Oct. 28, 1947. J. R. BAKER 2,429,912

WELL CEMENTING APPARATUS

Filed Dec. 29, 1944

Fig. 1.

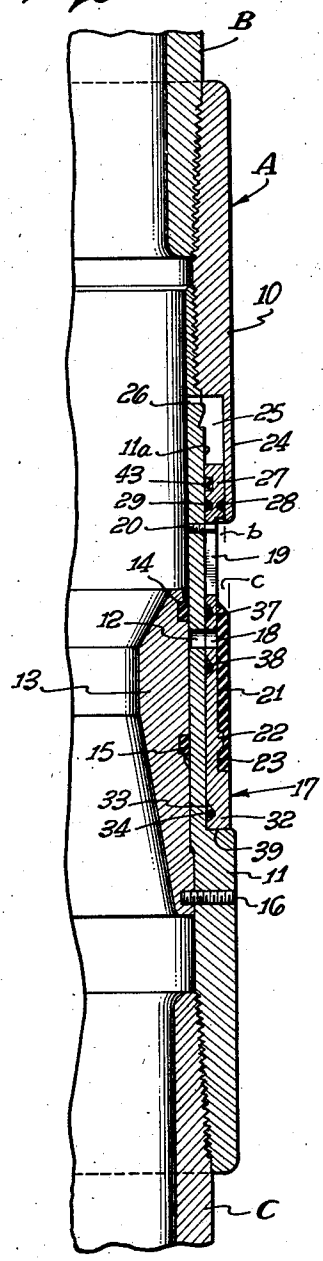


Fig. 2.

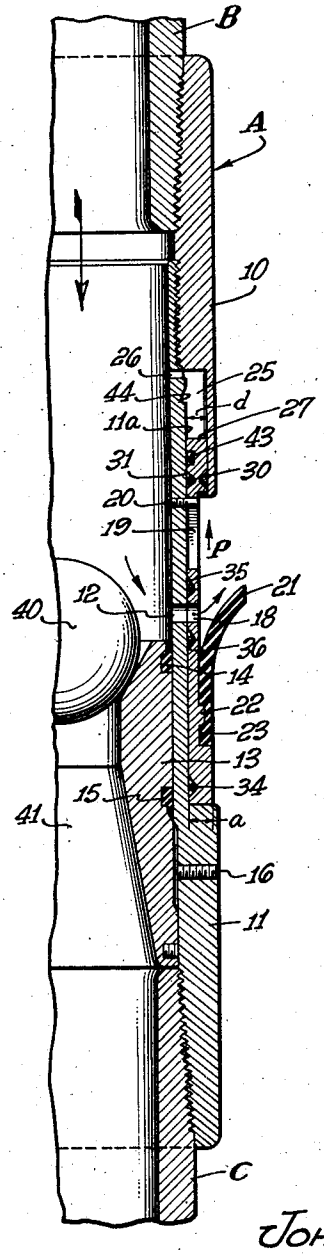
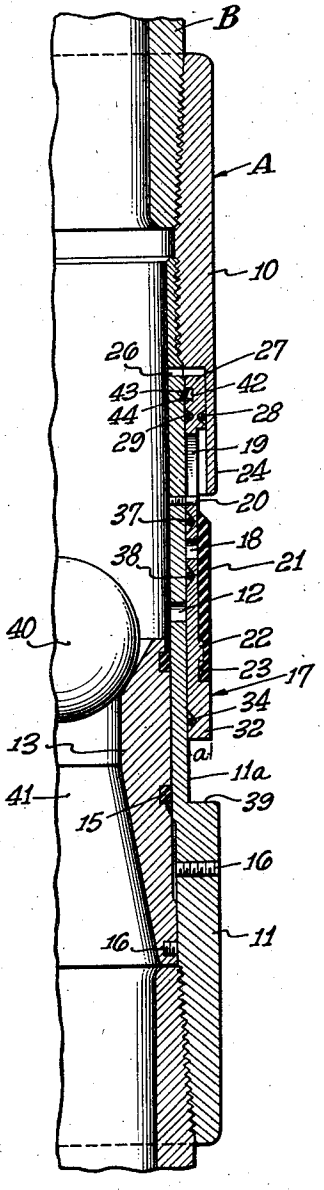


Fig. 3.



INVENTOR.
JOHN R. BAKER,
BY Oscar A. Mellin
ATTORNEY.

Patented Oct. 28, 1947 2,429,912

UNITED STATES PATENT OFFICE

2,429,912

WELL CEMENTING APPARATUS

John R. Baker, Philadelphia, Pa., assignor to Baker Oil Tools, Inc., Vernon, Calif., a corporation of California

Application December 29, 1944, Serial No. 570,392

5 Claims. (Cl. 166—1)

1

This invention relates to apparatus for cementing casing in well bores, and more particularly to apparatus embodying side ports through which cementitious material can be ejected for passage into the annulus between the casing and wall of the well bore.

It is an object of the present invention to control fluid flow through the side ports of casing or similar apparatus by the hydrostatic or pressure head of fluid disposed externally of the casing.

Another object of the invention is to utilize the hydrostatic head of a column of cementitious material, like cement slurry, placed around the string of casing to close casing ports through which such material has been ejected and thereby prevent its return flow into the casing.

A further object of the invention is to provide an improved side ported well cementing apparatus through which cementitious material can be ejected into the annulus around the casing string, in which the ports are closed after the material has been ejected to prevent subsequent passage of fluids from the interior of the apparatus, through the ports to the exterior of the apparatus.

Still another object of the invention is to employ the hydrostatic head of a column of cementitious material placed around a string of casing to close casing ports through which such material has been ejected and thus prevent subsequent passage of fluid from the interior of the apparatus outwardly through the casing ports.

This invention has other objects that will become apparent from a consideration of the embodiment shown in the drawings accompanying and forming part of the present specification. This form will now be described in detail, but it is to be understood that such detailed description is not to be taken in a limited sense since the scope of the invention is best defined by the claims appended hereto.

Referring to the drawings:

Figure 1 is a partial longitudinal section of a well cementing apparatus;

Figure 2 is a view similar to Figure 1, with parts of the apparatus in another operative position; and

Figure 3 is a view similar to Figure 1, with the parts of the apparatus in still another operative position.

The well cementing apparatus is disclosed in the drawings as a collar A adapted to form part of a string of casing having its ends threaded to separated upper and lower casing sections B,

2

C. The specific collar disclosed comprises an upper tubular member 10 secured to the upper casing section B, in which is threadedly received a lower tubular member 11 attached to the lower casing section C.

The lower tubular member 11 is provided with a plurality of ports 12, initially closed to prevent passage of fluids between the interior and exterior of the casing by an inner sleeve valve 13 having upper and lower seals 14, 15 disposed on opposite sides of the ports. This sleeve valve is held in position over the ports by one or more shear screws 16 threaded into the lower tubular member 11 and sleeve valve 13. An outer sleeve valve 17 is slidably mounted on the lower tubular member and is provided with a plurality of ports 18 adapted to coincide with the ports 12 through the lower tubular member, in order that fluids may pass from the interior to the exterior of the cementing collar A. The outer sleeve valve 17 is movable from a position in which its ports 18 are in alignment with the lower tubular member ports 12 to a position of disalignment wherein the metal of the sleeve valve is disposed over the lower member ports to prevent flow of fluid therethrough. To guard against inadvertent rotation or angular movement of the outer sleeve valve, its upper end is provided with one or more guide slots 19 in which are received keys or pins 20 threaded into the lower tubular member. This key connection 19, 20 permits longitudinal movement of the outer sleeve valve 17 on the lower tubular member 11 but prevents rotation therebetween.

Return flow of fluid into the casing string after its ejection through the coinciding ports 12, 18 is precluded by a back pressure valve on the exterior of the outer sleeve valve. The specific form of back pressure valve illustrated in the drawing consists of an elastic sleeve 21 of rubber or similar material having one end secured to the sleeve in any suitable manner, as by the interlocking flanges 22, 23 on the sleeve 17 and rubber valve member 21. The back pressure valve 21 extends over the ports 18 and is capable of flexing outwardly under the action of the fluid passing through the ports to discharge into the annulus between the casing string and wall of the well bore. The inherent elasticity of the sleeve, however, causes it to close back over the ports 18 and against the exterior of the outer sleeve valve 17 whenever the internal pressure is relieved, to prevent return flow of fluids through the ports 18, 12.

The upper tubular member 10 has a depending

skirt or cylinder wall 24 spaced from the outer surface 11a of the lower tubular member to form an annular cylinder 25 communicating with the interior of the collar and casing string by one or more inlet or bleeder ports 26, extending through the wall of the lower tubular member at the upper end of the cylinder. The cylinder 25 contains an upper annular head or piston 27 on the external sleeve valve 17. Leakage in both directions between this piston 27, on the one hand, and the cylinder wall 24 and external surface 11a of the lower tubular member, on the other hand, is prevented by outer and inner sealing rings 28, 29 disposed in generally wedge or V-shaped grooves 30, 31 formed in the outer and inner surfaces of the piston. The sealing rings are circular in cross section and tend to be wedged by the tapered sides of the grooves into leakproof engagement with the surfaces of the cylinder wall 24 or lower tubular member 11 when pressure is imposed on them either from above or below.

The external sleeve valve 17 is also provided with a lower annular head or piston 32 having an inner generally wedge or V-shaped groove 33 in which is contained a round sealing or piston ring 34 adapted to slidably engage the external surface 11a of the lower tubular member. The external sleeve valve is also provided with intermediate generally V-shaped grooves 35, 36 above and below the sleeve ports 18, in which are contained round sealing rings 37, 38 slidably engageable with the external surface 11a of the lower tubular member.

The apparatus forms part of the casing string and is lowered therewith into the well bore with its parts in the relative positions shown in Figure 1, in which the inner sleeve valve 13 is disposed over the lower member ports 12, and the external sleeve valve 17 is in its lowermost position resting upon a shoulder 39 on the lower tubular member with its ports 18 coinciding, or communicating with, the ports 12 through the lower member.

When fluid is to be ejected from the apparatus, a suitable bridging member, such as a ball 40, is lowered or allowed to gravitate through the fluid in the well casing until it comes to rest on the inner sleeve valve 13, closing its central passage 41 and enabling sufficient pressure to be built up in the fluid in the casing string thereabove to shear the screws 16 and move the inner sleeve valve 13 and ball 40 downwardly to a position below the ports 12. Fluid can then pass outwardly through the aligned open ports 12, 18, flexing the elastic back pressure valve 21 in an outward direction and passing outwardly into the annulus around the casing.

In the event that the external sleeve valve 17 may have shifted upwardly during lowering of the casing string in the well bore, the pressure built up inside the casing after seating of the bridging member 40 on the inner sleeve 13 acts through the inlet port 26 on the upper end of the piston 27, to shift the outer sleeve valve 17 downwardly into contact with the shoulder 39 on the lower tubular member, to realign the sleeve ports 18 with the lower member ports 12 and thus allow outward flow of fluid into the annulus around the casing, in the manner aforementioned.

The fluid ejected from the casing may consist of a cementious material, such as cement slurry, and this material rises in the annulus around the casing to the desired height. Usually only a small quantity or height of cement slurry is allowed to remain in the casing string above the ports 12, producing a back pressure effect upon relieving of the pressure within the casing, caused by the fact that the outer column of cement slurry extends much higher than the slurry remaining inside the casing, and by the further fact that the specific gravity of the cement slurry is much greater than that of the water or other displacement fluid in the casing used to eject the slurry from the casing string through the open ports. The greater hydrostatic or pressure head of the cement slurry externally of the casing presses the elastic back pressure valve 21 firmly against the exterior of the outer sleeve valve 17, and over the sleeve valve ports 18, to prevent return flow of the cement slurry into the casing.

The greater hydrostatic head of the cement slurry on the exterior of the casing string is also employed to shift the outer sleeve valve 17 bodily along the lower tubular member 11 to disalign the ports 18, 12 and provide a further means for preventing return flow of cement slurry from the annulus around the casing into the casing string. Such shifting of the outer sleeve valve 17 is also availed of to prevent passage of fluid from the interior of the casing to its exterior through the ports 12, as will now be described.

It is to be noted that the hydrostatic head of fluid on the exterior of the casing can act longitudinally on the outer sleeve valve 17 in both directions. This unit hydrostatic head or pressure "P" is capable of acting on the underside of the upper piston 27 across its pressure active area b, to urge the outer sleeve 17 in an upward direction; across the pressure active surface c extending around the elastic back pressure valve, to urge the outer sleeve 17 in a downward direction; and across the pressure active undersurface a of the lower annular piston 32 to urge the outer sleeve valve in an upward direction. The resultant total force tends to shift the outer sleeve valve in an upward direction, and is equal to $P(a+b-c)$. The force tending to shift the outer sleeve 17 in a downward direction is represented by the unit hydrostatic head or pressure p inside the casing acting over the area d at the upper surface of the upper piston 27. So long as the resultant force acting upwardly on the outer sleeve valve is greater than the downward force from within the casing acting downwardly on the sleeve valve, the external hydrostatic head elevates the sleeve valve and shifts it to closed position over the ports 12 in the lower tubular member. Expressed in another manner, the hydrostatic head of fluid on the exterior of the casing will shift the outer sleeve valve 17 in an upward direction whenever $P(a+b-c)$ is greater than pxd.

The relieving of the pressure within the casing, following ejection of all desired cement slurry from the ports 12, 18, will insure a large excess of external elevating force acting on the outer sleeve valve 17 over the internal lowering force. To take a simple design, if it is assumed that the area b equals the area c, and that the area a equals the area d, the outer sleeve valve will be elevated whenever the hydrostatic head externally of the casing string is greater than that internally of the casing string.

It is to be noted that elevation of the outer sleeve valve 17 disposes the intermediate lower seal 38 above the ports 12 extending through the lower tubular member. The bottom sealing ring 34 will remain below the latter ports, thus pro-

viding an imperforate sleeve portion disposed over the ports 12 with sealing rings on opposite sides of these ports, preventing passage of fluid under pressure from the interior of the collar to its exterior. The back pressure valve 21 prevents return flow of fluid from the exterior of the casing into the collar A. As a result, the ports 12 are closed to prevent the passage of fluid between the exterior and the interior of the casing string in both directions.

A positive port closure has thus been obtained against flow of fluid in both directions. The pressure of the fluid inside the casing may act through the inlet ports 26 and tend to shift the outer sleeve 17 in a downward direction to realign the ports 18, 12, but ordinarily any such pressure would not be imposed until after the cement slurry has set and hardened around the casing and the outer sleeve valve 17, securely locking the latter in closed position and preventing its downward shifting. However, as a precautionary measure, to insure that pressure exerted through the inlet port 26 will not shift the outer sleeve valve 17 to port aligning position, the upper head 27 on the sleeve may be provided with an inner groove 42 carrying a split contractile ring 43 adapted to snap into a companion groove 44 formed on the exterior of the lower tubular member upon elevation of the outer sleeve valve 17 to port closing position. The engagement of the split ring 43 in the groove 44 will lock the outer sleeve valve 17 against movement in a downward direction and prevent pressure exerted through the inlet port 26 from so shifting the outer sleeve member.

I claim:

1. An apparatus including a tubular member having a port and adapted to form part of a casing string, a back-pressure valve for preventing passage of fluid through said port from the exterior of said apparatus to the interior of said tubular member, a valve member on said tubular member for controlling flow of fluid through said port, said valve member being so constructed and arranged as to be shifted on said tubular member by fluid pressure externally of said apparatus to a position closing said port to the passage of fluid from the interior of said tubular member to the exterior of said apparatus.

2. An apparatus including a tubular member having a port and adapted to form part of a casing string, a back-pressure valve for preventing passage of fluid through said port from the exterior of said apparatus to the interior of said tubular member, a sleeve valve on said tubular member for opening and closing said port to the passage of fluid from within said tubular member to the exterior of said apparatus, said sleeve valve having a pressure active surface subject to the action of fluid pressure externally of said apparatus to slide said sleeve valve on said tubular member to port closing position to prevent passage of fluid from the interior of said tubular member to the exterior of said apparatus.

3. An apparatus including a tubular member having a port and adapted to form part of a casing string, a sleeve valve on said tubular member for opening and closing said port to the passage of fluid from within said tubular member to the exterior of said apparatus, said sleeve valve having a pressure active surface at one end thereof communicable with the interior of said tubular member to enable fluid pressure internally of said tubular member to shift said valve to port opening position, said sleeve valve having a fluid pressure active surface on its other end communicable with the exterior of said apparatus to enable fluid pressure externally of said apparatus to shift said valve on said tubular member to port closing position, and back pressure valve means for preventing passage of fluid from externally of said apparatus through said port.

4. An apparatus including a tubular member having a port and adapted to form part of a casing string, a sleeve valve on said tubular member for opening and closing said port to the passage of fluid from within said tubular member to the exterior of said apparatus, a back-pressure valve mounted on said sleeve valve for preventing passage of fluid through said port from the exterior of said apparatus to the interior of said tubular member, said sleeve valve having a pressure active surface subject to the action of fluid pressure externally of said apparatus to shift said sleeve valve on said tubular member to port closing position to prevent passage of fluid from the interior of said tubular member to the exterior of said apparatus.

5. An apparatus including a tubular member having a port and adapted to form part of a casing string, a sleeve valve on said tubular member having a port adapted to align with said tubular member port to permit passage of fluid from within said tubular member to the exterior of said apparatus, a back-pressure valve on said sleeve valve for closing said sleeve valve port and prevent passage of fluid from the exterior of said apparatus to the interior of said tubular member, said sleeve valve having a pressure active surface subject to the action of fluid pressure externally of said apparatus to shift said sleeve valve on said tubular member to disalign said ports and prevent passage of fluid from the interior of said tubular member to the exterior of said apparatus.

JOHN R. BAKER.

REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
2,187,482	Baker et al.	Jan. 16, 1940
2,330,267	Burt et al.	Sept. 28, 1943
2,344,120	Baker	Mar. 14, 1944
1,793,780	Daniel	Feb. 24, 1931
1,832,088	Boynton	Nov. 17, 1931