Aug. 19, 1958 J. L. CURRY 2,848,053

BACK PRESSURE VALVE

Filed June 21, 1956 3 Sheets-Sheet 1

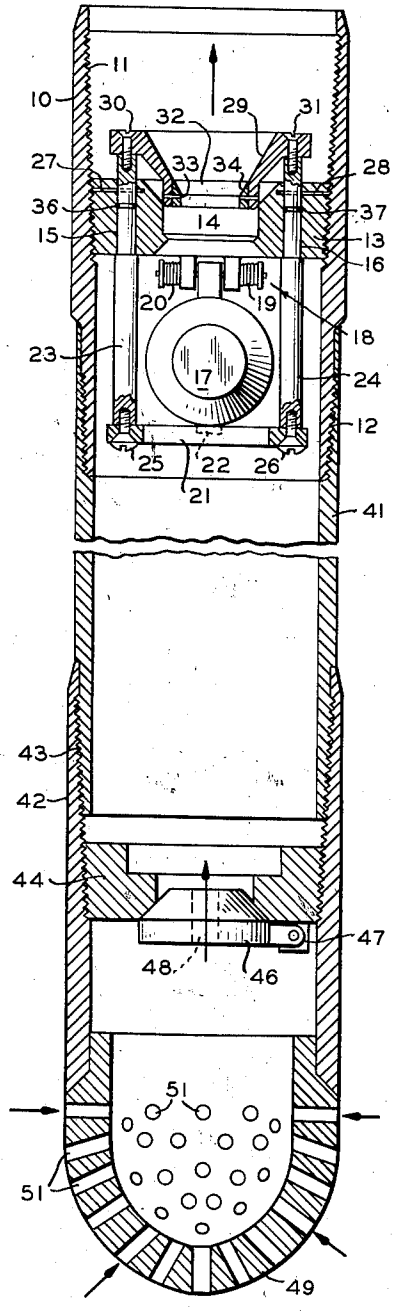


FIG. 1.

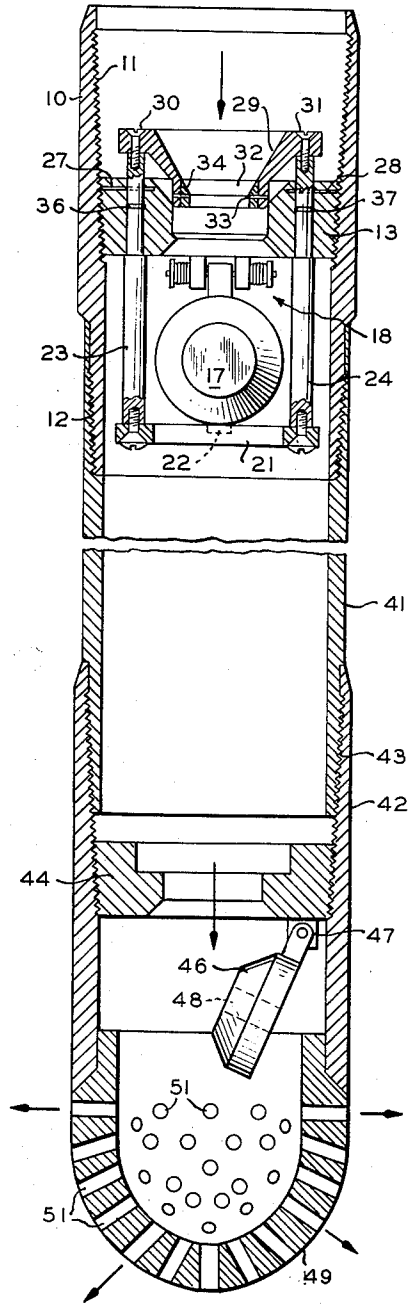


FIG. 2.

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BACK PRESSURE VALVE

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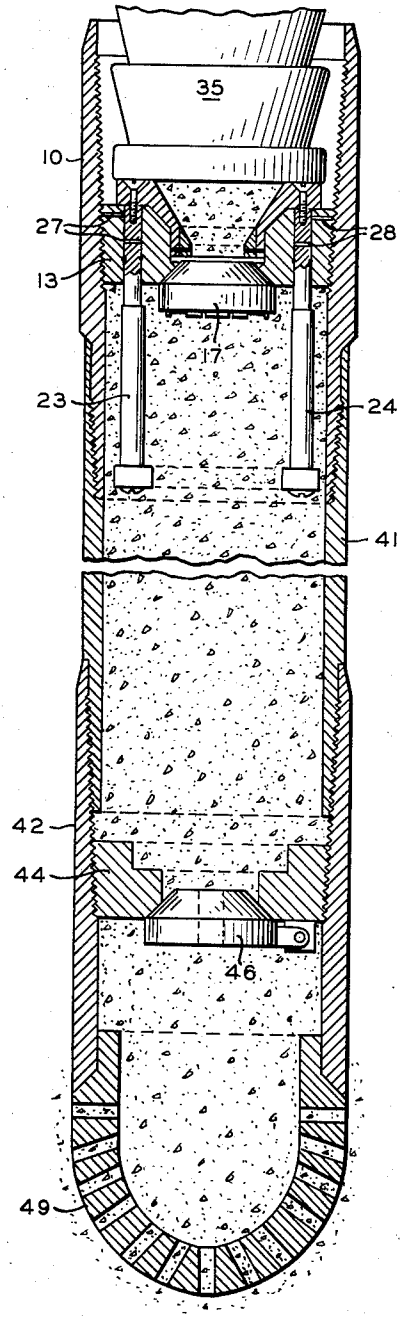


FIG. 3.

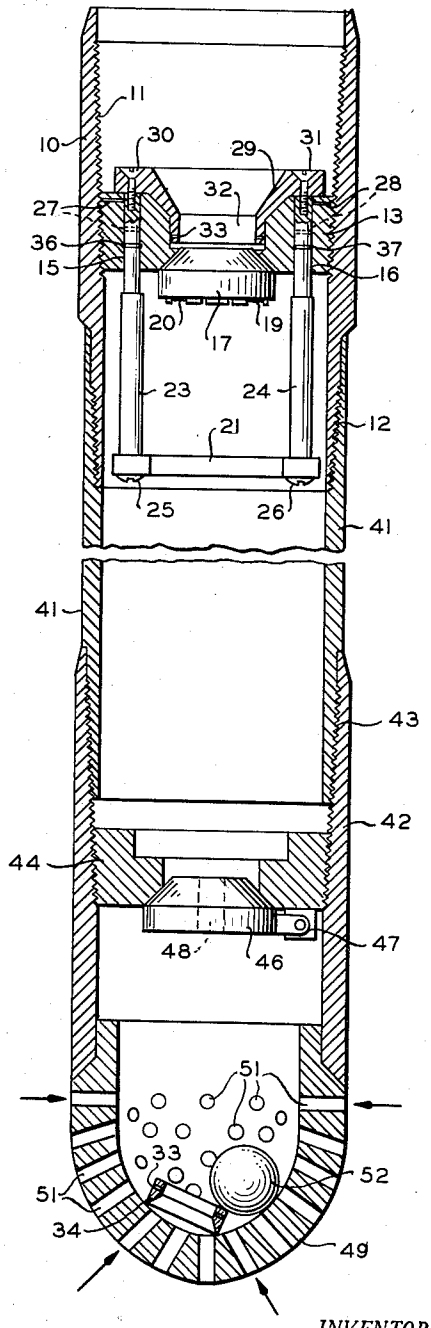


FIG. 4.

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Aug. 19, 1958 J. L. CURRY 2,848,053

BACK PRESSURE VALVE

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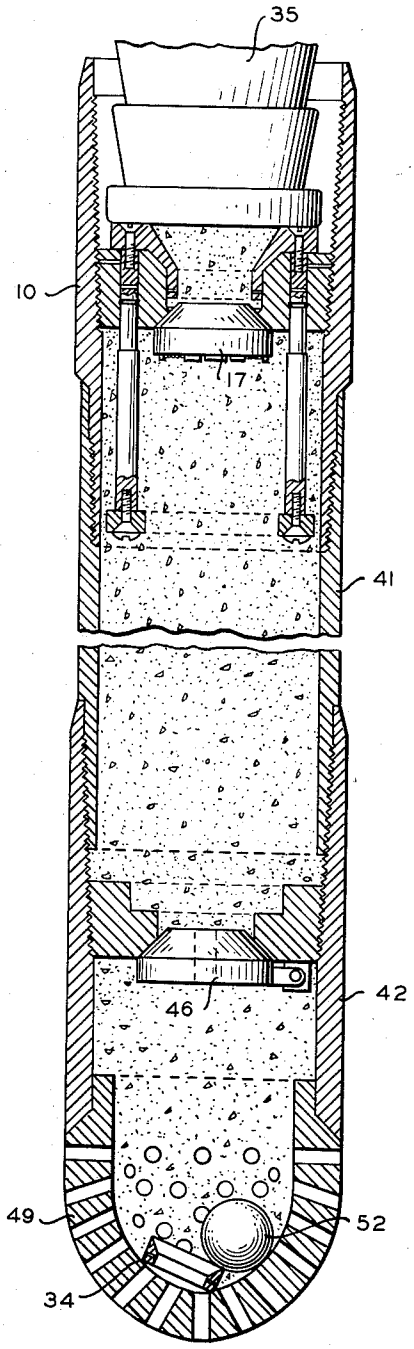


FIG. 5.

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United States Patent Office 2,848,053 Patented Aug. 19, 1958

2,848,053

BACK PRESSURE VALVE

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Application June 21, 1956, Serial No. 592,900

19 Claims. (Cl. 166—224)

This invention relates to an improved back pressure valve for use in a well conduit such as a casing or tubing string. A specific aspect of the invention pertains to a combination fill collar and fill shoe.

In the past, in the completion of oil and gas wells, casing strings often were run with a float collar and/or a float shoe at or near the bottom of the casing. These devices provided protection against blow out through the casing during the running and prevented back flow of the cement, after it was placed behind the casing. However, these devices had very serious disadvantages. For example, to prevent collapse of the casing, due to the weight of the fluid in the annulus, it was necessary to stop running the casing periodically, so that the pipe could be filled. This resulted in loss of time and, in certain areas, sometimes resulted in stuck casing. Another disadvantage resulted from the fact that, with the back pressure valve installed, a buildup of pressure occurred immediately below the bottom of the casing as it was run into the well. At times, this pressure buildup was sufficient to break down an underground formation, causing lost circulation and, possibly, blow out.

A prior invention of G. S. Ormsby, disclosed in application Serial No. 460,930, filed October 7, 1954, greatly improves the operation in that it provides a back pressure valve which is held open during the casing running operation, but which is made operable when the casing cementing plug reaches the bottom of the pipe. The present invention is an improvement in that the valve can be made operable at any time while the casing is being run, before the cementing plug is run, while still retaining the capacity to be made operable by the casing cementing plug; and it also provides controlling constant fill while running a casing.

One object of the invention is to provide a back pressure valve for use in a well conduit which leaves the conduit open to flow into its lower end during running but which can be released for operation by either a cementing plug or an auxiliary actuating device. Another object is to provide a back pressure valve for use in running a well casing which leaves the casing open to flow into its lower end but which can be released for operation by either a cementing plug or an auxiliary actuating device which can be then moved through the valve to permit flow of cement into the annulus surrounding the casing. It is also an object of the invention to provide a back pressure valve for use in running a well casing which leaves the casing open to flow into its lower end while being run and which has independently operable dual actuating devices, one of which passes on through the valve together with the contacting device used in actuating same so as to again open the valve to flow. A further object is to provide a flow control check valve in combination with the novel back pressure valve of the invention. Other objects of the invention will become apparent from a consideration of the accompanying disclosure.

The present invention comprises a back pressure valve, means to hold the valve open, a seat for a casing cementing plug, a seat for an auxiliary actuating device, shear pins which allow the valve holding means to be moved into a position which frees the valve for operation, and shear pins which allow the auxiliary actuating device seat to be disengaged after actuation of the casing cementing plug seat. A more restricted aspect of the invention comprises the aforesaid structure enclosed in a tubular housing or conduit in combination with an orifice choke check valve below same.

A more complete comprehension of the device of the invention may be had by reference to the accompanying schematic drawings of which Figure 1 is a partial longitudinal sectional view of the device of the invention; Figure 2 is a similar view showing the position of the valves during circulation; Figure 3 is a similar view showing the valve positions when a cementing plug reaches the actuating member of the upper valve; Figure 4 is a similar view showing the valve positions during floating and after the inner valve seat of the upper valve has been driven through the valve seat; and Figure 5 is a similar view showing the valve positions after knock out and floating with the cementing plug in actuating position. Corresponding elements in the various figures are correspondingly numbered.

Referring to Figure 1, the numeral **10** designates a cylindrical valve housing which is provided with internal threads **11** in the upper end portion and external threads **12** on the lower end portion. An annular valve support **13** is attached to the inner wall of housing **10** by threads **11**. Support **13** is provided with a generally circular and tapered valve seat **14** and with vertical holes **15** and **16** which may be two or more in number. A flapper valve **17** is pivotally attached to support **13** by hinge **18** which includes springs **19** and **20** arranged to urge the valve toward and into contact with seat **14**. An arcuate or ring member **21** engages a lug **22** on the lower edge of valve **17** when in the vertical position to hold valve **17** open. Arcuate member **21** is supported by cylindrical rods **23** and **24** and is attached thereto by screws **25** and **26**. Rods **23** and **24** pass through holes **15** and **16** in slidable engagement with the valve support **13** and are held in fixed relation therewith by means of shear pins **27** and **28**. A cementing plug seat **29** is attached to the upper ends of rods **23** and **24** by screws **30** and **31**. Cementing plug seat **29** is spaced a sufficient distance from valve support **13** to permit releasing of valve **17** when shear pins **27** and **28** are sheared by an actuating force applied by a cementing plug or auxiliary actuator pumped into the casing string and into contact with the actuating mechanism. An auxiliary seat **32** is attached to the inner wall of seat **29** by shear pins **33** and **34** which are of greater strength and require greater shearing force than shear pins **27** and **28**. The seating surfaces of seats **29** and **32** are continuous and take the form of an inverted truncated cone so that an actuating contacting device such as a rubber ball or circular plug of smaller diameter than the internal diameter of seat **29** will actuate auxiliary actuating device **32** and then pass through the axial opening in cementing plug seat **29** and through valve seat opening **14** so as to avoid obstructing the downward flow of cement or other fluid through the casing string. In order for the actuating contactor applied to seat **32** to pass through the valve device, it is essential that the opening in valve seat **14** and through annular valve support **13** be at least as large as the actuating contactor. Seats **29** and **32** comprise a dual actuating device for releasing valve flapper **17**.

Housing or collar **10** attached by means of threaded section **12** to a corresponding threaded section of a pipe

or casing string 41. On the lower end of the casing section 41 is positioned shoe 42 which is attached to the casing by means of threaded section 43. Threaded into the upper end of shoe 42 is a valve body 44 into which is fitted a spring loaded flapper valve 46 which is urged against the seat by spring 47. Flapper valve 46 is provided with an axial orifice 48 which functions as a choke during filling of the pipe or casing string as the casing is run. This orifice is replaceable with any orifice of a size smaller than the opening in 32. A bullet-shaped or round nosed element 49 is attached to the lower end of shoe 42. Openings 51 in nose 49 provide passageways for fluids passing into and out of the casing string.

In operation, the housing 10 is attached to the collar of a lower joint of casing by threads 12 and to the lower end of an upper joint of casing by threads 11, thus becoming a part of the casing string. Shoe 42 is attached to the lower end of a joint of casing which connects with collar 10 or it may be attached to a lower joint of casing in the string. As the casing is lowered into the well, valve 17 remains in the open position and the flow of fluid into the lower end of the casing string is restricted only by the diameter of auxiliary seat 32 or by the diameter of orifice 48 when shoe 42 is utilized with fill collar 10. When the casing is in position for cementing, the cement is pumped into the casing in a normal manner, and the first cementing plug contacts seat 29, exerting a force on seat 29, due to the pressure of fluid above, forcing seat 29, rods 23 and 24 and ring 21 downward, thereby shearing pins 27 and 28 and releasing valve 17 for operation. However, while the casing is being run into the well, if it becomes necessary to close valve 17 to prevent blow out through the casing, an auxiliary actuating device, such as a rubber ball, having an external diameter small enough to pass through seat 29 but large enough to engage seat 32, is pumped downward through the casing. When this device engages seat 32, a force is applied through shear pins 33 and 34 to seat 29, to rods 23 and 24 and ring 21. Since shear pins 33 and 34 are stronger than shear pins 27 and 28, shear pins 27 and 28 will be broken, allowing the assembly to move downward, thus freeing valve 17. When the lower portion of seat 29 engages support 13, a further buildup of pressure causes seat 32 and the auxiliary actuating device to move downward, shearing pins 33 and 34 and opening the pipe to circulation in a downward direction.

Flapper valve 46 functions as a partial check valve on fluids flowing into the casing string when valve 17 is in the position shown in Figure 1, the orifice 48 acting as a choke and providing controlled constant fill of the casing string when the same is being run into the well containing mud.

Although the device is illustrated in a preferred embodiment comprising a flapper back pressure valve, the principle of operation is suitable for use with other types of back pressure valves, for example, ball check valves. The device also can be built into a casing shoe, if desired, and run on the bottom of the casing string.

Figure 2 shows the unrestricted passage through the fill collar and shoe during circulation from the casing string into the annulus of the well. The use of flapper valves insures free passage for the fluid, resulting in greater volumes at reduced pump pressure with higher fluid velocity in the annulus.

The structure shown permits interruption of pipe running to circulate the well as often and for as long as desired with continued orifice fill when running of the casing is resumed. The device of the invention greatly reduces pressure surges during running of a casing string, thereby decreasing the danger of breaking down weak formations which results in lost circulation problems, loss of drilling fluids, and danger of blow outs. It also eliminates time-consuming manual fill, greatly reduces piperunning time, promotes safety during this operation, and reduces the danger of sticking the casing. It also converts to a float at any desired point in the operation by dropping a weighted trip ball (shown in Figures 4 and 5) into the casing at the surface so that it gravitates or can be pumped down to the seat 32 in the fill collar, thereby driving this seat through valve body 13 from which it passes on through the casing string and through the valve seat in valve body 46 coming to a rest in nose 49 where the ball and valve seat do not obstruct flow through the nose.

Certain modifications of the invention will become apparent to those skilled in the art and the illustrative details disclosed are not to be construed as imposing unnecessary limitations on the invention.

This application is a continuation-in-part of my copending application Serial No. 543,498, filed October 28, 1955.

I claim:

1. A back pressure valve for use in a well comprising a tubular housing attachable at the ends to a pipe string; an annular valve support attached to the inner wall of said housing providing an annular seat for an upwardly-closing valve closure member; a valve closure member conforming to said seat and adapted to close the passageway through said valve support; a second annular seat supported spaced-apart from the upper side of said valve support; supporting elements for said second annular seat slidably extending through said valve support and rigidly attached thereto by shear pins; means on the lower portion of said supporting elements for holding said valve closure member away from its seat when said supporting elements are attached by said shear pins to said valve support, and releasing said member when said pins are sheared by a downward force on said second annular seat so as to move same downwardly; a third annular seat of smaller outer diameter than the diameter of the axial opening in said second annular seat and adapted to pass therethrough, said third annular seat being attached to the inner wall of said second annular seat by shear pins requiring greater downward shearing force than first said shear pins; and a flapper check valve, having a flow control orifice therein, positioned in said housing below said supporting elements.

2. The valve of claim 1 wherein said valve closure member comprises a flapper valve hinged on the lower side of said valve support and spring urged into closed position when released.

3. The device of claim 2 wherein said supporting elements comprise at least two rods extending below said valve support and having extending therebetween said holding means comprising an arcuate member at the level of the lower edge of said flapper when fully open and extending downwardly, said arcuate member engaging said edge when said rods are attached to said support by first said shear pins to block its closing and releasing same when first said shear pins are sheared and said first annular seat is moved toward said support.

4. The device of claim 1 wherein each said second and third annular seats have the form of a truncated cone and lie in the same conical surface so that the inner seat is actuatable independently of the outer seat by a plug of smaller diameter than the inner diameter of said outer seat.

5. A back pressure device for use in a well conduit comprising an upwardly-closing valve; holding and releasing means for said valve; a first actuating means for said releasing means positioned above said valve, a second actuating means for said releasing means connected therewith and adapted to first actuate said first actuating means under pressure and then, upon additional pressure, to detach from said first actuating means and pass through said valve so as to avoid obstructing flow therethrough, said first actuating means being also directly operative.

6. The device of claim 5 wherein said first actuating means is held in actuating position by shear pins and said second actuating means is attached to said first actuating

means by shear pins requiring a larger shearing force than first said shear pins.

7. The device of claim 6 wherein said valve comprises a flapper valve, said holding and releasing means is downwardly urged by said first actuating means upon shearing of first said shear pins by a downward force on said first actuating means, and said first and second actuating means comprise annular coaxial members with said second actuating means adapted to pass through said first actuating means, each actuating means being provided with an annular seat adapted to receive a generally circular actuating contactor.

8. A back pressure valve for use in a well comprising a tubular housing attachable at the ends to a pipe string; an annular valve support attached to the inner wall of said housing providing an annular seat for an upwardly-closing valve closure member; a valve closure member conforming to said seat and adapted to close the passageway through said valve support; a second annular seat supported spaced-apart from the upper side of said valve support; supporting elements for said second annular seat slidably extending through said valve support and rigidly attached thereto by shear pins; means on the lower portion of said supporting elements for holding said valve closure member away from its seat when said supporting elements are attached by said shear pins to said valve support, and releasing said member when said pins are sheared by a downward force on said second annular seat so as to move same downwardly; and a third annular seat of smaller outer diameter than the diameter of the axial opening in said second annular seat and adapted to pass therethrough, said third annular seat being attached to the inner wall of said second annular seat by shear pins requiring greater downward shearing force than first said shear pins.

9. The valve of claim 8 wherein said valve closure member comprises a flapper valve hinged on the lower side of said valve support and spring urged into closed position when released.

10. The valve of claim 9 wherein said supporting elements comprise at least two rods extending below said valve support and having extending therebetween said holding means comprising an arcuate member at the level of the lower edge of said flapper when fully open and extending downwardly, said arcuate member engaging said edge when said rods are attached to said support by first said shear pins to block its closing and releasing same when first said shear pins are sheared and said first annular seat is moved toward said support.

11. The valve of claim 8 wherein each said second and third annular seats have the form of a truncated cone and lie in the same conical surface so that the inner seat is actuatable independently on the outer seat by a plug of smaller diameter than the inner diameter of said outer seat.

12. A back pressure device for use in a well comprising in combination an annular valve body having means for fixing same in a well casing for axial flow through said body; an upwardly-closing valve below said valve body adapted to seat on said body and prevent upwardly flow therethru; means for holding said valve off its seat; releasing means for said valve to permit it to seat; a first actuating means for said releasing means comprising an annular member positioned above said valve body; a second actuating means for said releasing means detachably mounted on said first actuating means so that both move downward as a unit when a first actuating force is applied to either actuating means, said second actuating means being separately actuatable thereafter by a second actuating force of greater magnitude and adapted to pass through said valve body to open said valve after its release by said releasing means upon actuation of said first actuating means.

13. A back pressure device for use in a well tubing string comprising a conduit adapted to attach to said string; a first upwardly-closing valve and a seat therefor mounted in said conduit; pivotal means supporting said valve in said conduit; means for closing said valve when released; first releasable holding means for holding said valve away from said seat and actuatable to release said valve; second releasable holding means for holding said first releasable holding means in fixed relation relative to said valve seat to hold said valve off said seat; first releasing means connected to said first releasable holding means actuatable to release same; second releasing means connected to said first releasing means and actuatable to release said first releasable holding means when pressure is applied thereto and then, upon greater pressure, to detach from said first releasing means and pass thru said valve seat so as to avoid obstructing flow therethru, said first releasing means being also operable by direct pressure thereon; a second upwardly-closing valve in said conduit below said first valve having a flow control orifice therein; and a seat for said second valve mounted in said conduit.

14. The device of claim 13 wherein said second valve moves longitudinally out of and into engagement with its seat and said flow control orifice provides restricted upward flow thru said second valve when seated; and said device further includes a partial closure means on the lower end of said conduit below said second valve having at least one passageway therethru and a weighted ball in said conduit larger than said passageway adapted to actuate said first and second releasing means, pass thru said first and second valve seats, and come to rest on said closure means without stopping fluid flow thru said passageway and without said ball returning to said orifice upon upward fluid flow thru said conduit.

15. A back pressure device for use in a well comprising in combination an annular valve seat positioned across a tubular member adapted to be fixed on a tubing string in a well casing for axial flow thru said seat; an upwardly-closing valve below said valve seat adapted to seat thereon and prevent upward flow therethru; first releasable holding means for holding said valve off said seat extending upwardly thru said valve seat; pivotal means for supporting said valve; means for closing said valve when released; second releasable holding means for holding said first releasable holding means in position holding said valve off said seat; first releasing means for releasing said first and second releasable holding means connected with said first releasable holding means comprising an annular member positioned above said valve seat; second releasing means for releasing aforesaid first and second releasable holding means comprising an annular member detachably mounted on and within said first releasing means so that both move downward as a unit when a first actuating force is applied to either releasing means, said second releasing means being detachable from said first releasing means by an actuating force of greater magnitude than said first actuating force and adapted to pass thru said valve seat to open said valve after its release; and a second upwardly closing valve in said tubular member below first said valve having a flow control orifice therein; and a seat for said second valve mounted in said tubular member.

16. A back pressure device for use in a well conduit comprising an upwardly-closing valve and a seat therefor; pivotal means supporting said valve; means for closing said valve when released; first releasable holding means for holding said valve away from said seat, actuatable to release said valve; second releasable holding means for holding said first releasable holding means fixed to said valve seat and in position holding said valve away from said seat; first releasing means connected to said first releasable holding means actuatable to release said first and second releasable holding means and release said valve holding means from said valve; second releasing means connected to said first releasing means

and actuatable to release said first and second releasable holding means and pressure is applied thereto and then, upon additional pressure, to detach from said first releasing means and pass thru said valve seat so as to avoid obstructing flow therethru, said first releasing means being also operable by direct pressure thereon to release said fixed valve holding means; and conduit means housing said valve for longitudinal flow therethru.

17. A back pressure device for use in a well comprising in combination an annular valve seat positioned across a tubular member adapted to be fixed on a tubing string in a well casing for axial flow thru said seat; an upwardly-closing valve below said valve seat adapted to seat thereon and prevent upward flow therethru; first releasable holding means for holding said valve off said seat extending upwardly thru said valve seat actuatable to release said valve; pivotal means for supporting said valve; means for closing said valve when released; second releasable holding means for holding said first releasable holding means fixed to said valve seat and in position holding said valve away from said seat; first releasing means for releasing said first and second releasable holding means connected with said first releasable holding means comprising an annular member positioned above said valve seat; second releasing means for releasing aforesaid first and second releasable holding means comprising an annular member detachably mounted within said first releasing means so that both move downward as a unit when a first actuating force is applied to either releasing means, said second releasing means being detachable from said first releasing means by an actuating force of greater magnitude than said first actuating force and adapted to pass thru said valve seat to open said valve after its release.

18. The device of claim 17 wherein said second releasable holding means comprises shear pins extending from said annular valve seat into said first releasable holding means and said second releasing means is attached to said first releasing means by shear pins requiring a larger shearing force than first said shear pins.

19. The device of claim 18 wherein said valve comprises a flapper valve, said first releasable holding means is downwardly urged by said first releasing means upon shearing of first said shear pins by a downward force on said first releasing means, and said first and second releasing means comprise annular coaxial members with said second releasing means being adapted to pass thru said first releasing means, each releasing means being provided with an annular seat adapted to receive a generally circular actuating contactor.

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UNITED STATES PATENT OFFICE

CERTIFICATE OF CORRECTION

Patent No. 2,848,053

August 19, 1958

John L. Curry

It is hereby certified that error appears in the printed specification of the above numbered patent requiring correction and that the said Letters Patent should read as corrected below.

Column 6, line 34, for "compris-" read -- comprising --; column 7, line 2, for "and", first occurrence, read -- when --.

Signed and sealed this 3rd day of March 1959.

(SEAL)

Attest:

KARL H. AXLINE
Attesting Officer

ROBERT C. WATSON
Commissioner of Patents