

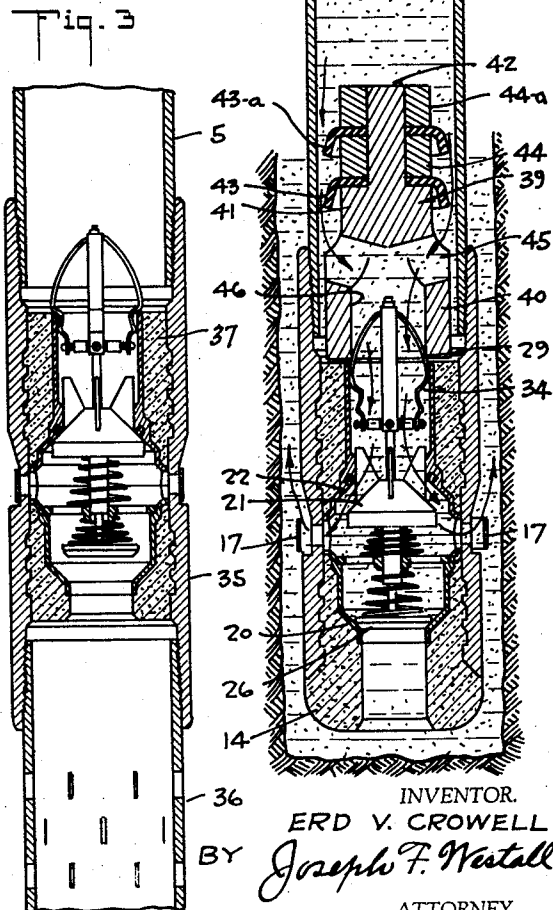
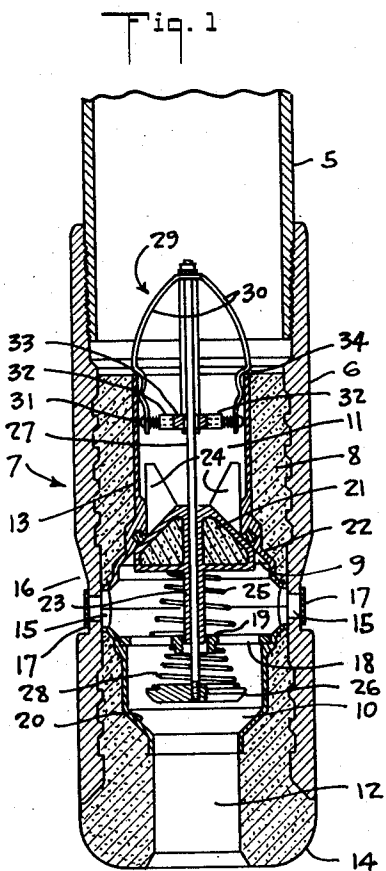
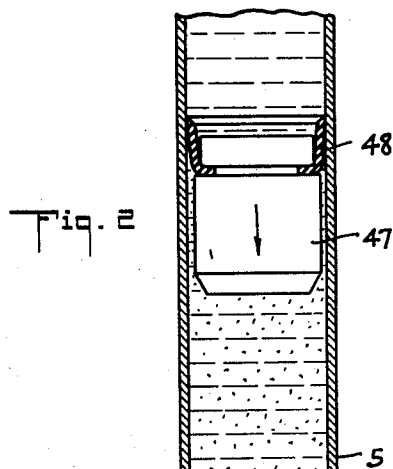
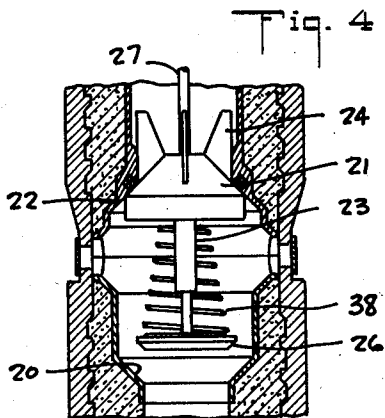
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APPARATUS FOR CEMENTING WELLS

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APPARATUS FOR CEMENTING WELLS

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This invention relates to apparatus and methods for cementing wells and contemplates generally a ported well casing string embodying individually-operable valve mechanism for closing the ports and the bore of the casing to fluid in the well in combination with means for selectively opening said valve mechanism to permit most effective placement of fluent cement in the well bore around the casing and shoe therefor or at any predetermined zone of the annular area in the well around the casing. In these particulars the invention is similar to the structure embodied in my prior Patents No. 2,071,391 and No. 2,071,392, the objects and advantages hereof including those contemplated for the structure of said patents. This application is a continuation in part of my copending applications S. N. 27,041 filed June 17, 1935, now Patent No. 2,120,694, granted June 14, 1938, and S. N. 146,406 filed June 4, 1937, and the applications and patents related thereto.

In devices of this character it is desirable to provide the string of casing to be cemented in the well hole with a float valve adjacent its lower end, preferably above the lateral ports in the casing through which cement is to be subsequently discharged, to close the bore of the string to pressure outside thereof, and thereby facilitate initial positioning of the casing, and further, to prevent the return flow of cement into the casing after completion of the cementing process. Preliminary to cementing it is essential that circulation of mud fluid be established downwardly through the bore of the casing for discharge from the shoe and thence upwardly to the well surface through the annular area of the hole around the casing to remove debris and to indicate that cementing is in order. Various means have been devised for maintaining the lateral ports closed while circulating through the lower end of the casing. After circulation of mud fluid is established the casing below the ports is closed to deflect cementitious fluid pumped from the well surface through the ports. In the art prior to my invention, the cement is held in position while lapidifying principally by individual valves located on the casing over each port; and also by maintaining a tight head on the casing to prevent the development of a pressure differential in the area within and around the casing adjacent the ports.

It is a principal object to provide, in a ported casing structure of the character above indicated, a pair of independently operable upper and lower valve means to control the bore of the cas-

ing above and below, respectively, the lateral cement discharge ports whereby in normal operation to successively close the bore of the casing above the ports to pressure therebelow while maintaining the bore of the casing below the port open; opening the upper float valve means for the ejection of fluid through the bore of the casing below, or optionally through, the ports; closing the lower valve means while fluid from the well surface is ejected from the ports; and finally, closing both valve means to form a closed chamber with which the ports are in communication to prevent the return of cementitious or other fluid into the casing through the ports.

Another object is the provision of a tubular member forming a section or a continuation of a casing string having a valve releasably supported in the bore of the member in combination with means operated from the well surface to effect its release and thereby close the bore of the casing to pressure thereabove.

Another object is to provide a casing string, equipped with a pair of independently operable valve means to close the bore thereof to pressure above and below lateral ports in the casing, in combination with releasable means located above the upper valve means to normally maintain the lower valve from contact with its seat to permit fluid to be moved into the lower bore and be expelled from the casing below both valves.

Another object is the provision of a method of cementing well casing wherein the casing bore may be closed to pressure at or below the level at which a series of lateral ports are disposed; then opening the bore of the casing, and while maintaining the lateral ports closed, discharging circulating fluid from the casing at a lower level; closing the bore of the casing below the lateral ports to deflect fluent cement introduced into the casing outwardly through said ports; and subsequently closing the ports and the bore of the casing above and below the level at which the ports are located.

Other objects and salient features of my invention 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 casing shoe embodying my improvement;

Fig. 2 is a view in section of a casing string equipped with a ported shoe embodying the present invention, illustrating particularly the parts as positioned during the ejection of cement from the lateral ports in the shoe;

Fig. 3 is a sectional view of a combination string of casing with my invention embodied in a casing section or collar;

Fig. 5 is a broken portion of a collar or shoe depicting a modified form of valve actuating means.

Referring to the drawing in detail, the numerals of which indicate similar parts throughout the several views, 5 designates generally in broken section an imperforate casing string, to the lower end of which is attached by threading, the barrel 6 of a casing shoe 7. A hollow cement valve body 8 is cast in the bore of barrel 6, forming a pair of connected upper and lower valve chambers 9 and 10, respectively, and an upper passageway 11 axially aligned with the barrel connecting the upper valve chamber 9 with the bore of casing string 5 and a lower passageway 12 extending from the lower valve chamber 10 through the lower end of shoe 7. The upper passageway 11 and the valve chambers are lined by a member 13 for obvious purposes.

The hollow cement valve body 8 is extended below the lower end of the shoe barrel 6 and is curved inwardly to form a shoe guide 14. Barrel 6, cement valve body 8, and liner member 13 are provided with a series of axially aligned lateral cement-discharge ports 15. The exterior of barrel 6 is indented at the ports as at 16. A series of valves 17, each comprising a strip of spring metal, are secured at one of its ends to the barrel in the indentation 16 to extend horizontally over a respective port 15.

A transverse spider 18 having a hub 19 is secured to the liner 13 intermediate ports 15 and a conical lower valve seat 20, formed on the liner member at the lower extremity of valve chamber 10. A float valve 21 having an upper surface disposed parallel to the face of an upper conical valve seat 22 formed by liner 13 at the upper end of valve chamber 9, is reciprocally supported in axial alignment with the shoe 7 by means of a hollow valve stem 23 slidable in the hub 19 of the spider. Vertical radially-disposed valve guides 24 are integrally attached to the upper portion of the bevelled surface of valve 21 and slidably engage the portion of liner 13 forming the upper passageway 11. A helical spring 25 encircling the stem is supported on spider 18 and bears against the under-side of float valve 21 to urge the same toward a closed position.

A lower cement deflecting valve 26 in chamber 10 is secured to the lower end of a rod 27 which extends upwardly through the bore of stem 23 and the passageway 11. A helical spring 28, encircling rod 27 between the spider and valve 26 urges the lower valve to a closed position on seat 20 but the spring is normally held compressed and the valve maintained in a position spaced from its seat by means of a yoke 29 secured to the upper end of rod 27. Yoke 29 consists of a series of bowed spring members 30, each having one of their ends attached to the upper end of rod 27, and their opposite ends bowed outwardly and downwardly into the bore of the valve body 8 so as to engage the inner surface of the liner 13 of the passageway 11. The lower ends of spring members 30 are slidably mounted on transverse screws 31 attached to the arms 32 of a cross 33 encircling the rod. Helical springs 31a are preferably provided on screws 31 between members 30 and arms 32 to resiliently urge the members outwardly against the walls of passageway 11. The members 30

are each bent sharply inward at corresponding distances from their upper ends to form shoulders 34 which engage the upper end of the liner and valve body when the valve is in its upper open position to thereby resist seating of the valve 26 in response to expansive force of spring 28.

In Fig. 3 the invention is shown in a collar 35 comprising a unit of a combination string of casing; the collar 35 connecting the upper imperforate string 5 to a casing screen 36. A hollow cement valve body 37, which is identical with valve body 8 with the omission of the lower extension comprising the shoe guide 14, is cast in collar 35. In the bore of the valve body, liner 13 is disposed as in the device of Fig. 1.

In a modification of the above-described structure, the spider 18 is omitted (see Fig. 4) and a single valve chamber contains valves 21 and 26. Spring 38 encircles stem 23 and rod 27 to urge each of the valves to closed position.

The operation of my invention is briefly described as follows: The shoe 7 or collar 35 embodying the invention is assembled with the string of casing to be cemented in the well. The bowed spring members 30 are preliminarily arranged above the valve body 8 or 37 with shoulders 34 engaging the upper end of the valve body to suspend valve 26 from its seat. As the string is assembled and lowered into the well, float valve 21 will remain closed to fluid in the well and permit the casing to be partially "floated" to position, thus alleviating strain on the casing and equipment.

Circulation may be established at any time during the lowering operation to remove obstructions in the well shaft. If the cement is to be placed around the shoe or adjacent the bottom of the well, the string provided with the shoe of my invention is suspended from the well bottom a short distance and mud circulating fluid is introduced into the casing at the surface. Under pump pressure the circulating fluid displaces valve 21 and enters the valve chambers 9 and 10. With valves 17 resiliently resisting displacement from ports 15, the fluid will normally pass into the lower passageway 12 and enter the well bore through the lower end of the shoe, or, in a string including collar 35, through any opening in the casing therebelow, as, for example, the perforations of the screen 36.

When free circulation has been definitely established, a traveling Y-plug 39 is inserted in the casing. Y-plug 39 comprises a lower hollow portion 40, only slightly smaller diametrically than the bore of the casing and an upper solid portion 41 of lesser diameter. Portion 41 of the plug is provided with an upper extension 42 on which a collapsible annular packer 43 of any conventional design is mounted for sliding engagement with the casing. A sleeve 44 encircles the extension on top of the packer to maintain the packer 43 flat on the plug. A second packer 43a identical with packer 43 is placed on extension 42 and is held against sleeve 44 by a second sleeve 44a. The plug may carry any number of packers, each preferably surmounted by a sleeve. The lower portion of plug 39 is provided with a series of lateral openings 45 at the point of its juncture with the solid portion 41 thereof which communicate with the hollow bore 46 of the lower portion of the Y-plug 39.

On top of plug 39 cementitious fluid is pumped in an amount predetermined to be sufficient to fill the area of the portion of the well shaft

around the casing to be cemented. Into the casing on top of the cement an indicator plug 47, slidable with the casing and carrying an upwardly extending calathiform packer 48, is introduced. Mud fluid is then introduced on top of plug 47 and the slug of cement is forced downwardly between plugs 39 and 47 to the valve body 8 or 37.

When the Y-plug is moved by pump pressure on packers 43 and 43a and the upper end thereof to a point in the casing adjacent the valve body, the lower portion of the plug will telescope the yoke 29. The bore 46 of plug 39 is slightly smaller than the bore of the valve body to insure the inward contraction of the bowed spring members 30 and the disengagement of shoulders 34 from the upper end of the valve body. The expansion of spring 28 (or 38 in Fig. 4) and the force of the downwardly passing fluid will thereupon lower the deflecting valve 26 against its seat 20, drawing the yoke partially into the passageway 11 as the Y-plug seats on the upper end of the valve body. The continued introduction of mud fluid into the casing at the well surface under pump pressure will collapse the packers 43 and 43a, causing movement of the fluent cement through the openings 45 of the Y-plug, passageway 11 and thence through the ports 15 due to the closure of the casing bore therebelow by valve 26. The cement discharge through lateral ports will be completed when plug 47 abuts against plug 39, which will leave the cement tailings between the upper end of the plug 47 and ports 15 within the casing. This condition will be indicated to the operator by the pressure built up in the casing above the packer 48.

With pressure in the valve chambers 9 and 10 and upper passageway 11 substantially equalized, the float valve will close in response to the urge of spring 25 (or 38 in Fig. 4). Individual port valves 17 will likewise close. It will thus be seen that valves 17, the lower valve 26, and the float valve 21 will all cooperate to prevent the return of the ejected cementitious fluid through the ports as well as resist the displacement of the mud fluid supporting the cement.

Various modifications may be made in the operation of the apparatus, as, for example, the mud circulating fluid may be discharged partially or entirely through the ports 15, by introducing the plug 39 in advance of the fluid to be so ejected should the lower end of the casing be clogged by bridging obstructions in the well shaft. Cement may be ejected from the lower end of the casing by introducing it into the casing at the well surface prior to the placement therein of the Y-plug.

It will be observed in the embodiment of Fig. 4 that the urge of spring 38 against float valve 21 will be greater while lowering the casing into the well shaft due to the suspension of valve 26, which forms the lower support for spring 38, from its seat during this operation. Similarly the spring 38 will exert greater force against valve 26 after its release by the Y-plug, during the ejection of cement from the ports 15 due to the downward displacement of the float valve which tends to compress the spring.

It will be understood by those of skill in the art that numerous changes may be made in size design, arrangement, and number of the various parts, all without departing from the spirit of my invention as defined by the appended claims.

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

1. In a device of the character described, a ported tubular member, a valve body of lapideous material secured in said 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, a pair of independently operable valves arranged spaced apart in said valve body on opposite sides of the port in said member, means supporting the uppermost valve in a position to close said upper passageway to pressure therebelow, means releasably supporting the lowermost valve in a position permitting the passage of pressure fluid downwardly through said lower passageway, and means actuated by fluid pressure to release said lower valve to close the bore of said lower passageway to pressure thereabove.

2. In a device of the character described, a ported tubular member, a valve body secured in said member having a passageway formed longitudinally through said body, a pair of independently operable valves arranged spaced apart in said passageway on opposite sides of said port, resilient means supporting the uppermost valve in a position to close said passageway to pressure therebelow, means releasably supporting the lowermost valve in a position permitting the passage of pressure fluid downwardly through said passageway, said lower valve being adapted for release to close said passageway to pressure thereabove.

3. In a device of the character described, a tubular member, a valve body secured in said member having a passageway formed longitudinally through said body, a pair of independently operable valves arranged spaced apart in said passageway to control the passage of fluid there-through, resilient means supporting the uppermost valve to prevent the passage of fluid upwardly through the body, means releasably supporting the lowermost valve in a position permitting the passage of fluid downwardly through the body, said body and tubular member having lateral ports communicating at their innermost ends with said passageway intermediate the valves and at their outer ends with the area surrounding said tubular member, and means actuated by fluid pressure to release said lower valve and close the bore of said passageway below said ports.

4. In a device of the character described, a well casing, a tubular member secured to said casing forming a shoe for the lower end of the casing, a valve body in said member, a valve in said body to open and close said member to a balance of pressure above and below, respectively, said valve, a second valve means releasably supporting said second valve in said body, said second valve permitting the passage of fluid downwardly through said member but adapted upon release to discontinue the flow of fluid downwardly through said body, said member having cementing ports formed through the side thereof, outwardly opening valves for said ports preventing the flow of fluid into said member from the exterior thereof, said outwardly opening valves adapted to open to permit the discharge of cement through said ports from the interior of said member only after said second valve is made effective for discontinuing the flow of fluid downwardly through said member.

5. A cementing and float plug for well casing

- comprising a cylindrical shoe, a valve structure including a valve cage secured in said shoe, valve means in said cage comprising a downwardly opening valve and a downwardly closing valve, said valves being independently operable to control the passage of fluid through the bore of said shoe, a guide member secured in the bottom of said shoe and depending downwardly therefrom, the valve structure and guide being formed of friable material whereby they may be subsequently broken out, said shoe having lateral openings formed therethrough adjacent the valve structure for the egress of fluid from said shoe.
6. A cementing and float plug for well casing comprising a cylindrical shoe, a valve structure including a valve cage secured in said shoe, said valve cage having an opening formed longitudinally therethrough, a downwardly opening valve and a downwardly closing valve mounted in said cage, a spring between said valve, a guide member secured in the bottom of said shoe and depending downwardly therefrom, the valve structure and guide being formed of friable material whereby they may be subsequently broken out, said cylindrical shoe having lateral openings formed therethrough intermediate the valves for the egress of fluid from said shoe.
7. In a device of the character described, a tubular member having a lateral port therein, valve means to close the bore of said member to pressure from below, fluid means under pressure to displace said valve means and move adjacent said port, means normally closing said port to deflect said fluid means downwardly through said tubular member below said port, and valve means to close said tubular member below said port to

pressure thereabove simultaneously with closure of said first-named valve means.

8. In a device of the character described, a tubular member, a hollow valve body in said member forming a pair of communicating upper and lower valve chambers therein, a valve in each of said chambers, means to urge said upper valve to closed position, a stem connected to said lower valve extending above said upper valve engageable with said valve body to releasably suspend said lower valve in open position, a plug actuated by fluid pressure to release said means, and means to urge said lower valve to closed position upon release of said means by said plug.

9. An apparatus of the character described comprising a ported tubular member having an opening throughout its length for the passage of pressure fluid downwardly therethrough, a valve body in said opening adjacent said ports having a valve chamber formed between the ends thereof communicating with the ports, valve means in said chamber, and means to move said valve means to close said passage above and below said ports simultaneously to pressure in the member adjacent said ports.

10. In an apparatus for cementing wells, a well casing, a valve, means to support said valve below a port in the casing, and a cementing plug carrying means slidably fitting said well casing adapting said plug to be forced by fluid pressure downwardly through the casing to release said valve to permit said valve to close the bore of said casing to pressure thereabove while said pressure fluid by-passes said plug to said port.

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