This invention relates to new and useful improvements in fill-up and cementing devices.

In the usual procedure for cementing a well such as an oil well, a cementing valve or shoe is disposed on the lower end of a casing or pipe for lowering the valve or shoe to a predetermined point in the well bore. During the lowering of the valve or shoe, the casing tends to float in the drilling mud or fluid in the well bore and to overcome such tendency and also to prevent the collapse of the casing due to internal fluid pressure, it has generally been the practice to periodically halt the lowering movement of the casing to partially fill the casing with fluid admitted at the upper end of the casing near the well surface. Such procedure is obviously slow and expensive. One type of apparatus for automatically admitting well fluid into the casing or well pipe as it is lowered into the well bore is disclosed in my co-pending United States patent application, Serial No. 357,531, filed May 26, 1953.

It is an object of this invention to provide a fill-up and cementing device which is an improvement over the fill-up and cementing device disclosed in the aforesaid co-pending patent application.

An important object of this invention is to provide a new and improved fill-up and cementing device which will initially function as a pressure actuating valve for automatically admitting sufficient well fluid into the casing or well pipe with which the device is connected to control the level to which the fluid will rise within said casing or well pipe but upon subsequent manipulation will act as a normal backcheck valve.

Another object of this invention is to provide a fill-up and cementing device wherein the device is adapted to open and close in accordance with a predetermined fluid pressure differential acting on the device during the lowering of the device into a well bore, such device having therewith means for closing off fluid flow through the device to prevent a blow-out of the well.

A further object of this invention is to provide a fill-up and cementing device having therewith a circulating valve which is used to circulate foreign material out of the casing to which the device is attached.

A still further object of this invention is to provide a new and improved fill-up and cementing device which is adapted to automatically maintain a predetermined desired fluid level in the casing or well pipe to which the device is attached, such device having means resiliently urging the device to a closed position when the predetermined level in the casing or well pipe has been reached.

The construction designed to carry out the invention will be hereinafter described, together with other features thereof.

The invention will be more readily understood from a reading of the following specification and by reference to the accompanying drawings forming a part thereof, wherein an example of the invention is shown, and wherein:

Figure 1 is a sectional view illustrating the device of this invention in its normal position for closing fluid flow into the well casing.

Figure 2 is a partial sectional view illustrating the device of Figure 1 when such device is open for permitting fluid flow into the casing.

Figure 3 is a view similar to Figure 2, but illustrating the device of this invention after the flapper valve has been disconnected from the valve body so that the valve acts as a normal backcheck valve.

Figure 4 is a view, partly in elevation and partly in section, illustrating the device of Figure 1 in a position for preventing a blow-out of the well during the lowering of the casing into the well bore.

Figure 5 is a view of the closure flap of Figure 1 as viewed from below.

Figure 6 is a sectional view illustrating the valve assembly of the circulating valve shown in Figure 1.

Figure 7 is a sectional view illustrating a modified form of the device of Figure 1.

In the drawings, the letter A designates generally the fill-up and cementing device of this invention which is mounted in a collar 10 connected to the lower end of a string of casing or pipe P which extends to the surface of the well bore in which the device A is lowered for cementing purposes. The device A is preferably fixed in the collar 10 by a concrete liner 11 which is formed in the shape of a cylinder and is interposed between the collar 10 and the valve device A. As will be explained, the valve device A is adapted to open to permit fluid to flow into the casing or pipe P during the lowering of the device A into the well bore to its desired position for injecting cement into the well. The device A automatically closes when the fluid level in the casing or pipe P reaches a predetermined level with respect to the fluid level in the annulus between the pipe P and the well bore (not shown). Thus, during the lowering of the device A into the well bore, there is an automatic filling of the casing or pipe P with well fluid so as to maintain the fluid in the casing or pipe P at a predetermined level without the necessity for halting the lowering operation to fill the casing or pipe P with fluid. Therefore, it will be evident that this device enhances the speed of lowering the pipe or casing.

The fill-up and cement device A illustrated in Figures 1–6, has a cylindrical valve body 12 which is retained in the collar 10 by the concrete liner 11. The body 12 has a plurality of external circumferential ribs or projections 12a which serve to securely anchor the body 12 in the concrete liner 11. Similarly, the collar 10 has a plurality of inner circumferential ribs or projections 10a which extend into the concrete liner 11 for securely anchoring the liner 11 to the collar 10. It will be appreciated that the body 12 could be secured to the collar 10 by threads or other equivalent securing means instead of the concrete liner 11, if desired.

The annular body 12 includes an annular cap 14 which is positioned on the upper end of the body 12 and is provided with a bore 14a which is of a reduced size as compared to the bore 12c of the body 12. However, the bore 14a is of the same, or substantially the same, diameter as the bore 11a of the concrete liner 11 disposed above such cap 14. Of course, such bores 11a and 14a can be varied if desired so that they are not of the same diameter.

A floating valve sleeve or annular piston 16 is disposed within the bore 12c of the valve body 12 and such sleeve or piston is adapted to move longitudinally within the valve body 12. Seal rings 17 and 18, formed of rubber or a similar elastic material, are disposed around the periphery of the sleeve 16 for engagement with the wall of the bore 12c to provide a sealing engagement with the
inner bore 12c during the relative longitudinal movement of the sleeve or piston 16 with respect to the body 12. On the upper end of the annular piston 16, there is positioned a plurality of arcuate stop segments 20 which are substantially triangular in cross-section so as to present a knife edge for abutment with the radial lateral surface 14b of the upper cap 14. The stop segments 20 are spaced from each other so as to leave fluid flow passages 20b therebetween to permit the fluid pressure within the casing or pipe P to act upon the entire upper end of the seat or piston 16 when the stop segments 20 are in contact with the upper lateral end of the sleeve 16 and the cap 14 so as to exert a predetermined amount of pressure downwardly on the piston 16 to assist in controlling the opening and closing thereof under normal circumstances, as will be explained.

The peripheral surface at the upper end of the piston 16 is of an enlarged diameter so as to form the external radial shouldering 16a which is adapted to abut an inwardly directed annular shouldering 12b on the internal surface of the bore 12c of the body 12 to limit the downward movement of the piston 16 during the use of the device as the normal backcheck valve, as will be explained hereinafter.

A flapper closure or disc 25 is mounted on the lower end of the annular piston 16 for opening and closing fluid flow through the bore 16b of the sleeve 16 by a seating of the closure or disc 25 in contact with the seating surface of the lower internal edge of the piston 16. The piston 16 has a downwardly extending lug 26 formed therewith to which a trunnion 27 extending from the closure 25 is adapted to be connected by a pivot pin 28 which extends through the lug 26 and the trunnion 27. In some instances, it may be desirable to position a torsion spring 30 around the pivot pin 28 with one end of the spring 30 being connected with the lug 26, while the other end thereof is connected with the trunnion 27, so as to normally urge the closure 25 to its closed position (Figure 1). It will be evident, from the following description, that the spring 30 is not essential to the operation of the device, but merely assists in closing the closure 25 when the valve functions as a normal backcheck valve.

The closure 25 has depending therefrom a pivot lug 32 which is pivotally connected to a link or linkage 33 by a pivot pin 31 which extends through one end of the pivot lug 32. In the forms of the invention shown in Figures 1–6, the link 33 is formed with an outer housing 34 and an inner stem 35 which extends into the housing 34 and is longitudinally movable relative thereto. The stem 35 is maintained in its telescoped or retracted position relative to the housing 34 with an annular shoulder 35a in engagement with the lower end 34a of the housing 34 by means of a spring 36 which acts upwardly on a retaining ring 35b of the stem 35 to urge the stem 35 upwardly or inwardly relative to the housing 34. The lower end of the coil spring 36 rests upon an internal shoulder 340 of the housing 34.

The link 33 has the lower end thereof connected to a downwardly depending extension 38 on the lower end of the body 12 by a shear pin 40 which extends through the lower end of the stem 35 and through the extension 38. Such shear pin 40 is of sufficient strength to shear off at a predetermined pressure applied to the annular piston 16 from above, as will be explained hereinafter.

The closure 25 has a circulating valve C therewith for controlling fluid flow or circulation out of the casing for washing from foreign material such as sand that may be picked up while running the casing into the well bore. Such circulating valve C includes a plurality of guide rods 42, each of which extends through a guide opening 25a in the closure 25. The lower ends of the valve rods 42 are connected to an annular valve element 43 (Figures 1 and 6) and the upper ends of the rods 42 are connected to a perforated disc 45 having one or more openings 45a therethrough. A spring 46 surrounds each rod 42 and acts to normally urge the disc 45 upwardly to maintain the annular valve element 43 in a seated or closed position with respect to fluid passages 25b (Figure 5) so as to prevent fluid flow or circulation upwardly through the passages 25b and the openings 25a. When the fluid pressure above the disc 45 reaches a predetermined amount, it urges the downwardly against the upward urging action of the springs 46 so as to move the valve element 43 downwardly to open the flow or circulation of fluid downwardly through passages 25b (Figure 5) in the closure 25. The rods 42 are of such length that flow of the fluid downwardly through the passages 25b contacts the valve surfaces 45a on the lower side of the disc 45 adjacent each rod 42 contacts the upper wall surface of the passages 25b to close the fluid flow downwardly through the passages 25b and the openings 25a. Thus, the valve element 43 is normally in an upright position to close fluid flow upwardly through the openings 25a and the passages 25b in the closure 25, but upon the application of a predetermined pressure from the casing or pipe P to the upper surface of the disc 45, the element 43 is moved downwardly to open the fluid flow or circulation downwardly through the passages 25b and the openings 25a. When the fluid pressure in the casing reaches a predetermined amount which is substantially greater than that required for initially opening the element 43, then the disc 45 is moved downwardly so as to move the valve surface 45a thereof into closing position to thereby prevent fluid flow downwardly through the passages 25b and the openings 25a.

In the operation or use of the fill-up and cementing device A of Figures 1–6, such device is lowered into a well bore by the lowering of the well pipe P. Ordinarily, the well pipe P will be a well casing which has sections of the casing added thereto during the lowering into the well bore. Since the well bore normally will have drilling mud or fluid therein which will tend to float the well pipe P, it is important that the pipe P be filled, or partially filled, with the fluid so that the lowering of the pipe P into the well bore is not retarded or prevented and so that the exterior fluid pressure does not collapse the pipe. By means of the fill-up or cementing device A of this invention, fluid in the well bore is automatically admitted into the interior of the well pipe P so as to maintain a predetermined fluid level within the well pipe P relative to the fluid level in the annulus between the well pipe P and the wall of the well bore into which the pipe is lowered.

As the well pipe P and the device A connected therewith are lowered into the well bore, the pressure of the well fluid acts upon the lower end of the sleeve or piston 16 to move same upwardly within and relative to the body 12. Such upward movement of the piston 16 effects a pivotal movement of the closure 25 from its closed position (Figure 1) to its open position (Figure 2). The pivotal swinging of the closure 25 is caused by reason of the pivotal connection of the closure 25 to the lower end of the piston 16 and its pivotal linkage connection through the link 33 to the lower extension 38 of the body 12. It should be noted that during the normal opening and closing of the closure 25, the spring 36 maintains the surfaces 34a and 35a in contact with each other so that the link 33 acts in the same manner as a solid member would act during normal operation. Also, the valve element 43 is maintained in its upper closed position under the normal opening and closing of the closure 25.

In the form of the invention shown in Figures 1–6, the amount of pressure which is necessary to cause a longitudinal movement of the piston 16 relative to the annular body 12 depends in part upon the valve annular internal end areas at the upper and lower ends of the piston 16. The upper end of the piston 16 is enlarged and therefore the upper lateral end surface of the piston is of a slightly larger area than the lateral end surface
at the lower end thereof, whereby a slightly lower pressure within the well pipe or casing P will effect the fluid pressure externally of the sleeve as compared with the fluid pressure externally of the casing P. Also the difference in the lateral end areas of the sleeve reduces somewhat the amount of pressure within the casing that is required to shear the shear pin relative to the fluid pressure externally of the casing P, which of course tends to minimize the possibility of bursting the casing P due to excessive internal pressure required during the shearing operation.

However, the difference in the areas of the ends of the piston 16 is very small and for all practical purposes, the well fluid pressure within the casing P is substantially the same as the well fluid pressure externally thereof when the closure is moved to its closed position. Thus, if the springs 21 were not employed, the fluid pressure within and externally of the casing or pipe P would be maintained substantially equal during the lowering of the device A and the casing P into the well bore. However, the springs 21 assist the fluid pressure within the casing P in returning the sleeve 16 to its lower position for closing the valve 25 so that a faster closing action of the closure 25 is effected when the pressure internally of the casing is substantially the same as the pressure externally thereof. It will be evident that the springs 21 may be of different strengths and if made sufficiently strong can actually cause the sleeve 16 to move downwardly to close the valve closure 25 when the pressure in the casing is somewhat less than the pressure externally of the casing so that a constant differential in the fluid levels is maintained regardless of the depth to which the device A is lowered. For example, the springs 21 may effect a closing of the closure 25 when the fluid level exteriorly of the pipe P is about 100 feet above the fluid level inside of the pipe P.

As previously mentioned, the circulating valve C which is mounted in the closure 25 is normally inactive, but when it is desired to circulate fluid downwardly through the closure 25 while such member 25 is closed with respect to the piston seating surface 16, fluid pressure is build up within the casing or pipe P from the surface of the well to a predetermined pressure at which the disc 45 is moved downwardly to unseat the valve element 43, whereby fluid is circulated downwardly through the passage 42 to remove any foreign material that may be present in the casing as a result of the running in of the casing into the well bore. For example, normal circulating pressure could be between about 250 and 300 pounds per square inch, during which time both the valve element 43 and the valve surfaces 45a are unseated and the fluid pressure acting on the disc 45 and the upper lateral end area of piston 16 from the fluid in the casing exceeds the 300 pounds per square inch, the disc 45 would be moved downwardly to seat the surface 45a to thereby stop fluid circulation from the casing P, whereby the fluid pressure then acts on the disc 45 to urge the link 33 downwardly to shear the shear pin 40. When the shear pin 40 is severed, the closure 25 then acts as a normal backpressure or backcheck valve. The spring 30 would assist inretaining the closure 25 in a seated position in contact with the seating surface 16c. The shear pin 40 is severed, but upon the application of a cement under pressure from the casing, the closure 25 could, of course, be opened for injecting the cement below the device A.

While the shear pin 40 is still connected and the link 33 therefor still has connection with the closure 25, the special linkage 33 illustrated in Figures 1-4, serves as a blow-out preventer. Thus, normally as the pressure in the annulus around the well casing or pipe P increases with respect to the fluid pressure interiorly of the casing P, the piston 16 is forced upwardly to open the area between the piston and the closure 25 so that the fluid flow of the well fluid is into the inside of the casing P. With such a construction, it will be evident that there is, at all times, therefore, a danger of a blow-out pressure blowing through the open valve. With the link arrangement shown in Figures 1-4, if the pressure outside of the casing or pipe P reaches a predetermined amount, equivalent to blow-out pressures, then the high velocity and pressure surge of the fluid would force the closure 25 upwardly against the action of the spring 36. In other words, the housing 34 would be forced upwardly relative to the inner stem 35 to compress the coil spring 36 and to permit the closure 25 to seat against and in contact with the seating surface 16c of the piston 16 when the piston 16 is in its completely raised or upper position (Figure 4). It will thus be evident that even though the link 33 is connected by the pivot pin 40 to the extension of the body 12, the valve is entirely closed and the blow-out pressure is confined below the device A in the well bore. Thus, danger of a blow-out is prevented.

In Figure 7, a modification of the device A is illustrated and such modification is indicated by the letter A'. The device A' has a modified annular piston 116, as compared to the piston 16 of the device A in that the upper and lower annular ends of the piston 116 are of equal area and only the coil springs 121 are utilized in moving the piston 116 to a closed position. Therefore, a predetermined fluid level in the casing or pipe P is maintained by the action of the springs 121 only rather than the differential in areas of the ends of the piston 116. Thus, when the pressure of the fluid externally of the casing or pipe P reaches a predetermined value sufficient to overcome the urging force of the springs 121, the sleeve 116 is moved upwardly to pivot the closure 125 for opening same to admit fluid into the casing or pipe P. After a predetermined amount of fluid is within the casing or pipe P, the pressure thereof acts on the upper end of the piston 116, together with the springs 121 so as to again move the piston 116 downwardly to close the closure 125.

The closure 125 is modified in the device A' as compared to the closure 25 of the device A in that the circulating valve C is eliminated in the closure 125. However, in the normal opening and closing, the closure 125 functions in the same manner as the closure 25 so that it would pivot about the pivot pin 28, the shear pin 40 and the pivot pin 31 as it moves from open to the closed position, and vice versa.

The link 133 in the device A' is modified as compared to the link 33 of the device A in that the mechanism for preventing a blow-out has been eliminated from the link 133. The remainder of the parts of the device A' of Figure 5 are identical with those in the device A of Figures 1-4 and have like numerals.

The operation of the device A' is substantially identical with the device A, except that the circulating valve C is not employed and the blow-out preventer mechanism associated with the link 33 is eliminated. However, the elimination of both of such mechanisms from the device A' does not change the normal opening and closing of the valve device A' as compared to the device A. However, the closing and opening of the closure 125 by the movement of the annular piston 116 is through the action of the springs 121 and not by reason of any difference in the lateral end areas of the piston 116.

When the casing or pipe P has reached its lower limit and it is desired to pump cement into the well bore for cementing the casing or pipe therein, the cement under fluid pressure is forced downwardly to urge the upper annular piston 116 and the closure 125 and the link 133 downwardly to shear the shear pin 40, whereby the annular piston 116 moves downwardly until the lower end 116z thereof contacts the lower internal annular shoulder 112e of the body 112. The closure 125 is then free to swing and act as a normal backpressure valve and if the torsion spring 30 is employed, it normally maintains
the closure 125 in the seated or closed position, even though the shear pin 40 has been severed. It is believed that the linkage 33 could be substituted for the linkage 133 in the device A', so that the blow-out preventer mechanism of the linkage 33 could be utilized with the device A'.

Also, the circulating valve C could be incorporated with the device A', rather than the closure 125 illustrated in Figure 7. It should also be pointed out that the springs 21 can be eliminated from the modification of Figures 1-4, since the differential in the lateral end areas of the piston 16 permits a closing of same prior to the fluid level in the casing reaching the same level as the fluid outside the casing. Thus, the overflow of the fluid in the casing or pipe is prevented with the differential area device of Figure 1, even if the springs 21 are not employed. However, with the piston 116 of the device A', wherein the lateral end areas are the same, the springs 121, of course, have to be utilized to assure that the sleeve 116 closes prior to the overflow of the fluid at the top of the casing being lowered into the well.

The foregoing disclosure and description of the invention is illustrative and explanatory thereof and various changes in the size, shape and materials, as well as in the details of the illustrated construction, may be made within the scope of the appended claims without departing from the spirit of the invention.

What is claimed is:

1. In an improved fill-up and cement device adapted to be mounted on a well pipe for lowering into a well bore, including an annular body, an annular piston disposed in said body for longitudinal movement relative thereto, and a closure flap pivotally connected to said piston and adapted to normally close the bore through the piston, an extensible linkage connecting said flap to said annular body and a point below the pivotal connection between the flap and piston, said flap being moved to a closed position with respect to said piston by an extended seal linkage when the pressure acting on said flap reaches a predetermined amount.

2. In a device for automatically opening and closing fluid flow between the interior of a well pipe and the exterior thereof during the lowering of the well pipe into a well bore for maintaining a predetermined fluid level in the well pipe relative to the fluid level exteriorly thereof, a hollow body, a hollow piston disposed in said body for longitudinal movement relative thereto, a closure flap pivotally connected to said piston at its lower end and adapted to normally close the bore through said piston, means connecting the closure flap to the hollow body at a point below the pivotal connection of the flap to the piston whereby the flap is swung to an open position upon an upward movement of the piston, said hollow piston having equal areas at each end thereof, and a resilient means positioned in recesses in the upper end of said piston for controlling the opening and closing of the device.

3. A well device adapted to be connected in a well pipe and including, a hollow body having means for connecting it in said well pipe, a pressure-actuated element slidably within the hollow body and having a passage extending completely therethrough, a closure member cooperating with the lower end of the passage of the pressure-actuated element and movable with respect thereto to open and close said passage, releasable means for securing the closure member to the body in a position to be engaged by the pressure-actuated element, means connecting the pressure-actuated element to the closure member whereby a movement of the pressure-actuated element upwardly within the hollow body will effect a disengagement of the closure member from the pressure-actuated element to open the passage therethrough, and pressure-actuated valve means associated with said opening for controlling flow therethrough, and means connected to a pressure-actuated element slidably within the hollow body and having a passage extending completely therethrough, a closure member cooperating with the lower end of the passage of the pressure-actuated element and movable with respect thereto to open and close said passage, releasable means for securing the closure member to the body in a position to be engaged by the pressure-actuated element, means connecting the pressure-actuated element to the closure member whereby a movement of the pressure-actuated element upwardly within the hollow body will effect a disengagement of the closure member from the pressure-actuated element to open the passage therethrough, the releasable connection between the closure member and the hollow body comprising an extensible link having its upper portion pivoted to the closure member and its lower portion pivoted to the hollow body, said extensible link including two members having a spring of predetermined strength maintaining the members in telescoped position, the link being moved to extend against the pressure, the pressure from exteriorly of the well pipe acting upon the closure member exceeding a predetermined amount so that said closure member may be moved independently of the pressure-actuated element to a closed position.

6. A well device as set forth in claim 5, wherein the pressure-actuated element has a first surface exposed to the pressure in the well pipe and a second surface exposed to the pressure exteriorly of the well pipe, said surfaces being substantially equal, and spring means acting upon the pressure-actuated element to urge the latter in a direction toward the closure member.

7. A well device including, a well pipe adapted to be disposed in a well bore, a hollow housing connected in said well pipe, a piston-like element slidable longitudinally within the hollow housing and having a central passage extending therethrough, a closure member forming a valve member adapted to seat on the lower end of said piston-like element, said closure member being actuated by a pressure exceeding a predetermined point, whereby a blow-out-through the well pipe due to excessive pressure is prevented.

8. A well device adapted to be connected in a well pipe and including, a hollow body having means for connecting it in said well pipe, a pressure-actuated element slidably within the hollow body and having a passage extending completely therethrough, a closure member cooperating with the lower end of the passage of the pressure-actuated element and movable with respect thereto to open and close said passage, releasable means for securing the closure member to the body in a position to be engaged by the pressure-actuated element, means connecting the pressure-actuated element to the closure member whereby a movement of the pressure-actuated element upwardly within the hollow body will effect a disengagement of the closure member from the pressure-actuated element to open the passage therethrough, and pressure-actuated valve means associated with said opening for controlling flow therethrough, and means connected to a pressure-actuated element slidably within the hollow body and having a passage extending completely therethrough, a closure member cooperating with the lower end of the passage of the pressure-actuated element and movable with respect thereto to open and close said passage, releasable means for securing the closure member to the body in a position to be engaged by the pressure-actuated element, means connecting the pressure-actuated element to the closure member whereby a movement of the pressure-actuated element upwardly within the hollow body will effect a disengagement of the closure member from the pressure-actuated element to open the passage therethrough, the releasable connection between the closure member and the hollow body comprising an extensible link having its upper portion pivoted to the closure member and its lower portion pivoted to the hollow body, said extensible link including two members having a spring of predetermined strength maintaining the members in telescoped position, the link being moved to extend against the pressure, the pressure from exteriorly of the well pipe acting upon the closure member exceeding a predetermined amount so that said closure member may be moved independently of the pressure-actuated element to a closed position.
upon movement of the piston-like element in one direction and which will guide the closure member upon movement in an opposite direction, a connection between the closure member and the hollow housing for seating and unseating said closure member upon movement of the piston-like element in opposite directions, said piston-like element having one side exposed to pressure in the well pipe and its opposite side exposed to pressure exteriorly of the pipe whereby said element is moved by the differential in such pressures, said connection between the closure member and the hollow housing being releasable whereupon said closure member is actuated by a predetermined pressure in the well bore exteriorly of the pipe which acts upon the closure member whereby a blow-out through the well pipe is prevented.

8. A well device as set forth in claim 7, together with a downwardly opening circulating valve mounted in the closure member and movable to an open position by the application of pressure from interiorly of the well pipe, whereby a limited downward circulation may be carried out with the closure member in its seated position.

References Cited in the file of this patent

UNITED STATES PATENTS

2,630,178  Brown  Mar. 3, 1953