

- [54] **SUBSURFACE WELL SAFETY VALVE**
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 [22] Filed: **Nov. 19, 1971**
 [21] Appl. No.: **200,401**

- [52] U.S. Cl. **166/72, 137/494, 166/224 S, 251/62**
 [51] Int. Cl. **E21b 33/03, E21b 43/12**
 [58] Field of Search **66/72, 224, 315; 137/458, 137/494; 251/58, 62, 99**

[56] **References Cited**

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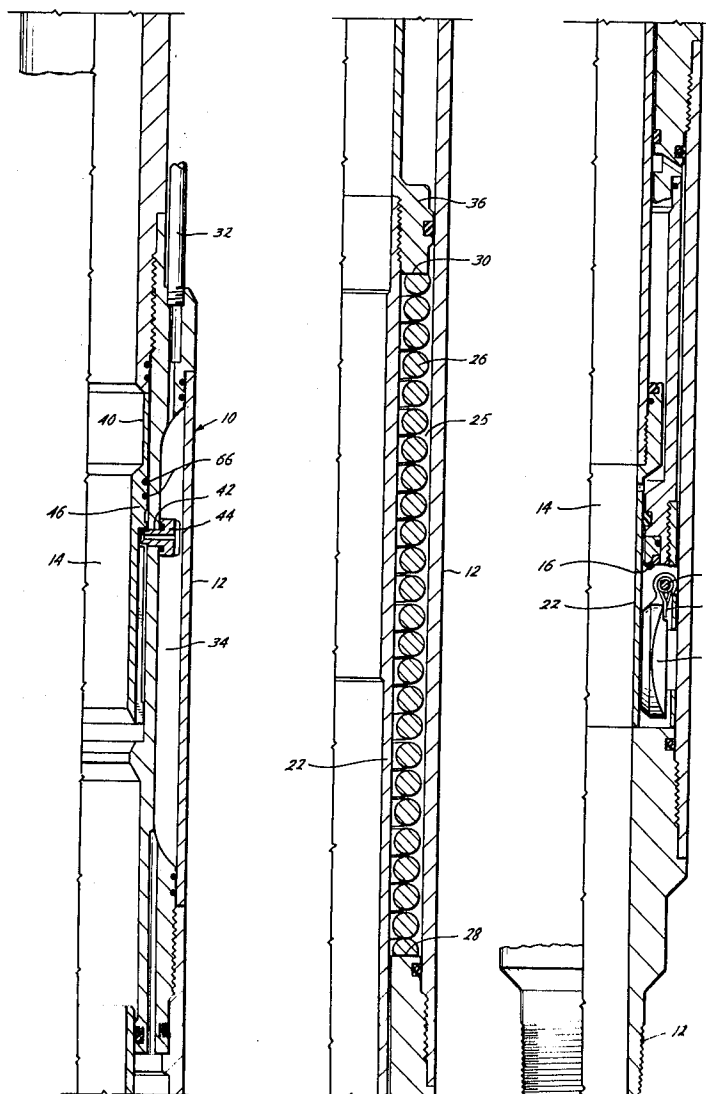
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[57] **ABSTRACT**

A subsurface well safety valve for connection directly into a well tubing for shutting off flow of well fluids through the tubing when adverse well conditions occur, but yet providing a valve bore of substantially the same size as the bore of the well tubing for allowing unrestricted passage of well equipment. The valve bore of the safety valve including means for supporting a second safety valve in the event that the first safety valve becomes inoperative. A fluid control line extending from the surface to the first safety valve which valve includes a port communicating with the control line and opening into the valve bore with shearable means initially closing the port but when sheared communicating control fluid into the first valve bore for controlling a second safety valve supported in the first valve bore.

5 Claims, 5 Drawing Figures



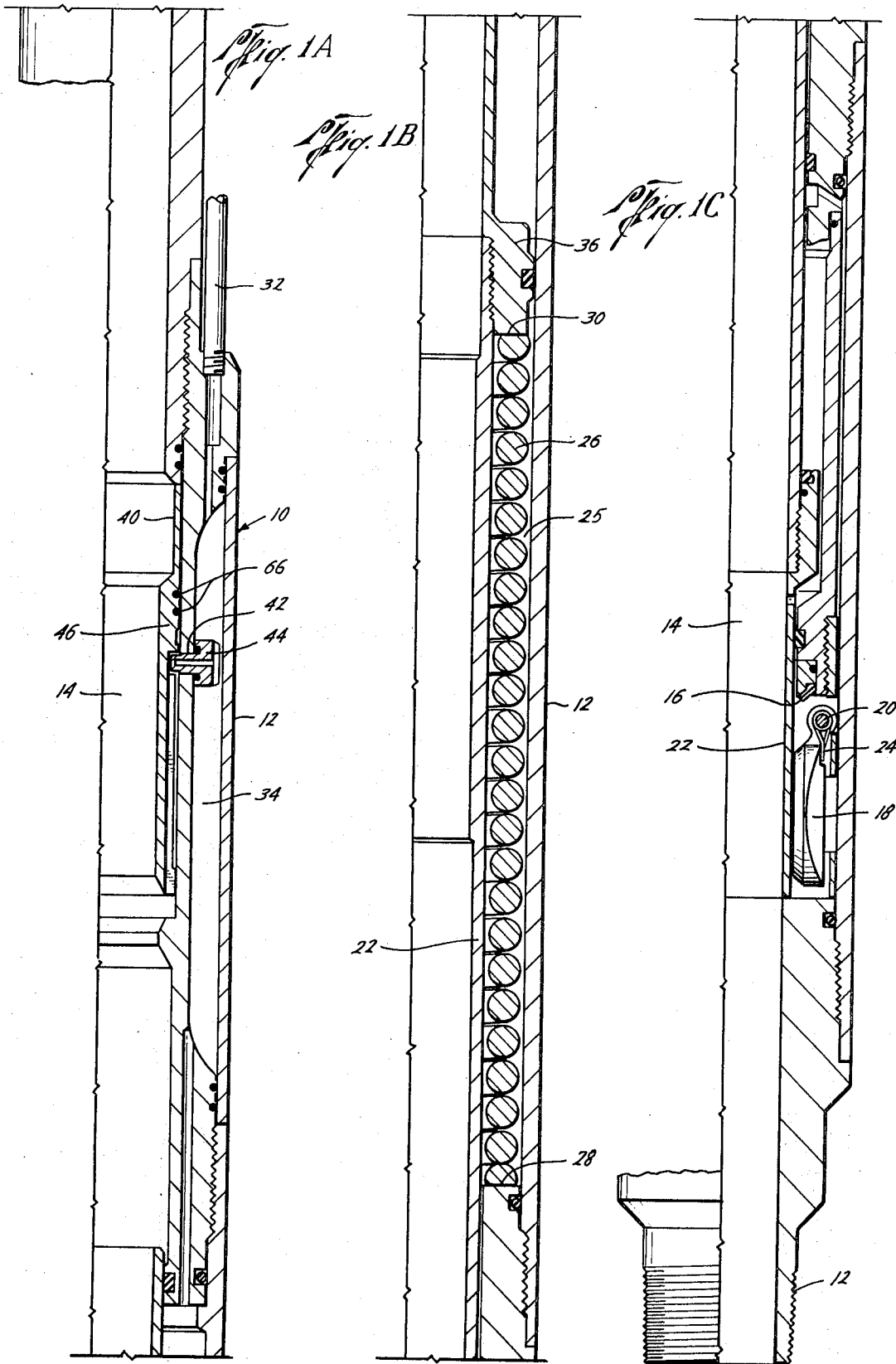


Fig. 2A

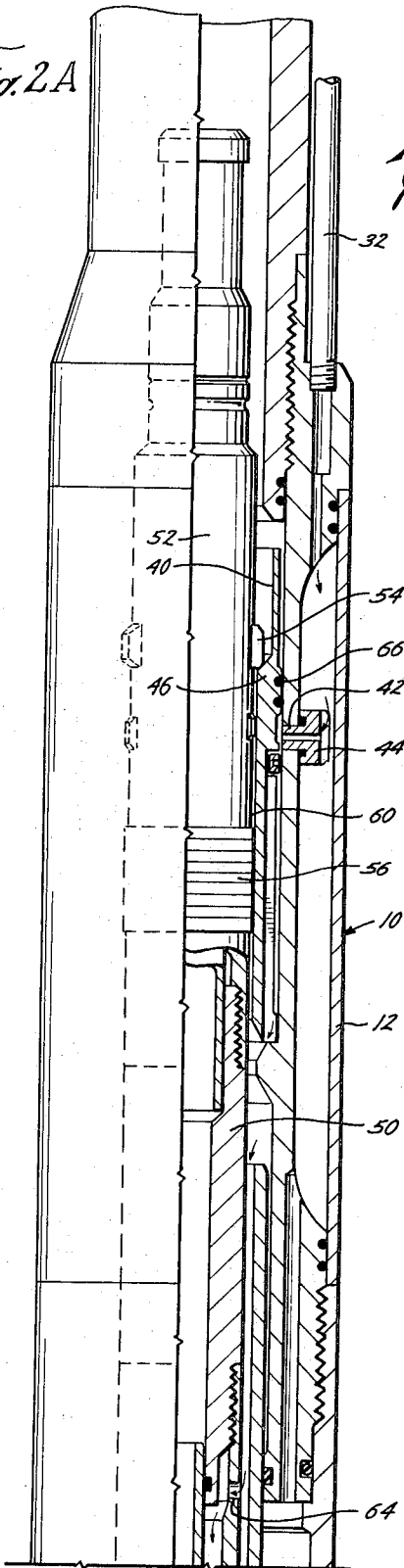
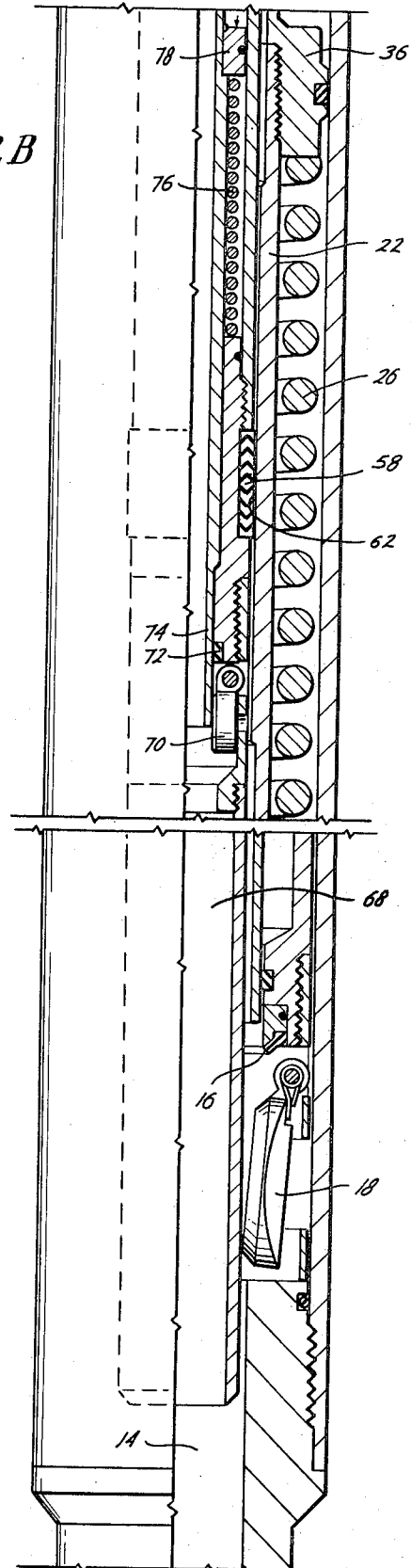


Fig. 2B



SUBSURFACE WELL SAFETY VALVE

BACKGROUND OF THE INVENTION

Generally, it is old to use a retrievable type safety valve that is removably inserted in the well tubing of an oil and/or gas well for protecting the well. However, such retrievable safety valves create a restriction in the well bore and generally have to be removed prior to moving other well tools through the well tubing for performing various well operations below the point of the safety valve installation.

The present invention is directed to an improved subsurface well safety valve which may be installed directly in line with the well tubing and provide a valve bore of substantially the same size as the bore of the well tubing and which need not be removed for allowing the passage of other well tools therethrough, and yet which will support a second retrievable safety valve in the event the first valve becomes inoperative.

SUMMARY

The present invention is directed to an improved subsurface well safety valve having connecting means at each end for connecting the valve into and forming a portion of the well tubing in which the bore of the valve has a size substantially as great as the bore of the well tubing thereby avoiding restricting the well tubing bore when the valve is open.

Yet a further object of the present invention is the provision of a non-retrievable safety valve for forming a portion of the well tubing and includes means for supporting a second safety valve in the bore of the first safety valve in the event that the first valve ever becomes inoperative.

Still a further object of the present invention is the provision of a fluid controlled subsurface non-retrievable well safety valve which is controlled from the well surface and includes a port in communication with the control fluid which port extends into the valve bore and may be opened whereby a second valve positioned in the bore of the first safety valve may be controlled by surface fluid control in the event the first safety valve fails.

Yet a further object of the present invention is the provision of a subsurface well safety valve which may be threadably connected in a well tubing and has a full open valve bore adapted to receive a second safety valve in a position to contact and hold the first safety valve in an open position whereby the second safety valve will control the flow of well fluid through the well tubing.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGS. 1A, 1B and 1C are continuations of each other of a fragmentary elevational view, partly in cross section, illustrating the present invention which is shown with the valve in the open position.

FIGS. 2A and 2B are continuations of each other of a fragmentary elevational view, partly in cross section, illustrating a retrievable fluid actuated safety valve in position in the non-retrievable safety valve of FIGS. 1A, 1B and 1C.

DESCRIPTION OF PREFERRED EMBODIMENTS

While the present improvement in a subsurface well safety valve will be shown, for purposes of illustration only, as incorporated in a flapper type well safety valve,

it will be understood that the present invention may be used with other types of safety valves having various types of seating elements.

Referring now to the drawings, in particular to FIGS. 1A and 1B, the subsurface safety valve of the present invention is generally indicated by the reference numeral 10 and is of a non-retrievable type as connecting means are provided on each end of the valve 10 such as a threaded pin 12 at one end and a threaded box (not shown) at the other end for connecting the safety valve 10 directly into the tubing (not shown) of an oil and/or gas well. The safety valve 10 generally includes a body 12 adapted to be connected in a well tubing to form a part thereof and to permit production therethrough under normal operating conditions but in which the safety valve may close or be closed in response to abnormal conditions such as might occur when the well over-produces, blows wild, or in the event of a failure of well equipment.

The safety valve body 12 generally includes a bore 14, an annular valve seat 16 positioned about the bore 14, a flapper valve element 18 connected to the body by a pivot pin 20. Thus, when the flapper 18 is in the upper position and seated on the valve seat 16, the safety valve 10 is closed blocking flow upwardly through the bore 14 and the well tubing. A sliding tube 22 is telescopically movable in the body 12 and through the valve seat 16.

As best seen in FIG. 1C, when the sliding tube 22 is moved to a downward position, the tube 22 pushes the flapper 18 away from the valve seat 16. Thus, the valve 10 is held in the open position so long as the sliding tube 22 is in the downward position. When the sliding tube 22 is moved upwardly, the flapper 18 is allowed to move upwardly onto the seat 16 by the action of a spring 24 and also by the action of fluid flow moving upwardly through the bore 14 of the body 12.

It is to be noted while the safety valve 10 is non-retrievable since it is threaded into and forms a portion of the well tubing. The bore 14 is a full bore, that is, the bore 14 is of a size substantially as great as the bore of the well tubing and thus allows the passageway of well tools therethrough without requiring removal of the safety valve 10 from the well tubing as would be the case of a retrievable safety valve positioned inside the well tubing.

Various forces may be provided to act on the sliding tube 22 to control its movement so that under normal conditions the sliding tube 22 will be in the downward position holding the flapper 18 away from and off of the valve seat 16 so that the valve 10 will be opened. When abnormal conditions occur, the sliding tube 20 will be moved upwardly allowing the flapper 18 to close shutting off flow through the valve 10 and well tubing. Thus, yieldable means such as pressurized fluid in a chamber 25 and/or a spring 26 may act between a shoulder 28 on the valve body 12 and a shoulder 30 connected to the sliding tube 22 for yieldably urging the tube 22 in an upward direction to release the flapper 18 for closing the valve 10.

The safety valve 10 is controlled by the application or removal of a pressurized fluid through a control path or line such as conduit 32 (FIG. 1A) extending to the well surface which supplies a pressurized fluid to chamber 34 and to the top of a piston 36 (FIG. 1B) which is connected to the sliding tube 22. When pressure is applied through the conduit 32, the piston 36 and tub-

ing 22 will be moved downward forcing the flapper 18 off of the seat 16 and into the full open position. If the fluid pressure in the conduit 32 is reduced sufficiently relative to the forces urging the tube 22 upwardly, the tube 22 will be moved upwardly beyond the seat 16 allowing the flapper 18 to swing and close the seat 16.

However, the safety valve 10 while providing a dependable valve, is non-retrievable and therefore is not subject to being periodically maintained unless the well tubing is pulled. Of course, the valve 10 may be periodically tested. In the event that the valve 10 becomes inoperative for any reason, means are provided in the bore 14 of the valve 10 for supporting a second safety valve which may take over the function of protecting the well while at the same time deactivating the safety valve 10. While any suitable means may be provided in the bore 14, one such means may be a recess 40 for supporting a well lock and second safety valve therein as will be more fully described hereinafter.

In addition, assuming that the safety valve 20 has become inoperative, which condition is not due to a malfunction of the flow control conduit 32, the valve 10 includes means whereby the flow control fluid in the conduit 32 may be used to control a second safety valve positioned in the valve bore 14.

Referring now to FIG. 1A, a port 42 is provided, in communication with the chamber 34 and thus the fluid in the control line 32, and extends into the bore 14 of the valve 10. The port 14 is initially closed by a shear screw 44 for preventing the control fluid from entering the well bore 14 while the safety valve 10 is operative. A shearing sleeve 46 is provided in the bore 14. When the valve 10 becomes inoperative, and it is desired to place a second safety valve in the bore 14 which is to be controlled by the fluid in the control line 32, the shearing sleeve 46 is actuated by a suitable well tool and moved downwardly to shear the shear screw 44 allowing the control fluid to pass through the now opened port 42 and into the bore 14 to control a second fluid control safety valve.

Referring now to FIGS. 2A and 2B, the installation of a second safety valve 50 into the safety valve 10 is best seen. In FIG. 2A, the shear screw 44 has been sheared allowing the flow of control fluid from control line 32 to pass through the port 42 and into the bore 14 of the safety valve 10. The valve 50 is a retrievable safety valve which is fluid controlled such as a Camco type B safety valve. The safety valve 50 is held in position in the well bore 14 by means of a suitable well lock 52 such as a Camco M lock in which the locking dogs 54 are expanded in engagement with the recess 40 for supporting the well lock 52 and the second safety valve 50.

Suitable seal means are provided for directing the fluid flow from the port 42 to the actuation mechanism of the second valve 10. Thus, a seal 56, here shown positioned on the well lock 52 and a seal 58 on the valve 50 engage sealing surfaces 60 and 62 on the interior of the bore 14 of the valve 10 for insuring that the control fluid flowing through the port 42 will flow into a port 64 in the valve 50 for control thereof. As shown, the shearing sleeve 46 may include the sealing surface 60 and further include seals 66 for preventing leakage of control fluid into the bore 14.

Still referring to FIGS. 2A and 2B and assuming that the valve 10 has become inoperative, with the tubing 22 in an upward position, the flapper 18 of the valve 10

would close and shut off the flow of fluid to the valve and well tubing. Therefore, valve 50 is provided with an extension 68 which extends through the valve seat 16 of the valve 10 holding the flapper 18 in a deactivated position so that only the second safety valve 50 will control the flow of fluid through the well tubing.

As is conventional, the second safety valve 50 may include a flapper 70, a valve seat 72, a sliding tube 74 which is yieldably urged upwardly by a spring 76. The control fluid flowing through the port 64 acts against a piston 78 to move the sliding tube 74 downwardly for controlling the position of the flapper 70. Thus, as shown in FIGS. 2A and 2B the second fluid actuated safety valve 50 may be inserted into the bore 14 of the non-retrievable safety valve 10 and assume the function of protecting the well, deactuating the first safety valve 10, and being controlled by control fluid in the control line 32.

Of course, the second valve 50 of FIGS. 2A and 2B may be conventionally removed from the well bore 14 if desired to allow other well tools passage there-through for performing well operations therebelow. In addition, the secondary valve 50 may be conveniently removed periodically for maintenance.

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 presently preferred embodiments of the invention are given for the purpose of disclosure, numerous changes in the details of construction and arrangement of parts will readily suggest themselves to those skilled in the art and are encompassed with the spirit of the invention and the scope of the appended claims.

What is claimed is:

1. In a fluid controlled safety valve for use in a well tubing and having a valve element and seat for controlling the fluid flow through the valve bore and tubing and yieldable means biasing said valve in a direction to close, and a fluid control line extending to the surface for supplying a fluid acting on the valve in a direction to open said valve, the improvement comprising, connecting means on each end of the safety valve for connecting the valve in a well tubing, the bore of the valve being of a size substantially as great as the bore of the well tubing thereby avoiding restricting the well tubing bore when the valve is open, said valve bore including means for supporting a second safety valve in said first valve bore, said first valve having a port in communication with the control fluid for the first valve and opening into the first valve bore, and means initially closing said port but openable for communicating control fluid into the first valve bore for controlling a second safety valve supported in the first valve bore.

2. The apparatus of claim 1 including a second safety valve supported in the first valve bore and positioned to contact and hold the first safety valve in the open position.

3. In a fluid controlled safety valve for use in a well tubing and having a valve element and seat for controlling the fluid flow through the valve bore and tubing with yieldable means biasing the valve in a direction to close, and a fluid control line extending to the surface for supplying a pressurized fluid acting on a piston in

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a direction to open the valve, the improvement comprising,
threaded connecting means on each end of the safety valve for connecting the valve in a well tubing, the bore of the valve being of a size substantially as great as the bore of the well tubing thereby avoiding restricting flow therethrough when the valve is open,
said valve bore including a recess for supporting a second safety valve in the first valve bore,
said first valve bore including a sealing surface for co-acting with an external seal means on the second valve,
a port in the first valve in communication with the control fluid in the valve and opening into the first bore,
shearable means initially closing said port, and
a shearing sleeve in the first valve bore which when

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actuated shears the shearable means for supplying control fluid into the first valve bore for controlling a second safety valve positioned in the first valve bore.

4. The apparatus of claim 3 including,
a second safety valve supported in the first valve bore and including a piston which when actuated opens said second valve, and
seal means on said second safety valve sealing on the bore of the first safety valve for directing the control fluid from the port to the piston in the second valve.

5. The apparatus of claim 4 including,
said second safety valve supported in the first valve bore and positioned to contact and hold the first safety valve in the open position.

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