Sept. 20, 1949. C. E. BURT 2,482,651

WELL CEMENTING APPARATUS

Filed Oct. 25, 1944

Fig. 1.

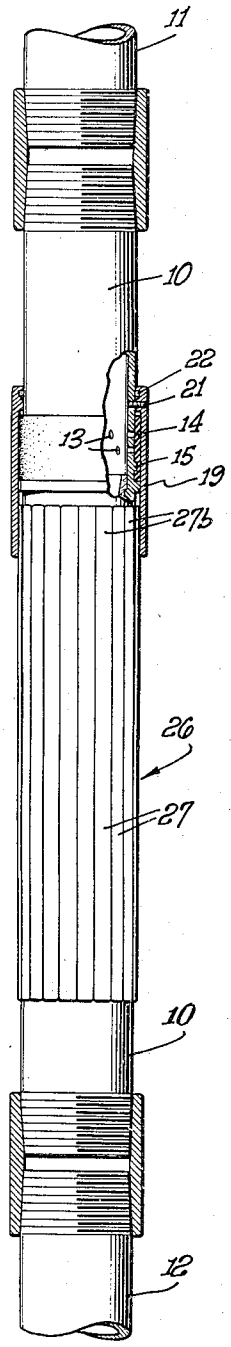


Fig. 2.

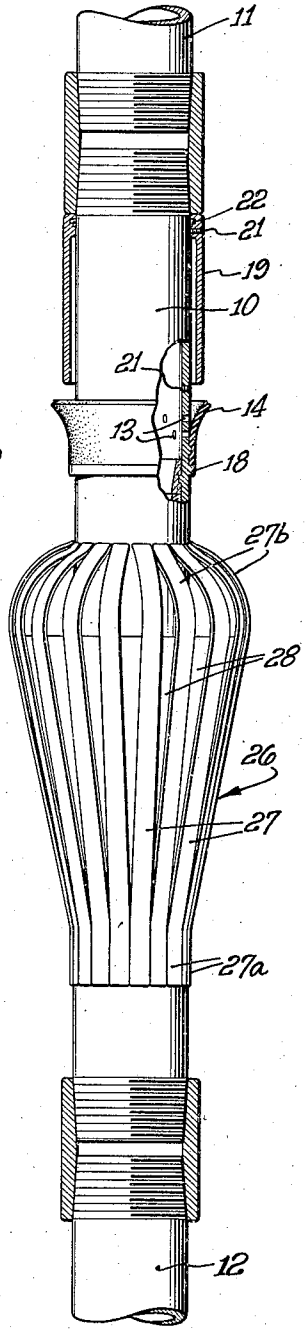


Fig. 3.

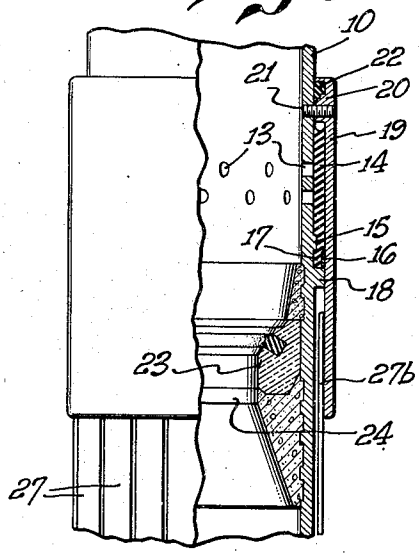
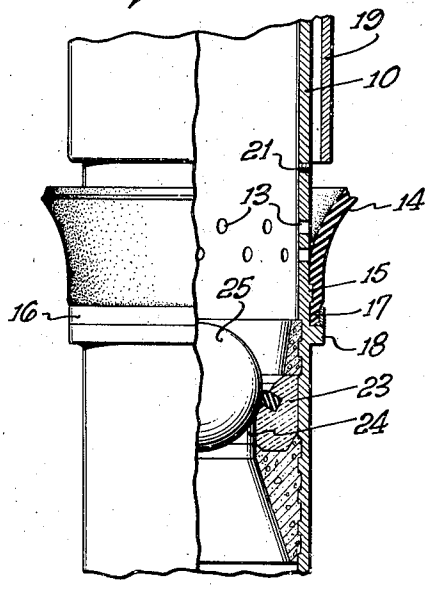


Fig. 4.



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WELL CEMENTING APPARATUS

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7 Claims. (Cl. 166—1)

1

This invention relates to well cementing apparatus adapted to form part of a casing string.

Apparatus for cementing well casing at one or more points above the lower end of the casing string embody side ports through which the cementitious material can be ejected from the casing for passage into the annulus between the casing and wall of the well bore. A back pressure valve may be provided on the exterior of the casing to close the ports and prevent return flow of the cementitious material into the casing. Under some conditions of operation, it is also desired to confine the cementitious material deposited behind the casing to a particular location along its length by providing an annular barrier around the casing to bridge the space between the casing and wall of the bore hole.

One phase of the present invention is concerned with the control of back pressure valves in apparatus of the character indicated; and another phase of the invention is directed to controlling such valves in conjunction with the control of annular casing barriers or bridges.

More specifically, it is an object of the present invention to provide a ported well casing apparatus embodying an external back pressure valve protected against damage while the well casing is run in the well bore by a device which also serves to hold an annular casing bridge or barrier in retracted position until the latter is to be released.

Another object of the invention is to provide an improved side ported well casing apparatus having an external back pressure valve subject to the pressure of fluid within the apparatus, which is prevented from allowing passage of fluid from within the casing by a device which also serves to hold an annular casing bridge or barrier in retracted position until the latter is to be released.

A further object of the invention is to provide an improved side ported well casing apparatus having an external back pressure valve subject to the pressure of fluid within the apparatus, but which is prevented from allowing fluid to pass from within the casing through the port to the exterior until a predetermined pressure is built up within the casing, thereby allowing fluid at a lower pressure to be pumped through the casing to a point below the port.

Still another object of the invention is to provide a protective device around a back pressure valve on the exterior of a well casing apparatus which is movable from its protective position when the back pressure valve is to function.

2

Yet another object of the invention is to provide an apparatus useful in the multiple stage or series cementing of well bores embodying a retainer device on the exterior of the casing for preventing flow from within the casing to its exterior until a predetermined pressure is built up, allowing cementitious material to be first ejected from the casing at a lower point.

A further object of the invention is to provide a well casing apparatus embodying an external back pressure valve cooperable with an external retainer in such manner as to prevent flow of fluid within the casing to its exterior until a predetermined hydraulic pressure is imposed on the combination from within the casing.

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 longitudinal section and elevation of a well casing, illustrating the apparatus in one position of operation;

Figure 2 is a view similar to Figure 1, illustrating the apparatus in another position of operation;

Figure 3 is an enlarged view of part of the apparatus shown in Figure 1; and

Figure 4 is an enlarged view of part of the apparatus shown in Figure 2.

As disclosed in the drawings, the apparatus includes a tubular nipple or collar 10 adapted to form part of a casing string by being connected to adjacent casing sections 11, 12. The collar is provided with a plurality of circumferentially spaced side ports 13 for establishing communication between its interior and exterior. A back pressure valve is arranged around the collar over the ports in such manner as to permit outward passage of fluid from the interior of the casing, and to prevent its return flow into the casing. In the specific example shown, such back pressure valve takes the form of an elastic, rubber or similar sleeve 14, having one end anchored to the collar 10 by a collar rib 15 fitted within a companion groove in the sleeve 14. This end may also be held securely to the collar by an encompassing strap 16, firmly clamping an inner sleeve rib 17 into its companion groove formed between the

collar rib 15 and a lower outwardly projecting collar flange 18.

The sleeve 14 tends to close inherently in an inward direction over the ports 13 to prevent fluid from passing back into the collar 10, but the pressure of the fluid within the casing and its collar can flex the free end of the sleeve in an outward direction to enable outward fluid passage from the interior of the collar to its exterior.

The back pressure valve 14 is initially held against outward flexure by a retainer 19 in the form of a rigid sleeve extending over the valve, and having an upper head 20 adapted to slide along the collar 10 above the free end of the elastic sleeve valve. The retainer 19 is held in this position by releasable means, such as one or more frangible shear screws 21 extending through the head 20 and threaded into the collar. Leakage between the head and collar is prevented by a side seal 22 in the head slidably sealing with the outer surface of the collar.

The shear screws 21 have a predetermined shear value and will not disrupt until the fluid pressure in the casing exceeds a corresponding predetermined amount. Cement slurry and other fluids may be pumped down through the casing string and its collar for discharge at some point therebelow, as through a shoe (not shown) at the lower end of the casing string. Increase of the fluid pressure within the casing to a predetermined amount will cause sufficient fluid force to be exerted against the inner surface of the retainer head 20, after passing through the ports 13 and along the inner surface of the flexible sleeve valve 14, to disrupt the shear screws 21 and elevate the retainer 19 sufficiently until it is removed from contact with the rubber sleeve valve 14 (see Figure 2). The fluid can then pass outwardly through the ports 13 and stretch, or otherwise flex, the free end of the sleeve valve 14, in an outward direction to discharge into the annulus around the casing. Decrease in the pressure of the fluid will allow the valve 14 to move back inherently to closed position over the ports 13, being held in this position by the hydrostatic head of the heavier fluid, such as cement slurry, on the exterior of the casing, which presses it firmly against the collar 10 and holds it in leakproof relation over the ports.

Sufficient pressure can be built up in the fluid within the collar 10, forming part of the casing, by any suitable means. In the example disclosed in the drawings, a seat 23 for a bridging element may be rigidly secured to the interior of the collar 10 below the ports 13. This seat has a central passage 24 through which fluid can pass for discharge at a point below the collar. When pressure is to be built up in the collar to the aforementioned predetermined value to shear the screws, a suitable ball 25 or other bridging member is dropped into the casing and allowed to gravitate to its companion seat 23, closing the central passage 24 and enabling the fluid pressure in the casing thereabove to be increased sufficiently to shear the screws 21 and elevate the retainer 19 from engagement with the flexible sleeve valve 14.

It is to be noted that fluid under pressure is incapable of passing through the ports 13 and into the annulus around the casing in one direction by the sealing action of the side seal 22 in the retainer head 20 against the external wall of the collar 10 and also by the engagement of the external surface of the sleeve valve 14 with the interior wall of the retainer sleeve 19. Leakage of this fluid in the other direction is prevented by the locking of the lower end of the sleeve valve 14 to the collar 10 by the interfitting ribs 15, 17, which may be supplemented by the steel strap 16. The outwardly projecting flange 18 on the collar serves to support the secured end of the rubber sleeve valve 14 and also functions as a guide along which the retainer sleeve 19 may slide in shifting to its ineffective position shown in Figure 2.

In installations wherein the cementitious material is to be prevented from gravitating or othewise depositing below the collar, an annular barrier or bridge 26 is secured to the collar. Such barrier may assume various forms and is disclosed in the drawings as of the "petal" type, described in Patent No. 2,117,538. This barrier is in the form of a basket when released and consists of a plurality of leaf springs 27 secured to the exterior of overlapping basket "petals" 28, with the ends 27*a* of the springs welded or otherwise suitably attached to the collar. The springs 27 and "petals" 28 inherently tend to assume an expanded generally frusto-conical or basket shape. The basket is fastened to the collar with its attached "petals" and springs held initially in retracted position against the casing. As shown in the drawings, the retainer sleeve 19 extends beyond the collar flange 18 to encompass the free ends 27*b* of the leaf springs and "petals," holding them against the collar 10 and free from contact with the wall of the well bore. When sufficient pressure is imparted to the fluid within the casing to shear the screws 21, the elevation of the retainer 19 to free the back pressure valve 14 also removes restraint from the free ends 27*b* of the springs 27 and "petals" 28 to allow their inherent expansion outwardly into engagement with the wall of the well bore, thus forming an annular barrier to the passage of fluids in a downward direction, in the particular arrangement shown in the drawings.

Although the drawings specifically illustrate an upright barrier or basket 26 to prevent the cementitious material or other fluids discharged through the ports 13 from moving downwardly below the basket, the arrangement can also be incorporated in the casing string in an inverted position to prevent upward passage of fluids around the casing beyond the point at which the expanded casing bridge or barrier might be located.

It is, accordingly, apparent that a well cementing apparatus has been provided in which a back pressure valve 14 is protected against damage while the casing string is being lowered in the well bore by a device which cooperates with the valve to prevent outward flow of fluid through the ports 13 to the exterior of the casing until desired. Such outward flow will only occur after a predetermined degree of pressure has been built up in the fluid within the casing. In addition, the protective or retainer device 19 can also be used to hold a casing barrier 26 in retracted position while the casing is being run in the well bore and until such time as it is to perform its function, thereby preventing potential damage to the barrier structure, especially when used in an inverted position, while the casing is lowered through the bore hole. Moreover, the initial securing of the basket 26 in retracted position permits more ready circulation to take place along the entire casing string to condition the hole along its whole length preparatory to the cementing operation. The arrangement lends itself readily

to multiple stage or series cementing operations by allowing fluid under pressure to be pumped past the side ports 13 for ejection from the casing string at a predetermined location below the ports, after which the ports may be opened to permit the flow of fluid therethrough to the exterior of the casing.

I claim:

1. An apparatus including a ported tubular member adapted to form part of a well casing string, an elastic back pressure sleeve valve disposed over the member port and having one end secured to said tubular member and its other end movable to permit outward flow of fluid from the interior of the member through said port to the exterior of said member, and a shiftable sleeve disposed over and engageable with said elastic sleeve valve in leakproof relation with respect thereto, said shiftable sleeve making slidable sealing engagement with the exterior of said member at said other end of said elastic sleeve valve.

2. An apparatus including a ported tubular member adapted to form part of a well casing string, an elastic back pressure sleeve valve disposed over the member port and having its lower end secured to said tubular member and its upper end movable to permit outward flow of fluid from the interior of the member through said port to the exterior of said member, and a shiftable sleeve valve disposed over and engageable with said elastic sleeve valve in leakproof relation with respect thereto, said shiftable sleeve valve making slidable sealing engagement with the exterior of said member above said elastic sleeve valve.

3. An apparatus including a ported tubular member adapted to form part of a well casing string, an elastic back pressure sleeve valve disposed over the member port and having one end secured to said tubular member and its other end movable to permit outward flow of fluid from the interior of the member through said port to the exterior of said member, a well device mounted on said member for bridging the annular space between said member and the surrounding wall of a well bore, and a shiftable sleeve disposed over and engageable with said elastic sleeve valve in leakproof relation with respect thereto, said shiftable sleeve having one end disposed over said well device to hold the same in retracted position and its other end in slidable sealing engagement with the exterior of said member at said other end of said elastic sleeve valve.

4. An apparatus including a ported tubular member adapted to form part of a well casing string, an elastic back pressure sleeve valve disposed over the member port to permit outward flow of fluid from the interior of the member and to prevent inward flow of fluid through said port, a retainer sleeve slidable along the exterior of said member and disposed over and engaging the exterior of said elastic sleeve valve to prevent outward flow of fluid from the interior of the apparatus to its exterior, said retainer sleeve in its valve engaging position defining a sealed chamber with said member in communication with the interior of said member, whereby fluid at a predetermined pressure within said member shifts said retainer sleeve along the exterior of said member and elastic sleeve valve to a position permitting such outward flow of such fluid.

5. An apparatus including a ported tubular member adapted to form part of a casing string, a back pressure valve disposed over the member port to permit outward flow of fluid from the interior of the member and to prevent inward flow of fluid through said port, a well device mounted on said member for bridging the annular space between said member and the surrounding wall of a well bore, shiftable means disposed over and engaging the back pressure valve and well device to prevent such outward flow of fluid and to hold said well device in retracted position, said shiftable means in its valve engaging position defining a sealed chamber with said member in communication with the interior of said member, whereby fluid at a predetermined pressure within said member shifts said shiftable means from engagement with said back pressure valve and well device, thereby allowing outward passage of fluid from the interior of the apparatus to its exterior and expansion of said well device into engagement with the wall of said well bore.

6. An apparatus including a ported tubular member adapted to form part of a casing string, an elastic back pressure sleeve valve disposed over the member port to permit outward flow of fluid from the interior of the member and to prevent inward flow of fluid through said port, a well device mounted on said member for bridging the annular space between said member and the surrounding wall of a well bore, a retainer sleeve slidable along the exterior of said member and disposed over and engaging the exterior of said elastic sleeve valve and said well device to prevent such outward flow of fluid and to hold said well device in retracted position, said retainer sleeve in its valve engaging position defining a sealed chamber with said member in communication with the interior of said member, whereby fluid at a predetermined pressure within said member shifts said retainer sleeve along the exterior of said member, said elastic sleeve valve and said well device to a position permitting the aforesaid outward flow of fluid and expansion of said well device into engagement with the wall of said well bore.

7. An apparatus including a ported tubular member adapted to form part of a well casing string, a back pressure valve disposed over the member port to permit outward flow of fluid from the interior of the member and to prevent inward flow of fluid through said port, hydraulically shiftable means slidable along the exterior of said member and disposed over and engaging the exterior of said valve to prevent outward flow of fluid from the interior of the apparatus to its exterior, said hydraulically shiftable means in its valve engaging position defining a sealed chamber with said member in communication with the interior of said member, whereby fluid at a predetermined pressure within said member shifts said hydraulically shiftable means along the exterior of said member and valve to a position permitting such outward flow of such fluid.

CLARENCE E. BURT.

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