

Jan. 20, 1942.

W. L. CHURCH

2,270,648

CEMENTING PLUG

Filed Feb. 16, 1940

3 Sheets-Sheet 1

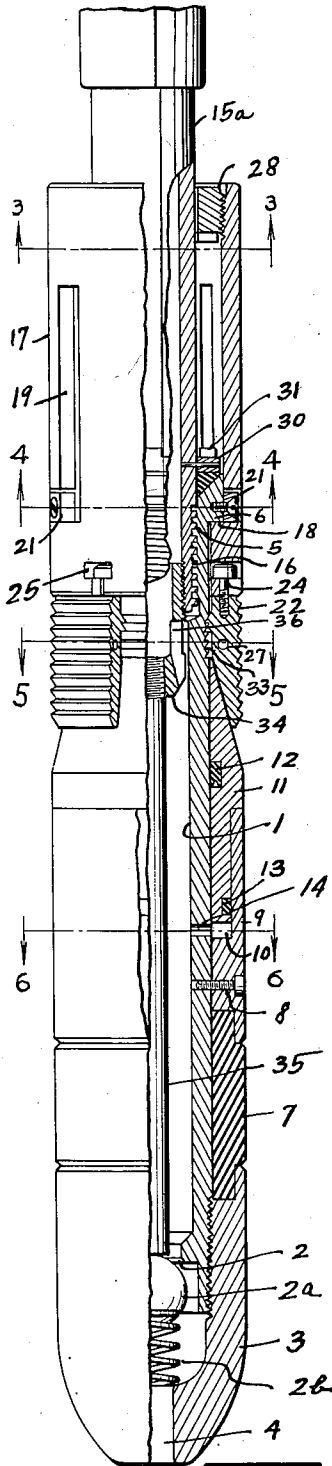


Fig. 1.

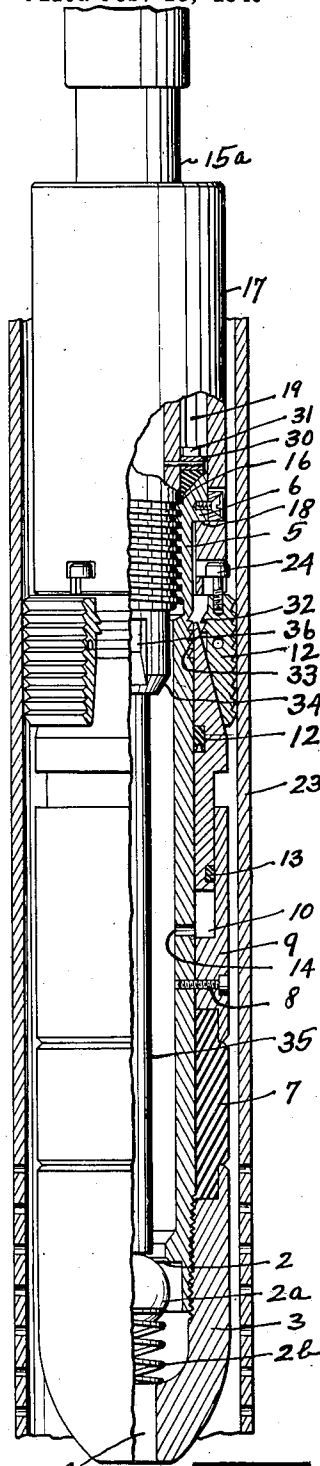


Fig. 2.

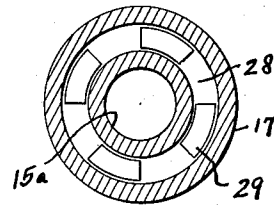


Fig. 3.

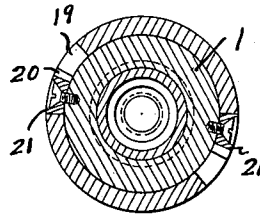


Fig. 4.

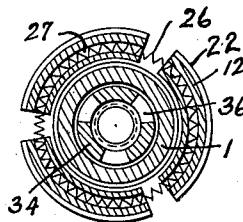


Fig. 5.

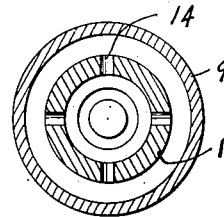


Fig. 6.

INVENTOR.
Walter L. Church
By E. V. Hardway.
ATTORNEY.

Jan. 20, 1942.

W. L. CHURCH

2,270,648

CEMENTING PLUG

Filed Feb. 16, 1940

3 Sheets-Sheet 2

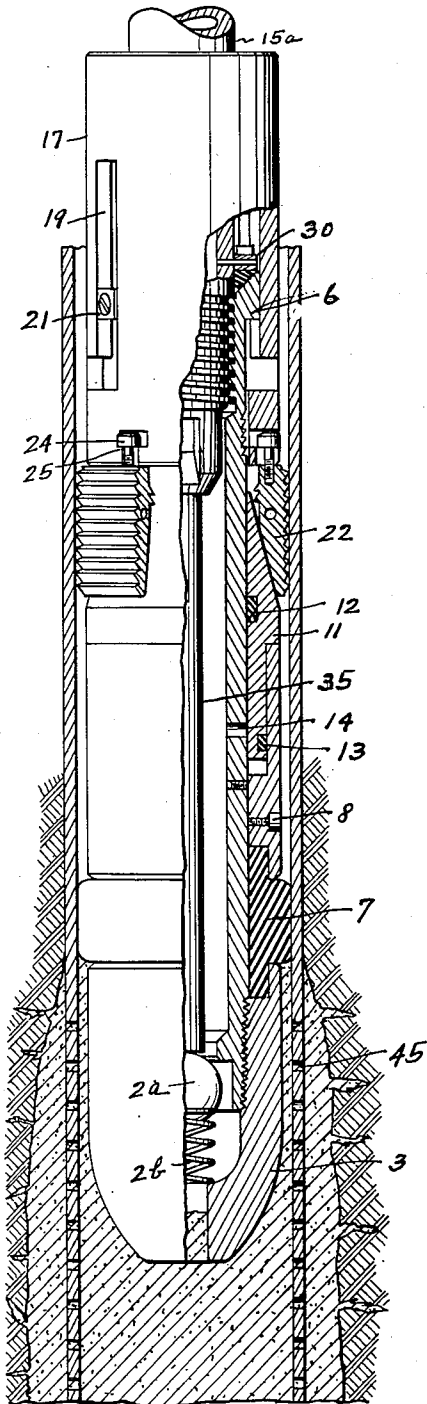


Fig. 7.

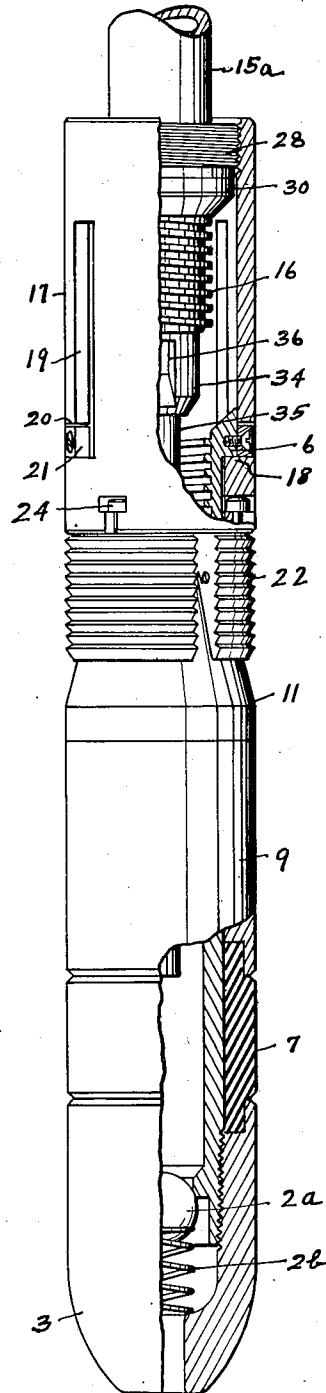


Fig. 8.

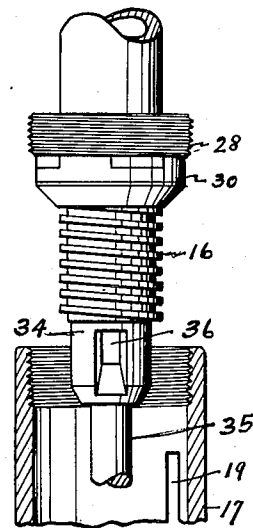


Fig. 9.

INVENTOR.
Walter L. Church
By E. V. Hardaway,
ATTORNEY.

Jan. 20, 1942.

W. L. CHURCH

2,270,648

CEMENTING PLUG

Filed Feb. 16, 1940

3 Sheets-Sheet 3

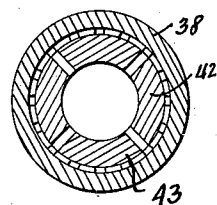
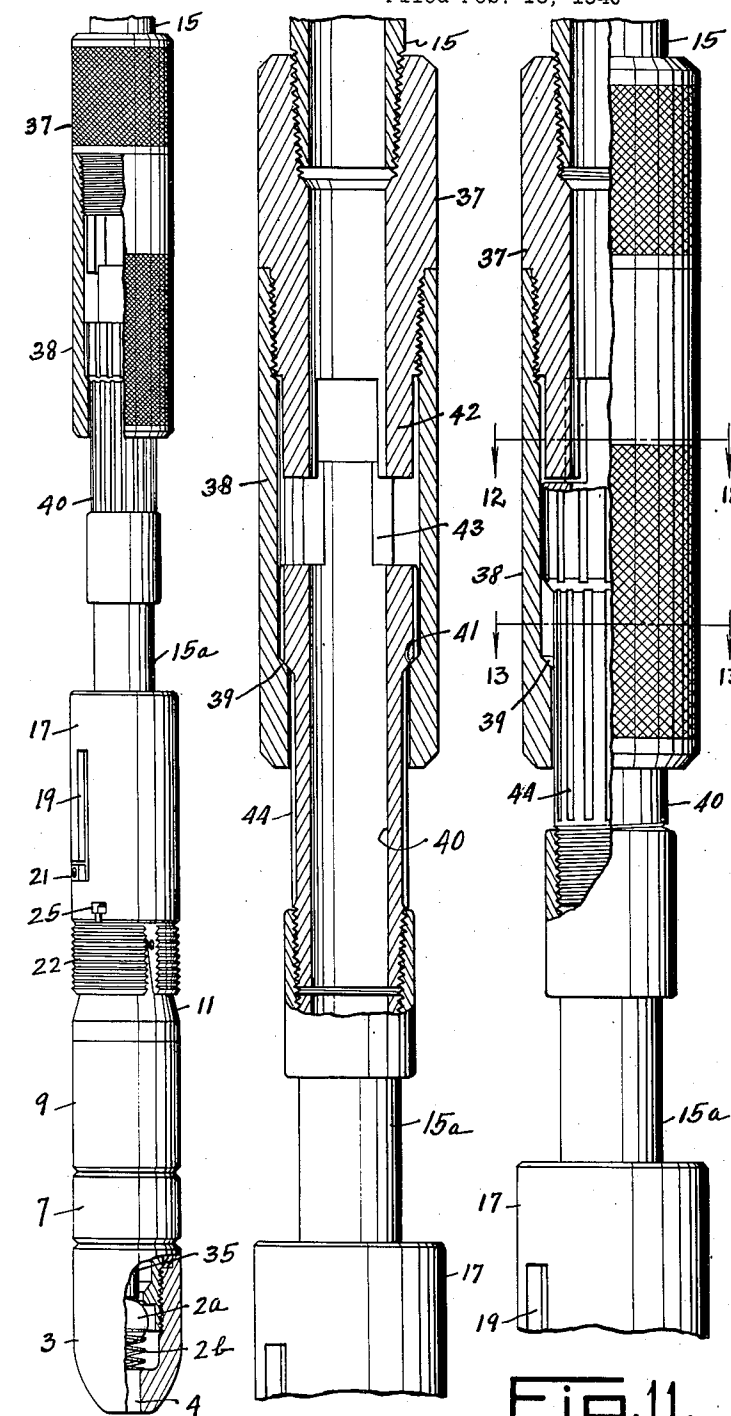


Fig. 12.

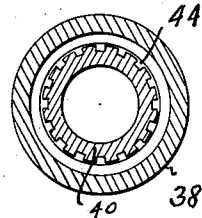


Fig. 13.

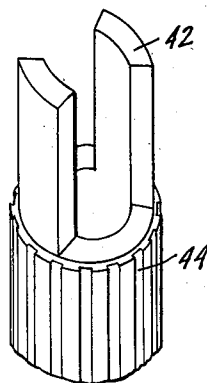


Fig. 14.

Fig. 11.

BY

INVENTOR.
Walter L. Church
E. V. Hardway
ATTORNEY

Fig. 15.

Fig. 10.

UNITED STATES PATENT OFFICE

2,270,648

CEMENTING PLUG

Walter L. Church, Houston, Tex., assignor to
C-M-P Fishing Tool Corporation, Houston,
Tex., a corporation

Application February 16, 1940, Serial No. 319,329

3 Claims. (Cl. 166—12)

This invention relates to a cementing plug.

The invention embodies certain improvements in that type of casing plug described in my co-pending application, Serial No. 279,261 of which the present application is a continuation in part.

An object of the invention is to provide a cementing plug, or bridge plug, that may be set in a well so that cement, forced downwardly therethrough, may be forced into the formation for the purpose of cutting off water encroachment and reducing the excessive gas, oil ratio.

The plug may also be used in testing various strata in connection with the method of cementing and testing wells disclosed in my United States Patent No. 2,016,916.

The plug may be left in the well on completion of the cementing job or removed at will and for that purpose the plug is equipped with a valve that may be controlled from the ground surface. Upon completion of the cementing operation the pump bleeder valve may be opened to determine whether or not there is an appreciable back flow against the hydrostatic head in the operating string. Should there be such back flow the pump pressure is again built up and the valve in the plug is closed from the surface by manipulation of the operating string and the plug is left in the well to allow the cement to set. Should there be no considerable back flow the pressure of the fluid in the operating string is relieved and the plug is removed from the well.

Means are also provided for draining the drilling fluid from the operating string and filling said string with clear water prior to the introduction of the cement.

With the above and other objects in view the invention has particular relation to certain novel features of construction, operation and arrangement of parts, an example of which is given in this specification and illustrated in the accompanying drawings, wherein:

Figure 1 shows a side elevation of the plug, partly in section, in inactive position as being run into the well.

Figure 2 shows a side view, partly in section, showing the plug anchored in the well casing.

Figure 3 shows a cross-sectional view taken on the line 3—3 of Figure 1.

Figure 4 shows a cross-sectional view taken on the line 4—4 of Figure 1.

Figure 5 shows a cross-sectional view taken on the line 5—5 of Figure 1.

Figure 6 shows a cross-sectional view taken on the line 6—6 of Figure 1.

Figure 7 shows a side view, partly in section, showing the plug anchored in the casing with the packer expanded and the perforated casing beneath cemented.

Figure 8 shows a side elevation, partly in section, showing the plug released after the cementing operation and ready to be withdrawn.

Figure 9 shows a fragmentary, side view, partly in section, showing the operating string detached for withdrawal.

Figure 10 shows a vertical, sectional view of a type of valve assembly employed and incorporated into the operating string showing the valve closed.

Figure 11 shows a side view thereof, partly in section, showing the valve open.

Figure 12 shows a cross-sectional view taken on the line 12—12 of Figure 11.

Figure 13 shows a cross-sectional view taken on the line 13—13 of Figure 11.

Figure 14 shows a perspective view of the valve employed in said assembly, and

Figure 15 shows a side elevation, partly in section, of the assembled plug and valve.

Referring now more particularly to the drawings wherein like numerals of reference designate the same parts in each of the figures, the numeral 1 designates a tubular mandrel whose lower end is provided with an inside, downwardly facing, seat 2 and screwed onto said lower end there is a guide plug 3 having a lower end opening 4. Within the plug beneath the seat 2 there is a downwardly opening back pressure valve 2a arranged to cooperate with, and close, the seat 2 and normally held in closed position by a strong coil spring 2b on which the valve is seated. The upper end of the mandrel is provided with the internal course threads 5 and with the external downwardly facing, annular shoulder 6 around the mandrel above the guide plug 3 there is an expansible, sleeve-like packer 7.

Mounted on the mandrel above the packer and secured thereto by a frangible pin 8 there is a retaining sleeve 9. The ends of the sleeve 9 and guide plug 3 overlap the adjacent ends of the packer 7 as shown in Figures 1, 2, 7 and 8 so as to retain the packer in place about the mandrel.

The upper end of the retainer sleeve is internally enlarged forming a cylinder 10. A slip expander 11 surrounds the mandrel above said retainer sleeve and the lower end of this expander is reduced and fitted closely into the cylinder. Annular seal rings 12, 13 are countersunk into the expander and form seals between the expander and mandrel and between the ex-

pander and walls of the cylinder 10, respectively. Suitable ports 14 lead through the mandrel into the lower end of the cylinder 10.

The numeral 15 designates a tubular operating string which extends to the ground surface and whose lower end is formed with a tubular nipple 15a having external, coarse, left-hand threads 16 which may be meshed with the threads 5 to attach the plug to the operating string.

The numeral 17 designates a tubular cage whose lower end is inwardly thickened forming an inside, annular shoulder 18 on which the external shoulder 6 of the mandrel hangs when the plug is assembled and in inactive position. The cage 17 has the vertical J-slots 19 whose lower ends are overturned, to the right, as shown, providing the notches 20. Attached to the upper end of the mandrel are the keys 21 which move in said slots.

The external surface of the expander 11 is upwardly tapered as shown and swung from the lower end of the cage are the slips 22 whose inner sides diverge outwardly and are shaped to fit closely against the tapered portion of the expander 11. The outer sides of the slips are toothed so as to readily engage the surrounding well casing 23. The slips are swung from the cage by means of cap screws 24 which are fitted into T-slots 25 on the lower end of the cage wherein said cap screws have the required radial movement to permit the slips to expand and contract. The slips are maintained in assembled relation in any preferred manner, preferably by a coil pull spring 26 which is located in a circular bore 27 in the slip assembly.

A gland 28 is screwed into the upper end of the cage 17 and on its under side has the depending lugs 29. The nipple 15a fits snugly through said gland and screwed onto said nipple and normally resting on the upper end of the mandrel there is a clutch ring 30 whose upper side has the spaced lugs 31.

The plug is assembled and connected to the operating string to be lowered into the casing as shown in Figure 1, the keys 21 being turned into the notches 20 with the clutch ring 30 resting on the upper end of the mandrel and with the packer 7 collapsed. The slips have inside, downwardly tapering, ratchet teeth 32, positioned above their tapered portion, which teeth hang on externally, upwardly pitched ratchet teeth 33 on the mandrel, when the plug is assembled for lowering as shown in Figure 1. These interengaging ratchet teeth guard the slips against accidental or inadvertent engagement with the casing prematurely and while the plug is being lowered.

Screwed into the lower end of the nipple 15a there is a rod anchor 34 depending from which there is the valve control rod whose lower end normally engages the valve 2a and holds the same open as shown in Figures 1, 2 and 7. The anchor 34 has the side outlets 36 to permit the passage of fluid downwardly therethrough.

At the present time it is common practice to lower a casing into a well and permanently set it and thereafter perforate the casing opposite a supposed oil bearing stratum. If, upon perforation of the casing the stratum does not produce it is then desirable to close the perforations 45 of the casing by cementing. As hereinabove indicated it may become desirable to force cement out into the formation for other purposes.

As illustrated in Figures 12 to 15, inclusive, there is a valve assembly incorporated into the

string 15. This assembly comprises a coupling member 37 connected into the string 15 and onto the lower end of which a tubular valve casing 38 is screwed. The lower end of the valve casing 38 is inwardly reduced forming a downwardly tapering valve seat 39. A tubular valve 40 is connected to the upper end of the nipple 15a and extends up into the valve casing 38 and is provided with an enlarged head having an external, downwardly facing, tapering valve face 41 adapted to cooperate with the seat 39 to open and close the seat. The adjacent ends of the coupling 37 and the valve 40 have the intermeshing clutch teeth 42, 43 which permit the relative longitudinal movement of the operating string relative to the valve 40 but which clutch them together for simultaneous rotation so that the nipple 15a will rotate with the operating string 15 at all times. The valve has the external, vertical flutes 44 extending from the upper to the lower ends thereof providing ample fluid passageway when the valve is open, that is, when the face 41 is elevated above the seat 39.

The complete assembly as shown in Figure 15 is lowered into the casing to a point just above the perforations to be closed as is illustrated in Figure 7. At this time the operating string contains drilling fluid, or drilling mud. Pressure is applied to the fluid in the operating string by means of a pump at the ground surface and the opening 4 being restricted, a portion of the pressure fluid will pass through the ports 14 into the cylinder 10 and force the expander upwardly which will in turn force the slips 22 outwardly into engagement with the casing as shown in Figure 2. The plug will thus be anchored to the casing. The operating string may then be turned to the left to disengage the keys 21 from the notches 20 and the string then pulled upwardly into the position shown in Figure 7 shearing the pin 8 and expanding the packer 7 into close contact with the surrounding casing. The operating string may then be lowered so as to open the seat 39 as shown in Figure 11. The drilling mud in the string 15 may then be displaced by clear water by forcing the latter downwardly through the operating string, the drilling mud passing out through the flutes 44 and back up around the string. It is desirable that the operating string be filled with clear water before the cement is lowered so that drilling mud will not become intermingled with the load of cement.

A load of cement may then be placed in the string at the ground surface followed by a plug or plunger and upon application of fluid, under pressure, to said plunger the load of cement will be forced downwardly through the operating string and through the mandrel and out through the seat 2 and the lower end opening 4 into the casing and through the perforations 45, said cement surrounding the perforated portion of the casing and penetrating into the surrounding formation. This cement is forced downwardly while the operating string is under tension and the packer 7 expanded so as to confine the cement within the casing beneath.

Thereupon and while the string is under tension and with the valve 40 in closed position the pump bleeder valve may be opened. If there is any considerable pressure in the well which would tend to displace the load of plastic cement when the pump bleeder valve is opened there will be a back flow of liquid up through the operating string. If this happens it indicates to the operator that the plug should be left in the well to

prevent displacement of the cement. Thereupon the operating string should be lowered and turned to the right thus screwing the mandrel 15 upwardly and withdrawing the rod 35 from the valve 2a to permit said valve to seat and close the lower end of the mandrel, and the plastic cement will thus be trapped beneath the plug notwithstanding the pressure exerted against it. Under these conditions the plug should be left in the well, the pressure exerted against the lower end of the plug maintaining the packer 7 expanded.

If, while the valve 2a is open and the pump bleeder valve is open, should there not be any back flow of liquid through the operating string the entire plug may be withdrawn.

If the plug is to be left in the well to retain the cement therein the operating string 15 may be turned to the right to disconnect the threads 16 from the threads 5 and the string may be pulled upwardly until the lugs 31 are interengaged with the lugs 29 and the rotation continued until the gland 28 is disconnected from the cage 17 and the operating string together with the nipple 15a is withdrawn.

If the conditions in the well are such that the plug is not necessary to retain the cement in place and may be withdrawn the tension may be released on the operating string 15 and the string unscrewed from the upper end of the mandrel 1 and elevated until the clutch ring 30 engages the gland 28. The cage 17 will move upwardly until the shoulder 18 engages underneath the shoulder 6, the slips 22 moving inwardly into released position and thereupon the plug and operating string may be readily removed from the casing as a unit.

The drawings and description are illustrative merely, while the broad principle of the invention will be defined by the appended claims.

What I claim is:

1. A cementing plug comprising a tubular mandrel having a passageway therethrough, a packer on the mandrel, casing grappling means, an expander on the mandrel arranged to be actuated by the pressure of fluid in the mandrel to force the grappling means into engagement with the

surrounding casing, abutments on the mandrel defining the packer, one of said abutments being retained by the grappling means and the other being movable with the mandrel whereby the packer will be expanded by longitudinal movement of the mandrel in one direction, a downwardly opening valve controlling the flow of fluid through said passageway, means normally tending to hold the valve closed and means operative from the ground surface and effective to open, or permit the closing of, said valve.

2. A cementing plug comprising a tubular mandrel having a passageway therethrough, a packer on the mandrel, casing grappling means, an expander on the mandrel arranged to be actuated by the pressure of fluid in the mandrel to force the grappling means into engagement with the surrounding casing, abutments on the mandrel defining the packer, one of said abutments being retained by the grappling means and the other being movable with the mandrel whereby the packer will be expanded by longitudinal movement of the mandrel in one direction, a downwardly opening valve controlling the flow of fluid through said passageway, means normally tending to hold the valve closed, means operative from the ground surface and effective to open, or permit the closing of, said valve and means for releasing said grappling means to permit withdrawal of the plug from the casing.

3. A device for cementing a well comprising a tubular operating string; a packer assembly on the string; said assembly comprising a packer, means for expanding the packer upon appropriate manipulation of the string, said expanding means including a releasable grapple engageable with the walls of the well; means arranged to be actuated by the pressure of fluid exerted through the string for actuating the grapple into engagement with the walls of the well; means for releasing the grapple by manipulation of the string; valve means for controlling the flow of fluid through said passageway and means arranged to be manipulated by the string to one position to hold the valve open and to another position to permit the valve to close.

WALTER L. CHURCH.