July 26, 1955 R. C. BAKER 2,713,870

APPARATUS FOR AUTOMATICALLY FILLING WELL CASING

Filed Feb. 3, 1953 2 Sheets-Sheet 1

Fig. 1.

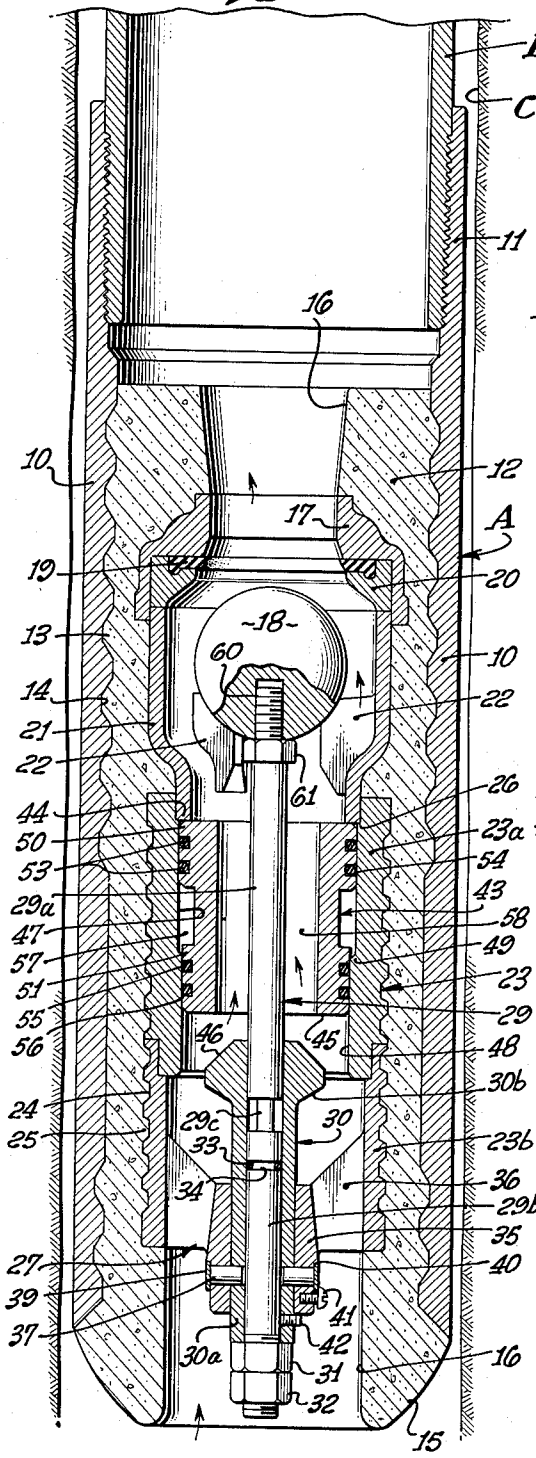
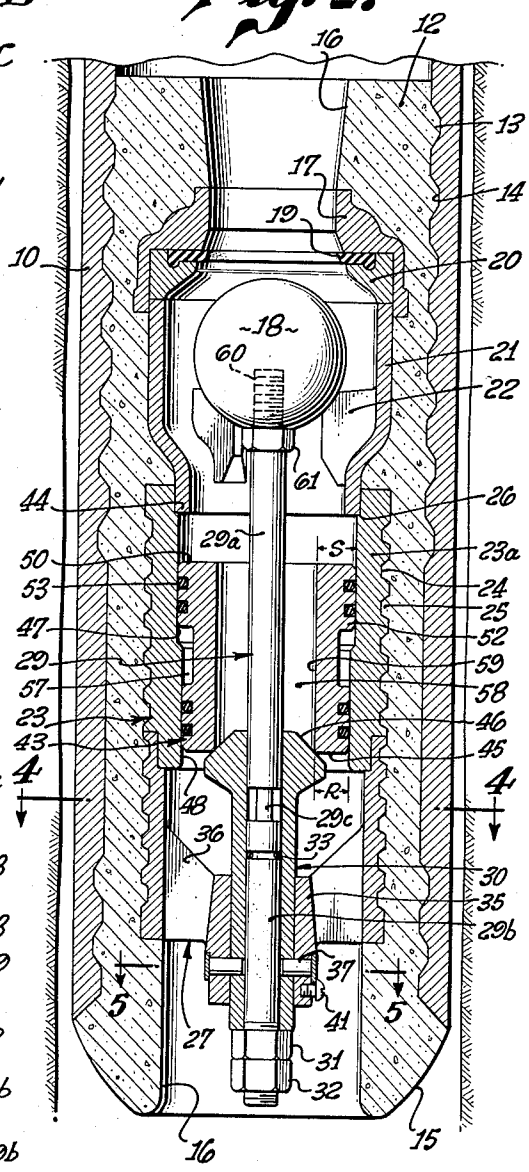


Fig. 2.



REUBEN C. BAKER,
INVENTOR.

BY

Mellen and Hanscom
ATTORNEYS

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Fig. 3.

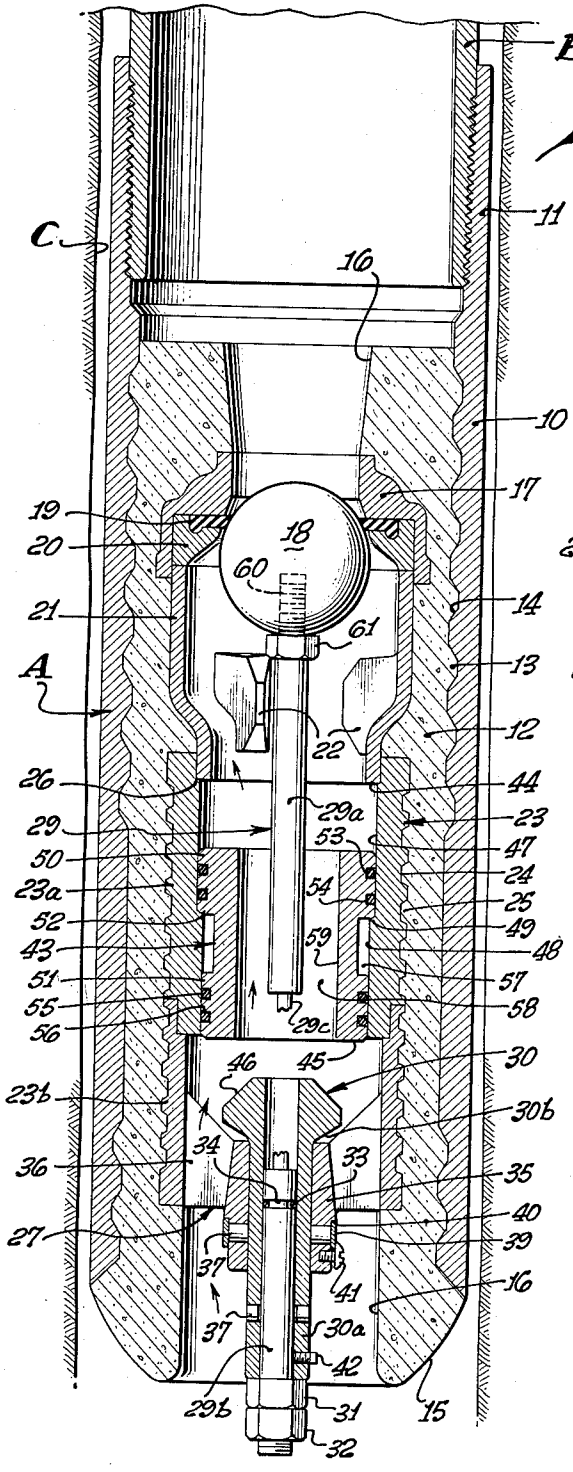


Fig. 4.

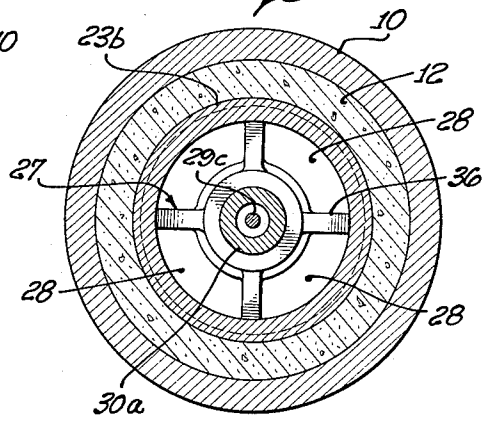
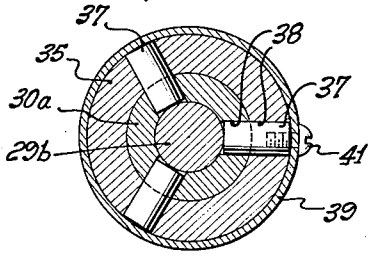


Fig. 5.



REUBEN C. BAKER,
INVENTOR.

BY

Mellen and Hanscom
ATTORNEYS

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APPARATUS FOR AUTOMATICALLY FILLING WELL CASING

Reuben C. Baker, Coalinga, Calif., assignor to Baker Oil Tools, Inc., Los Angeles, Calif., a corporation of California

Application February 3, 1953, Serial No. 334,784

15 Claims. (Cl. 137—68)

The present invention relates to subsurface well apparatus, and more particularly to apparatus for filling a string of well casing, or the like, with fluid in the well bore as it is lowered therewithin.

This application is a continuation-in-part of my prior application for "Apparatus for Automatically Filling Well Casing," Serial No. 295,007, filed June 23, 1952.

In my above-identified application, differential valve apparatus is disclosed for filling a well casing string with the fluid in the well bore as the string is lowered therewithin, the fluid level within the casing string preferably being held at a predetermined lower level than that existing externally of the casing string. The apparatus for controlling the filling of the casing string also holds the back pressure valve element from its companion seat until the casing string has been lowered to the desired depth in the well bore, at which time the valve element can be released, to move upwardly into engagement with the companion seat.

Under some special operating conditions, the back pressure valve element has been released prematurely before the casing string reached its proper depth in the well bore. Such premature release precludes further automatic filling of the casing string with the well bore fluid, rendering a portion of the apparatus ineffective for accomplishing its function.

The differential valve portion of the apparatus may tend to leak, resulting in improper filling of the well casing with the well bore fluid. The leakage is probably due to the difficulty of properly aligning the valve parts, even when such parts are machined accurately.

Accordingly, an object of the present invention is to provide subsurface apparatus for automatically filling well casing with the well bore liquid and for releasably holding a back pressure valve element from its seat, in which the back pressure valve element is not released prematurely.

Another object of the invention is to insure the proper alignment of the differential valve parts of the apparatus, so that leakage therebetween is prevented when the differential valve is in closed position.

A further object of the invention is to provide subsurface well apparatus for controllably allowing a casing string to fill with the well bore fluid, which is comparatively economical to manufacture and which can be assembled with facility.

Yet another object of the invention is to provide an automatic device for filling well casing with the well bore fluid and for holding a back pressure valve element from its seat, in which the element is held in a stationary position during lowering of the casing in the well bore, to preclude its hammering or vibrating against a companion stop or rest, which might cause failure of the apparatus.

This invention possesses many other advantages, and has other objects which may be made more clearly apparent from a consideration of a form in which it may be embodied. This form is shown in the drawings accompanying and forming part of the present specification. It will now be described in detail, for the purpose of illustrating the general principles of the invention; but it is to be understood that such detailed description is not to be taken in a limiting sense, since the scope of the invention is best defined by the appended claims.

Referring to the drawings:

Figure 1 is a longitudinal section through an apparatus embodying the invention, disposed in a well bore, with the filling valve in open position;

Fig. 2 is a view similar to Fig. 1, with the casing filling valve in closed position;

Fig. 3 is a view similar to Fig. 1, with the filling valve rendered inoperable and the back pressure valve released;

Fig. 4 is a cross-section taken along the line 4—4 on Fig. 2;

Fig. 5 is a cross-section taken along the line 5—5 on Fig. 2.

The apparatus A disclosed in the drawings is designed to form part of a string of well casing B to be run in a well bore C. As specifically illustrated, it is embodied in a casing shoe forming the lower terminus of the casing string. However, it is to be understood that this apparatus could also be incorporated in the casing string B at an intermediate point along its length, in which event is would be considered to be a casing collar.

The apparatus includes an outer tubular member **10** having an upper threaded box **11** for threaded attachment to the lower end of an adjacent casing section B. The tubular member has a cementitious plug **12** cast therein, ribs **13** on the plug being formed during the casting operation by external grooves **14** in the tubular member for the purpose of inseparably uniting the parts against relative movement. The lower end of the cementitious plug **12** is rounded to provide a guiding nose **15** for facilitating passage of the casing string through obstructions and restrictions in the well bore C as it is being lowered therewithin.

The cementitious plug **12** has a central passage **16** therethrough. This passage is surrounded by a valve seat **17** cast within the plug and adapted to be engaged by a back pressure valve element **18** in the form of a ball, preferably buoyant in cement slurry. In order to prevent leakage between the ball and the seat, a seal ring **19** may be clamped to the seat **17** by a retainer ring **20**, which is held in appropriate position by a tubular stop member **21** secured within the cementitious plug **12**. This stop member has inwardly directed and circumferentially spaced lugs or fingers **22** upon which the ball valve member **18** may engage when shifted in a downward direction out of contact from its companion seat **17**.

It is desired to maintain the ball valve member **18** out of engagement with its seat **17** during lowering of the casing string B through the fluid in the well bore C, for the purpose of allowing the well bore fluid to flow upwardly through the apparatus and into the casing. It is also desired to controllably fill the casing string B with the well bore fluid up to a level that is preferably less than the level of the fluid externally of the casing string. To accomplish these objectives, a valve device is embodied in the tubular member **10** below its back pressure valve portion **18**. This device includes a tubular housing **23** having external grooves **24** receiving ribs **25** in the cementitious plug to prevent relative movement between the two. The housing, as shown, is formed of an upper section **23***a* piloted into a lower section **23***b*. The upper section has a shoulder **26** engaging the lower end of the stop member **21** to properly locate the parts with respect to each other.

The lower housing portion **23***b* has a spider **27** integral with it, or otherwise united to it, this spider being pro-

vided with one or more ports or openings 28 therethrough to allow well fluid to flow upwardly into the housing 23. As stated above, it is preferred to have the back pressure ball 18 initially prevented from engaging its seat 17. This objective is accomplished by threading the upper end of a tie rod 29 into a threaded bore in the ball 18, the lower end of the tie rod extending completely through a valve seat 30. The tie rod 29 has an upper portion 29*a* and a lower portion 29*b*, the terminus of the lower portion being threaded for reception of an adjusting nut 31 and a lock nut 32, the adjusting nut 31 being adapted to engage the lower end of the depending or tubular stem portion 30*a* of the valve seat, in order to secure the back pressure ball valve element 18 snugly and firmly in engagement with the stop lugs or fingers 22. After this securing action has taken place, the lock nut 32 is tightened against the adjusting nut 31 to prevent loosening or displacement of these parts with respect to one another.

The upper and lower portions 29*a*, 29*b* of the tie rod are interconnected by a reduced diameter or weakened portion 29*c* that is integral therewith. This weakened portion is preferably disposed within the tubular valve seat member 30 and is a location at which the tie rod 29 is to be pulled apart, in the manner described hereinbelow, whenever the back pressure ball valve element 18 is to be released and allowed to engage its companion seat. Leakage of fluid between the lower portion 29*b* of the tie rod and the depending or tubular stem portion 30*a* of the valve seat is prevented by providing a suitable side seal 33, such as a rubber O ring, located in a groove 34 in the tie rod and engaging the inner wall of the tubular stem 30*a*.

The valve seat 30 has its depending or tubular stem portion 30*a* extending through an elongate hub 35 of the spider 27. This hub is secured to the lower housing portion 23*b* by means of a plurality of circumferentially spaced and generally radially disposed webs or ribs 36, which provide the ports or openings 28 therebetween. In order to obtain the required length of the spider hub 35, it may depend substantially below the spider ribs 36.

The tubular stem portion 30*a* of the valve seat 30 is secured to the spider hub 35 by a plurality of shear pins 37 arranged in generally radial fashion, these pins being located in aligned holes 38 in the spider hub and the tubular stem portion, preferably at a location below the spider ribs 36 and below the lower end of the lower valve housing 23*b*, in order to facilitate insertion of the pins 37 in place when the apparatus is being assembled. The pins 37 are prevented from displacement from their appropriate location within the tubular stem portion 30*a* and the spider hub 35 by an encompassing retaining sleeve 39 which abuts an upper shoulder 40 on the spider, and which is prevented from dropping downwardly from its assembled position by a suitable screw 41 threaded into the spider hub 35 adjacent the lower end of the retainer sleeve.

From the description given so far, it will be evident that the engagement of the ball 18 with the stop lugs or fingers 22 prevents the former from moving downwardly, and that the engagement of the adjusting nut 31 with the lower end of the tubular stem portion 30*a* prevents the ball 18 from moving upwardly. It is also evident that the valve seat 30 is initially held in a predetermined stationary position by the shear pins 37, releasably attaching it to the hub 35 of the spider 27. When these shear pins 37 are disrupted, as described below, the valve seat 30 can move downwardly to a position determined by engagement of the lower transverse surface 30*b* of its upper portion with the spider hub (Fig. 3). Upward movement of the valve seat 30 after the shear pins 37 have been disrupted is prevented by a stop screw 42 which is threaded transversely through the tubular stem portion 30*a* of the valve seat and into the lower portion 29*b* of the tie rod. This stop screw 42 is located adjacent the lower end of the spider hub 35 when the shear pins 37 are intact. It has the purpose of attaching the lower portion 29*b* of the tie rod to the tubular stem portion 30*a* of the valve seat, so that the tie rod is prevented from dropping out of the apparatus when the tie rod is disrupted at its weakened section 29*c*, in the manner described below. Following such disruption, the stop screw or element 42 has the further purpose of limiting the amount of upward movement of the valve seat 30, since the stop screw will then engage the lower end of the spider hub 35.

It is to be noted that fluid can flow upwardly through the spider ports or openings 28, through the valve housing 23, around the valve seat 30 and tie rod 29, continuing on up through arcuate spaces between the stop lugs 22, and around the ball valve member 18, and on up through the back pressure valve seat 17 into the casing section B thereabove. The ability of the fluid to flow upwardly in this manner is dependent upon the location of a tubular valve member 43 that is slidable within the upper valve housing portion 23*a* between an upper position in engagement with the lower end 44 of the stop members 21, in which the lower end of the valve member 37 is disposed substantially above the valve seat 30 (Fig. 1), and a lower position in which the lower inner sealing edge 45 of the valve member is in engagement with the tapered valve seat surface 46 (Fig. 2).

The upper housing portion 23*a* has an upper enlarged cylindrical wall 47 and a lower cylindrical wall 48 of smaller diameter than the upper wall. Between these two walls is provided a transverse shoulder 49. The valve member 43 has a corresponding large diameter upper portion 50 adapted to slide along the upper wall 47 and a smaller diameter portion 51 slidable along the lower cylindrical wall 48. When the valve member 43 moves in a downward direction to place its sealing edge 45 in engagement with the valve seat surface 46, for the purpose of preventing passage of fluid through the apparatus, a transverse shoulder 52 on the larger diameter portion 50 is disposed in spaced relation to and above the housing shoulder 49 (Fig. 2), for a purpose that will be described hereinafter.

Suitable slidable types of seals are provided between the cylindrical walls 47, 48 of the upper housing portion 23*a* and the valve member 43. Thus, rubber or rubber-like seal rings 53, that may be of round cross-section, are disposed in one or more peripheral grooves 54 in the large diameter upper valve member portion 50 for slidable sealing along the larger diameter cylindrical wall 47. A similar seal ring or rings 55 are provided in ring grooves 56 in the lower valve member portion 51 for slidable sealing against the wall 48 of the smaller diameter cylindrical portion of the valve housing 23. These seals 53, 55 cooperate with the valve member 43 and housing 23 to form a confined annular cylindrical space 57 into which the well fluid cannot enter.

The tubular valve member 43 has an inside diameter which is substantially greater than the diameter of the tie rod 29, to provide a comparatively large passage area 58 through which fluid can flow. Thus, when the valve member 43 is in its upward position, out of engagement from the companion seat 30, fluid can pass upwardly through the spider ports or openings 28, around the valve seat 30, and through the annular space 58 between the tie rod 29 and valve member 43, continuing on upwardly around the back pressure ball valve element 18, and through the back pressure valve seat 17 into the casing section B thereabove. It is to be noted that in pursuing this path, the fluid can flow smoothly, and does not have or partake of any abrupt changes in direction, that would create turbulence and tend to cause erosive wear on the parts.

In view of the fact that the smaller cylinder 48 has a lesser diameter than the larger cylinder 47, and the lower portion 51 of the valve member 43 has a corresponding-

ly lesser diameter than the diameter of the upper portion 50 of the valve member, the downwardly facing area R of the valve member 43 over which fluid can act to urge the valve 43 in an upward direction is substantially less than the upwardly facing area S over which the fluid above the valve member can act. Thus, the annular area R between the inner wall 59 of the valve member and the smaller diameter cylinder wall 48 is less than the annular area S between the inner wall 59 of the valve member and the larger diameter cylinder wall 47. Accordingly, fluid under pressure below the valve member 43, which corresponds to the hydrostatic head of fluid externally of the casing string B, is acting over the area R, to urge the valve member 43 in an upward direction out of engagement from its companion seat 30. The pressure of the fluid within the casing string B, which corresponds to the hydrostatic head of fluid therewithin, is acting in a downward direction over the area S of the valve member 43, tending to urge the latter in a downward direction into engagement with the valve seat 30. A balanced condition on the valve will be realized when the pressure acting upwardly on the valve member over the area R is equal to the pressure acting on the valve member in the opposite direction over the area S. Since the area R is less than the area S, a balanced condition will be obtained when there is a lesser pressure internally of the casing string B than exists externally thereof. Expressed by way of formula, a balanced condition will exist when:

$$P_1R=P_2S$$

in which P_1=the hydrostatic head of fluid externally of the well casing; and P_2=the hydrostatic head of fluid internally of the well casing.

The hydrostatic heads of fluid externally and internally of the well casing will, therefore, be inversely proportional to the areas S and R. Since the area S is greater than the area R, the hydrostatic head of fluid internally of the well casing B will be less than the hydrostatic head of fluid externally of the well casing. As the hydrostatic head of fluid within the well casing increases to a sufficient extent, it will shift the valve member 43 downwardly into engagement with the valve seat 30, preventing further upward passage of fluid into the well casing, until the casing string has been lowered in the well bore fluid to a further extent.

The apparatus is run in the well bore with the parts occupying the relative positions disclosed in Fig. 1. During such lowering, the hydrostatic head of fluid externally of the well casing will act over area R of the valve member 43, to shift it out of engagement from the valve seat 30, or to open position, allowing the fluid to flow upwardly into the casing string B. If the casing string is brought to rest, the fluid will flow therewithin until it rises to a level satisfying the aforenoted equation, and when the level tends to exceed the amount indicated by the equation, then the pressure of the fluid within the well casing will shift the valve member 43 downwardly into engagement with the valve seat 30, as disclosed in Fig. 2, thereby preventing further passage of fluid upwardly into the well casing B. If the descent of the casing string in the well bore fluid is recommenced, the valve 43 will again slide upwardly to open position, as indicated in Fig. 1, and additional fluid will enter the casing string. The above actions will continue, with the valve 43 shifting between open and closed positions, until the casing B has been lowered to the desired depth in the well bore. The level of the fluid in the well casing B, however, will always be maintained at a lower point than the level of the fluid in the well bore externally of the well casing, depending upon the relationships of the aforenoted areas R and S. During all of this time, the tie rod 29, valve seat 30 and spider mechanism 27 are preventing the back pressure valve member 18 from engaging its companion seat 17, avoiding interference with the upward flow of fluid in the casing string.

After the casing has reached its desired depth in the well bore, the control valve mechanism 43, 30, for determining the height to which the liquid level will be allowed to rise in the casing string, is no longer needed, but the back pressure valve element 18 should be released, so that it can thereafter perform its intended function. Accordingly, the casing string can now be filled completely with fluid, which will urge and maintain the valve member 43 in a downward direction in sealing engagement with the valve seat 30, and pressure then applied to the fluid in the well casing. Such pressure acts downwardly over the area S of the valve member 43 and also over the upper surface of the valve seat 30, urging them in a downward direction, this force being transmitted through the valve seat to the shear pins 37 and also to the tie rod 29 and its weakened section 29*c*. When the force is sufficient to overcome the shear strength of the pins 37, they are disrupted, and the tie rod is pulled apart at its weakened section 29*c*, which frees the upper portion 29*a* of the tie rod and allows the ball valve member 18 to shift upwardly into engagement with its seat 17.

The disruption of the lower shear pins 37 attaching the tubular valve seat stem 30*a* to the spider 27 allows the valve member 43 and the valve seat 30 to shift downwardly along the valve housing 23 as a unit, until the shoulder 52 on the valve member engages the housing shoulder 49. When this occurs, the valve seat 30 is then pumped downwardly to a greater extent until the shoulder 30*b* on the seat engages the upper end of the spider hub 35, the valve seat 30 then occupying a position spaced downwardly away from the sealing edge 45 of the valve member 43 (see Fig. 3). The valve member 43 is, accordingly, now in open position, fluid pumped downwardly through the casing string B being capable of passing through the valve member 43 and around the valve seat 30 for discharge through the spider ports or openings 28, and from the casing shoe A. In the event the fluid now tends to flow in a reverse direction back into the casing string, such action is precluded by the upward movement of the back pressure valve member 18 into engagement with its companion seat 17.

As noted above, following disruption of the tie rod 29 at its weakened section 29*c*, the lower portion 29*b* of the tie rod is prevented from dropping completely out of the apparatus since it is securely attached to the tubular stem portion 30*a* of the valve seat 30 by the stop screw 42. Thus, the lower portion 29*b* of the tie rod and the valve seat 30 will be pumped downwardly within the spider hub 35 as a unit, until the valve seat shoulder 30*b* engages the upper end of the spider hub. In the event the valve seat 30 tends to slide upwardly within the spider hub, the extent of such upward movement is limited by engagement of the stop screw 42 with the lower end of the spider hub 35. The valve seat 30, of course, will move back into engagement with the valve member 43, but the valve seat 30 cannot move upwardly to any further extent than is permitted by engagement of the stop element 42 with the spider hub. The valve member 43, however, is capable of sliding upwardly in the valve housing 23 to a further extent, to open the differential valve mechanism and allow fluid to tend to flow upwardly around the valve seat 30. This fluid cannot flow in any substantial quantity in a reverse direction, since the back pressure valve member 18 shifts into engagement with its companion seat 17 to preclude such movement.

As stated above, the relationship between the areas R, S of the downward and upwardly facing pressure actuatable surfaces of the valve member 43 determines the level to which the fluid in the well casing B can rise with respect to the fluid level externally of the casing string. If these areas are made equal, then the well casing string will be able to fill with the well bore fluid to a level equalling that of the fluid externally of the well casing. In this

event, of course, the seal rings 53, 55 need not be used at all. For that matter, if the seal rings are omitted, then the confined space 57 would no longer be present into which the well fluid cannot enter. Instead, the well bore fluid can also enter such space by flowing between the housing 23 and the valve member 43, the pressure below the valve member 43 then being capable of acting over an area equal to the area over which the pressure above the valve member can act. Under these circumstances, the apparatus is useful to maintain the back pressure valve member 18 from its seat 17 during lowering of the casing string within the well bore, whereupon the application of sufficient pressure in a downward direction on the internal casing fluid will shear the pins 37 and disrupt the tie rod 29 at its weakened section 29c, to free the back pressure valve element 18 for subsequent engagement with the valve seat 17.

The differential valve mechanism 43 is also useful in the absence of the back pressure valve 18, in order to control the filling of the well casing string B to levels less than the external fluid level. After the casing has been lowered to the required depth in the well bore, the application of sufficient pressure to the fluid within the casing string will shear the pins 37 holding the valve seat 30 to the spider 27, and allow the valve seat to shift downwardly out of engagement from the valve member 43 in the manner described above (Fig. 3), which then allows the downward pumping or flowing of the well fluid within the well casing from the casing shoe A. Even if the areas R and S were made equal to each other and the back pressure valve member 18 omitted, the device is still operable to allow the well casing to fill with fluid, but to preclude downward passage of fluid from the well casing until desired, this latter action being able to occur only after the valve seat 30 has been freed from the spider 27, and shifted downwardly, in the manner described above.

During the lowering of the apparatus through the fluid in the well bore, the back pressure ball valve element 18 should be held securely against the ball stop lugs or fingers 22. This holding is assured by appropriately turning the adjusting nut 31 until the ball member is pulled tightly against the lugs or fingers. The lock nut 32 at the lower end of the tie rod 29 will hold the rod in the proper position, to assure the snug engagement. However, it is also desirable to insure against inadvertent turning of the ball 18 itself on the threaded upper end 60 of the tie rod 29. Such turning action is precluded, in the present instance, by providing a lock nut 61 on this threaded portion which will engage the lower end of the ball 18, after the ball has been securely tightened on the upper end of the tie rod. The tightening of this lock nut 61 to the predetermined degree will insure that the ball will not loosen on the upper end of the tie rod 29, whereas the lock nut 32 at the lower end of the tie rod 29 will assure that the tie rod cannot shift upwardly with respect to the valve seat 30, which is, in turn, initially firmly secured to the spider 27 by the shear pins 37. As a matter of fact, the adjusting nut 31 at the lower end may be tightened to an extent to place a slight tension on the tie rod 29. As a result, during lowering of the apparatus in the well bore, the ball valve element 18 is held snugly against the stop lugs or fingers 22, precluding its chattering against the lugs, or vibrating with respect thereto, which might cause premature release of the ball valve element.

It is preferred that the major pressure to release the ball valve element 18 not be imposed upon the ball valve element itself. For this reason, the shear pins 37 securing the tubular stem portion 30a of the valve seat to the spider hub 35 require a much greater force to disrupt them than the force required to pull the tie rod 29 apart at its weakened section 29c. As an example, six times the unit pressure may be required to shear the pins 37, as is required to pull the weakened section 29c of the tie rod apart. Actually, due to the tendency of the weakened section 29c to elongate to a slight extent before disrupting, the shear pins 37 will be sheared before the weakened section is pulled apart. Accordingly, the tie rod is not subjected to a high pressure when it is to be pulled apart, which avoids placing a large compressive load on the ball valve element 18, which is usually made of a synthetic resin, so as to be buoyant in cement slurry. However, despite the fact that a heavy load is not imposed on the ball valve element 18, a comparatively great force is required to shear the pins 37, which is a condition precedent to release of the ball valve element through disruption of the tie rod 29 at its weakened section 29c. Since high pressures are still necessary to disrupt the shear pins 37 (which may be, for example, of the order of 1200 p. s. i.), inadvertent shearing of these pins during lowering of the casing string in the well bore is precluded.

The use of the tie rod 29 and its extension completely through the tubular valve seat 30 not only provides a ready mode of adjusting the ball valve member 18 into snug engagement with the stop fingers or lugs 22, but it also provides a relatively long tubular stem valve seat portion 30a which can slide within a comparatively long spider hub 35. The long character of these relatively slidable portions insures the appropriate centering of the valve seat 30 with respect to the spider 27 and the valve housing 23. That is to say, there is little tendency for the valve seat 30 to assume even a slightly inclined position with respect to the spider hub 35, which tendency might take place if the hub were of comparatively short length. In addition, the valve member 43 is comparatively long, and makes a sliding engagement with the wall of the housing 23 at spaced points that are separated from each other by a comparatively large distance. Accordingly, the appropriate coaxiality or centering of the valve member 43 with respect to the housing 23 is assured. Since the valve member 43 can be centered with respect to the housing 23, and since the valve seat 30 can also be centered with respect to the housing 23 and its spider 27, then the valve seat 30 and the valve member 43 are appropriately centered with respect to one another, which insures that a proper sealing engagement is obtained between the lower inner edge 45 of the valve member 43 and the tapered upper surface 46 of the valve seat, completely around their engaging circumferences. The proper engagement of these two members provides a good metal-to-metal seat therebetween through which fluid will not leak, and avoids the necessity for furnishing some type of an elastic seal therebetween, which may be washed away or cut during the operation of the apparatus in the well bore.

It is, accordingly, apparent that an apparatus has been provided for automatically filling the well casing B with the well bore fluid as the apparatus is being lowered in the well bore C itself. Premature release of the ball valve member 18 is prevented by holding it snugly against the companion stop lugs or fingers 22, and the parts are all centered with respect to each other, in view of the large bearing surfaces therebetween. In addition, the apparatus is very easy to assemble, since it is a simple matter to insert the tie rod 29 through the tubular valve seat 30 and secure the nuts 31, 32 in place. The mounting of the shear pins 37, stop screw 42 and sleeve screw 41 can also be performed very easily, since their respective points of assembly are readily accessible, being disposed below the lower end of the valve housing 23.

The inventor claims:

1. In a well apparatus: a tubular member having means thereon for securing said member in a casing string; a valve seat in said tubular member; a tubular valve member slidable along said tubular member into and out of engagement with said seat; means releasably securing said valve seat to said tubular member, in order that engagement of said valve member with said seat enables fluid pressure above said valve member to act on said valve member and release said securing means; back pressure

valve means in said tubular member to prevent flow of fluid in one direction through said tubular member; means releasably associated with said back pressure valve means to prevent said back pressure valve means from closing comprising a rod connected to said back pressure valve means and extending through said valve seat; and means adjustably positioning said rod with respect to said seat.

2. In well apparatus: a tubular member having means thereon for securing said member in a casing string; a valve seat in said tubular member; a tubular valve member slidable along said tubular member into and out of engagement with said seat; means releasably securing said valve seat to said tubular member, in order that engagement of said valve member with said seat enables fluid pressure above said valve member to act on said valve member and release said securing means; back pressure valve means in said tubular member, including an upwardly movable valve element adapted to engage a companion seat to prevent upward flow of fluid in said tubular member; stop means carried by said tubular member and engaged by said element when said element is disengaged from its companion seat; means releasably associated with said valve element to prevent said valve element from engaging said companion seat comprising a rod connected to said valve element and extending through said valve seat; and means engaging said rod and valve seat for adjustably tightening said valve element against said stop means.

3. In well apparatus: a tubular member having means thereon for securing said member in a casing string; a valve element in said member movable upwardly to engage a companion seat in said member; stop means carried by said tubular member and engaged by said element when said element is disengaged from its companion seat; means for preventing passage of fluid through said tubular member comprising a valve seat; a rod connected to said valve element and extending through said valve seat; means engaging said rod and valve seat for adjustably tightening said valve element against said stop means and for preventing said valve element from engaging said companion seat; and means for enabling at least a portion of said rod to be released from said adjustable tightening means to allow said valve element to engage its companion seat.

4. In well apparatus: a tubular member having means thereon for securing said member in a casing string; a valve element in said member movable upwardly to engage a companion seat in said member; stop means carried by said tubular member and engaged by said element when said element is disengaged from its companion seat; means for preventing passage of fluid through said tubular member comprising a valve seat; a rod connected to said valve element and extending through said valve seat; shiftable means engaging said rod and valve seat for tightening said valve element against said stop means and for preventing said valve element from engaging said companion seat; said rod having a weakened section where said rod is disruptable to free said valve element for engagement with its companion seat.

5. In well apparatus: a tubular member having means thereon for securing said member in a casing string; a valve element in said member movable upwardly to engage a companion seat in said member; stop means carried by said tubular member and engaged by said element when said element is disengaged from its companion seat; means for preventing passage of fluid through said tubular member comprising a valve seat; a rod connected to said valve element and extending through said valve seat; means engaging said rod and valve seat for adjustably tightening said valve element against said stop means and for preventing said valve element from engaging said companion seat; means for enabling at least a portion of said rod to be released from said adjustable tightening means to allow said valve element to engage its companion seat; and means for securing said rod to said valve seat.

6. In well apparatus: a tubular member having means thereon for securing said member in a casing string; a valve element in said member movable upwardly to engage a companion seat in said member; stop means carried by said tubular member and engaged by said element when said element is disengaged from its companion seat; means for preventing passage of fluid through said tubular member comprising a valve seat; a rod connected to said valve element and extending through said valve seat; means threaded on said rod and engaging said valve seat for tightening said valve element against said stop means and for preventing said valve element from engaging said companion seat; and means for enabling at least a portion of said rod to be released from said threaded means to allow said valve element to engage its companion seat.

7. In well apparatus: a tubular member having means thereon for securing said member in a casing string; a valve element in said member movable upwardly to engage a companion seat in said member; stop means carried by said tubular member and engaged by said element when said element is disengaged from its companion seat; means for preventing passage of fluid through said tubular member comprising a valve seat; a rod threadedly secured to said valve element; a lock nut threaded on said rod and engaging said valve element; said rod extending through said valve seat; means threaded on said rod and engaging said valve seat for tightening said valve element against said stop means and for preventing said valve element from engaging said companion seat; and means for enabling at least a portion of said rod to be released from said threaded means to allow said valve element to engage its companion seat.

8. In well apparatus: a tubular member having means thereon for securing said member in a casing string; a valve element in said member movable upwardly to engage a companion seat in said member; stop means carried by said tubular member and engaged by said element when said element is disengaged from its companion seat; means for preventing passage of fluid through said tubular member comprising a valve seat; a rod connected to said valve element and extending through said valve seat; means threaded on said rod and engaging said valve seat for tightening said valve element against said stop means and for preventing said valve element from engaging said companion seat; said rod having a weakened section where said rod is disrupted to free said valve element for engagement with its companion seat.

9. In well apparatus: a tubular member having means thereon for securing said member in a casing string; a valve element in said member movable upwardly to engage a companion seat in said member; stop means carried by said tubular member and engaged by said element when said element is disengaged from its companion seat; means for preventing passage of fluid through said tubular member comprising a valve seat; a rod connected to said valve element and extending through said valve seat; means threaded on said rod and engaging said valve seat for tightening said valve element against said stop means and for preventing said valve element from engaging said companion seat; said rod having a weakened section where said rod is disruptable to free said valve element for engagement with its companion seat; and means for securing said rod to said valve seat.

10. In well apparatus: a tubular member having means thereon for securing said member in a casing string; a spider attached to said tubular member and having a central hub portion; a valve seat in said tubular member slidable longitudinally in said hub portion; a tubular valve member slidable along said tubular member into and out of engagement with said seat; means releasably

securing said valve seat to said hub portion, in order that engagement of said valve member with said seat enables fluid pressure above said valve member to act on said valve member and release said securing means; back pressure valve means in said tubular member, including an upwardly movable valve element adapted to engage a companion seat; stop means carried by said tubular member and engaged by said element when said element is disengaged from its companion seat; means releasably associated with said valve element to prevent said valve element from engaging said companion seat comprising a rod connected to said valve element and extending through said valve seat; and means engaging said rod and valve seat below said hub portion for adjustably tightening said valve element against said stop means and for preventing said valve element from engaging said companion seat.

11. In well apparatus: a tubular member having means thereon for securing said member in a casing string; a spider secured to said member and comprising transversely extending and circumferentially spaced ribs secured to a central hub portion depending below said ribs; a valve seat slidable longitudinally in said hub portion; a tubular valve member slidable along said tubular member into and out of engagement with said seat; frangible means extending through said hub portion and valve seat below said ribs for releasably securing said valve seat to said hub portion, in order that engagement of said valve member with said seat enables fluid pressure above said valve member to act on said valve member and disrupt said frangible means; back pressure valve means in said tubular member, including an upwardly movable valve element adapted to engage a companion seat; stop means carried by said tubular member and engaged by said element when said element is disengaged from its companion seat; means releasably associated with said valve element to prevent said valve element from engaging said companion seat comprising a rod connected to said valve element and extending through said valve seat; and means engaging said rod and valve seat below said hub portion for adjustably tightening said valve element against said stop means and for preventing said valve element from engaging said companion seat.

12. In well apparatus: a tubular member having means thereon for securing said member in a casing string; a spider secured to said member and comprising transversely extending and circumferentially spaced ribs secured to a central hub portion depending below said ribs; a valve seat slidable longitudinally in said hub portion; a tubular valve member slidable along said tubular member into and out of engagement with said seat; frangible means extending through said hub portion and valve seat below said ribs for releasably securing said valve seat to said hub portion, in order that engagement of said valve member with said seat enables fluid pressure above said valve member to act on said valve member and disrupt said frangible means; back pressure valve means in said tubular member, including an upwardly movable valve element adapted to engage a companion seat; stop means carried by said tubular member and engaged by said element when said element is disengaged from its companion seat; means releasably associated with said valve element to prevent said valve element from engaging said companion seat comprising a rod connected to said valve element and extending through said valve seat; means engaging said rod and valve seat below said hub portion for adjustably tightening said valve element against said stop means and for preventing said valve element from engaging said companion seat; and means disposed below the lower end of said hub portion securing said rod to said valve seat.

13. In well apparatus: a tubular member having means thereon for securing said member in a casing string; a spider secured to said member and having a central hub portion; a valve element in said member movable upwardly to engage a companion valve seat in said member; stop means carried by said tubular member and engaged by said element when said element is disengaged from its companion seat; means for preventing flow of fluid through said tubular member comprising a valve seat slidable longitudinally through said hub portion; means releasably associated with said valve element to prevent said valve element from engaging said companion seat comprising a rod connected to said valve element and extending through said valve seat; means engaging said rod and valve seat below said spider for adjustably tightening said valve element against said stop means and for preventing said valve element from engaging said companion seat; and means for enabling at least a portion of said rod to be released from said adjustable tightening means to allow said valve element to engage its companion seat.

14. In well apparatus: a tubular member having means thereon for securing said member in a casing string; a spider secured to said member and having circumferentially spaced ribs secured to a central hub portion depending below said ribs; a valve element in said member movable upwardly to engage a companion seat in said member; stop means carried by said tubular member and engageable by said element when said element is disengaged from its companion seat; means for preventing flow of fluid through said tubular member including a tubular valve seat slidable through said hub portion; frangible means interconnecting said valve seat and hub portion below said ribs; means releasably associated with said valve element to prevent said valve element from engaging said companion seat comprising a rod connected to said valve element and extending through said valve seat; means threaded on the lower portion of said rod and engaging said valve seat for tightening said valve element against said stop means and for preventing said valve element from engaging said companion seat; said rod having a weakened section at which said rod is disruptable to release said valve element following disruption of said frangible means.

15. In well apparatus: a tubular member having means thereon for securing said member in a casing string; a spider secured to said member and having circumferentially spaced ribs secured to a central hub portion depending below said ribs; a valve element in said member movable upwardly to engage a companion seat in said member; stop means carried by said tubular member and engageable by said element when said element is disengaged from its companion seat; means for preventing flow of fluid through said tubular member including a tubular valve seat slidable through said hub portion; frangible means interconnecting said valve seat and hub portion below said ribs; means releasably associated with said valve element to prevent said valve element from engaging said companion seat comprising a rod connected to said valve element and extending through said valve seat; means threaded on the lower portion of said rod and engaging said valve seat for tightening said valve element against said stop means and for preventing said valve element from engaging said companion seat; said rod having a weakened section at which said rod is disruptable to release said valve element following disruption of said frangible means; and means disposed below said hub portion securing said rod to said valve seat.

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