June 19, 1956 M. B. CONRAD 2,751,023

DEVICES FOR AUTOMATICALLY FILLING WELL CASING

Filed Dec. 18, 1950

Fig. 1.

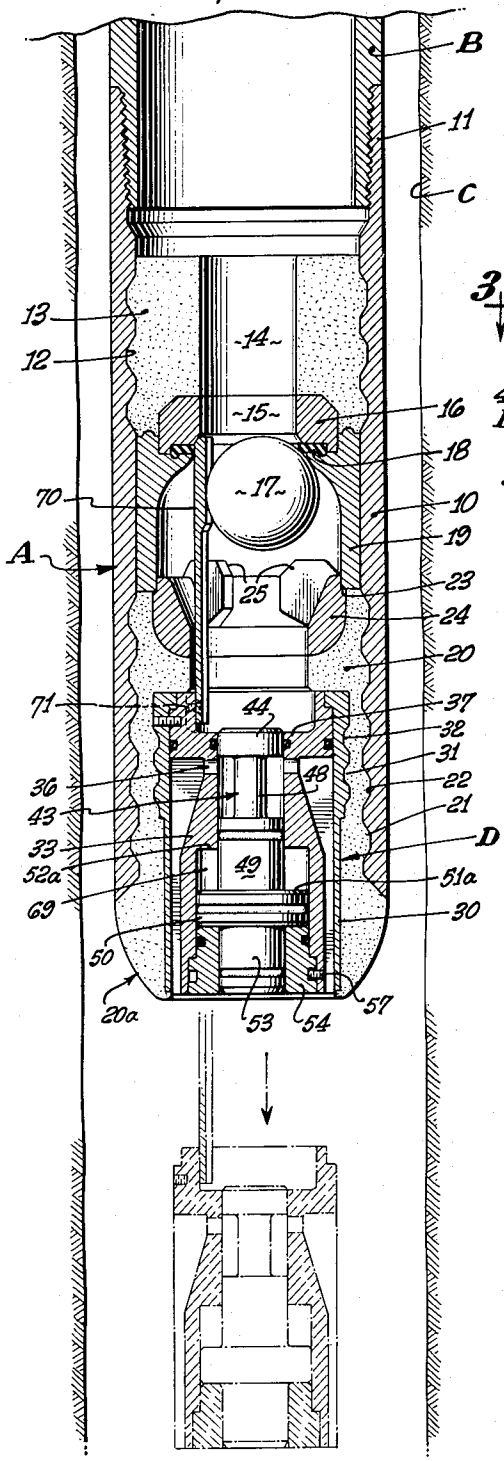


Fig. 2.

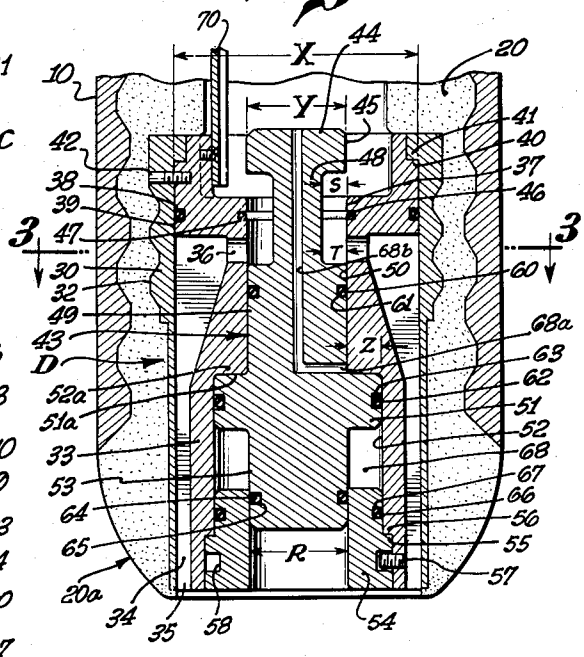
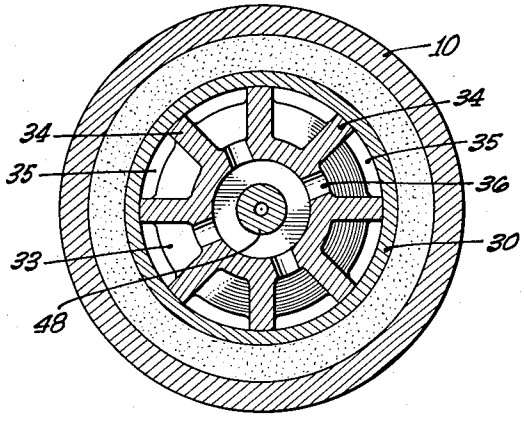


Fig. 3.



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DEVICES FOR AUTOMATICALLY FILLING WELL CASING

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14 Claims. (Cl. 166—225)

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

An object of the present invention is to provide improved apparatus for automatically filling a casing string, and the like, to predetermined levels below the level of the hydrostatic head of fluid in the well bore, as the casing is being lowered in the well bore to its final landing position.

Another object of the invention is to provide a valve mechanism for automatically filling well casing to a predetermined level, in which the hydrostatic head of fluid in the well bore is operative to maintain the valve in either fully open or fully closed position, thereby avoiding partial opening of the mechanism, with attendant throttling action on the fluid and erosion of the parts, caused by the relatively high velocity of the fluid.

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, with the valve mechanism in closed position;

Fig. 2 is an enlarged fragmentary longitudinal section through the apparatus, with the valve in fully open position;

Fig. 3 is a cross-section taken along the line 3—3 on Fig. 1.

The apparatus disclosed in the drawings is a casing shoe A adapted to be threaded, or otherwise suitably attached, to a casing section B thereabove; so as to form the terminal end of a casing string to be lowered in a well bore C. If the apparatus A is placed in an intermediate portion of the casing string, it would operate in the same manner, but would then be considered as a casing collar.

The device A includes an outer tubular member 10, usually made of steel, having an upper threaded box 11 for attachment to the adjacent casing section B. This tubular member is provided with a series of upper internal grooves 12 for securing an upper cementitious plug 13 to it, as a result of casting the plug directly in the tubular member. This plug has a central passage 14 in alignment with a passage 15 through a valve seat 16 disposed in the lower portion of the plug 13.

A back pressure valve element 17, that may be in the form of a ball buoyant in cement slurry, is disposed in the shoe below the seat 16, being movable upwardly into engagement with the latter to prevent upward flow of fluid into the well casing B. For the purpose of preventing

leakage around the ball, when seated, it engages a suitable seal ring 18 clamped between the valve seat 16 and a spacer sleeve 19 extending from the upper plug 13 to a lower plug 20 of cementitious material, which is anchored to the tubular member 10 by means of its external ribs 21 cast into internal grooves 22 in the tubular member.

The lower end of the spacer sleeve 19 engages a shoulder 23 on a stop member 24 seating in the lower cementitious plug 20, this member having a plurality of lugs or fingers 25 on which the ball valve element 17 can rest when fluid is being pumped downwardly through the casing string B and its casing shoe A. The valve seat 16, spacer sleeve 19 and stop member 24, in effect, form a valve cage containing the ball valve element 17.

The lower cementitious plug 20 may have a lower rounded nose 20a for guiding the casing string past any obstructions or restrictions in the well bore.

Apparatus of the general type so far described is known. During lowering of the casing string B in the well bore C, the drilling fluid, or other liquid, in the well bore would be prevented from entering the interior of the casing string, in view of the upward engagement of the valve element 17 against its companion seat 16 and seal 18. As a result, the interior of the casing string does not contain any fluid. As the casing string is lowered to greater depths in the well bore, the hydrostatic head of liquid acting on the exterior of the shoe and the lower portions of the casing string B increases. In deep wells, this hydrostatic head may be so extensive as to tend to collapse the casing string. To forestall this action, the casing string has heretofore been filled with fluid from the top of the well bore, creating a hydrostatic back pressure offsetting the external hydrostatic head, and reducing to a safe value the differential pressure tending to collapse the lower portion of the casing string inwardly.

By means of the type of device disclosed in this application, the well fluid itself is instrumental in causing its entry into the well casing, to provide a column of liquid within the casing that rises to a lesser elevation than the height of the liquid in the well bore surrounding the casing. In this manner, the differential hydrostatic head tending to collapse the casing is decreased, but the casing itself can be maintained empty to a large degree, to assist in floating it in the well bore while being lowered to its ultimate position.

As disclosed in the drawings, fluid is capable of entering the well casing B through the casing shoe A whenever permitted to do so by a differential valve device D which is fully opened or fully closed in dependence upon the proportionate hydrostatic heads of fluid within and outside of the casing string B. The valve device includes a tubular valve housing 30 disposed in the lower cementing plug 20 coaxial of the central passage 14 through the upper plug 13. This housing is secured to the plug by inner ribs 31 in the latter cast within external grooves 32 in the housing 30. A valve body 33 is disposed in this housing, including a series of circumferentially spaced longitudinally extending external ribs 34 engaging the inner wall of the sleeve 30, spaces 35 between the ribs providing passages for fluid to flow from the exterior of the shoe A upwardly into its interior. From these passages 35 the fluid can flow to the interior of the valve body 33 through a plurality of body side ports 36, the fluid then passing upwardly through a generally cylindrical valve seat 37 in the body and into the valve cage 16, 19, 24 housing the back pressure ball valve element 17. Leakage of fluid between the exterior of the body 33 and the housing 30 is prevented by a suitable side seal 38 in the body groove 39 engaging the inner wall of the housing.

The body 33 is originally disposed appropriately in the housing with an upper shoulder 40 on the body engaging an upper inturned flange 41 on the housing, the two parts

being secured together through the agency of one or more shear screws 42 extending laterally through the housing and into the body.

The ability of the external well fluid to flow upwardly into the shoe A, in the manner described above, is dependent upon the open or closed position of a valve member 43, which position is selected automatically by the differential pressure existing between the hydrostatic head of fluid externally of the casing string B and the hydrostatic head of fluid internally of the casing string. The parts are so arranged that the valve is maintained in either fully opened or fully closed position.

The valve member 43 includes an upper valve head portion 44 having a cylindrical periphery 45 which may be disposed within the cylindrical body seat 37. When in this position, upward flow of fluid into the casing shoe A is prevented by engagement of the head periphery 45 with a seal ring 46 disposed in a groove 47 in the valve seat 37. The valve head 44 is secured to, or is made integral with, a depending stem portion 48 that is substantially smaller in diameter than the valve head 44 and its cooperable seat 37. This stem merges into an upper piston portion 49 slidable within an upper body cylinder 50 whose upper end communicates with the side ports 36 through the body. For reasons to be explained below, the diameter of the upper cylinder 50 may be substantially equal to the diameter of the valve seat 37.

The upper piston portion 49 of the valve member is integral with an intermediate piston portion 51 of substantially larger diameter, which is slidable within an intermediate cylinder 52 of corresponding diameter, substantially larger in diameter than the diameter of the upper cylinder 50. Depending from the intermediate piston 51 is a lower piston portion 53 that is slidable through a lower cylinder member 54, that may be in the form of a head inserted in the lower end of the body member 33 until its flange 55 engages a shoulder 56 in the body, the head being held in place by one or more holding screws 57 threaded laterally through the body 33 and received within a head groove 58. The diameter of the lower piston 53 and the internal diameter of its companion cylinder 54 is substantially less than the diameter of the intermediate piston 51 and intermediate cylinder 52, for a reason to be explained below.

Leakage between the upper piston 49 and upper cylinder wall is prevented by a suitable piston ring 60 engaging the latter wall, and contained within a piston ring groove 61. Similarly, leakage between the intermediate piston 51 and the intermediate cylinder wall 52 is prevented by a piston ring 62 engaging the latter wall and contained within an intermediate ring groove 63; while leakage between the lower piston 53 and lower cylinder 54 is prevented by a piston ring 64 engaging the inner wall of the latter and contained within a ring groove 65. Leakage between the cylinder head element 54 of the body 33 and the main portion of the body is prevented by a suitable side seal 66 in the head groove 67 engaging the intermediate cylinder wall 52.

Fluid is prevented from entering the intermediate cylinder space 68 between the intermediate piston 51 and the lower head 54 by the side seals 62, 64, 66. This space 68 may originally contain air at atmospheric pressure. However, the fluid in the casing string B above the valve head 44 is allowed to act on the upper annular portion 51*a* of the intermediate piston 51, the fluid flowing through a passage 68*b* extending through the valve member 43 and having a lateral branch 68*a* exiting into the cylinder space 69 between the upper head portion 52*a* of the intermediate cylinder and the intermediate piston 51.

It is to be noted that the hydrostatic head of fluid externally of the well casing can act upwardly on the underside of the lower piston 53 across its transverse or cross-sectional area R, urging the valve member 43 in an upward direction, and lifting its head 44 to fully open position, determined by engagement of the intermediate piston 51 with the upper intermediate cylinder head 52*a* (Fig. 2). This same hydrostatic head of fluid is exerting its force through the body passages 35, 36 upon the annular area S on the underside of the valve head 44 between the periphery 45 of the latter and the reduced diameter stem 48, tending to elevate the head from its seat 37 to an open position. However, this same hydrostatic head of fluid is acting downwardly on the upper piston portion 49 over the annular area T between the stem 48 and the wall of the upper cylinder 50. It is preferred that the diameters of the upper cylinder 50 and the diameter of the valve seat 37 be made equal; so that the areas S and T are equal and opposite to one another. Accordingly, the hydrostatic head of fluid acting upwardly on the underside of the valve head 44, tending to elevate the latter to open position, is counterbalanced by an equal force acting in a downward direction on the upper piston 49, the result being the exertion of no force whatsoever by the fluid pressure in the side ports 36 and cylinder 50 tending to open or close the valve member 43.

Assuming that liquid is present in the casing string B, it exerts a downward closing force on the valve member 43 over the entire area Y of the valve head 44. This same internal hydrostatic head of fluid is exerting a downward force on the intermediate piston 51 over the annular area Z between the intermediate cylinder wall 52 and the upper piston 49, since the fluid can pass through the passage 68*b*, 68*a* extending through the valve member. The cylinder space 68 below the intermediate piston is closed against the entry of well or casing fluid, substantially no force in an upward direction being exerted on the intermediate piston 51, since the space 68 is occupied only by air at substantially atmospheric pressure.

Actually, as will be noted from an inspection of Fig. 2, the force of the hydrostatic head of fluid internally of the casing string is acting in a downward direction, tending to shift the valve member 43 downwardly to closed position, over the areas Y plus Z, which area is the cross-sectional area of the intermediate piston 51. The hydrostatic head of fluid externally of the casing string is acting upwardly against the smaller area R, urging the valve member in an upward position to passage opening position. As stated above, the areas S and T are equal and opposite, the effect of the hydrostatic head of fluid acting thereon being neutralized.

Since the pressure actuatable area Y plus Z is substantially greater than the pressure actuatable area R, a lesser unit hydrostatic head or pressure is effective internally of the casing strip to shift the valve member 43 downwardly to closed position than is required externally of the casing string acting over the area R to shift it to passage opening position. A balanced valve condition will exist when the following equation is satisfied, neglecting friction:

$$P_1R=P_2(Y+Z)$$

or

$$P_2=\frac{P_1R}{Y+Z}$$

in which P_1 is the hydrostatic head externally of the casing string and P_2 is the hydrostatic head internally of the casing string.

From the above equation, it is evident that the valve 43 will be shifted downwardly to closing position when the internal hydrostatic head P_2 is only a fraction of the external hydrostatic head P_1, since the area Y plus Z is much greater than the area R. Accordingly, as the casing string B is being lowered through the liquid in the well bore C, the hydrostatic head of fluid P_1 externally of the casing string will act over the area R at the underside of the lower piston to shift the valve member 43 upwardly to an open position, the well fluid then flowing through the passages 35, 36 and around the valve head 44, and upwardly into the casing string. As the

liquid level in the casing string rises, it will eventually just exceed the hydrostatic head P_2, which, acting over the larger area Y plus Z, would be suffcient to shift the valve member 43 downwardly, to locate the head 44 within its cylindrical seat 37, closing the valve. When this condition obtains, the hydrostatic head P_2 internally of the casing string B will be substantially lower than the hydrostatic head P_1 externally of the casing string. As the casing string is lowered to a still further extent through the well fluid, the valve 43 will again be opened automatically, allowing the external casing fluid to flow into the casing string.

It is apparent that the valve device D will automatically allow fluid to flow into the casing string B until a definite relationship exists between the hydrostatic head P_2 of fluid in the casing string and the hydrostatic head of fluid P_1 externally of the casing string acting on the valve device. The several areas R, Y and Z can be selected; so that the liquid level in the casing string is much lower than that in the well bore, providing a certain degree of buoyancy in the casing string that facilitates its floating in the well bore to its final landing position, while still precluding excessive external hydrostatic heads of fluid from tending to collapse the lower portion of the casing string.

The fluid passing upwardly through the passages 35 in the valve body 33 flows through the ports 36 and around the valve head 44, when the latter is elevated from its seat 37, continuing its flow through the stop member 24 and around the ball valve element 17 and through the upper plug passage 14 into the casing sections B above the shoe A. To allow such flow to occur around the ball valve element 17, the latter is prevented initially from moving upwardly into engagement with its seat 16 by a retainer arm 70 secured to the valve body 33 by a screw 71, or the like, which engages the ball 17 and holds it to one side of the valve seat axis, as shown in Fig. 1. When this retainer arm 70 is removed, the ball valve element 17 is allowed to move upwardly into engagement with its seat 16.

As explained above, during lowering of the casing string B through the well bore, the relationship between the hydrostatic heads of fluid P_2, P_1 internally and externally of the casing string determines the open or closed position of the valve member 43. The external hydrostatic head of fluid acts on the underside of the lower piston 53 over its area R, and this head of fluid is steady and constant, regardless of the velocity of flow of the liquid through the passages 35, ports 36, through the annular space between the stem 48 and seat 37, and around the valve head 44. The flow of fluid through and around such portions of the apparatus may occur at differing velocities, which will decrease the hydrostatic head of fluid in those regions. Changes in the hydrostatic head have no effect on shifting the valve member 43, since the same altered pressures are acting in a downward direction on the upper piston 49, as is acting on the underside of the head. Regardless of the velocity of fluid flow through the device, however, the external hydrostatic head of fluid is acting, to its full value, over the area R at the underside of the lower piston 43. Accordingly, if the hydrostatic head of liquid P_2 internally of the casing string is too low, the external pressure, acting in a steady and constant manner over the lower piston area R, is effective to shift the valve member to its full extent in an upward direction, in which the valve head 44 is in fully open position, spaced a substantial distance above the valve seat 37. When the fluid level internally of the casing rises to a sufficient extent to overcome the force of the external hydrostatic pressure P_1, this internal pressure acts over the areas Y plus Z in a constant and steady manner, and shifts the valve member downwardly to the full extent in which the head 44 is disposed completely within the seat 37, with its periphery 45 sealed against the seal ring 46.

Because of the valve arrangement illustrated, the valve occupies either of two positions; it is either in fully open position, when the fluid level in the casing string is below a predetermined value, determined by the relationship between the area R and the total area Y plus Z, or it is in fully closed position when the liquid level internally of the casing reaches a prescribed height. There is no middle ground, which would result in only partial opening or closing of the valve head 44 with respect to its seat 37. Such partial opening creates a throttling action, with attendant increased velocity of the liquid flowing into the casing string B between the seat 37 and valve head 44. High velocities of fluid, particularly when changing its direction of flow, would erode or cut away the valve parts to an extent that might prevent the valve from closing completely.

As has been stated, this condition cannot occur in the device under consideration, in view of the full opening or full closing of the valve D.

After the casing string B has been lowered in the well bore C to its full position, it can be completely filled with fluid from the top of the well bore. Such filling closes the valve 43 and precludes downward passage of fluid from the casing string. Pressure may now be applied to the fluid in the well casing, this pressure acting over the entire area X of the valve body 33, to shear the screws 42 and pump the valve body 33 and valve member 43 downwardly out of the casing shoe, as illustrated in broken lines in Fig. 1. During this downward movement, the retainer arm 70 secured to the valve body 33 is also ejected from the shoe, freeing the back pressure valve element 17 and allowing it to move upwardly into engagement with its seat 16, in the event that return flow of fluids into the well casing tends to occur. The well casing may now be cemented in place, as by pumping cement slurry down the casing string, during which time the ball valve element 17 rests on the supporting lugs 25 of the stop member 24, the cement slurry passing around it and out through the open passage in the housing 30, and into the well bore C, the cement then passing upwardly around the exterior of the casing string B. Subsequent relieving of the pressure inside the casing causes the cement slurry to tend to flow back into the well casing, this action being prevented by upward movement of the ball valve element 17 into engagement with its seat 16.

Accordingly, it is apparent that an automatic device has been provided for filling well casing, to maintain a predetermined relationship between the hydrostatic head of fluid P_1 externally of the well casing and the hydrostatic head of fluid P_2 internally of the well casing. The automatic fill-up valve D is either in fully open or fully closed position, in order to minimize erosion of the parts and also to accelerate the rate at which the fluid will enter the casing string. The casing can, therefore, still be floated in the well bore to its final landing position, because of the maintenance of the casing string in a partially empty state. However, after the final position has been reached in the well casing, the valve device D is readily rendered ineffective by ejecting it from the apparatus, leaving a wide open passage through the equipment.

Substantially all internal parts of the casing shoe, including the fill-up valve mechanism D, are preferably made of readily drillable material, to facilitate drilling up or other disintegration of the internal mechanism after the casing B has been cemented in place. As an example, the essential parts of the fill-up valve mechanism D may be made of cast iron, aluminum or magnesium.

The inventor claims:

1. In well apparatus: a tubular member having means thereon for securing said member in a conduit string posi-

tionable in a well bore; a valve body; means securing said body in said member; a valve seat in said body; a valve member having a head portion movable into and out of engagement with said seat; said tubular member having a cylinder portion along which said valve member is slidable; means providing a confined space between said cylinder portion and valve member into which fluid cannot enter while said apparatus is in the well bore; said valve member having a resultant total first fluid pressure actuatable surface externally of said confined space and subject to the pressure of fluid internally of said tubular member and on the downstream side of said valve member only to urge said valve head portion into engagement with said seat, said valve member having a resultant total second fluid pressure actuatable surface externally of said confined space, when said head portion is out of engagement with said seat, remote and upstream from said head and subject to the pressure of fluid externally of said tubular member only to urge said head portion in a direction out of engagement with said seat; the area of said first surface being substantially greater than the area of said second surface.

2. In well apparatus: a tubular member having means thereon for securing said member in a conduit string positionable in a well bore; a valve body; means securing said body in said member; a valve seat in said body; a valve member having a head portion movable into and out of engagement with said seat; said tubular member having a cylinder portion along which said valve member is slidable; means providing a confined space between said cylinder portion and valve member into which fluid cannot enter while said apparatus is in the well bore; valve member having a resultant total upwardly facing fluid pressure actuatable surface externally of said confined space and subject to the pressure of fluid in the conduit string above said tubular member and valve member only to urge said valve head portion downwardly into engagement with said seat, said valve member having a resultant total downwardly facing fluid pressure actuatable surface externally of said confined space, when said head portion is out of engagement with said seat, remote from and below said valve head and subject to the pressure of fluid externally of the conduit string only to urge the valve head portion in an upward direction to passage opening position; the area of said resultant total upwardly facing surface being substantially greater than the area of said resultant total downwardly facing surface.

3. In well apparatus: a tubular member having means thereon for securing said member in a conduit string positionable in a well bore; a valve body; a valve seat in said body; a valve member having a head portion movable into and out of engagement with said seat; said tubular member having a cylinder portion along which said valve member is slidable; means providing a confined space between said cylinder portion and valve member into which fluid cannot enter while said apparatus is in the well bore; said valve member having a resultant total first fluid pressure actuatable surface externally of said confined space and subject to the pressure of fluid internally of said tubular member and on the downstream side of said valve member only to urge said valve head portion into engagement with said seat, said valve member having a resultant total second fluid pressure actuatable surface externally of said confined space, when said head portion is out of engagement with said seat, remote and upstream from said head and subject to the pressure of fluid externally of said tubular member only to urge said head portion in a direction out of engagement with said seat; the area of said first surface being substantially greater than the area of said second surface; and means, releasable by hydraulic pressure within said tubular member imposed upon said valve member and body when said head engages said seat, for securing said valve body to said tubular member, release of said securing means enabling said valve member and body to be shifted within said tubular member to a position in which said valve member and body are ineffective to control passage of fluid within said tubular member thereby allowing fluid to flow in both directions in said tubular member.

4. In well apparatus: a tubular member having means thereon for securing said member in a conduit string positionable in a well bore; a valve body; a valve seat in said body; a valve member having a head portion movable into and out of engagement with said seat; said tubular member having a cylinder portion along which said valve member is slidable; means providing a confined space between said cylinder portion and valve member into which fluid cannot enter while said apparatus is in the well bore; said valve member having a resultant total upwardly facing fluid pressure actuatable surface externally of said confined space and subject to the pressure of fluid in the conduit string above said tubular member to urge said valve head portion downwardly into engagement with said seat, said valve member having a resultant total downwardly facing fluid pressure actuatable surface externally of said confined space, when said head portion is out of engagement with said seat, remote from and below said valve head and subject to the pressure of fluid externally of the conduit string only to urge the valve head portion in an upward direction to passage opening position; the area of said resultant total upwardly facing surface being substantially greater than the area of said resultant total downwardly facing surface; and means, releasable by hydraulic pressure within said tubular member imposed upon said valve member and body when said head engages said seat, for securing said valve body to said tubular member, release of said securing means enabling said valve member and body to be shifted within said tubular member to a position in which said valve member and body are ineffective to control passage of fluid within said tubular member thereby allowing fluid to flow in both directions in said tubular member.

5. In well apparatus: a tubular member having means thereon for securing said member in a conduit string positionable in a well bore; a valve body; a valve seat in said body; a valve member having a head portion movable into and out of engagement with said seat; said tubular member having a cylinder portion along which said valve member is slidable; means providing a confined space between said cylinder portion and valve member into which fluid cannot enter while said apparatus is in the well bore; said valve member having a resultant total upwardly facing fluid pressure actuatable surface externally of said confined space and subject to the pressure of fluid in the conduit string above said tubular member to urge said valve head portion downwardly into engagement with said seat, said valve member having a resultant total downwardly facing fluid pressure actuatable surface externally of said confined space, when said head portion is out of engagement with said seat, remote from and below said valve head and subject to the pressure of fluid externally of the conduit string only to urge the valve head portion in an upward direction to passage opening position; the area of said resultant total upwardly facing surface being substantially greater than the area of said resultant total downwardly facing surface; and frangible means securing said valve body to said tubular member, disruption of said frangible means enabling said valve member and body to be shifted within said tubular member to a position in which said valve member and body are ineffective to control passage of fluid within said tubular member thereby allowing fluid to flow in both directions in said tubular member.

6. In well apparatus: a tubular member having means thereon for securing said member in a conduit string positionable in a well bore; a valve body in said tubular

member having a passage surrounded by a valve seat; a valve member in said body having a head portion movable downwardly into engagement with said seat; a cylinder in said body below said seat; said valve member including a piston portion below said head portion slidable in said cylinder; means providing a confined space between said cylinder and piston into which fluid cannot enter while said apparatus is in the well bore, said piston portion having a downwardly facing surface externally of said confined space and subject to the pressure of fluid externally of said tubular member, said valve member having a resultant upwardly facing fluid pressure actuatable surface externally of said confined space and subject to the pressure of the fluid in the conduit string above said head; said resultant upwardly facing surface having a substantially greater area than the area of said downwardly facing surface.

7. In well apparatus: a tubular member having means thereon for securing said member in a conduit string positionable in a well bore; a valve body in said tubular member having a passage surrounded by a valve seat; a valve member in said body having a head portion movable in an upstream direction into engagement with said seat; a cylinder in said body upstream of said seat; said valve member including a piston portion below said head portion slidable in said cylinder; means providing a confined space between said cylinder and piston into which fluid cannot enter while said apparatus is in the well bore, said piston portion having a fluid pressure actuatable surface externally of said confined space and facing upstream of said seat and subject to the pressure of fluid upstream of said seat, said valve member having a resultant fluid pressure actuatable surface externally of said confined space and facing downstream of said seat and subject to the pressure of fluid downstream of said seat; said downstream facing surface being substantially greater in area than the area of said upstream facing surface.

8. In well apparatus: a tubular member having means thereon for securing said member in a conduit string positionable in a well bore; a valve body in said tubular member having a passage surrounded by a valve seat; a valve member in said body having a head portion movable in an upstream direction into engagement with said seat; a cylinder in said body upstream of said seat; said valve member including a piston upstream of said seat and slidable in said cylinder, said piston having a first portion of its transverse surface which faces upstream of said seat subject to the pressure of fluid upstream of said seat; means providing a confined space between said cylinder and piston into which fluid cannot enter while said apparatus is in the well bore, in order that said piston have a second portion of its transverse surface extending laterally of said first portion and facing upstream of said seat and disposed in said confined space which is not subject to the pressure of fluid upstream of said seat; said valve member having a resultant fluid pressure actuatable surface facing in a direction downstream of said seat and subject to the pressure of fluid downstream of said seat; said downstream facing surface being substantially greater in area than the area of the transverse surface of said first portion.

9. In well apparatus: a tubular member having means thereon for securing said member in a conduit string positionable in a well bore; a valve body in said tubular member having a passage surrounded by a valve seat; a valve member in said body having a head portion movable downwardly into engagement with said seat; a cylinder in said body below said seat; said valve member including a piston below said seat and slidable in said cylinder, said piston having a first portion of its transverse surface facing downwardly and subject to the pressure of fluid below said seat; means providing a confined space between said cylinder and piston into which fluid under pressure below said seat cannot enter while said apparatus is in the well bore, in order that said piston have a second portion of its downwardly facing transverse surface disposed in said confined space and extending laterally of said first portion which is not subject to the pressure of fluid below said seat; said valve member having a resultant upwardly facing fluid pressure actuatable surface subject to the pressure of fluid above said seat; said upwardly facing surface being substantially greater in area than the area of said transverse surface of said first portion.

10. In well apparatus: a tubular member having means thereon for securing said member in a conduit string positionable in a well bore; a valve body in said tubular member having a passage surrounded by a valve seat; a valve member in said body having a head portion movable in an upstream direction into engagement with said seat; a cylinder in said body upstream of said seat; said valve member including a piston slidable in said cylinder, said piston having a first portion of its transverse surface which faces upstream of said seat subject to the pressure of fluid upstream of said seat; means providing a confined space between said cylinder and piston into which fluid cannot enter while said apparatus is in the well bore, in order that said piston have a second portion of its transverse surface extending laterally of said first portion and facing upstream of said seat and disposed in said confined space which is not subject to the pressure of fluid upstream of said seat; said valve member having a resultant fluid pressure actuatable surface facing in a direction downstream of said seat and subject to the pressure of fluid downstream of said seat; said downstream facing surface being substantially greater in area than the area of the transverse surface of said first portion; said valve member further including a stem portion between said head and piston spaced from said seat to form an annular space with said seat through which fluid may flow when said head is out of engagement with said seat.

11. In well apparatus: a tubular member having means thereon for securing said member in a conduit string positionable in a well bore; a valve body in said tubular mmeber having a passage surrounded by a valve seat; a valve member in said body having a head portion movable in an upstream direction into engagement with said seat; a cylinder in said body upstream of said seat; said valve member including a piston slidable in said cylinder, said piston having a first portion of its transverse surface which faces upstream of said seat subject to the pressure of fluid upstream of said seat; means providing a confined space between said cylinder and piston into which fluid cannot enter while said apparatus is in the well bore, in order that said piston have a second portion of its transverse surface extending laterally of said first portion and facing upstream of said seat and disposed in said confined space which is not subject to the pressure of fluid upstream of said seat; said valve member having a resultant fluid pressure actuatable surface facing in a direction downstream of said seat and subject to the pressure of fluid downstream of said seat; said downstream facing surface being substantially greater in area than the area of the transverse surface of said first portion; said valve member further including a stem portion between said head and piston spaced from said seat to form an annular space with said seat through which fluid may flow when said head is out of engagement with said seat; the cross-sectional area of the upstream side of said head between said stem and the point of engagement of said head with said seat being substantially equal to the cross-sectional area of the downstream facing portion of said piston between said stem and cylinder.

12. In a well apparatus: a tubular member having means thereon for securing said member in a conduit string positionable in a well bore; a valve body in said tubular member having a passage surrounded by a valve seat; a valve member in said body having a head portion movable in an upstream direction into engagement with

said seat; a cylinder in said body upstream of said seat; said valve member including a piston upstream of said seat and slidable in said cylinder, said piston having a first portion of its transverse surface which faces upstream of said seat subject to the pressure of fluid upstream of said seat; means providing a confined space between said cylinder and piston into which fluid cannot enter while said apparatus is in the well bore, in order that said piston have a second portion of its transverse surface extending laterally of said first portion and facing upstream of said seat and disposed in said confined space which is not subject to the pressure of fluid upstream of said seat; said valve member having a resultant fluid pressure actuatable surface facing in a direction downstream of said seat and subject to the pressure of fluid downstream of said seat; said downstream facing surface being substantially greater in area than the area of the transverse surface of said first portion; and means, releasable by hydraulic pressure within said tubular member on the downstream side of said seat imposed upon said body and valve member when said head engages said seat, for securing said valve body to said tubular member, release of said securing means enabling said valve member and body to be shifted within said tubular member to a position in which said valve member and body are ineffective to control passage of fluid within said tubular member.

13. In well apparatus: a tubular member adapted to form part of a conduit string positionable in a well bore; a valve body in said tubular member having a passage surrounded by a valve seat; a valve member in said body having a head portion movable in an upstream direction into engagement with said seat; a first cylinder in said body upstream of said seat; a second cylinder in said body upstream of said seat of larger diameter than said first cylinder; said valve member including a first piston upstream of said seat slidable in said first cylinder and a second piston slidable in said second cylinder; a third piston extending from said second piston and subject to the pressure of fluid upstream of said seat, said third piston having a substantially lesser diameter than said second piston and second cylinder; means providing a confined space in said second cylinder into which fluid under pressure upstream of said seat cannot enter; and means for conducting fluid under pressure from the downstream side of said seat into said second cylinder for action upon said second piston to urge said head toward engagement with said seat.

14. In well apparatus: a tubular member adapted to form part of a conduit string positionable in a well bore; a valve body in said tubular member having a passage surrounded by a valve seat; a valve member in said body having a head portion movable in an upstream direction into engagement with said seat; a first cylinder in said body upstream of said seat; a second cylinder in said body upstream of said seat of larger diameter than said first cylinder; said valve member including a first piston upstream of said seat slidable in said first cylinder and a second piston slidable in said second cylinder; a third piston extending from said second piston and subject to the pressure of fluid upstream of said seat, said third piston having a substantially lesser diameter than said second piston and second cylinder; means providing a confined space in said second cylinder into which fluid under pressure upstream of said seat cannot enter; means for conducting fluid under pressure from the downstream side of said seat into said second cylinder for action upon said second piston to urge said head toward engagement with said seat; and means, releasable by hydraulic pressure within said tubular member on the downstream side of said seat imposed upon said body and valve member when said head engages said seat, for securing said valve body to said tubular member, release of said securing means enabling said valve member and body to be shifted within said tubular member to a position in which said valve member and body are ineffective to control passage of fluid within said tubular member.

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