June 6, 1939. E. V. CROWELL 2,161,282

APPARATUS FOR CEMENTING WELLS

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Fig. 1

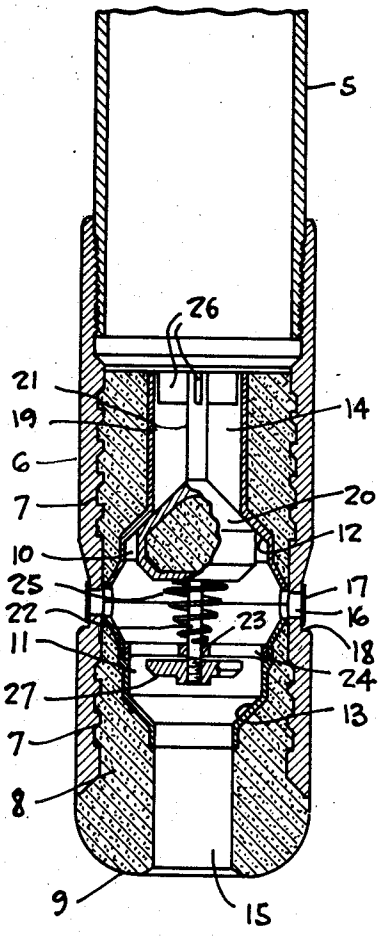


Fig. 2

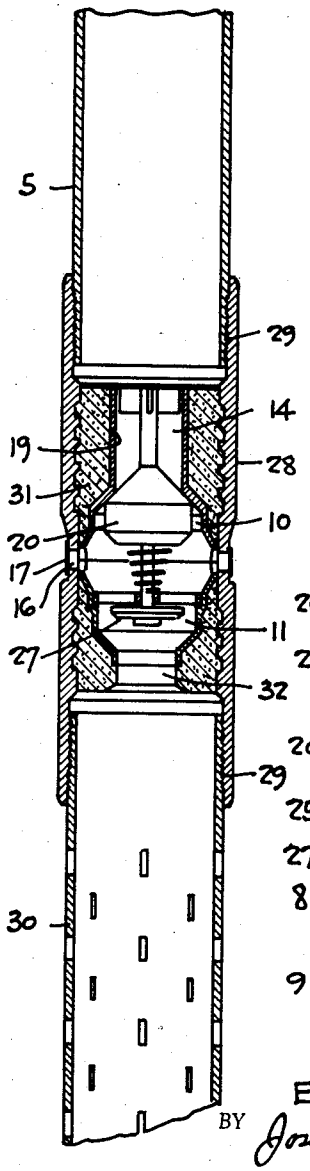
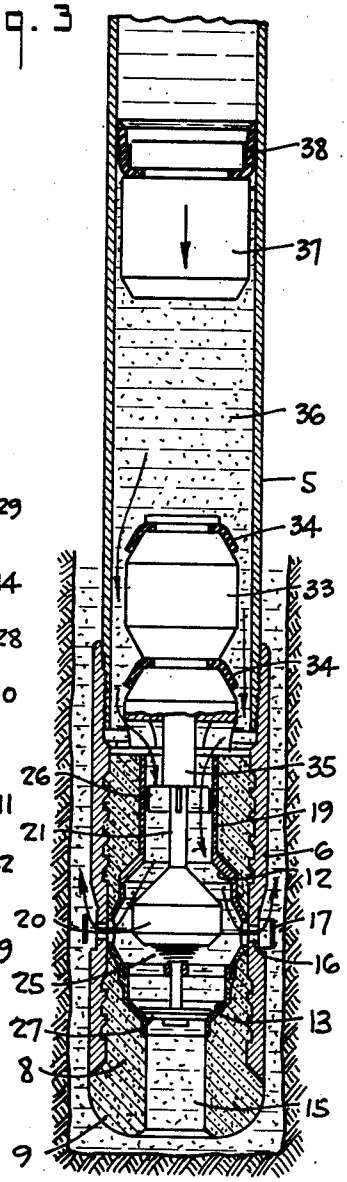


Fig. 3



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APPARATUS FOR CEMENTING WELLS

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14 Claims. (Cl. 166—1)

This invention relates to apparatus for cementing casing in wells whereby cement may be introduced into and passed downwardly through a casing string for discharge from lateral ports therein to fill the annular area of a well between the wall of the hole and the casing or any section thereof, and specifically contemplates improvements in the casing-valve means of my co-pending application, Serial No. 27,041, filed June 17, 1935, issued as Patent No. 2,120,694, on June 14, 1938; Letters Patent No. 2,071,391, granted to me February 23, 1937; and my patents and applications therein mentioned.

Important objects and numerous advantages of my said prior application and patent are also applicable to the present invention, which being generally the provision of valve means to enable floating of the casing to position in the well bore by closure of the lower end of the casing to pressure outside thereof, adapted to be displaced to permit the passage thereby of circulating fluid into the lower bore of the casing and well to remove matter within the well tending to obstruct positioning of the casing or placement of cement outside thereof; to deflect cementitious fluid through lateral ports in the casing by closure of the bore below the ports; and to subsequently prevent return flow of the cement into the upper bore of the casing.

A principal object distinguishing the present invention from my above-mentioned co-pending application and patent is to provide in a well casing, a pair of valves located in separate, but communicated, valve chambers, from between which a series of cementing ports extend through the casing, said valves being adapted to close the bore through the casing above and below the ports when desired to permit floating the casing into the well; circulating the casing with mud fluid while positioning, if necessary or desirable; washing down the casing preparatory to cementing; closing the bore of the casing below the lateral ports to deflect cementitious fluid pumped from the well surface therethrough; and to subsequently close the casing bore above the ports to minimize tendency of return flow of the cement into the casing.

Another object is the provision of a device of the character designated, particularly adapted for use with poppet type valves, in combination with resilient means to normally urge one of said valves to a position closing the bore of the casing above lateral cement-discharge ports to pressure therebelow.

Another object is to provide a device, as an improvement, and having the identical purposes, of my said Patent No. 2,071,391, incorporating dual valves with a valve-operating spring therebetween to afford the advantage of positioning the spring in a protected position within the plug, thus to prevent clogging detritus from fouling the valves, and particularly the valve-operating spring, while the casing is lowered to position through a cavey well bore.

Still other objects and salient features of my invention are simplicity of construction insuring positive and improved operation, and integrality of structure to eliminate operative displacement of any of the various parts, as will be apparent to those of skill in the art upon an examination of the following description read in the light of the accompanying drawing, in which—

Fig. 1 is a sectional view of a ported casing shoe, embodying my invention, connected to the lower end of a string of casing;

Fig. 2 is a modification of the device shown in Fig. 1 illustrating its use as a coupling in a combination string of casing;

Fig. 3 is a sectional view of the casing shoe of Fig. 1 illustrating its use during the step of discharging cement from the lateral ports thereof.

Referring to the drawing in detail, the numerals of which indicate similar parts throughout the several views, 5 designates a section of imperforate casing adapted to be lowered into a well, to the lower end of which a casing shoe 6 is threaded. The bore of shoe 6 is grooved or corrugated in any manner well known in the art as at 7 to retain a composite hollow lapideous valve body 8 cast within the shoe. The valve body 8 extends below the lower extremity of the shoe 6, being turned inwardly and downwardly to form a guiding end 9 for the casing. The bore of body 8 is centrally enlarged to form a pair of upper and lower adjoining valve chambers 10 and 11 respectively.

In the upper end of the float valve chamber 10 a downwardly directed annular valve seat 12 is formed, and in the lower end of the lower valve chamber 11 another annular valve seat 13, directed obliquely upward, is provided. The valve chamber 10 is communicated with the bore of the casing 5 thereabove by a passage 14 through the valve body. A lower passage 15 from chamber 11 extends through the lower end of valve body 8 and the guiding end 9. A series of lateral ports 16 extend radially, or on any chord of the circumference of the shoe, from the zone between chambers 10 and 11 through the encircling valve body and casing shoe. Leaf

spring valves 17 are secured over each port 16 in recesses 18 on the outside of the casing shoe which will open to pressure from within the casing to permit the emission of fluid therefrom but prevent its return flow into the shoe or casing.

A lining 19, composed preferably of metal, is provided for passage 14 and each valve chamber 10 and 11, said lining having lateral openings therein forming a part of ports 16.

A float valve 20 located in chamber 10 is adapted to close the bore through the casing to pressure by contact with valve seat 12 and is provided with concentrically aligned upper and lower valve stems, 21 and 22, respectively. Lower stem 22 extends through the hub 23 of a spider 24 supported horizontally on, and integrally secured to, the lining 19 in the upper end of chamber 11. A helical spring 25 encircles stem 22 between the hub 23 of spider 24 and float valve 20 to urge the valve against seat 12.

A series of wings 26 are secured radially to the upper end of stem 21, which slidably engage the walls of lining 19 in passage 14 to maintain proper alignment of the valve with respect to seat 12 and for other purposes later referred to. On the lower end of stem 22 below spider 24 a valve 27 is secured which is adapted to close the bore of the casing, upon contact with valve seat 13, to pressure thereabove, and accordingly, to deflect fluid pumped downwardly through the casing from the well surface through the ports 16. The stem 22, as is illustrated in the drawing, is shorter than the distance between the bottom of valve 20 when seated and valve seat 13 to enable both valves to remain unseated when valve 20 is opened in response to fluid pressure in the casing above the valve, and to thereby permit mud circulating fluid to pass by the valves into the passage 15 from which it may pass into the well at the lower end of the shoe, leaf spring valves 17 resiliently resisting displacement.

In the modification of my invention as shown in Fig. 2, the valve structure above described is disposed within a collar 28 having its opposite ends threaded as at 29 for connection in a string of casing or for the connection for a casing screen 30 to the lower end of a string of imperforate casing 5. A valve body 31 is cast within the collar 28, in the manner above indicated with reference to Fig. 1, in which upper and lower adjoining valve chambers 10 and 11 are formed. Chambers 10 and 11 are communicated with the casing string above the collar through a central passage 14 and to the lower screen 30 through a short central passage 32. The lining 19 and valve structure therein is in this embodiment the same as that depicted in Fig. 1 and described above.

The operation of my invention is briefly described as follows: The casing string 5 having my invention incorporated therein, either in a shoe 6, or as a section of casing, or a collar 28, is lowered into the well as assembled. Float valve 20 will remain closed during this operation due to the urge of spring 25 and the pressure in the well thereagainst communicated through the lower passage 15 (Figs. 1 and 3) or 32 (Fig. 2), to minimize strain on the rig, derrick, and equipment by partially supporting the weight of the casing string on the fluid in the well. The lower end 9 of shoe 6 (Figs. 1 and 3) will serve to guide the casing by obstructions in the bore of the well.

When the casing has been placed in the well bore in the position at which it is desired that it be cemented, (or even during the lowering of the casing to position, where this operation is obstructed by cavings or the like) circulating fluid is introduced into the casing and pumped under pressure through float valve 20. Due partially to the upward urge of spring 25 in counteracting the tendency of the valves 20 and 27 to drop under the fluid pressure in the casing thereabove, the valves 20 and 27 will remain unseated during the flow of circulating fluid into chambers 10 and 11. As above indicated the resistance of leaf spring valves 17 on the outside of the casing normally closing ports 16, to displacement causes the deflection and downward direction of fluid through chamber 11 and lower passageway 15 (Figs. 1 and 3) or 32 (Fig. 2) and from the lower end of shoe 6, or into the casing screen 30 for discharge from the openings therein, or through a lower string of casing for emission from lower lateral ports or the end thereof. The circulating fluid thus expelled from the casing below the valve structure, following the path of least resistance, will move upwardly through the annular area of the well bore removing cavings, drillings and other detritus to insure a solid foundation for the cement subsequently placed in the well hole.

On top of the circulating fluid after the washing down operation, a traveling plug 33, comprising a cylindrical body slightly smaller than the casing bore, is inserted into the casing at the well surface. Plug 33 carries a pair of collapsible packers 34 adapted during their downward movement through the casing string to slidably engage the wall of the casing. At the lower end of the plug 33 a downward axial projection 35 of a diameter smaller than the diameter of passage 15 is provided to contact the upper end of stem 21 and the wings 26 and thereby depress the valves 20 and 27. The plug 33 is followed into the casing and forced downwardly therethrough by a volume of fluent Portland cement, indicated at 36 (Fig. 3) which is introduced into the casing in an amount sufficient to fill the area between the wall of the hole and the casing from the port 16 upwardly to any desired level.

On the cement, an indicator plug 37 is placed, carrying an upwardly turned calathiform packer 38, and the whole slug of cement between two separating plugs 33 and 37 is pumped through the casing by circulating fluid introduced into the casing under pressure on plug 37. Upon contact of projection 35 with stem 21 the downward movement of plug 33 will force valve 27 against said seat 13 closing the bore of the shoe or collar to the further flow of fluid therebelow from the upper casing. Continued pressure from the well surface will collapse packers 34 and cause the cement 36 from between plugs 33 and 37 to flow into chamber 10. With the lower passage of the valve body closed, leaf valves 17 will be forced open and the cement discharged from ports 16 to fill the area surrounding the casing. When substantially all the cement has been expelled through the ports (there being a small amount of tailings left in the casing and in chambers 10 and 11), the upper indicator plug 37 will be seated on plug 33. The expansion of packer 38 against the wall of the casing prevents the downward passage of the circulating fluid thereabove and consequently builds up pressure in the casing, which indicates to the operator the completion of the cement discharge. Leaf spring valves 17, permitted to close by the discontinuance of the flow through ports 16, will

normally prevent return flow of the cement or any disturbance of the cement due to change in pressure within the casing. A tight head may be held on the casing to assist in maintaining the position of the plug 37 on plug 33. Should plug 33 be displaced in any manner, for example, as might result from a leak in the casing above plug 37, float valve 20 will close in response to the urge of spring 25.

It will be seen by those of skill in the art to which my invention appertains that I have provided a device in which circulating fluid may be discharged from the lower end of the casing but that where such circulation is difficult, leaf spring valves 17 will open to permit washing of the bore by the ejection of fluid through the lateral ports; and that the operation of the valvular structure, embodying preferably spring-pressed poppet type valves, will be assured by the protection afforded the spring from clogging detritus tending to enter the lower end of the casing or shoe by its location between the valves.

While I have shown but two embodiments of my invention, it will be obvious that numerous changes may be made in shape, size, proportion or design of the various parts, and particularly in the type of valve employed; and that the valve chambers may be adjoining as shown or spaced from each other and be communicated through a separate passage; or that the valves for the bore of the casing may be independently operable with respect to each other, all without departing from the spirit of my invention as defined in the appended claims.

What I claim and desire to secure by Letters Patent is:

1. A device of the character described comprising a ported tubular member, a valve body secured within said member on each side of the port, a passageway formed longitudinally through said body, valve means comprising a pair of valves arranged in said passageway, spaced apart with respect to each other each adapted to close the passageway in response to pressure thereagainst, a spring above said lower valve to resiliently support the uppermost of said valves in a position closing the passageway to the flow of the fluid upwardly through the valve body, and a plug actuated by pressure fluid to compel said upper valve to open the passageway to pressure thereabove and to urge said lower valve to close the passageway to pressure thereabove.

2. In a cementing apparatus, a ported well casing section have a bore forming a passageway for pressure fluid, a valve seat formed in said section on each side of said port, upper valve means and lower valve means, means to connect said upper and lower valve means rigidly to each other at spaced distance apart in said passageway to control the passage of fluid up or down therethrough, means for resiliently supporting the uppermost valve means to urge the same on one of said seats to prevent the passage of fluid upwardly through the valve body, said upper and lower valve means adapted to contact said upper and lower seats respectively in response to a balance of pressure on the opposite sides of said valves.

3. A device of the character described comprising a tubular member, a valve body of lapideous material secured in said tubular member, said valve body being formed with communicating upper and lower valve chambers, said valve body having an upper passageway extending from the upper valve chamber through the upper end of the body and a lower passageway extending from the lower valve chamber through the lower end of the body, valve means comprising a valve in each of said chambers, means to connect said valves to each other in spaced relation to control the passage of fluid through said valve body, the uppermost valve being resiliently supported for closing said upper passageway, and a plug actuated by pressure fluid adapted to coact with said valve means for opening the upper valve and urging said lower valve to close the lower passageway.

4. A floating and guiding shoe comprising a ported tubular member adapted to be connected to the lower end of a string of casing, a plug of lapideous material secured in the lower end of said member, a portion of said plug projecting from the lower end of said member being tapered inwardly and downwardly to form a guiding end, a passageway formed centrally and longitudinally through said plug, spaced apart valve means comprising an upper and a lower valve, a spring, means to support said spring between said valves, the upper valve being resiliently supported by said spring for preventing the passage of fluid upwardly through the upper end of the plug, and means actuated by pressure fluid to compel said lower valve to close said passageway to prevent the passage of fluid downwardly through the lower end of the plug.

5. A floating and guiding shoe comprising a ported tubular member adapted to be connected to the lower end of a string of casing, a plug of lapideous material secured in the lower end of said member, a portion of said plug projecting beyond the lower end of said member, said portion being of substantially the same diameter as the exterior diameter of the shoe at the point where said plug and shoe unite, said projecting portion being tapered inwardly and downwardly to form a guiding end, a passageway formed centrally and longitudinally through said plug, a composite valve chamber formed in said passage intermediate the ends of said passageway with which said ports communicate, spaced apart valvular means in said chamber comprising an upper and a lower valve, said upper valve normally closing the bore thereof to pressure therebelow so as to permit pressure fluid to flow down or up through said passageway to said chamber and out through said ports, a spring, means to support said spring between said valve means to bear against said upper valve to urge said upper valve to closed position, and means actuated by said pressure fluid to compel said lower valve to close said passageway to pressure thereabove, thus to deflect the flow of said pressure fluid outwardly through said ports.

6. In a device of the character described, a tubular member having a lateral port therein, a hollow valve body in said tubular member forming an upper and a lower valve chamber therein, valve means in each of said chambers, each adapted to close the bore through the member, fluid pressure to urge said upper valve means to open, and means between said valve means to simultaneously hold said lower valve means from its seat.

7. In a device of the character described, a tubular member, a hollow valve body within said member forming a pair of valve chambers therein, said valve body and tubular member having a lateral port therein, a pair of valve means to control the passage of fluid through said valve

body on opposite sides of said port means of lesser diameter than the valve means to space said valve means from each other, and resilient means to urge said valve means to close the bore of the valve body above the port.

8. In a device of the character described, a tubular member, a float valve in said tubular member to close the bore through said member to a balance of pressure therebelow, resilient means to urge said valve to its seat, and means rigidly connected to said float valve to close the bore of the member below said resilient means.

9. In a device of the character described, a tubular member, a valve in said member, resilient means to normally urge said valve to a position closing the bore of the member, fluid pressure means to open said valve, and means rigidly connected to said float valve to close the bore of said member below said valve and resilient means.

10. In a device of the character described, a tubular member, means in said member forming a pair of valve chambers, a downwardly oblique upper valve seat in the uppermost of said valve chambers, and an upwardly oblique valve seat in said lower valve chamber below said upper valve seat, valve means in said upper valve chamber to close the bore of the member, and valve means in the lower chamber to close the bore of said member therein, and means to connect said valves.

11. In a device of the character described, a tubular member having a lateral port therein, valve means to close the bore of said tubular member above said port, to pressure therebelow, lower valve means to close the bore of said member below said port to pressure thereabove, and resilient means above said lower valve means to urge said upper valve means to a position closing the bore of said member.

12. In a device of the character described, a tubular member, valvular means to close the bore of the member to pressure from below, second valvular means to close the bore of the member to pressure thereabove at a point below the closure of the member by said first valvular means, pressure means to displace said first means to permit the passage of fluid downwardly by the first valve, and resilient means above said second valvular means to normally hold said second valve means from a position closing the bore of the member to pressure from above.

13. In a device of the character described, a tubular member, valvular means to close the bore of the member to pressure from below, second valvular means to close the bore of the member to pressure thereabove at a point below the closure of said member by said first valvular means, pressure means to displace first valvular means to permit the passage of fluid downwardly by the first valve, and resilient means above said second valvular means to urge said first valvular means to its position closing the bore of the member and upon its displacement by said pressure means to hold said second valve means from a position closing the bore of the member to pressure from above.

14. In a cementing apparatus, a tubular member, a valve body in said tubular member having a passage extending longitudinally therethrough, said passage being enlarged to form an upper and a lower valve chamber, spaced apart with respect to each other, said tubular member having a port therein between said valve chambers, a valve in said upper valve chamber movable to close said passage to pressure therebelow, a valve in the lower valve chamber movable to close the bore through said passage to pressure thereabove, said valves being spaced apart to form a zone therebetween into which fluid under pressure may move to exert pressure against the underside of said upper valve.

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