# United States Patent [19]

**Watkins et al.**

[11] **3,799,204**

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[54] **EQUALIZING MEANS FOR WELL SAFETY VALVES**


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[73] Assignee: **Camco Incorporated,** Houston, Tex.



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[52] **U.S. Cl.** ..... **137/629,** 166/224

[51] **Int. Cl.** ..... **F16k 31/12**

[58] **Field of Search** ..... 137/629, 630, 630.14; 166/224, 224 S, 226



[56] **References Cited**

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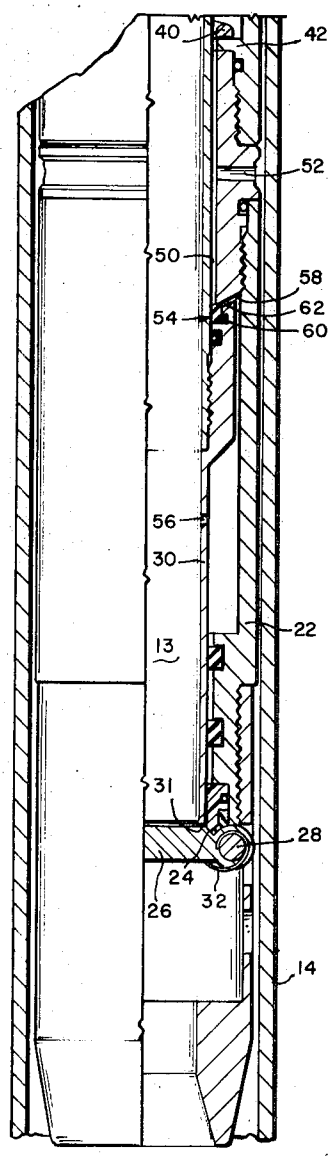
[57] **ABSTRACT**

Equalizing means are provided for reducing the pressure differential across the seat of a well safety valve when opening the valve to avoid damage to the valve element and seat. A passageway communicates with a point below the valve seat to a point above the valve seat and includes an equalizing valve which is closed when the valve is closed and opens prior to the opening of the safety valve. The pressure in the passageway downstream of the equalizing valve acting on the valve in a direction to keep the safety valve closed. A restriction in the passageway upstream of the equalizing valve dampens the speed of opening the well safety valve.


**5 Claims, 4 Drawing Figures**



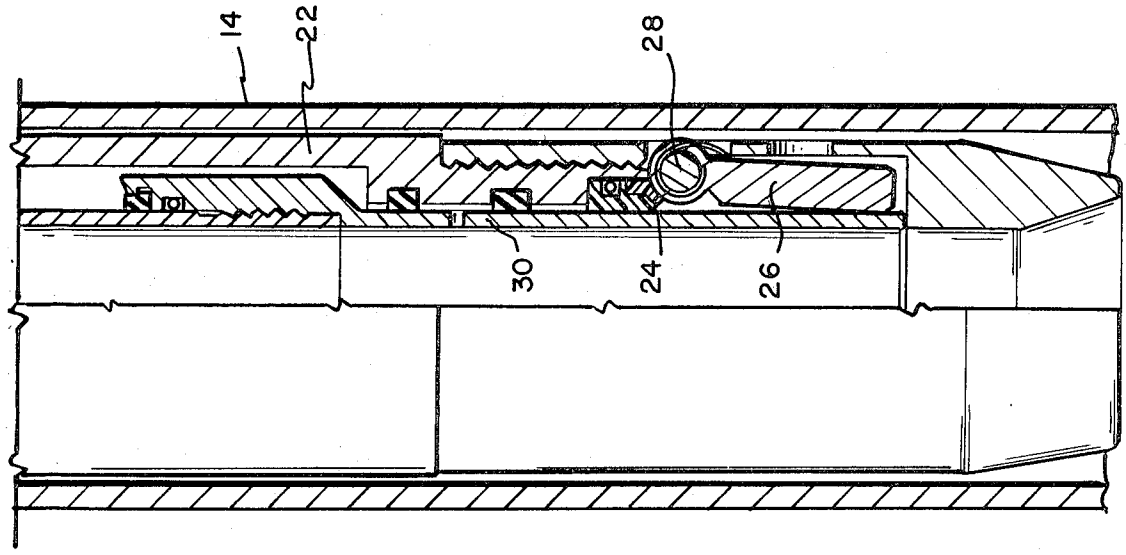



FIG. 3

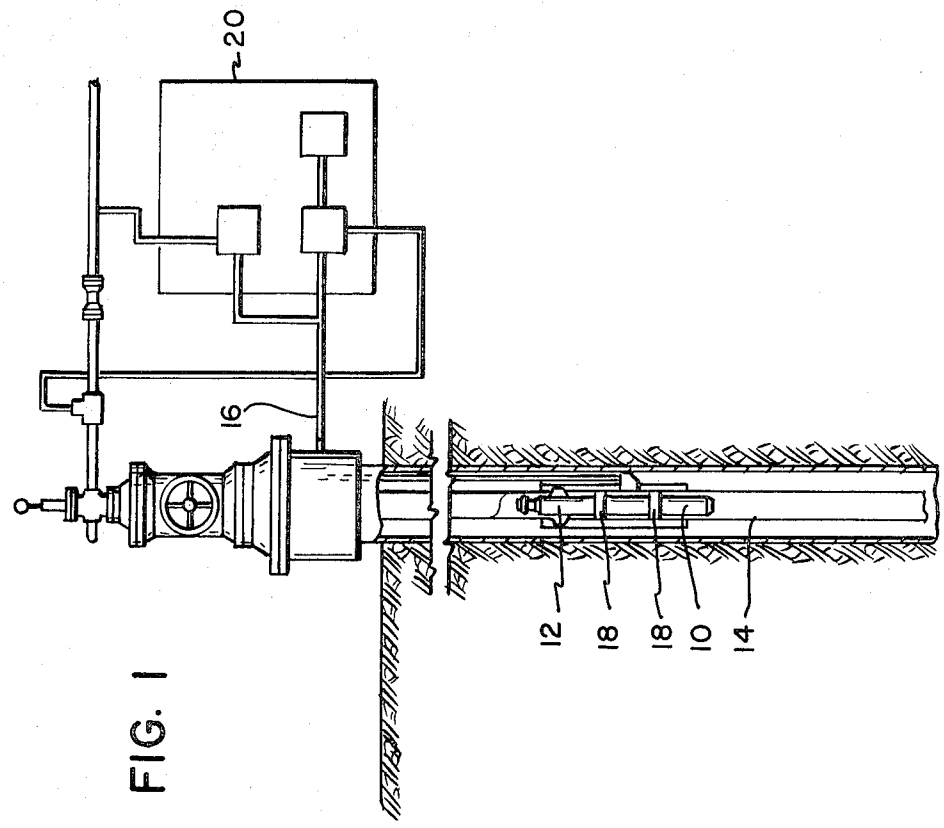



FIG. 1

FIG. 2A

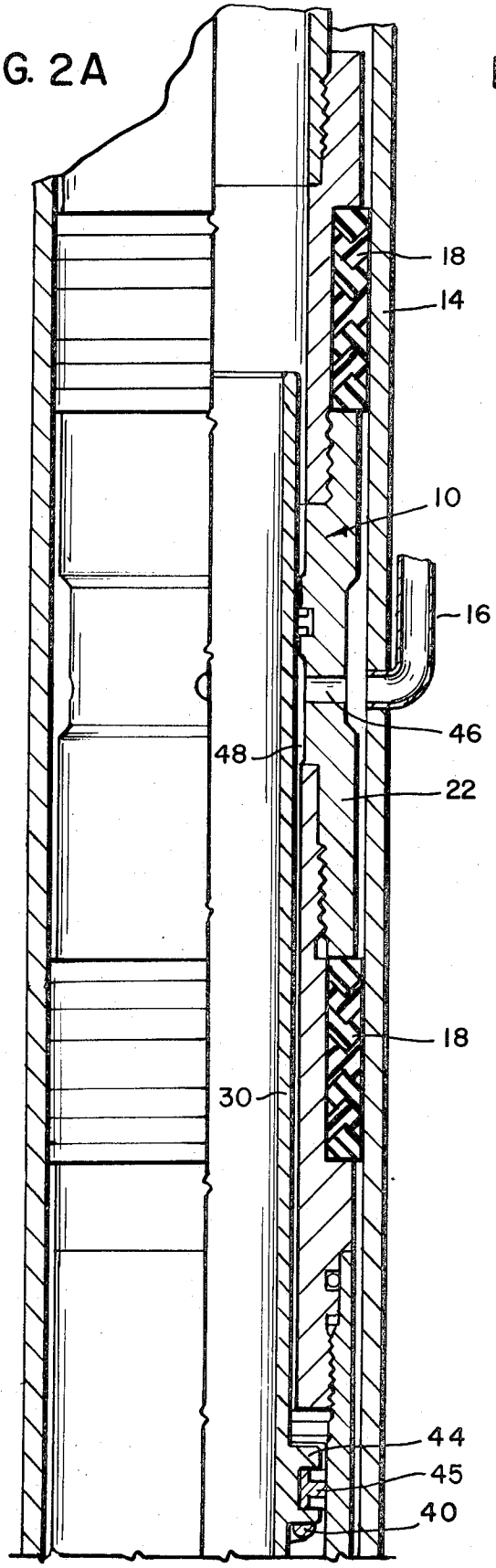

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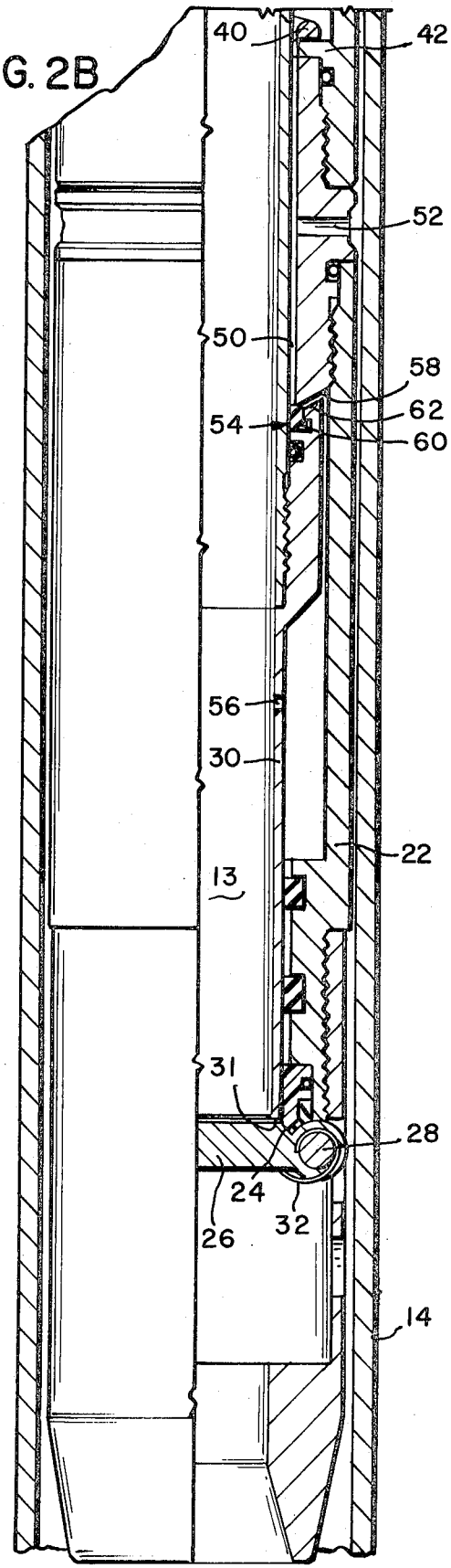
FIG. 2B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# EQUALIZING MEANS FOR WELL SAFETY VALVES

## BACKGROUND OF THE INVENTION

It is common to provide subsurface safety valves in wells in the oil and gas industry to close the well and prevent the flow of fluid to the surface in the event of problems or equipment failure, such as described in Bulletin S-105 of Camco, Incorporated dated January 1971, entitled Well Safety Systems.

However, when the well safety valve is actuated and closed, there may be a large pressure differential across the valve caused by a high shut in pressure below the valve and a low pressure above the valve. When the valve is later opened the high differential pressure across the valve may damage the valve element and seat. Of course, the pressure in the well tubing above the safety valve could be pressurized from the well surface to equalize the pressure across the safety valve prior to opening, but in many installations this is not feasible for various reasons. The present invention is directed to improvements in equalizing means for reducing the pressure differential across the valve element and valve seat of a well safety valve when opening the valve.

## SUMMARY

The present invention is directed to providing an equalizing means for reducing the pressure differential in a well safety valve when opening the valve including a passageway in the safety valve in communication with a point below the valve seat to a point above the valve seat which includes an equalizing valve which is closed when the safety valve is closed and opens prior to the opening of the safety valve for admitting well tubing pressure into the safety valve.

Another feature of the present invention is the provision wherein the pressure in the passageway upstream of the equalizing valve provides a resultant force against the valve in a direction to keep the valve closed.

A still further object of the present invention is the provision of a restriction downstream of the equalizing valve for reducing the speed of opening of the safety valve for preventing damage to the safety valve.

Other and further objects, features and advantages will be apparent from the following description of a presently preferred embodiment of the invention, given for the purpose of disclosure, and taken in conjunction with the accompanying drawings where like character references designate like parts throughout the several views.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is an elevational view, partly in cross section and partly schematic, illustrating the use of a well safety valve in a well tubing,

FIG. 2A is a fragmentary elevational view of the top portion of one type of well safety valve utilizing the present invention and shown in the closed position,

FIG. 2B is a continuation of FIG. 2A, and

FIG. 3 is a fragmentary elevational view, in cross section, of the lower portion of the safety valve of FIG. 2B, showing the valve in the open position.



## DESCRIPTION OF THE PREFERRED EMBODIMENT

The equalizing means of the present invention will be described, for purposes of illustration only, as used in a Camco Type B safety valve, although it is to be understood that the present invention can be used with various other types of well safety valves. which is adapted to be connected to a well lock **12** such as a conventional Camco M lock and locked in position in the tubing **14** of a well to permit production therethrough under normal operating conditions, but in which the valve **10** may close or be closed in response to abnormal conditions. A control line **16** may be provided leading from the surface to a position in the well tubing **14** between a seal **18** on the lock **12** and a seal **18** on the safety valve **10.** Conventional control means **20** are provided for controlling the fluid in the line **16** to control the actuation of the safety valve **10.**

Referring now to FIGS. 2A and 2B, the safety valve **10** generally includes a valve body **22** which has an annular valve seat **24** therein and a valve element such as flapper **26** connected to the body **22** by a pivot pin **28.** Thus when the flapper **26** is in the upper position seated on the valve seat **24,** the safety valve **10** is closed blocking flow upwardly therethrough. A movable member or sliding tube **30** is telescopically movable in the body **22** and through the valve seat **24.**

As best seen in FIG. **3,** when the sliding tube **30** is moved to a downward position, the tube **30** pushes against the flapper **26** and moves it away from the valve seat **24.** Thus, the valve is held in the open position so long as the sliding tube **30** is in the downward position. When the sliding tube **30** is moved upwardly, as best seen in FIG. 2B, the flapper **26** is allowed to move upwardly closing the valve by action of a spring **32** and also by the action of fluid flow moving upwardly through the bore **13** of the body **12.**

Various forces may be provided to act on the sliding tube **30** to control its movement so that under normal conditions the sliding tube **30** will be in the downward position (FIG. **3**) holding the flapper **26** away of and off of the valve seat **24** and the valve **10** will be opened. When abnormal conditions occur, the sliding tube **30** will be moved upwardly allowing the flapper **26** to close shutting off flow through the well tubing **14.** Thus, actuating means such as a spring **40** may be provided acting on the sliding tube **30** to move the sliding tube **30** upwardly to allow the flapper **26** to close. The spring **40** acts between a shoulder **42** on the body **22** and the bottom of a piston **44** on the sliding tube **30** having seal ring **45** sealing against body **22.**

The safety valve **10** may be controlled by the application or removal of fluid pressure through the control line **16** and a port **46** in the valve body **22** which opens into a chamber **48** and acts against the top of the piston **44.** Thus if fluid pressure is supplied to the port **46** of sufficient magnitude, the piston **44** and the sliding tube **30** will be moved downwardly, forcing the flapper **26** off of the seat **24** and into full open position. If the pressure applied through the control line **16** and port **46** above the piston **44** is reduced sufficiently relative to the force provided by the spring **40,** the piston **44** and the sliding tube **30** will move upwardly carrying the tube **30** above the valve seat **24** allowing the flapper **26** to swing in and close.

The above description of one type of safety valve **10** is conventional. However, it is to be noted that when the valve **10** is closed, the shut-in pressure in the well tubing below the valve **10** acts on the bottom of the valve flapper **26** to keep the flapper closed. When the valve is closed, the pressure above the valve may be considerably less than the pressure below the valve thereby creating a high differential pressure across the valve. While the valve may be opened when desired by pressurizing through the line **16** and against the top of the piston **44** and moving the tube **30** downwardly, a large differential pressure across the seat **24** and flapper **26** may damage the flapper **26** and seat **24** when opened. Of course, the pressure can be equalized by pumping down fluid through the tubing **14** above the valve **10,** but this operation is not feasible in many installations.

The present invention is directed to providing equalizing means in the valve **10** which reduces the differential pressure across the valve seat **24** prior to opening the valve element **26.** Referring now to FIGS. 2A and 2B, a passageway **50** is provided in the safety valve **10** and generally includes a first port **52,** and equalizing valve generally indicated by the reference numeral **54,** and a second port **56.** The port **52** opens exteriorily of the valve body **22** and is in communication with the pressure in the well tubing **14** below the valve seat **24** thereby admitting tubing pressure into the passageway **50.**

The equalizing valve **54** includes a valve seat **58** connected to the valve body **22,** a primary valve element including a soft resilient seal **60** connected to the sliding tube **30** and a secondary metallic valve element **62** which may provide a metal-to-metal seal with the seat **58.** It is to be noted that the soft L-shaped seal **60** is replaceable and seals all around the tube **30** as well as on the seat **58.** As noted in FIG. 2B, when the safety valve **10** is closed with the flapper **26** seated on the valve seat **24,** the sliding tube **30** is in its upward position and the equalizing valve **54** is closed.

When the safety valve **10** is closed, it is noted that the lower end **31** of the sliding tube **30** is positioned a slight distance above the valve element **26.** Therefore, when the sliding tube **30** is actuated to open the safety valve **10,** the sliding tube **30** moves downwardly and first opens the equalizing valve **54** allowing the high pressure well pressure from the tubing **14** below the safety valve **10** to pass through the passageway **50** through port **52,** through the equalizing valve **54,** and through the port **56** and into the bore **13** of the safety valve **10** above the valve seat **24.** The differential pressure across the valve seat **24** is thus reduced prior to actuation and opening of the valve element **26.**

Referring to FIGS. 2A and 2B, it is to be noted that the high pressure in the well tubing **14** beneath the safety valve **10,** while the safety valve and equalizing port **54** are closed, acts on the sliding tube **30** to keep the safety valve **10** in the closed position. That is, the pressure in the port **52** and passageway **50** acts upwardly on the bottom of the piston **44** and downwardly on the portion of the resilient valve element **60** that is exposed to the pressure in the passageway **50** above the equalizing valve **54.** Since the area of the bottom of the piston **44** is greater than the area of the valve element **60** exposed to the tubing pressure, there is a greater force acting on the tube **30** to keep it in the upward position thereby keeping the equalizing valve **54** closed.

However, once the sliding tube **30** is moved downwardly by applying pressure in the control line **16,** the equalizing valve **54** is opened allowing the high pressure in the port **52** to flow through the passageway **50** and past the equalizing valve **54.** In order to prevent the sliding tube **30** from moving downwardly, after the equalizing valve **54** is opened, with a snap action and damaging the flapper **26,** the port **56** is sized smaller than the port **52** thereby providing a restriction in the passageway **50** dampening the downward movement of the sliding tube **30.**

Therefore, the equalizing means of the present invention is closed when the safety valve **10** is closed and opens prior to the opening of the safety valve to equalize the pressure across the valve seat **24.** The equalizing means also acts on the movable sliding tube **30** to maintain tube **30** in its upward position and helps to hold the equalizing valve **54** in the closed position. The equalizing means also provides a dampening effect as the tube **30** is actuated downwardly to open the valve seat **24** to prevent damage to the valve element **26.**

The present invention, therefore, is well adapted to carry out the objects and attain the ends and advantages mentioned as well as others inherent therein. While a presently preferred embodiment of the invention is given for the purpose of disclosure, numerous changes in the details of construction and arrangement of parts may be made which will readily suggest themselves to those skilled in the art and which are encompassed within the spirit of the invention and the scope of the appended claims.

What is claimed is:

**1.** In a well safety valve for controlling fluid flow through a well tubing and having a housing, a first valve being movable between an open and closed position for controlling flow through the housing and tubing, a flow tube telescopically movable in the housing, said tube when in the downward position holds the valve in the open position and when in the upward position allows the valve to close, first actuation means acting on the tube for closing of said valve, second actuating means acting on the tube in a direction to open said valve, the improvement of equalizing means for reducing the pressure differential across said first valve while opening said first valve comprising,

an equalizing valve between the housing and the tube, said equalizing valve being closed when the tube moves to the upward position and opens as the tube moves to the downward position, said equalizing valve opening prior to the opening of the first valve,

a passageway in said safety valve through the equalizing valve for communicating pressure from below the first valve to a point inside said tubing above the first valve, said passageway including a first port in the housing upstream of the equalizing valve and in fluid communication with the tube whereby pressure in the passageway passes through the first port and acts on the tube in a direction to keep the tube upward when the equalizing valve is closed, said passageway including a second port in the tube downstream of the equalizing valve, said second port being smaller than the first port thereby dampening the movement of the tube as it moves downwardly to the open position.

2. In a well safety valve for controlling fluid flow through a well tubing and having a housing, a first valve being movable between an open and closed position for controlling flow through the housing and tubing, a flow tube telescopically movable in the housing, said tube when in the downward position holds the valve in the open position and when in the upward position allows the valve to close, first actuation means acting on the tube for closing said valve, second actuation means including a piston acting on the tube in a direction to open said valve, the improvement of equalizing means for reducing the pressure differential across said first valve while opening said first valve comprising,

a passageway in said safety valve in communication between a point upstream of said first valve and a point interiorly of the tube and downstream of said first valve,

an equalizing valve between the housing and the tube in said passageway, said equalizing valve being closed when the tube moves to an upward position and opens as the tube moves to the downward position, said equalizing valve opening prior to the opening of the first valve, and

said passageway upstream of the equalizing valve being in communication at all times with the piston whereby pressure in the passageway acts on the piston in a direction for moving and holding the equalizing valve in a closed position.

3. The apparatus of claim 2 including, a restriction in the passageway downstream of said piston for dampening the movement of the tube as the tube moves in a direction to open the first valve.

4. The apparatus of claim 3 wherein the restriction is positioned downstream of the equalizing valve.

5. In a well safety valve for controlling fluid flow through a well tubing and having a housing, a flapper valve being movable between an open and closed position for controlling flow through the housing and tubing, a flow tube telescopically movable in the housing, said tube when in the downward position holds the flapper valve in the open position and when in the upward position allows the flapper valve to closed, first actuation means acting on the tube for closing said valve, second action means including a piston on the tube exposed to fluid pressure in a conduit extending from the well surface and acting on the piston in a direction to open said valve, the improvement of equalizing means for reducing the pressure differential across said first valve while opening said first valve comprising,

a passageway in said safety valve in communication between a point upstream of said flapper valve and a point interiorly of the tube and downstream of the flapper valve,

an equalizing valve between the housing and the tube in said passageway, said equalizing valve being closed when the tube moves to an upward position and opens as the tube moves to a downward position, said equalizing valve opening prior to the opening of the flapper valve,

said passageway upstream of the equalizing valve being in communication at all times with the piston whereby pressure in the passageway acts on the piston in a direction for moving and holding the equalizing valve in a closed position, and

a restriction in the passageway downstream of said piston for dampening the movement of the tube as the tube moves in a direction to open the flapper valve.

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