

Feb. 9, 1943.

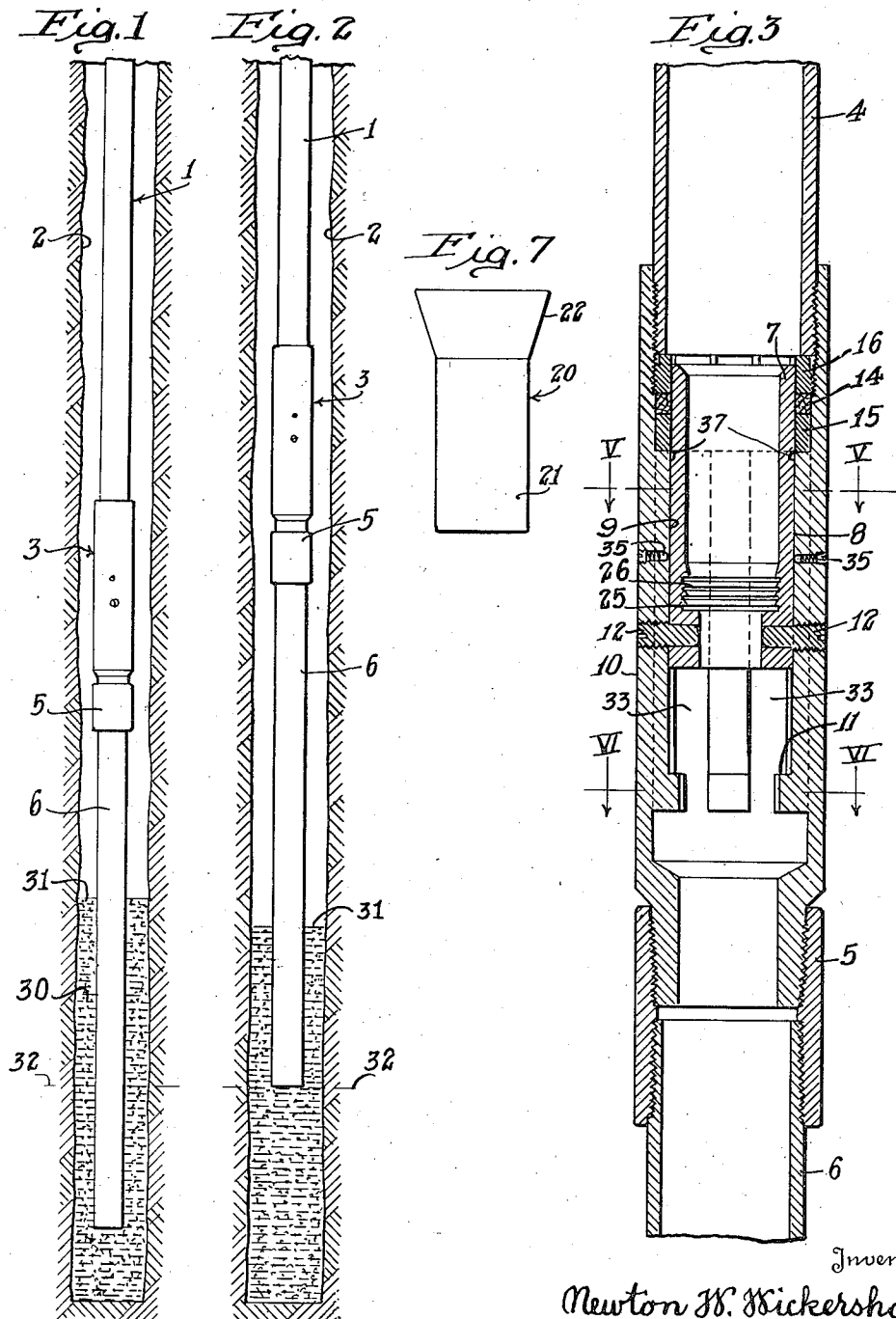
N. W. WICKERSHAM

2,310,483

WELL CEMENTING APPARATUS

Filed March 1, 1940

2 Sheets-Sheet 1



Inventor

Newton W. Wickersham

By *Lyon & Lyon*
Attorneys

Feb. 9, 1943.

N. W. WICKERSHAM

2,310,483

WELL CEMENTING APPARATUS

Filed March 1, 1940

2 Sheets-Sheet 2

Fig. 4

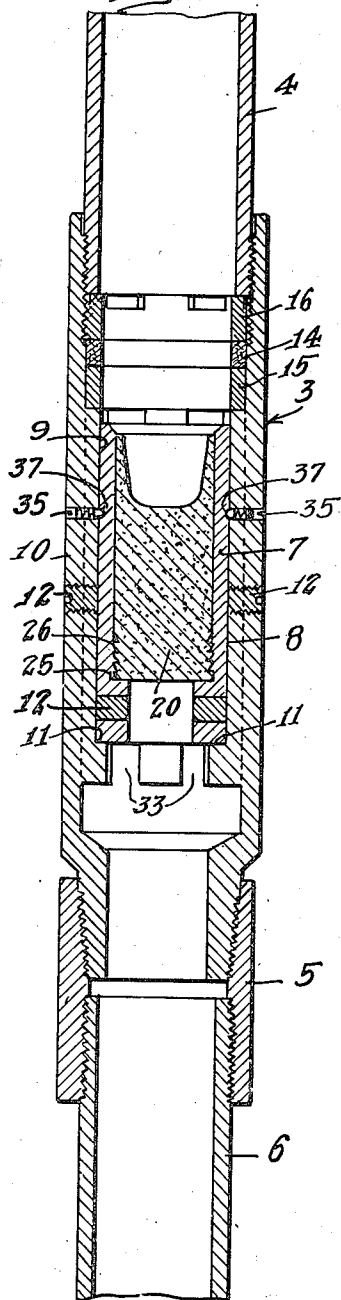


Fig. 5

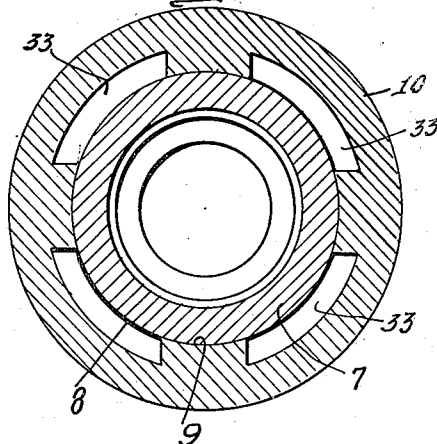
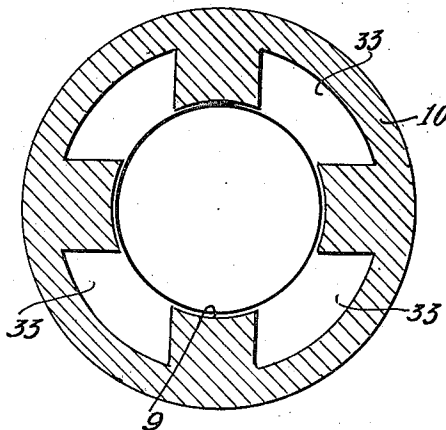


Fig. 6



Inventor
Newton W. Wickersham

By *Lyon & Lyon*

Attorneys

UNITED STATES PATENT OFFICE

2,310,483

WELL CEMENTING APPARATUS

Newton W. Wickersham, Whittier, Calif., assignor, by mesne assignments, to Halliburton Oil Well Cementing Company, a corporation of Delaware

Application March 1, 1940, Serial No. 321,652

6 Claims. (Cl. 166—1)

This invention relates to apparatus for cementing wells, and has to do particularly with devices incorporated in the tubing in a well for controlling the flow therethrough of cement and drilling fluid.

An object of the invention is to provide apparatus capable of indicating to the operator at the surface when all the cement has been discharged from the tubing or drill pipe into the well, and which is also capable of being manipulated to permit washing the well above the cement after the latter is deposited in the well.

Another object is to provide apparatus capable of washing the well after the cement has been deposited therein, by direct flow from the tubing or drill pipe into the well, as distinct from washing by reversing the flow from the well into the tubing. This is particularly important because of the fact that washing by reversing the flow temporarily increases the pressure in the formation and also puts a pressure on the placed cement which may drive it into the formation so that the cement is not left at the desired height, with the result that when the pressure is later reduced to normal, the bore wall may be weakened or caused to cave in in places.

Another object is to provide a particularly simple and effective apparatus insertable in well tubings for intercepting a plug transmitted through the tubing and blocking flow through the tubing, but capable of reopening a passage for resumed flow of fluid therethrough in response to a predetermined increase in the pressure of the fluid in the tubing.

Various other more specific objects and features of the invention will become apparent from the detailed description to follow of a preferred embodiment of the invention as illustrated in the drawings.

Briefly, the invention consists in a device which is inserted in the well tubing, preferably adjacent the lower end thereof for seating the usual rubber plug, which is forced down the tubing between the cement and the displacement fluid in the tubing. The device differs from devices previously employed for stopping the rubber plug, referred to, in that it is adapted to open a passageway around the plug for the free passage of fluid or cement through the tubing in response to application of a predetermined, increased pressure on the fluid in the tubing.

By providing for the reopening of a passage for fluid circulation through the well tubing or the drill pipe, the invention achieves the objects aforementioned. Another advantage of opening up

the tubing string or drill string following the seating of the rubber plug is that it eliminates the necessity of pulling a "wet string," since the fluid contents of the string can drain out as the string is pulled.

The device and its operation will now be described in detail with reference to the drawings, in which:

Fig. 1 is a schematic view showing the device positioned in a string of tubing and the tubing positioned in a well to be cemented;

Fig. 2 is a view similar to Fig. 1, but showing the tubing in raised position for washing the well following deposit of the cement;

Fig. 3 is a vertical sectional view through the device of the present invention, showing the latter in normal or closed position;

Fig. 4 is a view similar to Fig. 3, but showing the device with the rubber plug positioned therein and the device actuated into open position;

Fig. 5 is a cross section taken in the plane V—V of Fig. 3; and

Fig. 6 is a cross section taken in the plane VI—VI of Fig. 3.

Referring first to Fig. 1, there is shown a string of tubing 1, positioned in an uncased borehole 2, and extending substantially to the bottom thereof for cementing the bottom of the hole.

Positioned near the lower end of the string 1 is a device 3 which constitutes the novel apparatus in accordance with the present invention.

Referring now to Fig. 3, the device 3 comprises a tubular body member 10 internally threaded at the upper end to receive the male thread on the lower end of the tubing section 4 thereabove and having male threads on the lower end for connection by a coupling 5 to a tubing section 6 therebelow.

Slidably positioned within the body member 10 is a sleeve 7 having a cylindrical outer surface 8 slidably fitting against a cylindrical surface 9 in the body member 10. The cylindrical surface 9 in body member 10 extends a substantial distance below the lower end of the sleeve 7 and terminates in a shoulder 11. The sleeve 7 is normally maintained in the upper position shown in Fig. 3 by screw plugs 12 screwed into threaded apertures in the wall of the body member 10, the ends of the plugs extending into apertures in the sleeve 7. With the sleeve 7 in the normal position as shown in Fig. 3, there is a fluid passage extending through the interior of the sleeve 7, but there is no passage for fluid between the sleeve 7 and the body member 10. Thus the outer peripheral surface 8 of sleeve 7 seals with a packing member 14, which is com-

the tubing string or drill string following the seating of the rubber plug is that it eliminates the necessity of pulling a "wet string," since the fluid contents of the string can drain out as the string is pulled.

The device and its operation will now be described in detail with reference to the drawings, in which:

Fig. 1 is a schematic view showing the device positioned in a string of tubing and the tubing positioned in a well to be cemented;

Fig. 2 is a view similar to Fig. 1, but showing the tubing in raised position for washing the well following deposit of the cement;

Fig. 3 is a vertical sectional view through the device of the present invention, showing the latter in normal or closed position;

Fig. 4 is a view similar to Fig. 3, but showing the device with the rubber plug positioned therein and the device actuated into open position;

Fig. 5 is a cross section taken in the plane V—V of Fig. 3; and

Fig. 6 is a cross section taken in the plane VI—VI of Fig. 3.

Referring first to Fig. 1, there is shown a string of tubing 1, positioned in an uncased borehole 2, and extending substantially to the bottom thereof for cementing the bottom of the hole.

Positioned near the lower end of the string 1 is a device 3 which constitutes the novel apparatus in accordance with the present invention.

Referring now to Fig. 3, the device 3 comprises a tubular body member 10 internally threaded at the upper end to receive the male thread on the lower end of the tubing section 4 thereabove and having male threads on the lower end for connection by a coupling 5 to a tubing section 6 therebelow.

Slidably positioned within the body member 10 is a sleeve 7 having a cylindrical outer surface 8 slidably fitting against a cylindrical surface 9 in the body member 10. The cylindrical surface 9 in body member 10 extends a substantial distance below the lower end of the sleeve 7 and terminates in a shoulder 11. The sleeve 7 is normally maintained in the upper position shown in Fig. 3 by screw plugs 12 screwed into threaded apertures in the wall of the body member 10, the ends of the plugs extending into apertures in the sleeve 7. With the sleeve 7 in the normal position as shown in Fig. 3, there is a fluid passage extending through the interior of the sleeve 7, but there is no passage for fluid between the sleeve 7 and the body member 10. Thus the outer peripheral surface 8 of sleeve 7 seals with a packing member 14, which is com-

the tubing string or drill string following the seating of the rubber plug is that it eliminates the necessity of pulling a "wet string," since the fluid contents of the string can drain out as the string is pulled.

The device and its operation will now be described in detail with reference to the drawings, in which:

Fig. 1 is a schematic view showing the device positioned in a string of tubing and the tubing positioned in a well to be cemented;

Fig. 2 is a view similar to Fig. 1, but showing the tubing in raised position for washing the well following deposit of the cement;

Fig. 3 is a vertical sectional view through the device of the present invention, showing the latter in normal or closed position;

Fig. 4 is a view similar to Fig. 3, but showing the device with the rubber plug positioned therein and the device actuated into open position;

Fig. 5 is a cross section taken in the plane V—V of Fig. 3; and

Fig. 6 is a cross section taken in the plane VI—VI of Fig. 3.

Referring first to Fig. 1, there is shown a string of tubing 1, positioned in an uncased borehole 2, and extending substantially to the bottom thereof for cementing the bottom of the hole.

Positioned near the lower end of the string 1 is a device 3 which constitutes the novel apparatus in accordance with the present invention.

Referring now to Fig. 3, the device 3 comprises a tubular body member 10 internally threaded at the upper end to receive the male thread on the lower end of the tubing section 4 thereabove and having male threads on the lower end for connection by a coupling 5 to a tubing section 6 therebelow.

Slidably positioned within the body member 10 is a sleeve 7 having a cylindrical outer surface 8 slidably fitting against a cylindrical surface 9 in the body member 10. The cylindrical surface 9 in body member 10 extends a substantial distance below the lower end of the sleeve 7 and terminates in a shoulder 11. The sleeve 7 is normally maintained in the upper position shown in Fig. 3 by screw plugs 12 screwed into threaded apertures in the wall of the body member 10, the ends of the plugs extending into apertures in the sleeve 7. With the sleeve 7 in the normal position as shown in Fig. 3, there is a fluid passage extending through the interior of the sleeve 7, but there is no passage for fluid between the sleeve 7 and the body member 10. Thus the outer peripheral surface 8 of sleeve 7 seals with a packing member 14, which is com-

the tubing string or drill string following the seating of the rubber plug is that it eliminates the necessity of pulling a "wet string," since the fluid contents of the string can drain out as the string is pulled.

pressed between a ring 15 and a gland 16 in the body member 3.

The remaining details of construction of the device 3 will be described in connection with the description of one mode of operation thereof.

Referring to Fig. 1, the tubing string 1 with the device 3 incorporated therein, is lowered into the well until the lower end of the tubing is adjacent the bottom of the well, where the cement is to be deposited, the device 3 being in the condition shown in Fig. 3, in which there is a free fluid passage therethrough.

A calculated quantity of cement is then pumped into the tubing string at the top, after which a plug 20 (Fig. 7) is inserted in the tubing string and then displacement fluid is pumped into the string. The plug 20 comprises a cylindrical body member 21 of sufficiently small dimensions to pass readily through the tubing string but having an outwardly projecting flared skirt 22 on its upper end which is adapted to expand and contract as necessary to fill the tubing and act as a moving dam or piston between the upper end of the column of cement in the string and the fluid thereabove which is pumped into the string to force the cement down therethrough.

The column of cement moves down through the tubing and out of the lower end thereof as the fluid is pumped into the upper end of the string. Finally, when the upper end of the cement column has passed through the device 3, the rubber plug 20 is forced into the sleeve 7, thereby blocking the flow of fluid through the tubing, which fact is indicated to the operator of the surface by a rise in the pressure of the fluid. The operator permits the pressure to increase by a margin of about 500 pounds to the square inch, which is sufficient to force the plug 20 fully into the sleeve 7, in which position the lower end of the plug is seated against an annular shoulder 25 in the sleeve 7. The interior wall of sleeve 7 is provided with downwardly directed annular flanges or corrugations 26 which engage the outer surface of the solid body member 21 of plug 20 and firmly anchor it against withdrawal in response to any reverse pressures that might incidentally be applied to the apparatus.

The rise in the pressure of the fluid in the tubing having indicated to the operator that the discharge of the cement has been substantially completed, the operator then raises the tubing string sufficiently to bring the lower end thereof at the level where it is desired to have the upper end of the cement plug. As shown in Fig. 1, the cement 30 has risen to a level 31 substantially higher than the desired level which is indicated at 32. Even after the tubing string has been raised to bring the lower end thereof to the level 32 (Fig. 2) the upper level 31 of the cement is still substantially too high. The excess cement must be removed by washing, or pressure forcing cement into the formation, to bring the level to the desired point 32. The washing is done by circulating fluid down through the tubing string 1 and back up through the well surrounding the tubing, and obviously, in order to effect such circulation, a passage must be provided through the device 3.

The operator produces such a passage by increasing the pressure on the fluid to a predetermined value, which may be approximately eighteen hundred pounds to the square inch, which pressure causes the pins 12 to shear off and the sleeve 7 to move into a lower position, as shown

in Fig. 4, the sleeve being stopped in this lower position by the shoulder 11. This movement of the sleeve 7 uncovers the upper ends of longitudinal recesses 33 in the cylindrical surface 8, these recesses extending from the lower edge of the filler ring 15 downward past the shoulder 11 so that four clear passages of substantial cross-sectional dimensions are provided past the sleeve 7 and the plug 20, which is blocking the central opening in the sleeve. This free passage through the device 3 permits the operator to circulate fluid downwardly through the string 1 and upwardly therearound through the well bore to wash the tubing and the well, forcing out of the well all cement above the desired level.

Spring-pressed lockpins 35 (Figs. 3 and 4) are provided in the body member 10 which, when the sleeve 7 moves into lower position, as shown in Fig. 4, enter a groove 37 provided in the wall 8, thereby preventing the sleeve 7 from being returned to upper position by any ordinary reverse pressure thereon. Therefore, should the operator for any reason desire to do so, he can wash the well by reverse flow through the tubing string and the device 3 after the sleeve 7 has been forced into lower position, as previously described.

It will be understood, of course, that with the particular assembly shown in Figs. 1 and 2, in which a section of tubing is provided below the device 3, that the lower tubing section will be filled with cement at the time the plug 20 seats in the device 3, and this cement will not be discharged until the passage has been reopened through the member 3 by the application of excess pressure, as described. It is not necessary, however, that the device 3 be inserted intermediate the ends of the tubing string, and, if desired, it may be mounted on the extreme lower end of the string, thereby effecting substantially complete discharge of all the cement from the tubing into the well at the time that plug 20 seats.

The expression "tubing string" as used in the claims, is intended to cover any string of pipe within the well which is of smaller diameter than the well bore, if the hole is uncased, and of smaller diameter than the casing if the hole is cased. Ordinarily this pipe string would be either a tubing string or a drill string.

For the purpose of fully explaining the invention, a specific embodiment and application thereof has been described in detail. However, it is to be understood that variations from the particular structure and purpose disclosed can be made without departing from the invention, which is to be limited only to the extent set forth in the appended claims.

I claim:

1. A device of the type described comprising a tubular member adapted to be connected to a tubing string for selectively controlling transmission of fluid therethrough, said tubular member having slidably supported therewithin an open sleeve member for the passage of fluid therethrough, means releasably holding said sleeve member in an upper position in which the exterior surface of said sleeve member seals with said tubular member, said sleeve member being adapted to retain and seal with a packing plug forced down through said tubing, said holding means being releasable and said sleeve member being movable in response to predetermined pressure differential thereon into a lower position, and said tubular member having a fluid passage therein which is blocked by said sleeve member when the latter is in its upper position but is

uncovered by movement of said sleeve member into said lower position.

2. A device of the type described, comprising a tubular member adapted to be connected to a tubing string, said member having an interior vertical guide wall terminating in a shoulder at the lower end thereof and having a fluid passage extending from a level adjacent the upper end of said guide wall to a level below said shoulder, a sleeve slidable along said guide wall between an upper position in which it blocks said fluid passage and a lower position against said shoulder in which it uncovers said fluid passage, and releasable means holding said sleeve in upper position, said sleeve having a vertical fluid passage therethrough adapted to receive and be blocked by a cementing plug.

3. A device as described in claim 2, in which

said sleeve has downwardly directed edges therein for gripping a cementing plug seated therein, and resisting return movement of the plug upward out of the sleeve.

4. A device as described in claim 2, with packing means in said tubular member above said fluid passage therein for sealing with said sleeve when the latter is in upper position.

5. A device as described in claim 2, in which said releasable holding means comprises shear pins extending between said tubular member and said sleeve.

6. A device as described in claim 2, with cooperating locking means on said tubular member and said sleeve, respectively, for retaining said sleeve in said lower position when once moved into that position.

NEWTON W. WICKERSHAM.