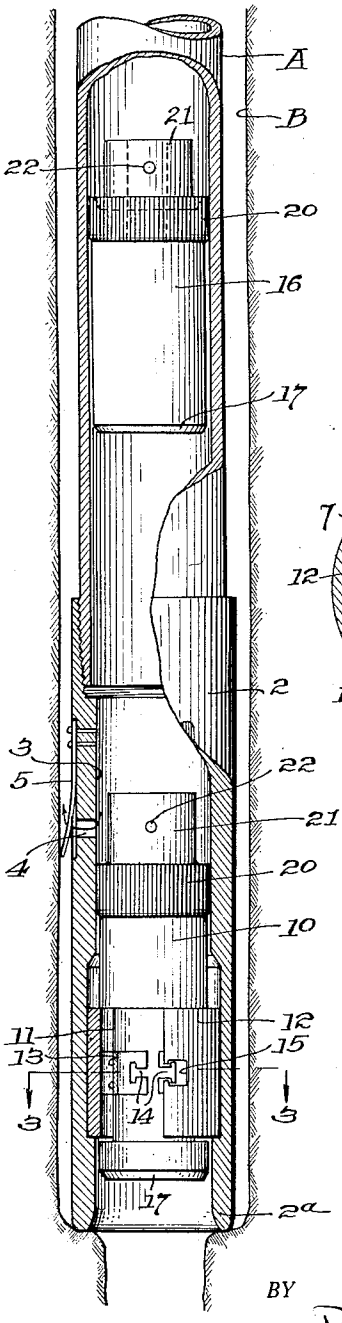
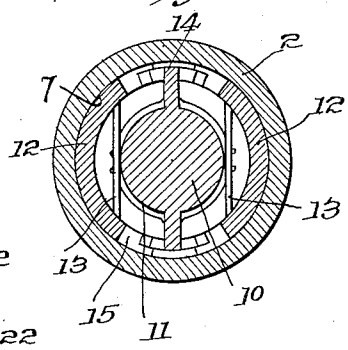


Fig. 3.



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UNITED STATES PATENT OFFICE

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METHOD OF CEMENTING WELLS

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This invention is a method of cementing wells, the present application being a division of my co-pending application Ser. No. 171,851, filed March 1, 1927; and it is the object of the invention to carry on drilling operations or circulate a washing medium through the unobstructed bore of a string of casing in a well and thence upwardly in the surrounding well bore, and then force a cementing mixture downwardly through the unobstructed bore of the casing to any predetermined level and thence outwardly through the casing to fill the surrounding bore.

In practice it has been found advantageous to have the full bore of a string of casing available when carrying on drilling operations or washing down the string of casing, and it is also desirable when circulating a washing medium preparatory to a cementing operation, to utilize the full bore of the casing and to then supply the cementing mixture through the unobstructed bore of the casing and discharge said cementing mixture at any predetermined level.

It is therefore the particular object of the present invention to provide for flow of a circulating medium downwardly through the unobstructed bore of well casing and thence upwardly in the surrounding well bore, preferably by discharging the washing medium outwardly through the casing at the predetermined level at which the cementing mixture is adapted for subsequent discharge, and to then anchor a plug which is lowered in the casing in back of the washing medium, immediately below peripheral ports which are provided in the casing at said predetermined level so that a subsequently introduced cementing mixture flows downwardly through the unobstructed bore of the casing to the anchored plug, but is then prevented from flowing downwardly through the casing below the plug and is consequently discharged through the peripheral ports into the surrounding well bore.

It is a further object of the invention to force a traveling plug downwardly through the unobstructed bore of the well casing in back of the quantity of cement which is to be discharged into the surrounding well bore so as to force the cement through the peripheral ports of the well casing, and to then arrest the traveling plug by seating it on the anchored plug and thus indicate that all of the cement has been forced through the peripheral ports into the surrounding bore and also close the peripheral ports against back flow of the cement into the bore of the casing.

The invention will be readily understood from the following description of the accompanying drawings, in which:

Fig. 1 is a vertical section through a well bore showing a string of casing, partly in axial section, and adapted for circulation of a washing medium prior to the cementing operation.

Fig. 2 is a similar view showing the lower plug anchored in the casing and the traveling plug co-operating therewith during the cementing operation.

Fig. 3 is a transverse section on the line 3—3 of Fig. 2.

The method forming the subject matter of this invention may be employed in connection with a usual string of well casing A which is adapted for reception in a well bore B, and at any predetermined level at which it is desired to discharge a cementing mixture a fixed section 2 of the string of casing, which has an unobstructed bore 3 forming a continuation of the uniform bore of the string, is provided with peripheral ports 4. The ports 4 may be normally closed by spring pressed valves 5, but these valves are adapted to open responsive to pressure in the casing so as to permit discharge of material into the surrounding well bore.

Below the ports 4 the bore of the ported section of the casing preferably has an increased diameter forming an elongated annular recess 7 terminating in upper and lower shoulders 8 and 9 formed by continuations of the uniform bore of the string of casing; and the lower shoulder 9 forms a seat for a plug 10 adapted for expansion into recess 7, while the upper shoulder 8 is preferably inclined to permit ready expansion of the plug when it is lowered through the bore of the casing to the level of the recess.

In order to provide anchoring means for plug 10 in recess 7, the plug is shown as provided with an intermediate reduced diameter 11 adapted to receive arcuate locking slips 12 which are adapted to contract wholly within the outer periphery of the plug. Bias springs 13 fixed to the plug in back of the slips engage the latter so as to tend to expand the same beyond the periphery of the plug, and expansion of the slips is preferably guided and limited by abutments 14 on the plug engaging in notches 15 in the slips. As the plug is lowered through casing A the uniform bore of the latter contracts the slips to permit free passage of the plug, and when the plug is opposite recess 7, the annular enlargement formed thereby permits springs 13 to expand the slips so that they rest on shoulder 9 and thereby anchor the plug.

Packing is preferably mounted on the plug to insure a tight shutting-off of the casing when the plug is anchored in recess 7, the parts being so arranged that when the plug is anchored its packing closes the bore of the casing just below ports 4. As a consequence a cementing mixture introduced into the well casing above the anchored plug is prevented from flowing down the casing past the plug and thereby forces valves 5 open for discharge of the cement through the ports 4 into the surrounding well bore.

A predetermined supply of the cementing mixture is preferably thus discharged through ports 4, the quantity of cement being measured by a traveling plug 16 lowered in the well casing in back of the cementing mixture. The traveling plug slides freely in the uniform bore of the casing and is preferably provided with packing to prevent leakage of the cementing material past the plug.

The lower ends of plugs 10 and 16 are preferably tapered as shown at 17 to guide the plugs through the bore of the casing, and the packing for the plugs may be mounted on annular shoulders 18 formed at the upper ends of the plugs by reducing their diameter as shown at 19. The packing is preferably annular cup-packing 20 snugly engaging the casing wall and fixed against shoulders 18 by followers 21 which may be held in place by pins 22.

In operation the section of the string of casing which is provided with ports 4 and recess 7, may form a shoe 2^a at the lower end of the string of casing, and the string of casing thus presents a uniform unobstructed bore prior to the lowering of plug 10, with ports 4 closed by their spring-seated valves 5. The casing may be washed down or drilling may be continued through the casing, the unobstructed bore permitting freedom of such operations; and when it is desired to circulate a washing medium the casing preferably rests upon the formation seat as shown in Fig. 1 so that the washing fluid forced downwardly through the casing will open valves 5 and thus flow outwardly through the ports and upwardly in the surrounding bore.

The washing medium may be forced downwardly through the casing by the plug 10 being lowered through the casing in back of the washing medium, the plug being preferably forced downwardly by a cementing mixture introduced into the casing above the plug, until the plug automatically anchors in recess 7 immediately below ports 4 and thus shuts off the bore of the casing below the ports as shown in Fig. 2.

The desired quantity of the cementing mixture is accurately measured by lowering the plug 16 into the casing in back of the predetermined quantity of cement as shown in Fig. 2, the plug 16 being forced downwardly against the cementing mixture by a suitable fluid so that the pressure opens valves 5 for discharge of the cementing material through the ports 4 and into the surrounding well bore.

When all of the cement is discharged, plug 16 is arrested by abutment against anchored plug 10, thereby indicating that the cementing operation is completed; and with the parts in this position the cement is prevented from back-flow into the casing, not only by the closing of valves 5, but also by the plug 16 closing the bore of the casing to ports 4.

I have thus provided for drilling operations or circulation of a washing medium through an unobstructed casing bore, with subsequent automatic anchoring of a plug in the bore, and flow of cementing material downwardly through the unobstructed bore of the casing until it is stopped by the plug, and thence outwardly through the casing to fill the surrounding well bore.

I claim:

1. The method of cementing wells which consists of lowering into a well a string of casing having an unobstructed open bore, and without subsequently withdrawing the casing establishing fluid circulation downwardly therethrough, continuing said circulation through peripheral ports in the casing in spaced relation above its lower end and thence upwardly in the space outside the casing, introducing a cementing mixture into the casing above the fluid and separated therefrom by a suitable barrier and forcing the cementing mixture downwardly to drive the fluid before it, anchoring the barrier in the unobstructed bore of the casing below the ports, and after introducing a predetermined quantity of the cementing mixture, introducing fluid into the casing above the cementing mixture and separated therefrom by a suitable barrier and forcing said latter barrier downwardly by said fluid for discharging the cementing mixture through the peripheral ports.

2. The method of cementing wells which consists of lowering into a well a string of casing having an unobstructed open bore, and without subsequently withdrawing the casing establishing fluid circulation downwardly therethrough, continuing said circulation through peripheral ports in the casing in spaced relation above its lower end and thence upwardly in the space outside the casing, introducing a cementing mixture into the casing above the fluid and separated therefrom by a suitable barrier and forcing the cementing mixture downwardly to drive the fluid before it, anchoring the barrier in the unobstructed bore of the casing below the ports so as to prevent further downward flow of the cementing mixture through the casing, and forcing the cementing mixture outwardly through the ports and upwardly outside the casing.

3. The method of cementing wells which consists of lowering into a well a string of casing having an unobstructed open bore, and without subsequently withdrawing the casing establishing fluid circulation downwardly therethrough and thence upwardly in the space outside the casing, introducing a cementing mixture into the casing above the fluid and separated therefrom by a suitable barrier and forcing the cementing mixture downwardly to drive the fluid before it, anchoring the barrier in the unobstructed bore of the casing below a ported section thereof so as to prevent further downward flow of the cementing mixture through the casing, and forcing the cementing mixture outwardly through the ports and upwardly outside the casing.

4. The method of cementing wells which consists of lowering into a well a string of casing having an unobstructed open bore, and without subsequently withdrawing the casing establishing fluid circulation downwardly therethrough and thence upwardly in the space outside the casing, closing the bore of the casing below peripheral ports in the casing in spaced relation above its lower end, and forcing a cementing mixture downwardly through the unobstructed bore of the casing and outwardly through the ports.

5. The method of cementing wells which consists of lowering into a well a string of casing having an unobstructed open bore, and without subsequently withdrawing the casing establishing fluid circulation downwardly therethrough and thence upwardly in the space outside the casing, closing the bore of the casing at a predetermined level, and forcing a cementing mixture downwardly through the unobstructed bore of the casing to said closure means and outwardly through the casing above said closure means.

6. The method of cementing wells which consists of lowering into a well a string of casing having an unobstructed open bore, and without subsequently withdrawing the casing establishing fluid circulation downwardly therethrough and thence upwardly in the space outside the casing, closing the bore of the casing below normally closed peripheral ports in the casing, and forcing a cementing mixture downwardly through the unobstructed bore of the casing above said closure means so that the pressure of the cementing mixture opens the normally closed ports for discharge of the cementing mixture into the surrounding well bore.

7. The method of cementing wells which consists of lowering into a well a string of casing having an unobstructed open bore, and without subsequently withdrawing the casing establishing fluid circulation downwardly therethrough and thence upwardly in the space outside the casing, closing the bore of the casing at a predetermined level, introducing a cementing mixture into the unobstructed bore of the casing above said closure means, and forcing a fluid downwardly through the unobstructed bore of the casing above the cementing mixture and suitably separated therefrom for forcing the cementing mixture downwardly to said closure means and outwardly through the casing above said closure means.

8. The method of cementing wells which consists of lowering into a well a string of casing having an unobstructed open bore, and without subsequently withdrawing the casing establishing fluid circulation downwardly therethrough and thence upwardly in the space outside the casing, closing the bore of the casing at a predetermined level, and forcing a cementing mixture downwardly through the unobstructed bore of the casing to said closure means and outwardly through the casing above said closure means, and then closing the bore of the casing above said closure means and against back-flow of the cementing mixture upwardly through the casing.

9. The method of cementing wells which consists of lowering into a well a string of casing having an unobstructed open bore, and without subsequently withdrawing the casing establishing fluid circulation downwardly therethrough and thence upwardly in the space outside the casing, closing the bore of the casing at a predetermined level, introducing a cementing mixture into the unobstructed bore of the casing above said closure means, and supplying fluid pressure to the unobstructed bore of the casing above the cementing mixture for forcing the cementing mixture downwardly through the unobstructed bore of the casing to said closure means and outwardly through the casing above said closure means.

10. The method of cementing wells which consists of lowering into a well a string of casing having an unobstructed open bore,

and without subsequently withdrawing the casing establishing fluid circulation downwardly therethrough, continuing said circulation through peripheral ports in the casing in spaced relation above its lower end and thence upwardly in the space outside the casing, closing the bore of the casing below said peripheral ports, and forcing a cementing mixture downwardly through the unobstructed bore of the casing and outwardly through the ports.

11. The method of cementing wells which consists of lowering into a well a string of casing having an unobstructed open bore, and without subsequently withdrawing the casing forcing fluid downwardly therethrough and thence outwardly through yieldably closed peripheral ports in the casing in spaced relation above its lower end, closing the bore of the casing below said peripheral ports, and forcing a cementing mixture downwardly through the unobstructed bore of the casing above said closure means so that the pressure of the cementing mixture opens the yieldably closed ports for discharge of the cementing mixture into the surrounding well bore.

12. The method of cementing wells which consists of lowering into a well a string of casing having an unobstructed open bore, and without subsequently withdrawing the casing establishing fluid circulation downwardly therethrough, continuing said circulation through peripheral ports in the casing in spaced relation above its lower end and thence upwardly in the space outside the casing, closing the bore of the casing below said peripheral ports, introducing a cementing mixture into the unobstructed bore of the casing above said closure means, and forcing a fluid downwardly through the unobstructed bore of the casing above the cementing mixture and suitably separated therefrom for forcing the cementing mixture downwardly to said closure means and outwardly through the peripheral ports.

13. The method of cementing wells which consists of lowering into a well a string of casing having an unobstructed open bore, and without subsequently withdrawing the casing establishing fluid circulation downwardly therethrough, continuing said circulation through peripheral ports in the casing in spaced relation above its lower end and thence upwardly in the space outside the casing, closing the bore of the casing below said peripheral ports, forcing a cementing mixture downwardly through the unobstructed bore of the casing to said closure means and outwardly through the peripheral ports, and then closing the bore of the casing above the peripheral ports and against back-flow of the cementing mixture upwardly through the casing.

14. The method of cementing wells which consists of lowering into a well a string of casing having an unobstructed open bore, and without subsequently withdrawing the casing establishing fluid circulation downwardly therethrough, continuing said circulation through peripheral ports in the casing in spaced relation above its lower end and thence upwardly in the space outside the casing, closing the bore of the casing below said peripheral ports, introducing a cementing mixture into the unobstructed bore of the casing above said closure means, and supplying fluid pressure to the unobstructed bore of the casing above the cementing mixture for forcing the cementing mixture downwardly through the unobstructed bore of the casing to said closure means and outwardly through the peripheral ports.

In testimony whereof he has affixed his signature.

ERD V. CROWELL.