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WELL SAFETY VALVE

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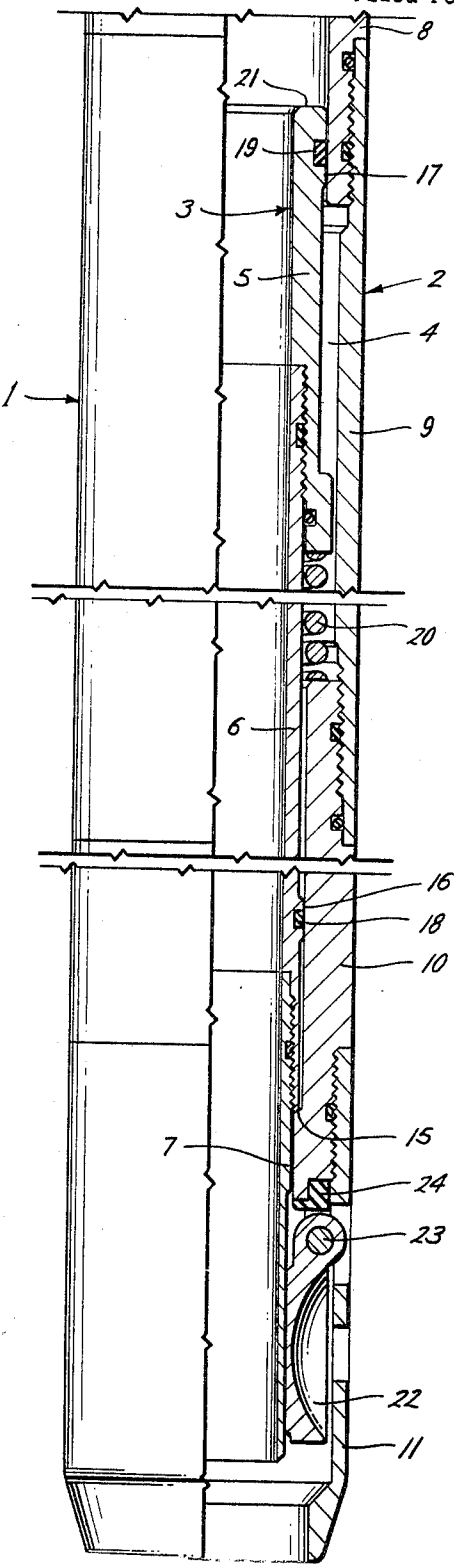


Fig. 2

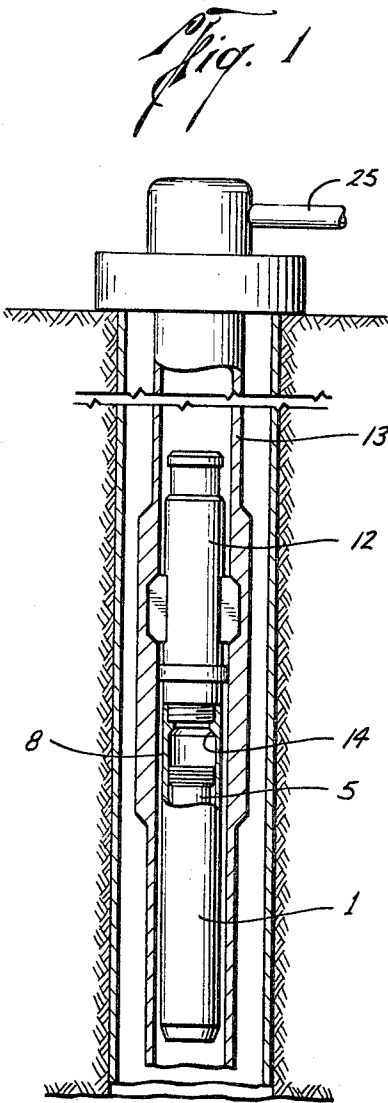


Fig. 1

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WELL SAFETY VALVE

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This invention relates to subsurface well tools and more particularly to an improved safety valve which shuts off production of well fluid from an oil or gas well and acts in response to pressure drop above the valve as may result from wild flow at a break or because of malfunctioning in the pipe system down stream of the self acting closure valve.

An object of the invention is to provide an automatically operated valve to shut off well production upon a system failure and to minimize the likelihood of personal injury and equipment damage as well as fire and loss of well fluids.

A further object is to provide a more reliable and simplified valve unit which is self contained without complicated and costly surface controlled connections and which remains open under normal flow conditions in response to the action thereon of tube pressure exerted downwardly and on unbalanced surface areas of a valve controlling slide tube and solely against mechanical spring force.

Another object is to provide a simple valve unit having a minimum number of easily manufactured parts comprising an outer body arranged for connection in a production tubing string and formed with an annular valve seat for a swing valve mounted on the body, together with an inner tube controlling swing valve operation by slide travel through the annular valve seat as governed by well pressure down stream thereof and active on an exposed upwardly facing area of inner tube surface which in relation to exposed downwardly facing inner tube surface area is unbalanced by a downwardly facing inner tube surface confined within a sealed-off chamber containing gas at ordinary atmospheric pressure.

Other objects and advantages will become apparent from the following specification having reference to the accompanying drawing wherein FIG. 1 is a vertical sectional view of a gas well installation including the improved safety valve, and FIG. 2 is a part elevational and part vertical section on a large scale of, the valve detail.

The valve unit 1 includes a pair of relatively slidable tubular members 2 and 3 concentrically nested one within the other with axially spaced apart portions in sealed slide bearing engagement and with intermediate portions radially spaced apart to form a closed annular chamber 4 which is completely enclosed between the tubular members and sealed at its ends between the slide bearing portions of the tubes. For convenience of manufacture and assembly, each tubular member consists of a number of separately machined sections screw threaded together in end-to-end succession. As shown, the inner tube 3 comprises a top section 5 whose wall is relatively thick, a thinner wall intermediate section 6 and a bottom section 7, all having the same internal diameter and providing an unrestricted open bore through the unit. From top to bottom the outer tube 2 comprises a relatively thick wall coupling section 8, a thinner wall intermediate body section 9, another intermediate body section 10 whose wall is somewhat thicker than the wall of the coupling section

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8 and a valve cage or terminal housing 11, all of these sections of the outer tube having the same outside diameter.

Internal screw threads within the upper end of the coupling section 8 are for fastening the outer tubular body 2 as a unit with a conventional type of locating hanger 12 as is seen in FIG. 1 wherein the hanger 12 is latched at a selected depth within a well production tubing string 13. The coupling section 8 also has an internal annular flange shown at 14 in FIG. 1 as being immediately below the attachment threads and this flange 14 provides a downwardly facing shoulder as an upper limit stop to slide travel of the inner tubular member 3 when its relatively wide bearing end surface 21 on the top section 5 rises into abutment with the shoulder 8.

In FIG. 2 the inner tube 3 is shown at its lower travel limit and with the bottom edge of the intermediate section 6 in downward abutment on an internal and upwardly facing annular shoulder at 15 on the outer tubing section 10. Peripherally enlarged bands 16 and 17 on the inner tubular members 6 and 5 have a close sliding fit on interior cylindrical surfaces of the outer tubing sections 10 and 8. Both cylindrical surfaces are smoothly machined and each is of a length greater than the travel range of their cooperating bearing bands 16 and 17. Both bands have external annular grooves to pocket elastic sealing rings 18 and 19 for snug engagement on the bearing surfaces of sections 10 and 8 and for sealing off the closed chamber 4 between the thin wall sections 6 and 9 of the inner and outer tubes. At the time of final assembly of the parts, the chamber 4 will be sealed off at atmospheric pressure and preferably within a room of relatively low humidity and the valve unit will be substantially free of chamber pressurization when installed in a well and will not be dependent in any sense on external sources of variable pressure for effective valve operation during its normal life.

A compression coil spring 20 enclosed within the atmospheric pressure chamber 4 is grounded at its lower end on the upper end of the thick body section 10 and bears upwardly on the chamber confined lower end surface of the inner tubular section 5. The force of the spring 20 yieldably biases the inner tube 3 upwardly and against the downward force of tubing pressure above the valve and active on the exposed end surface 21 of the inner tube when the unit is installed within a production tubing string and the well is producing fluid under normal conditions. Such tubing fluid pressure acting on the surface 21 will overcome the spring 20 and hold the inner tube 3 depressed to the position illustrated in FIG. 2.

In such downwardly projected position the lower section 7 of the inner tube extends below the bottom end of the outer tube section 10 and into the path of and obstructs inward and upward swing travel of a flap valve 22. The flap valve 22 depends from and is hingedly mounted on a pintle pin 23 secured at opposite ends in the wall of the terminal section 11. When free to close the flap valve seats upwardly against the lower annular face of the tube section 10. For better insuring against leakage, a rubber or similar gasket ring 24 is clamped within annular groove in the bottom face of the member 10 and by an internal shoulder on the tube portion 11. The gasket ring 24 is shown as having an inwardly protruding annular lip as a facing to overlap the valve seat and to be engaged by the flap valve 22.

During normal operation of the well the flap valve is

held open and the produced fluid leaves the well at the surface through a gathering line 25 which may contain a control valve and a suitable flow control orifice or choke. In such operation no pressure drop occurs across the slide tube 3 and the fluid pressure acting on the differential areas of downwardly and upwardly facing surfaces of the slide tube holds the slide tube at its downwardly retracted limit. Such upwardly facing area is constituted primarily by the relatively wide upper end face at 21 exposed above the seal ring 19 and which face is of greater area than any downwardly facing area of the slide tube exposed below the seal 18 and related in size to the narrow width of the intermediate tubing section 6.

Should breakage or a malfunction occur in the flow line down stream from the valve unit, such as to release pressure and cause a pressure drop at the safety valve unit, then the upward bias of the spring 20 will elevate the inner tube 3 into engagement with the upper limit stop 8 whereupon the bottom section 7 will be above the valve seat and out of interference and blocking relation to the free inward and upward swing of the flap valve 22. The flap valve will move up and be held closed by well fluid pressure beneath it to preserve the well from running wild and until necessary remedial measures have been taken. The coil spring 20 provides the sole force to shift the slide valve upwardly and to oppose tubing pressure, since air confined inside the chamber at atmospheric pressure and the limited range of variation of chamber size are insignificant in relation to the opposing spring and tubing pressures.

Extraneous pressure sources and complex controlled systems which often are troublesome are eliminated by the simple and low cost valve arrangement as herein described. Various modifications in the structural detail are comprehended as being within the scope of the attached claims.

What is claimed is:

1. A safety valve for installation in a well fluid production tubing, comprising an inner tube having an annular wall surrounding a full open straight bore therethrough and said wall having peripherally thereof a downwardly facing shoulder joining vertically offset peripheral portions of a relatively thick upper wall portion and a relatively thin lower wall portion, an outer body housing said inner tube and having axially spaced apart bearings slidably and sealingly engaged by said upper and lower wall portions to form a closed chamber containing air at approximately atmospheric pressure and housing said downwardly facing shoulder, said inner tube also having upwardly and downwardly facing surfaces exteriorly of the chamber and differing in area by the effective area of said downwardly facing shoulder, a downwardly facing annular valve seat on the body through which the lower portion of the inner tube is movable between a lower position in which the bottom tube edge is projected below the valve seat and an upper position in which said bottom tube edge is above said valve seat, spring means carried by the body and active upwardly on the inner tube as the sole force biasing the inner tube toward said upper position and flap valve pivoted on the body for closing engagement with the body carried valve seat and through a swing path which is obstructed by said inner tube when its bottom edge is below said valve seat.

2. A safety valve for subsurface installation in and control of a well production string, including an outer tube for securement in and as part of a well production tubing string and having a downwardly facing annular valve seat and a flap valve pivotally mounted below said valve seat for upward and inward swing travel toward the valve seat, an inner tube slidably fitted within the outer tube and shiftable between a first position in which the bottom of the inner tube is below said valve seat and obstructs the swing path of the flap valve and a second position in which the inner tube is wholly above said valve seat, spring means interposed between the tubes

and exerting the only upward force on the inner tube, a self contained and sealed-off gas chamber between said tube confining gas under low pressure on the order of atmospheric pressure, an upwardly facing surface on the inner tube exteriorly of said chamber and a downwardly facing surface on the tube exposed within the low pressure chamber.

3. A well tubing safety valve arranged to close upon fluid pressure drop to given valve downstream of the valve, comprising an outer tubular member having a downwardly facing valve seat, a flap valve hinged to the member below said seat for swing movement toward and from engagement with the seat, an inner tubular member slidably fitted within the outer tubular member for relatively axial movement between a lower position in which a bottom portion of the inner member projects below said valve seat and an upper position in which said bottom portion is above the valve seat, said members being arranged to provide a sealed chamber therebetween, said inner member having vertically offset peripheral portions and a downwardly facing shoulder intermediate said portions and enclosed within said sealed chamber and also having upwardly and downwardly facing surfaces exteriorly of the chamber and differing in area from one another and of which the larger surface area faces upwardly and is downstream and seated under compression against said shoulder and said sealed chamber being free of fluid other than a gas at atmospheric pressure.

4. A well tubing safety valve comprising an outer tubular member for connection in a well tubing string, a downwardly facing annular valve seat carried by said member, a valve movably mounted by said member for upward travel into closing engagement with said seat, an inner tube slidably fitted to said member for axial movement from one position in which the tube is wholly above said seat and another position in which a tube portion is below said seat and blocks valve closing movement, means on the tube responsive to tubing string fluid pressure downstream of the tube for urging the tube into its last mentioned position, spring means interposed under compression between the member and the tube for biasing the tube in opposition to said downstream fluid pressure and a spring enclosing chamber sealed at atmospheric pressure between the member and the slidable tube.

5. A well tubing safety valve comprising an outer tubular member having a valve seat thereon, a valve movably mounted on the member for travel into closing engagement with the seat, an inner tube slidably fitted in the outer member and movable between positions which respectively are in and out of the path of valve closing movement, elastic means interposed between the member and the tube and exerting yieldable force in the direction to shift the tube out of said path, fluid pressure seals between axially spaced apart portions of the member and the tube and enclosing therebetween a sealed atmospheric pressure chamber, said tube having upwardly and downwardly facing surfaces equal in area to one another and a portion of the downwardly facing area being enclosed within the atmospheric pressure chamber and thereby limiting the area of downwardly facing surface exposed exteriorly of the chamber to less than the area of the upwardly facing surface.

6. A well tubing safety valve comprising an outer tubular member having a valve seat thereon, a valve movably mounted on the member for travel into closing engagement with the seat, an inner tube slidably fitted in the outer member and movable between positions which respectively are in and out of the path of valve closing movement, elastic means interposed between the member and the tube and exerting yieldable force in the direction to shift the tube out of said path, said tube having upwardly and downwardly facing surfaces exposed to well fluid flowing through the tube and which upwardly facing surface is exposed to well fluid pressure downstream of the tube and is of larger area than the downwardly facing

surface, said tube and said member having axially spaced apart portions bearing on one another and radially spaced apart portions between said bearing portions to provide a chamber, means sealing said bearing portions to preserve the chamber at atmospheric pressure and a tubing 5 carried surface enclosed within the chamber whose effective downwardly facing area is equal to the difference in areas of the first mentioned upwardly and downwardly facing surfaces.

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