Jan. 3, 1939. E. A. RODGERS 2,142,376

FLOW CONTROLLING VALVE

Filed Aug. 17, 1936 2 Sheets-Sheet 1

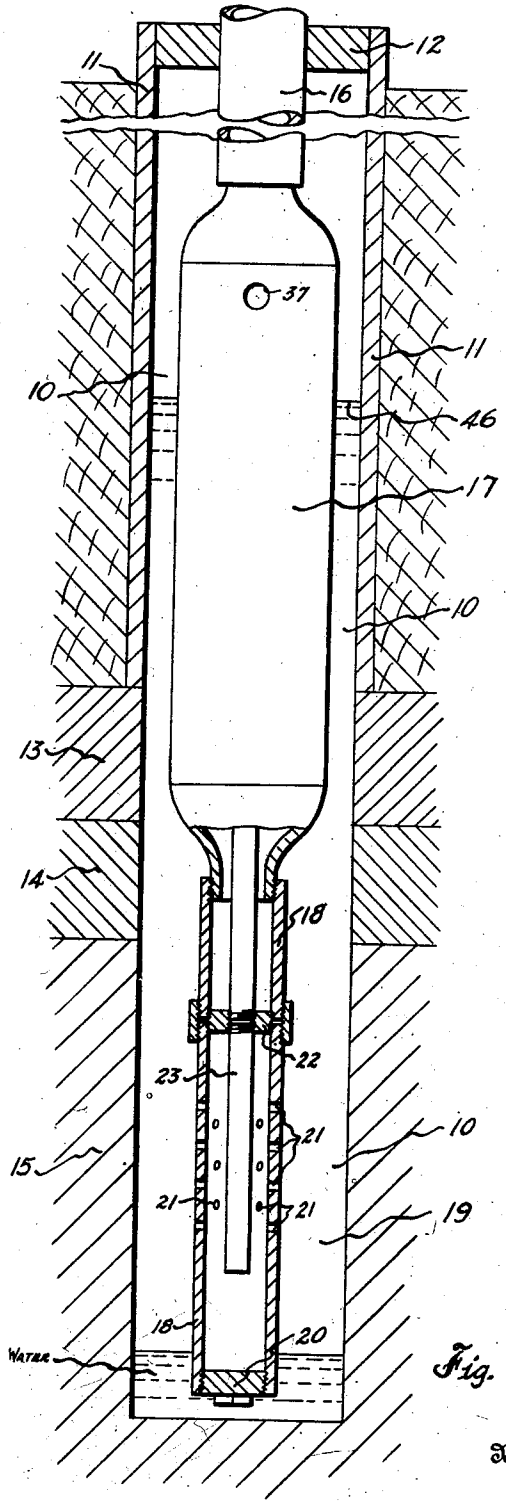


Fig. 1

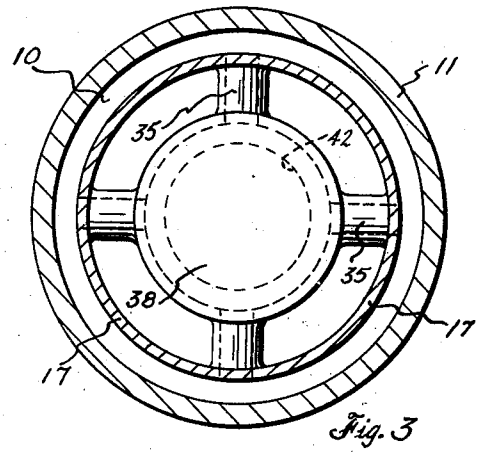


Fig. 3

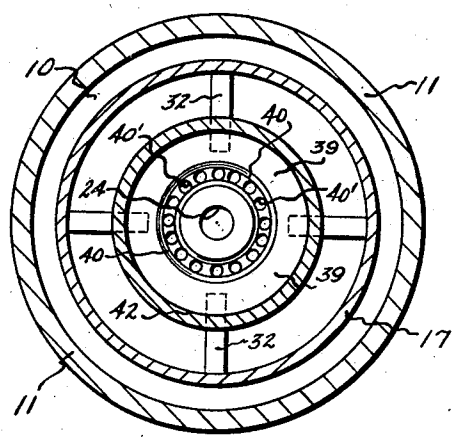


Fig. 4

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FLOW CONTROLLING VALVE

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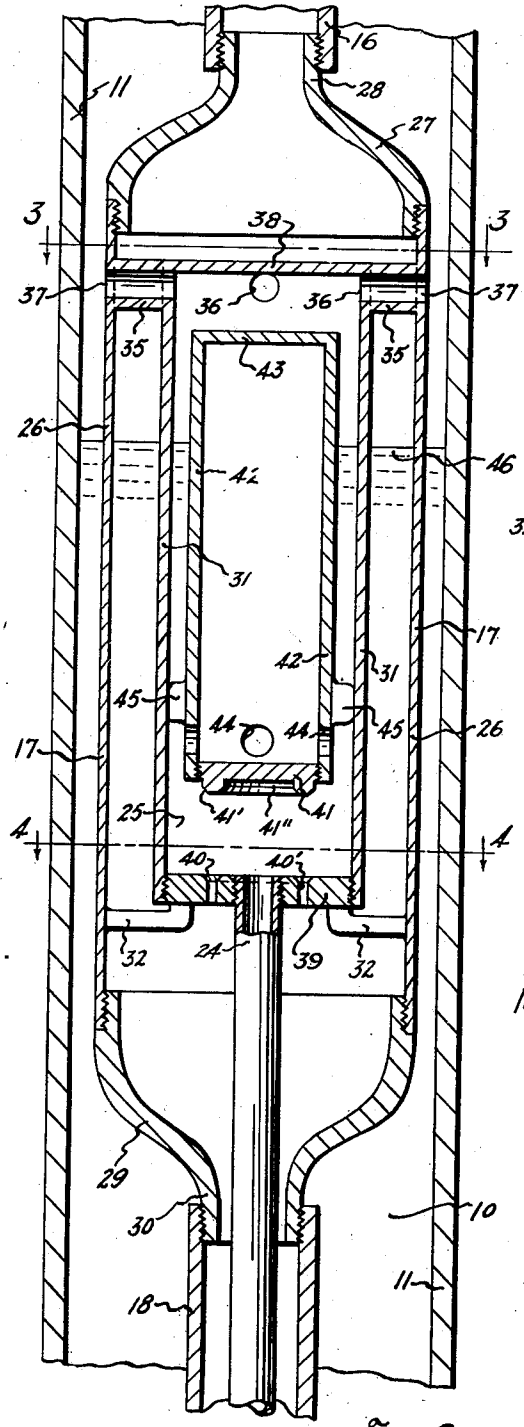


Fig. 2

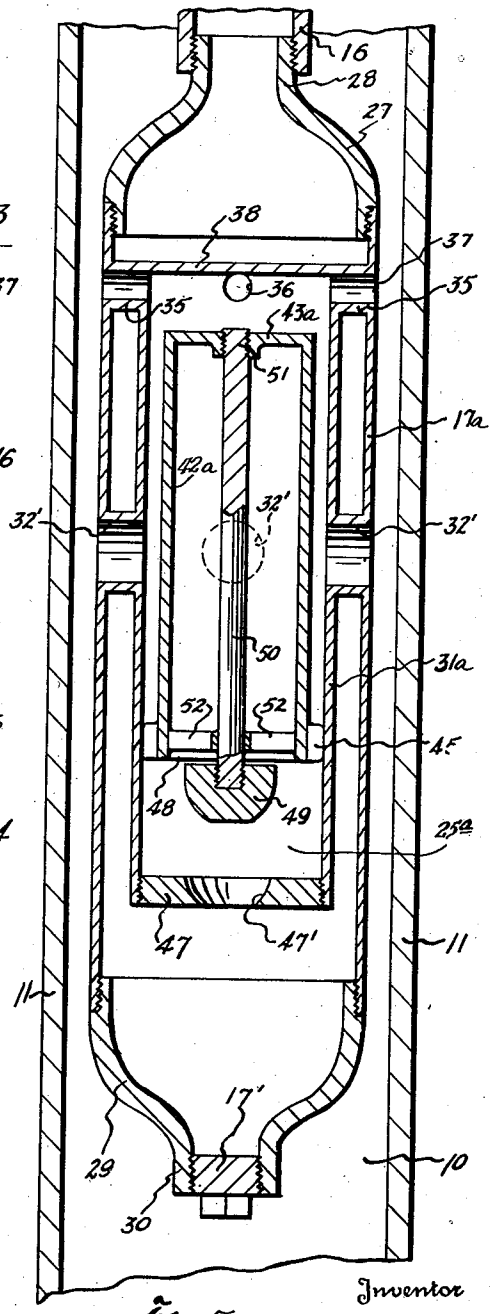


Fig. 5

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Patented Jan. 3, 1939 2,142,376

UNITED STATES PATENT OFFICE

2,142,376

FLOW CONTROLLING VALVE

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Application August 17, 1936, Serial No. 96,532

5 Claims. (Cl. 166—2)

This invention relates to flow controlling valves for oil and gas wells and the like.

It has for its principal object to produce a simple yet practical, dependable and durable float and balanced pressure valve device that can be readily placed operably in a well to maintain a definite liquid level and a gas pressure head thereabove in the well casing.

Another object is to produce a flow controlling float valve that acts quickly to close when the liquid in the well casing drops to a non-buoyant level and when closed positively prevents escape of gas.

A further object is to produce a valve device by the operation of which a complete separation of oil and gas is attained.

A still further object is to produce a practical flow controlling valve that can be opened and closed, at will, by regulation of pressures in the well casing and the flow line tubing.

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

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

Figure 1 is a view, partly in side elevation and partly in vertical section, showing a flow controlling valve assembly operably installed in a well;

Figure 2 is a vertical section, on an enlarged scale, of one practical construction and arrangement of a valve assembly;

Figure 3 is a cross section on the line 3—3 of Figure 2;

Figure 4 is a cross section on the line 4—4 of Figure 2; and

Figure 5 is a vertical section of a modified construction and arrangement of a valve assembly.

Referring now to the drawings the numeral 10 designates generally an oil well in which a tubular lining or casing 11 is provided, said casing being closed at its upper end by an ordinary head, shown conventionally at 12, and its lower end terminating, in accordance with the usual practice, at the impervious stratum 13 which overlies the gas producing formation or sand 14, next below which is the oil producing formation or sand 15. This is a practical installation in the conservation control of productive wells and the rehabilitation of declining or non-productive wells. However, the valve of the present invention is not limited to the particular installation illustrated, but is obviously adaptable for other installations for the maintenance of a liquid level in the well above a certain minimum and the stoppage of outflow and escape of gas.

At the lower end of the flow line tubing 16, which extends downwardly in the casing 11 from the head 12, is a hollow shell or valve shield 17, to the lower end of which is attached the reservoir tube 18. As shown in Figure 1, the tube 18 extends down to near the bottom of the well reservoir 19 and is closed at its lower end by a plug or cap 20.

Some distance above the plugged or capped end 20, or at least above the water level (if there be any water present) in the reservoir 19, the tube 18 is provided with a series of apertures 21, above which is a bushing or stopper 22. Extending axially through the stopper 22, with its lower end opened and below the apertures 21 of the tube 18, is an inner flow tube 23, the upper portion of said tube 23 extending up into the hollow shell or valve shield 17 and having its upper end portion 24 communicating with a float chamber 25 in the shell or shield 17, as and for the purpose to be presently more fully described.

Preferably, as shown, the shell or shield 17 comprises a cylindrical body member 26 at the upper end of which is an attached head 27 having a reduced neck or coupling extension 28 to which the flow line tube 16 is attached, while at its lower end is provided a similar head 29, to the reduced neck or coupling portion 30 of which the reservoir tube 18 is attached.

The float chamber 25 comprises an inner cylinder 31 which is preferably supported at its lower end on the shell or shield cylinder 26 by radial struts 32. The upper end portion of the inner cylinder 31 is attached to the shell or shield cylinder 26 by tubular struts 35 which are open at their inner ends to communication with the float chamber 25, as at 36, and at their outer ends to communication with the space in the well casing 11, as at 37.

The upper end of the float chamber cylinder 31 is closed by a head 38, while in the lower end of the cylinder 31 is fitted a plug 39 having a central opening in which the end portion 24 of the flow tube 23 is fitted. Surrounding said central opening, on the inner side of said plug 39 is an annularly grooved valve seat 40 to receive a counterpart valve head 41 mounted on the lower end of a hollow float cylinder 42, which latter is closed at its upper end, as at 43, and may be provided at its lower end portion with apertures 44 through which, if said cylinder 42 be

submerged in the cylinder 31, a certain amount of fluid will enter the float cylinder 42, but not in quantity enough to fill it, because there is always sufficient air pocketed in the float cylinder to make it buoyant. However, in some cases, the float cylinder may be made without the apertures 44, in order to have more buoyancy, but with less pressure balancing effect should the liquid level fall below a given minimum, as will be later more fully described.

To center the float cylinder 42 in the float chamber 25, the cylinder is preferably provided near its lower end with radial lugs 45 which bear slidably at their outer ends on the inner face of the float cylinder 31. Obviously, an upper set of the lugs 45 may also be provided, if desired, but in most cases the lower set alone will suffice for centering the float cylinder 42 and guiding the annular valve portion 41 to its seat in the groove 40 of the plug 39 at the bottom of the float chamber cylinder 31.

In the annular valve-seating groove 40 the plug 39 is provided with a series of apertures 40' through which fluid flow communication is established between the interior of the float chamber 25 and the interior of the shield shell 26 when the valve head 41 is lifted from said annularly grooved seat 40. As shown, the valve head 41 comprises a circular body which is screw-threaded annularly and inserted as a plug in the internally screw-threaded lower end portion of the float cylinder 42. On the under side of the body portion 41 is an annular seating portion 41', the corner portions of which are preferably beveled to fit with accuracy in the annular groove 40 whose marginal wall portions are correspondingly beveled. Obviously, said seat portion 41' may be formed integrally with the body portion 41 or otherwise provided thereon in any approved way.

By providing the annular seating portion 41' there is a limited space 41'' above the central inlet opening where the flow tube 23 is connected to the plug 39, whereby to receive the fluid from said tube 23 while the valve head 41 is seated, by which provision the opening of the valve is materially aided by the fluid pressure in said tube 23, yet, when the liquid level in the well falls below the minimum at which the float cylinder 42 is lifted by its buoyancy, the relative pressures in the well are such that the valve 41 is held seated in the groove 40 and effectively prevents escape of gas, that is to say, there is at least a balanced pressure above and below the closed valve whereby it remains seated in its closed position until the liquid level rises in the well sufficiently to float the cylinder 42 and thereby lift the valve 41 from the seating groove 40.

Obviously, by the maintenance of a gas pressure head above the level of the body of liquid in the well, at whatever stage the liquid level may be, and which is accomplished by sealing off the space between the well casing 11 and flow line tubing 16 some distance above the location of the controlling valve device of the present invention, the flow of the liquid from the well is controlled and at the same time no gas can escape through the controlling valve device because, in the first place, the construction, installation and operation of the device is such that an effective separation of the gas and liquid contents of the well is attained so that, normally, when the liquid is at or above the minimum level at which the float is raised and the valve opened, only liquid is delivered from the well through the flow controlling valve device to the flow line tubing 16, and, secondly, if the liquid level falls to near the bottom of the float chamber cylinder 31, no gas will escape because of the liquid seal above the openings 40', even if the valve 41 is unseated from the groove 40 at the time; and, should the liquid level fall below the bottom of the float chamber cylinder 31, still no gas will escape because, due to the weight of the valve cylinder 42 and the gas pressure in the chamber 25 above and surrounding the valve cylinder 42, which pressure is at least equalized with that outside of the float chamber cylinder 31.

In the use of the valve device of the present invention, the flow line tubing 16, with the valve assembly attached to the lower end thereof, is lowered into the well until the valve shell or shield 17 reaches the position in the region where it is desired to maintain the minimum liquid level at which the float valve cylinder 42 is buoyant and the valve member 41 is lifted from its seat in the annular groove 40 of the plug 39 at the bottom of the float chamber cylinder 31.

The approximate minimum valve-opening oil level is indicated at 46 in Figures 1 and 2 of the drawings, and at all levels thereabove the valve remains open, but upon the level falling below the minimum the valve immediately closes.

A gas pressure head is usually maintained in the well casing above the liquid level, either by the natural gas that becomes separated from the liquids in the well and rises thereabove, or by air or gas pressure supplied artificially to the well casing for the purpose. This pressure above the liquid, together with the natural pressure of the liquid coming from the producing formation, forces the liquid in the region of the apertures 21 of the pipe 18 into the pipe through said apertures, the free gas separating and rising upward through the body of liquid and only the non-vaporized gas enters with the liquid. By reason of the pipe 23, of relatively smaller diameter than the pipe 18, being extended below the series of apertures 21, the liquid is further separated from the free gas and passes up through said pipe 23 into the float chamber just beneath the valve member 41, and, as the float cylinder 42 is buoyed up by the liquid being at or above the minimum level in the well casing and entering the float chamber 25 through the tubular upper struts 35, the valve head 41 is lifted above the seating groove 40, whereby the liquid flows into the float chamber 25 through said tube 23, out through the openings 40' in the grooved portion 40 of the plug 39 and up through the space between the shell or shield 17 and the float chamber cylinder 31, and into the flow line tubing 16, either under the pressure within the well or suction of a pump attached to or applied in the flow line tubing 16, as the case may be.

Should the liquid level fall below the minimum the float cylinder 42 will drop and seat the valve head 41 in the groove 40 of the plug 39 at the bottom of the float chamber cylinder 31, whereupon there is a positive stoppage of outflow through the openings 40', as the valve head 41 remains seated until again lifted by the buoyancy of the float cylinder 42. That is to say, the natural gas or artificial pressure in the well casing will act to close rather than open the valve and the effect of pumping in the flow line tubing will also be to close the valve. However, if a back pressure exists or is specially created in the flow line tubing 16 greater than the pressure in the

well, the valve head 41 will be unseated from the groove 40. It will thus be seen that the valve can be controlled from the surface by regulating the pressures in the flow line tubing and the well casing. So, too, if it is desired to wash the well casing, the washing liquid can be supplied to the casing, thereby buoying and lifting the float valve 41 and passing up through the flow line tubing 16; or, if desired, the washing liquid may be supplied under pressure through the flow line tubing 16, thereby filling the space between the shell or shield 17 and the float chamber cylinder 31 whereby to pass through the apertures 40' and force the valve portion 41' from its seat in the groove 40 and passing the liquid out through the upper hollow struts 35 and also down through the pipe 23, and out through the apertures 21 in the pipe 18, whence it circulates up through the well reservoir and into the casing 11.

A modification of the valve structure and arrangement is shown in Figure 5 of the drawings, wherein the lower end of the shell or shield 17a is closed by a plug 17' and the float chamber cylinder 31a by a plug 47 having a central opening 47' which formed with a counterpart seat for a semispherical valve member to be presently described, the liquid intake to the inner float chamber cylinder 31a being directly through lower tubular struts 32' and also through the upper tubular struts 35 as in the first herein described structure. In this second modification the float cylinder 42a is open at its lower end, as at 48, and the valve member 49, which has a semi-spherical seating portion, is attached to the lower end of an axially disposed stem 50 whose upper end portion is secured, as at 51, in the head 43a of the float cylinder 42a, the lower end portion of said stem 50 being supported and braced by a spider frame 52 secured in the lower open end portion of the float cylinder 42a.

The stem 50 may be solid, as shown, but, obviously, it may be made tubular with its upper end closed and provided at its lower end with an opening or openings whereby to increase the buoyancy of the float cylinder 42a.

The operation of this modified valve assembly is the same as that of the first herein described structure and assembly except that the liquid of the well is admitted to the float chamber 25a directly through the tubular struts 32', 35, at which points the liquid and free gas separation takes place, instead of occurring at the lower level of the apertures 21 in the pipe 18 of the first herein described valve assembly. In some wells where there is but comparatively little gas production this second described valve assembly is practically effective, while in other wells where there is free gas in greater proportion to the liquid production the gas and liquid separation and intake of the liquid into the pipe 18 at the lower depth is the more effective.

It is here noted that in an installation of the valve device of the present invention for controlling the flow of an oil well, as illustrated in Figure 1 of the accompanying drawings, the oil level is maintained above the gas and oil producing strata or formations, but in an installation in a gas well the liquid level is maintained below the gas producing stratum or formation, in which latter case the object is to prevent the liquid level from rising in the well as high as the gas producing sand, the liquid being taken out of the well through the flow line tubing 16 and the gas taken out through the casing 11. It is further noted that, as hereinbefore stated, the valve device of the present invention is adaptable for other installations.

Obviously, the valve structure and assembly and the application thereof may be modified other than herein shown and described within the spirit and scope of the invention as defined in the appended claims. The invention, therefore is not limited to the particular construction and arrangement shown in the accompanying drawings.

What I claim and desire to secure by Letters Patent is:

1. A flow controlling valve device for oil and gas wells and the like, comprising, a tubular shield having an outlet opening in its upper end portion and being supportedly attachable to the flow line tubing of the well and communicable with the tubing through said outlet opening, an inner float chamber cylinder supported axially in said tubular shield and spaced therefrom, said float chamber cylinder having an axial opening in its bottom end communicably connected with liquid flow tubing from below in the well and an annular series of openings surrounding said axial opening for communication between the chamber and the interior of said shield but otherwise closed to communication with the shield, a float in said float chamber cylinder, a valve member carried by said float at the bottom thereof and in controlling relation to said axial opening and said annular series of surrounding openings in the bottom of the float chamber cylinder, and means of communication between the uppermost interior portion of said float chamber cylinder and the space in the well outside of said shield.

2. A flow controlling valve device for oil and gas wells and the like, comprising, a hollow cylindrical shield having an outlet opening in its upper end portion but otherwise closed to external communication, said shield being supportedly attachable at its upper end to the flow line tubing of the well and communicable with said tubing through said outlet opening, a hollow float chamber cylinder supported centrally in surroundingly spaced relation within said shield by strut members at the top of the inner cylinder and similarly therebelow, the upper strut members being tubular whereby to establish communication directly between the uppermost interior portion of the float chamber cylinder and the well space outside of the shield, said float chamber cylinder having an axial opening in its bottom with a pipe connection for communication between the cylinder and the lower well space outside of the shield and an annular series of openings for communication between said cylinder and the interior of said shield but otherwise closed to such communication, a float in said float chamber cylinder, and a valve member carried at the bottom of the float to control said axial opening and open and close said shield-communicating annular series of openings.

3. A flow controlling device arranged to be suspended within a well by a tubing string including, a tubular shield having an opening at its upper end communicating with the tubing, an inner float chamber cylinder supported within the shield and spaced therefrom, the cylinder having an axial opening in its lower end communicably connected with liquid flow tubing from below in the well and an annular series of openings surrounding the axial openings for establishing communication between the chamber of the cylinder and the interior of the shield, a float in the chamber of the cylinder, a valve

member carried by the lower end of the float and in controlling relation to said axial opening and the annular series of openings, the shield being provided with passages for establishing communication between the uppermost portion of the chamber and the space in the well outside of said shield.

4. A flow controlling device arranged to be suspended within a well by a tubing string including, a tubular shield having an opening at its uppermost end communicating with the tubing, an inner float chamber cylinder supported within the shield and spaced therefrom, the cylinder having an axial opening in its lower end communicably connected with liquid flow tubing from below in the well and an annular groove surrounding the upper end of the opening, the lower end of the cylinder having an annular series of openings surrounding the lower end of the axial opening and communicating with the annular groove, whereby communication is established between the chamber of the cylinder and the interior of the shield, a float in the chamber of the cylinder, an annular valve member at the lower end of the float for engaging the groove so as to open and close the axial opening and the annular series of openings, and means of communication between the uppermost interior portion of the chamber and the space in the well outside of said shield.

5. A flow controlling device arranged to be suspended within a well by a tubing string including, a hollow cylindrical shield having an opening at its upper end communicating with the tubing, a hollow float chamber cylinder supported in surroundingly spaced relation within said shield by strut members at the top of the cylinder and similarly therebelow, the upper strut members being tubular so as to establish communication between the uppermost interior portion of the chamber of the cylinder and the well space outside of the shield, said cylinder having an axial opening in its lower end with a pipe connection for establishing communication between the chamber and the lower well space outside of the shield and an annular groove surrounding the upper end of the opening, the lower end of the cylinder having an annular series of openings surrounding the lower end of the axial opening and communicating with the annular groove, whereby communication is established between the chamber and interior of the shield, a float in said chamber, and an annular valve member at the bottom of the float for engaging the groove so as to open and close said axial opening and the annular series of openings.

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