March 3, 1953 C. C. BROWN 2,630,178

VALVE

Filed April 22, 1949 2 SHEETS—SHEET 1

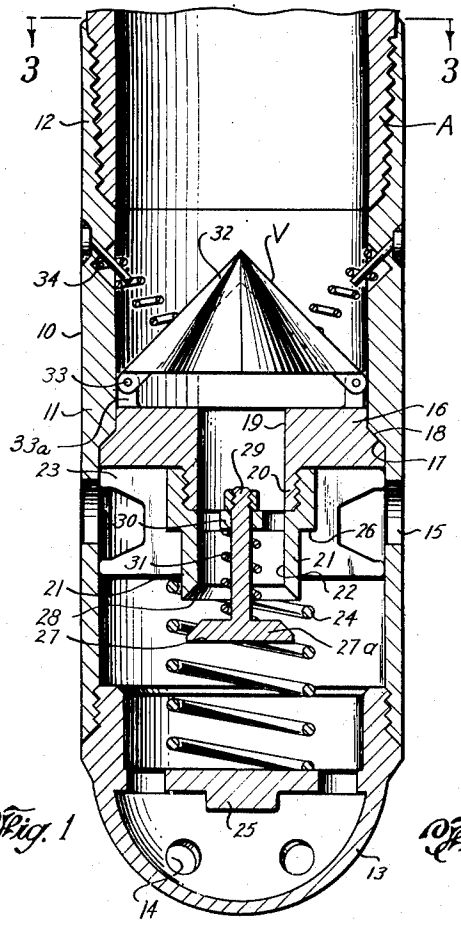


Fig. 1

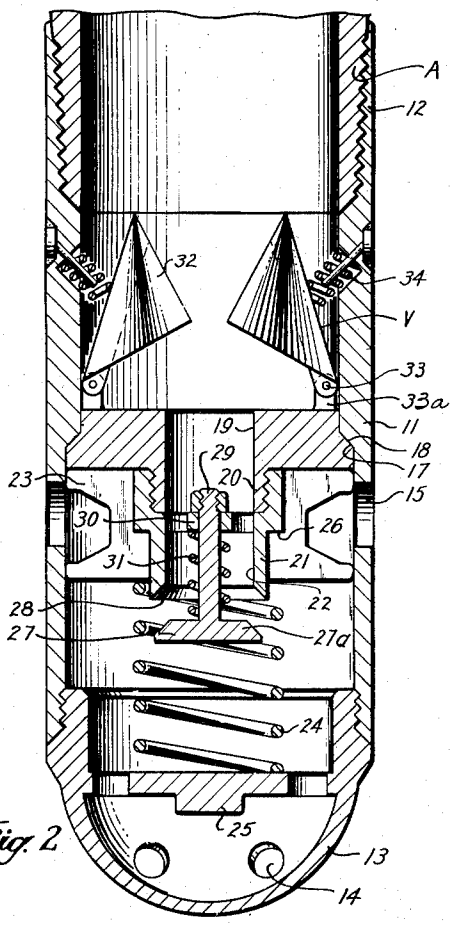


Fig. 2

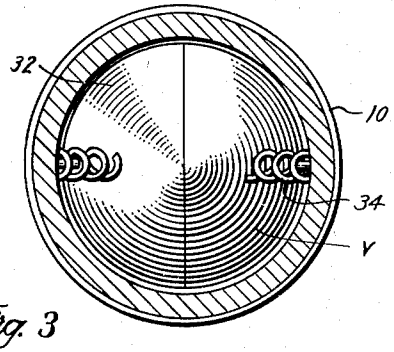


Fig. 3

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VALVE

Filed April 22, 1949 2 SHEETS—SHEET 2

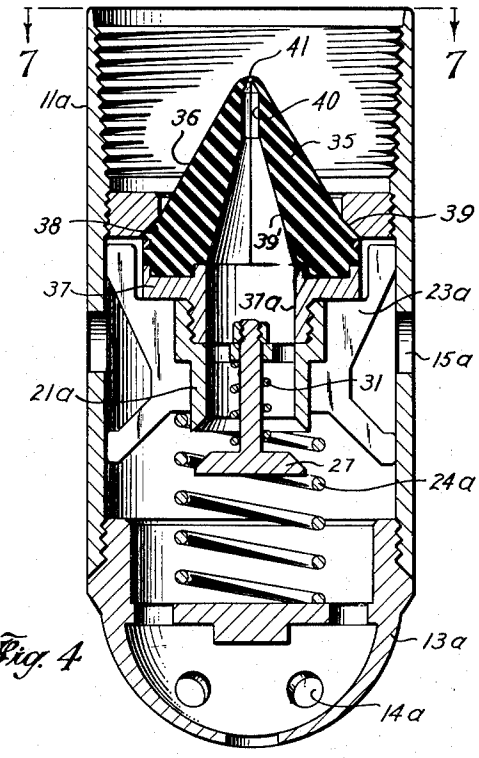


Fig. 4

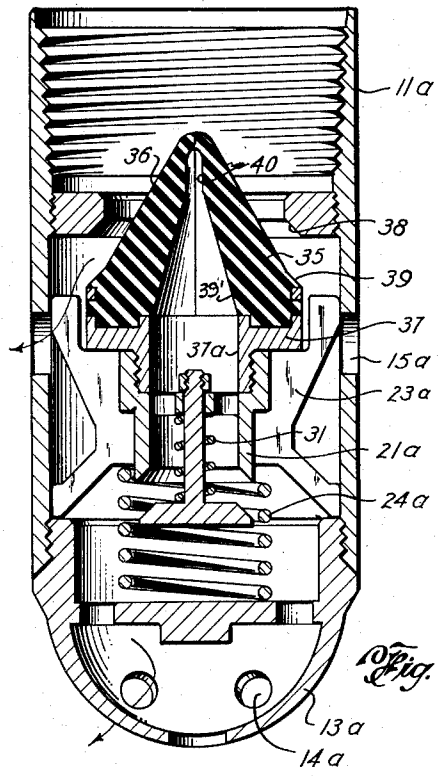


Fig. 6

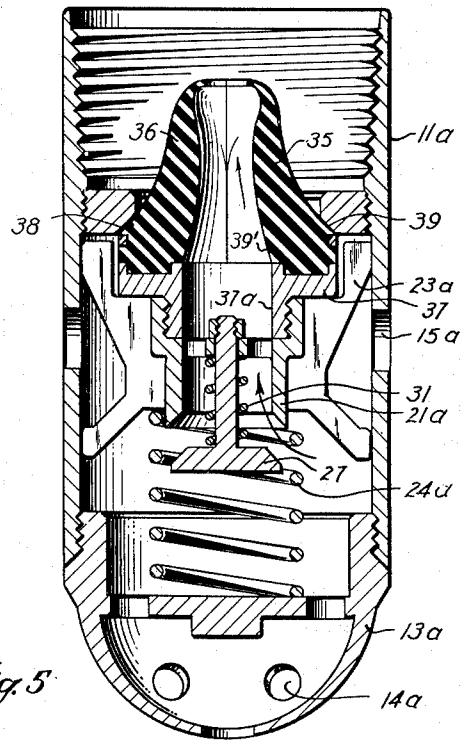


Fig. 5

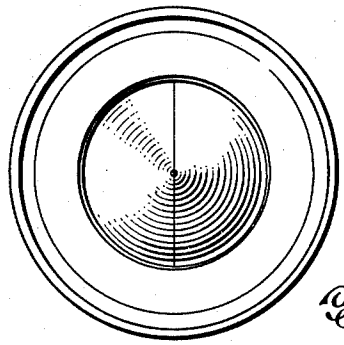


Fig. 7

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UNITED STATES PATENT OFFICE

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VALVE

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7 Claims. (Cl. 166—4)

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This invention relates to new and useful improvements in valves and relates particularly to fill-up valves employed for controlling the filling of well pipe as the same is lowered within a well bore.

A well pipe, such as well casing, which is to be lowered into a well bore is ordinarily equipped with a back check or cementing valve at its lower portion and said valve is upwardly closing so as to prevent admission of fluid from the well bore into the pipe during the lowering operation and thereby protect against a blowout through the pipe. However, after the pipe is landed in its final position within the bore, cement is pumped downwardly through the pipe and outwardly past the back check or cementing valve into the formation around the lower portion of the pipe to bond the pipe to the sub-surface formation.

As is well known, it is not generally desirable to run the entire pipe string dry and it is therefore the usual practice to fill the bore of the pipe with fluid during the lowering operation. The pipe is ordinarily filled by pumping fluid from the mud pit into said pipe, with the introduction of fluid being carried out periodically, as for example, upon the running of each two or three sections or stands of pipe. The filling operation requires holding the pipe stationary and considerable time is consumed in connecting and disconnecting the pump outlet to the pipe and in actually carrying out the filling operation. Filling of the pipe in this manner results in lost rig time and additional labor on the part of the crew and has the additional disadvantage of possibly sticking the pipe during the time that the pipe is held stationary; also since the pipe is filled from the mud pit at the surface, the particular fluid pumped into the pipe may not be identical to the fluid in the bore hole whereby these dissimilar fluids will subsequently admix which is undesirable.

It is, therefore, one object of this invention to provide an improved fill-up valve for well pipe which will effect filling of the pipe by fluid from within the well bore and which is so constructed that the cementing operation may be carried out in the usual manner after the well pipe has been landed in its final position in the well bore.

An important object of the invention is to provide an improved valve adapted to be mounted in the lower portion of a well pipe and functioning to automatically control filling of the pipe by fluid from the well bore as said pipe is lowered therein; said valve also including a positive back check closure means which prevents a blowout

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through the pipe in the event excessive pressures develop in the well bore.

Another object is to provide an improved valve, of the character described, which is actuated by the pressure differential thereacross and which operates to open the inlet to the pipe during lowering movement of the pipe and to close said inlet when a predetermined volume of fluid has been admitted to the pipe whereby filling of the pipe occurs automatically during lowering of said pipe to thereby obviate the necessity of filling the pipe from the surface.

A further object is to provide a fill-up valve for well pipe wherein the valve element extends transversely across the major portion of the bore of the pipe and has one side exposed to the pressure within the pipe bore with its opposite side exposed to the pressure within the well bore, whereby the valve is actuated by the differential in such pressures.

Still another object is to provide a valve, of the character described, wherein the valve element which is operated by the pressure differential thereacross may comprise a plurality of pivoted metallic members or may be a single annular resilient member which substantially spans the bore of the pipe within which the valve is mounted.

Other and further objects of the invention will appear from the description of the invention.

In the accompanying drawings, which form a part of the instant specification, which are to be read in conjunction therewith and wherein like reference numerals are used to indicate like parts in the various views:

Figure 1 is a transverse, vertical sectional view of a fill-up valve, constructed in accordance with the invention, with the filling valve element in a closed position,

Figure 2 is a similar view with the valve element which controls filling in an open position,

Figure 3 is a horizontal cross-sectional view, taken on the line 3—3 of Figure 1,

Figure 4 is a view, similar to Figure 1, illustrating a modified form of valve element for controlling filling, said element being in a closed position,

Figure 5 is a view, similar to Figure 4 with the filling valve open,

Figure 6 is a view, similar to Figures 4 and 5 and illustrating the position of the parts when the cementing operation is being carried out through the valve, and

Figure 7 is a horizontal cross-sectional view, taken on the line 7—7 of Figure 4.

In the drawings, the numeral 10 designates a valve device or unit which is adapted to be connected in the lower portion of the casing string (not shown) and which is arranged to control the entry of fluid from the bore of the well as the pipe or casing is lowered through the fluid within said bore. The valve device includes an outer tubular housing or body 11 which is formed with an internally threaded box 12 at its upper end whereby the device may be readily attached to the lowermost section of the well pipe A. The lower end of the body or housing 11 has a perforated plug 13 threaded therein and said plug is formed with a plurality of fluid inlet openings 14. Intermediate the ends of the body or housing are located a plurality of outlet ports 15 which establish communication between the interior of the body and the well bore. An upwardly closing valve disc 16 having an external annular seating surface 17 is slidable within the lower portion of the bore of the housing 11 and the surface 17 is adapted to engage an internal annular valve seat 18 formed within the bore of the housing when the valve disc is in its raised position.

An axial bore 19 extends through the valve disc and a depending collar which is externally threaded surrounds the bore. A sleeve 21 is threaded to the collar 20 and has a bore 22 which is of substantially the same diameter as the bore 19 through the valve disc. A plurality of radially extending guide wings or projections 23 are formed integral with the sleeve member 21 and function to guide the sliding movement of the valve disc 16 within the bore of the housing. A coil spring 24 which has its lower end engaging a transverse perforated partition 25 within the plug 13 and which has its upper end engaging an annular shoulder 26 provided on the sleeve member 21 functions to exert its pressure to urge the valve disc assembly upwardly within the housing, whereby the seating surface 17 of the valve disc 16 is maintained in engagement with the valve seat 18.

A back check valve 27 is adapted to close the bore 22 of the sleeve member 21 by engagement with a beveled seat 28 provided at the lower end of said bore and the valve 27 has a stem 29 which extends upwardly and axially within the bore. The upper portion of the stem is slidable within a guide spider 30 disposed in the bore of the sleeve member 21 and a coil spring 31 which is confined between the spider and the head 27*a* of the valve 27 constantly urges the valve to a lower or open position.

With the spring 24 maintaining the valve disc assembly in a raised position in engagement with the valve seat 18, fluid entering the lower portion of the bore of the housing 11 may normally pass upwardly through the bore of the sleeve member 21 and the bore 19 of the valve disc 16. If the pressure of this fluid becomes excessive such excessive pressure will move the check valve 27 to its upper or seated position to completely close off any flow through the valve assembly and thereby shut off any flow into the well pipe to which the housing 11 is connected. The check valve 27 thus provides a positive protection against possible blowout in the event the well bore pressure becomes excessive.

For controlling the admission of the well fluid into the well pipe a hinged valve V is mounted on the upper end of the valve disc 16 and this valve comprises a pair of complementary hinged sections 32, each section being pivotally mounted on a pivot pin 33 within upstanding ears 33*a* formed on the valve disc. A coil spring 34 is associated with each hinged section and said springs constantly urge the sections toward each other to the position shown in Figure 1, in which the valve V is closed to prevent flow in either direction to the interior of the well pipe above said valve. As illustrated, each section is generally semi-circular as viewed from above (Figure 3) and said sections are adapted to be swung on their respective pivots against the tension of the spring 34 to the position shown in Figure 2 whereby a flow through the valve sections may occur. It will be evident that the under side of the valve sections are normally exposed to the pressure of the fluid within the well bore while the upper surfaces of said sections are exposed to the pressure within the well pipe to which the housing 11 is connected. The pressure of the springs 34 is added to the pressure within the well pipe and by varying the strength of these springs the differentials in pressure across the valve which are necessary to move the valve to an open position may be controlled. Although the valve V is illustrated as made in two pivoted sections it is evident that said valve may be constructed of three, four or any desired number of sections or segments, each of which would be suitably pivoted to swing upwardly to an open position.

In the operation of the device or unit 10 said unit is connected to the lower end or in the lower portion of the well pipe string and is lowered downwardly through the fluid within the well bore. When first introduced into the the well bore the parts will be in the position as shown in Figure 1 with the valve disc 16, which may be termed the cementing valve, in its upper closed position and the back check valve 27 in its lowered open position; the valve V will be closed with its sections being maintained closed by the springs 34. As the well pipe is lowered through the fluid within the bore the kinetic pressure which is built up due to the movement of the pipe string into the well fluid will result in an impact pressure against the surface of the sections 32 of the valve V whereby the sections are swung to an open position to admit the fluid from the well bore into the interior of the well pipe A. It is noted that the pressure of the spring 31 on the check valve is sufficient to maintain the check valve open against the normal kinetic pressure developed during the lowering operation so that said check valve remains open to allow the pressures to act against the valve V under normal conditions.

An inflow of fluid into the well pipe continues until a sufficient volume of fluid has been admitted to the pipe so that the hydrostatic head pressure of such admitted fluid plus the pressure of the springs 34 is sufficient to overcome the pressure acting against the under side of the sections 32 of the valve V. When this occurs, the hydrostatic head pressure of the admitted fluid overcomes the pressure acting to hold the valve open and the sections 32 are returned to their original closed position to close the valve V as shown in Figure 1. The valve V remains closed until continued lowering through the fluid column again increases the pressure acting against the under side of the valve V and when this occurs the valve is again opened to admit additional fluid. The admission of such additional fluid continues until the head pressure of the admitted fluid plus the spring is again sufficient to overcome the pressure acting against the under side of the valve sections 32 whereby the valve is again closed.

The alternate opening and closing of the valve controlled solely by the differential in pressures acting there-across continues as the pipe is lowered through the fluid within the well bore and by the time the pipe is landed in its final position the desired volume of fluid has been admitted to fill the pipe in a desired manner. It is obvious that if excessive pressures are developed within the well bore during the time of lowering of the pipe such excessive pressure will be sufficient to overcome the tension of the spring 31 which normally holds the check valve 27 in its open position and the check valve 27 will be closed to shut off flow upwardly through the bore 22 of the sleeve member 21 and bore 19 of the valve disc 16. This effects a positive shut off of upward flow of fluid into the well pipe and assures protection against a possible blowout during the lowering operation.

After the pipe has been lowered to its final position cement may be pumped downwardly through the well pipe in the usual manner and acting against the valve V which is mounted on the upper surface of the cementing valve disc 16 will function to move the valve disc 16 downwardly against pressure of its spring 24 whereby the outlet ports 15 in the housing will be opened to permit a discharge of cement outwardly into the well bore. Therefore, after the well pipe has been finally landed in position a cementing operation may be carried out in the usual manner.

From the foregoing, it will be seen that the device provides a means whereby the well pipe or casing may be automatically filled by fluid from within the well bore as said pipe is lowered through said bore. A positive protection against blowout in case of excessive pressures within the bore is provided by means of the back check valve 27. The entire structure is such that after the pipe is lowered into position the ordinary cementing operation may be accomplished.

In Figures 4 to 7 a modified form of the invention is illustrated. In this form the valve disc 16 and the valve V are omitted and an elastic valve element 35 is substituted therefor. The valve element is constructed of rubber, rubber compound or other elastic material and has a normal shape which is generally conical or tapered toward its upper end. The base portion 36 of the valve element is molded or otherwise secured to a flanged supporting collar 37 and a sleeve member 21*a* is secured to the lower end of the collar. The sleeve 21*a* is similar in construction to the sleeve 21 of the first form and has the back check valve 27 mounted therein, while its external surface is formed with a plurality of radial guide wings or ribs 23*a*. A coil spring 24*a* normally urges the valve assembly upwardly whereby an annular beveled seating surface 38 on the valve element is engaged with a valve seat 39 mounted within the body or housing 11*a* of the device.

The valve element 35 has a tapered bore 39' which is reduced toward its upper end and which terminates in a restricted passage 40. The upper end of the passage 40 is further reduced whereby a relatively small orifice 41 is formed axially in the upper end of the element. The lower end of the bore of the element communicates through the opening 37*a* in the supporting collar and the bore of the sleeve member 21*a* with the interior of the housing below the valve assembly. Inlet openings 14*a* are formed in a plug member 13*a* threaded in the lower end of the body or housing 11*a* while outlet ports 15*a* are formed in the wall of the housing.

The operation of this form of the invention is substantially the same as the first form shown in Figures 1–3. The housing 11*a* is connected to the lower end or in the lower portion of the well pipe and the valve element 35 is normally in the position shown in Figure 4 with said valve element being in its upper position engaging the valve seat 39 and closing the outlet ports 15*a*. The back check valve 27 is maintained in its open position by its spring 31. As the device is lowered through the fluid within the well bore the kinetic pressure which is developed as a result of said lowering acts within the tapered bore 39' of the valve element 35 and since said member is constructed of an elastic material this pressure functions to expand or stretch the element to enlarge its bore as illustrated in Figure 5, whereby the fluid from the well bore may enter the well pipe. When the fluid which has entered the well pipe attains a predetermined hydrostatic head pressure which, added to the normal inherent resiliency of the element 35 is sufficient to overcome the pressure of the fluid acting within the bore of the element, said element is returned to its initial unexpanded position to substantially shut off further inflow of fluid from the well bore into the well pipe. It is noted that in such unexpanded position the small orifice may remain open so that actually there may never be a positive shut off through the elastic element; rather the diameter of the bore of the element is varied in accordance with pressure conditions to provide for a controlled filling of the well pipe.

After a predetermined entry of fluid has occurred and the element 35 has returned to its initial unexpanded position, continued lowering of the device to a point where the pressure exteriorly of the pipe is sufficient to overcome the pressure within the pipe acting downwardly on the valve element, the valve element again spreading or expanding to enlarge its bore to admit additional liquid and the intermittent opening and closing of the valve element 35 in accordance with pressures acting on opposite sides thereof continues until the pipe has been lowered to its final position within the bore. At such time proper filling of the pipe by the fluid from within the well bore has been carried out. It is obvious that if a blowout threatens at any time during the lowering operation, the check valve 37 will be moved upwardly to close any flow upwardly within the pipe.

After the well pipe has been properly positioned in the well bore the usual cementing operation may be completed by merely pumping cement downwardly through the well pipe and such cement will act against the upper end of the valve element 35 and will move the complete valve assembly downwardly as illustrated in Figure 6, whereby the seating surface 38 of the valve element moves away from the valve seat 39 and uncovers the outlet ports 15*a* through which the cement is discharged.

In both forms of the invention it is preferable that the various internal parts of the device be constructed of a material which may be readily drilled out whereby after the cementing operation is complete the said parts may be drilled out in the usual manner to open the lower end of the well pipe. In both forms the differential in pressures acting on opposite sides of the fill-up valve, either valve B in Figure 1 or the valve element 35 in Figure 4, actuates the valve to effect automatic filling of the pipe during lowering thereof. Also in the devices illustrated, a posi-

tive shut off of the well pipe will occur in case of a threatened blowout and yet the assembly is so constructed that an ordinary cementing operation may be accomplished in the usual manner following the final positioning of the well pipe within the well bore. Although only a single valve device is illustrated and described as mounted in the lower end or lower portion of the well pipe it is noted that several of the valve devices may be disposed in spaced relation in said pipe; in such event, the pressure drop occurring across each device would be lessened since the overall pressure drop is distributed over a plurality of devices, whereby excessive wear on the parts of each device due to abrasion caused by high velocity flowing fluid, is reduced.

From the foregoing it will be seen that this invention is one well adapted to attain all of the ends and objects hereinabove set forth together with other advantages which are obvious and which are inherent to the structure.

It will be understood that certain features and subcombinations are of utility and may be employed without reference to other features and subcombinations. This is contemplated by and is within the scope of the claims.

As many possible embodiments may be made of the invention without departing from the scope thereof it is to be understood that all matter herein set forth or shown in the accompanying drawings is to be interpreted as illustrative and not in a limiting sense.

Having described the invention, I claim:

1. A fill-up valve device for a well pipe which is adapted to be lowered within a well bore having fluid therein including, a tubular body adapted to be connected in the lower portion of the well pipe and having a fluid inlet whereby fluid from the well bore may enter the body and flow into the well pipe, a valve assembly mounted in the bore of the body and including an upwardly closing valve member and also including a valve element for controlling admission of fluid into the pipe and actuated by the pressure differential thereacross, said valve element being opened when pressure in the well bore exceeds the pressure in the well pipe, and closing after a predetermined volume of fluid has entered said pipe, and a back check valve forming part of the assembly for shutting off all flow into the well pipe in the event the pressure in the well bore becomes excessive, said upwardly closing valve member, said valve element and said back check valve of said valve assembly being connected together for axial movement in said tubular body.

2. A fill-up valve device for a well pipe which is adapted to be lowered within a well bore having fluid therein including, a tubular body adapted to be connected in the lower portion of the well pipe and having a fluid inlet whereby fluid from the well bore may enter the body and flow into the well pipe, a valve assembly mounted in the bore of the body and including a valve element for controlling admission of fluid into the pipe and actuated by the pressure differential thereacross, said valve being opened when pressure in the well bore exceeds the pressure in the well pipe, and closing after a predetermined volume of fluid has entered said pipe, a back check valve forming part of the assembly for shutting off all flow into the well pipe in the event the pressure in the well bore becomes excessive, said body having cementing outlet ports, and an upwardly-closing cementing valve forming part of the valve assembly and normally

preventing outward flow through the outlet ports, said cementing valve being adapted to be actuated to allow flow through the outlet ports by pressure from within the well pipe, said valve element, said back check valve, and said cementing valve of said valve assembly being connected together for axial movement in said tubular body.

3. A valve device as set forth in claim 1, wherein the valve element which controls the admission of fluid into the well pipe is formed of a plurality of pivoted sections.

4. A valve device as set forth in claim 1, wherein the valve element which controls the admission of fluid into the well pipe comprises an expansible member of elastic material having a central bore therethrough.

5. A fill-up valve device for a well pipe which is adapted to be lowered within a well bore having fluid therein including, a tubular body adapted to be connected in the lower portion of the well pipe and having a fluid inlet whereby fluid from the well bore may enter the body and flow into the well pipe, said body having cementing outlet ports leading from the bore thereof, a valve assembly mounted within the bore of the body and including an upwardly closing cementing valve which normally prevents outward flow from a well pipe through said outlet ports and which is arranged to be moved downwardly by predetermined pressure within the well pipe to permit outward flow through said ports, said cementing valve having an axial flow passage therethrough, and a valve means consisting of a plurality of pivoted sections mounted on the cementing valve for controlling the flow through said passage, and means for actuating said valve means by the differential in the pressures acting on opposite sides thereof, together with a back check valve mounted in the lower portion of the flow passage and normally maintained in an open position, and means for closing said back check valve to shut off flow through the passage when the well bore pressure becomes sufficiently excessive to threaten a blowout.

6. A fill-up valve device for a well pipe which is adapted to be lowered within a well bore having fluid therein including, a tubular body adapted to be connected in the lower portion of the well pipe and having a fluid inlet whereby fluid from the well bore may enter the body and flow into the well pipe, said body having cementing outlet ports, a valve assembly mounted within the bore of the body and including an upwardly closing cementing valve which normally prevents outward flow from the well pipe through said outlet ports and which is arranged to be moved downwardly to open the ports by predetermined pressure within the well pipe, said cementing valve having an axial flow passage therethrough, said cementing valve being formed of elastic material and having its upper portion tapered and cone-shaped with the flow passage extending entirely therethrough, the bore of the cone-shaped portion being exposed to the pressure within the well bore and the outer surface of said portion being exposed to the pressure within the well pipe, whereby said tapered portion is expanded and retracted to open and close the bore therethrough by the differential in pressures acting on opposite sides thereof.

7. A valve device as set forth in claim 6, together with a back check valve mounted in the lower portion of the flow passage and normally maintained in an open position, and means for closing said back check valve to shut off flow

through the passage when the well bore pressure becomes sufficiently excessive to threaten a blow-out.

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