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E. H. CLARK, JR., ET AL

3,351,133

TUBING WEIGHT-CONTROLLED SAFETY VALVE APPARATUS

Filed June 14, 1965

2 Sheets-Sheet 1

FIG. 1.

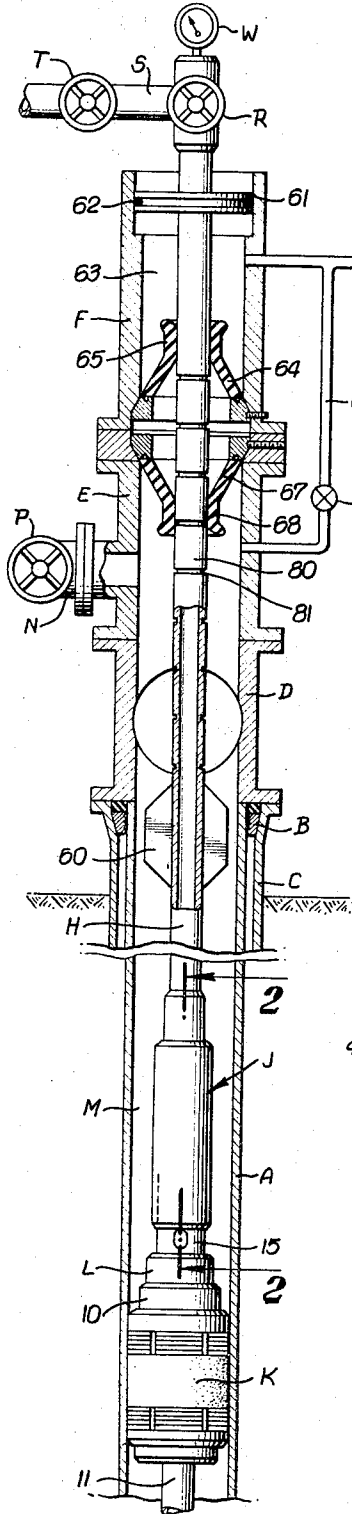


FIG. 2.

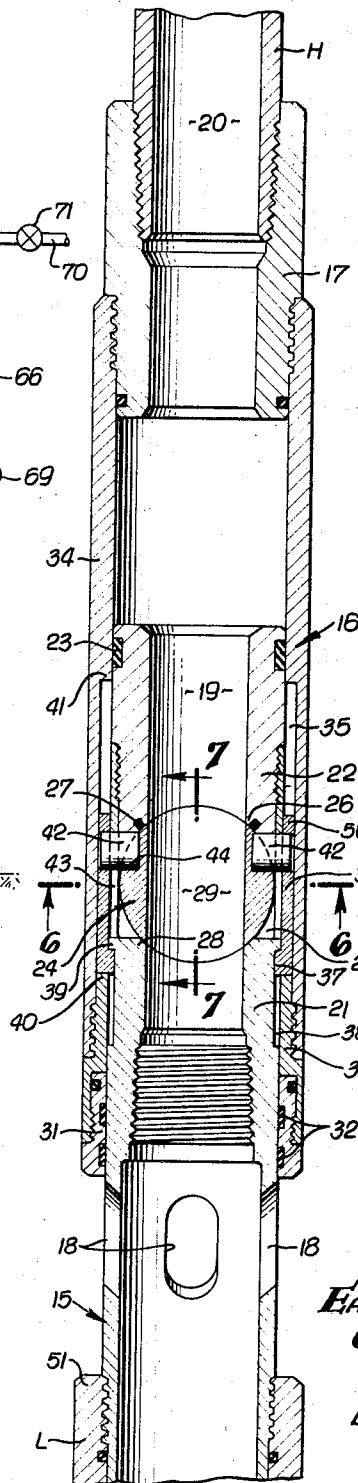
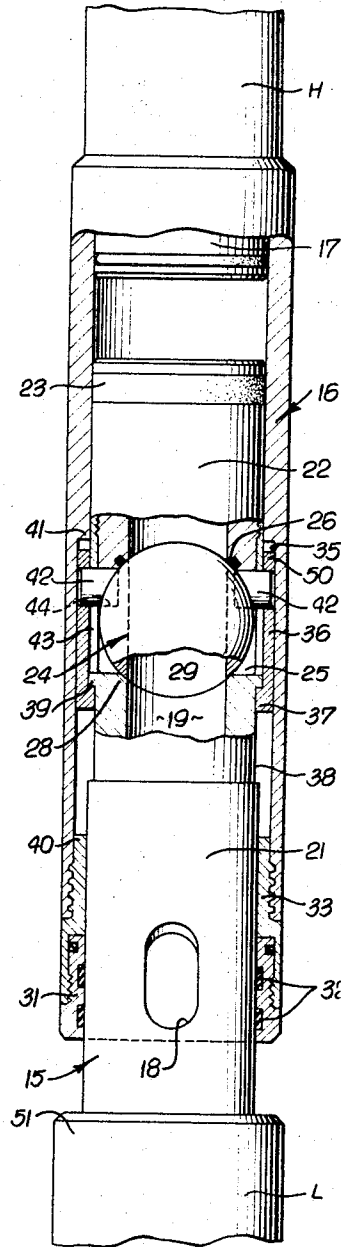


FIG. 3.



EARNEST H. CLARK, JR.
GEORGE M. RAULINS
INVENTORS.

By Bernard Kriegel
ATTORNEY.

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2 Sheets-Sheet 2

FIG. 4.

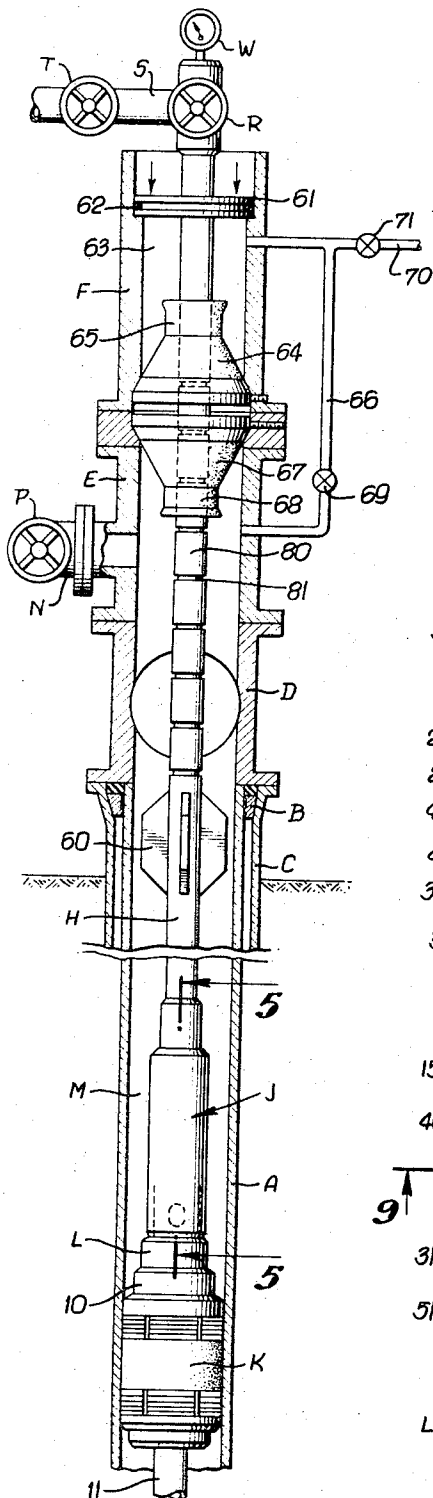


FIG. 5.

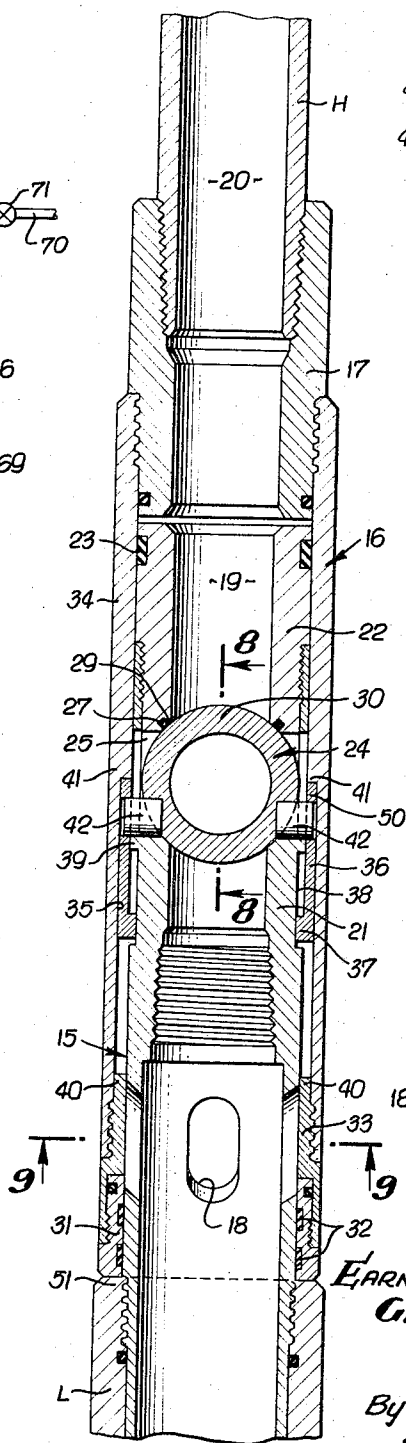


FIG. 6.

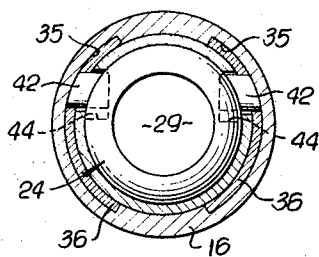


FIG. 7.

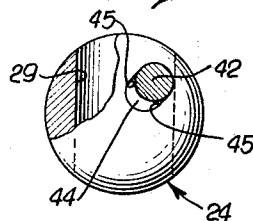


FIG. 8.

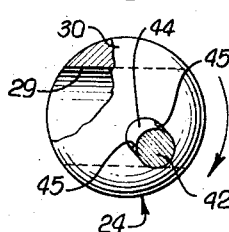
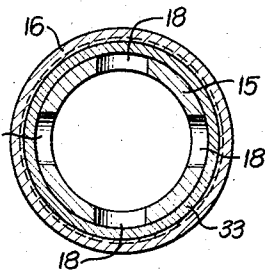


FIG. 9.



EARNEST H. CLARK, JR.
GEORGE M. RAULINS
INVENTORS.

By *Bernard Krieger*
ATTORNEY.

1

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TUBING WEIGHT-CONTROLLED SAFETY VALVE APPARATUS

Ernest H. Clark, Jr., Downey, Calif., and George M. Raulins, Houston, Tex., assignors to Baker Oil Tools, Inc., City of Commerce, Calif., a corporation of California

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26 Claims. (Cl. 166—53)

ABSTRACT OF THE DISCLOSURE

A safety valve apparatus including a subsurface upper member telescopically related to a lower member and connected to a tubing string extending to the top of a bore hole, a hydraulic piston and cylinder, or a readily breakable connection, or both, at the top of the hole holding the tubing string and upper member elevated relative to the lower member to retain the valve apparatus in open position, release of fluid pressure in the cylinder or breaking of the connection causing the tubing to drop and shift the upper member downwardly along the lower member to a valve closing position.

The present invention relates to well bore apparatus, and more particularly to apparatus for controlling the flow of fluid through a well bore.

Depleted zones of natural gas producing fields have been used for the storage of an oversupply of gas from other gas producing fields or sources, which occurs during a period of relative low demand, as in the summer months, the stored gas being withdrawn during a period of relatively greater demand, as in the winter months. The oversupply of gas injected into the depleted zone is usually stored under relatively low pressure (below 1,000 p.s.i.), and because of such low pressure large flow areas in the well are desirable for the subsequent withdrawal of gas in sufficient quantities.

Loss of control of a gas storage well could result in endangering lives, extensive property damage to the well equipment and the surrounding area, and the loss of great volumes of gas.

Accordingly, it is an object of the present invention to provide an improved safety valve apparatus that automatically closes and shuts in a gas storage or other well in the event of an unforeseen happenstance, such as a break in the flow line, failure in the well head equipment, or major well head damage.

Another object of the invention is to provide a safety valve apparatus for controlling the flow of fluid through a tubing string disposed in a well bore and also through the annular surrounding the tubing string, which is capable of shutting off the flow of fluids through both the tubing string and the surrounding annulus. In this connection, an additional object of the invention is to provide a safety valve apparatus having large flow areas to permit flow of large volumes through the tubing an annulus with a minimum of pressure drop.

A further object of the invention is to provide a safety valve apparatus that can be opened and closed at the will of the operator, and which closes automatically in the event of an unforeseen emergency.

Yet another object of the invention is to provide a safety valve apparatus which permits gas or other fluids to be injected through it into a well bore or storage reservoir, or to be withdrawn through it, which can be closed or opened whenever desired, and which will be closed automatically in the event of an emergency or hazardous condition presenting itself.

Still a further object of the invention is to provide a

2

subsurface safety valve apparatus for automatically shutting off the flow of fluids in a well bore, and which allows other tools to be run through it, such as logging or surveying instruments.

This invention possesses many other advantages, and has other objects which may be made more clearly apparent from a consideration of a form in which it may be embodied. This form is shown in the drawings accompanying and forming part of the present specification. It will now be described in detail, for the purpose of illustrating the general principles of the invention; but it is to be understood that such detailed description is not to be taken in a limiting sense, since the scope of the invention is best defined by the appended claims.

Referring to the drawings:

FIGURE 1 is a longitudinal section through a well bore and casing apparatus, illustrating an embodiment of the invention installed therein and in association therewith.

FIG. 2 is an enlarged section taken along the line 2—2 of FIG. 1, with the valve in open position;

FIG. 3 is a view similar to FIG. 2 disclosing the valve in another position in which it is being shifted toward a closed condition;

FIG. 4 is a view similar to FIG. 1 illustrating the apparatus with the valve in its closed condition;

FIG. 5 is an enlarged section taken along the line 5—5 on FIG. 4;

FIG. 6 is a cross-section taken along the line 6—6 on FIG. 2;

FIG. 7 is a section taken along the line 7—7 on FIG. 2;

FIG. 8 is a section taken along the line 8—8 on FIG. 5;

FIG. 9 is a cross-section taken along the line 9—9 on FIG. 5.

As illustrated in the drawings, a well casing A has been installed in a well bore, which may be supported at the top of the well bore by a suitable casing hanger B carried by surface casing C in the well bore. Additional surface connections and control devices are provided at the top of the well bore, such as a master valve D attached to the upper end of the casing A, to the upper end of which a tubular spool E is secured, there being a cylinder F attached to the upper end of this spool.

A tubing string H is disposed in the casing, its lower end being secured to the safety valve device J, which, in turn, is attached to a suitable packer K anchored in packed-off condition in the well casing above a zone (not shown) in the well bore, which may be a depleted gas zone, and into which gas is to be injected for storage, and from which gas is to be subsequently withdrawn. The lower end of the valve device J may be attached to a seal assembly L suitably secured to the body 10 of the packer, there being a tail pipe 11 extending through the packer body and depending therebelow to a suitable extent. Fluid can flow from the zone upwardly through the packer K and through the tubing string H to the top of the well bore when the safety valve J is open, and when the latter is in the open condition the gas can also flow through the annulus M in the casing A surrounding the tubing string, through the master valve D and spool E, passing outwardly through a suitable lateral line N controlled by a shut-off valve P. The fluid passing upwardly through the tubing string H can pass through a suitable tubing valve R and into a lateral line S which may also have a tubing valve T therein for shutting off or permitting flow therethrough. A pressure gauge W may also be attached to the upper end of the tubing string H for indicating the tubing pressure.

The safety valve J is normally held in its open condition when the tubing string H occupies an upper position within the casing in which fluid can flow both through

the tubing string H and through the tubing-casing annulus M. When the tubing string drops downwardly, the safety valve is shifted to a closed condition to prevent fluid flow through the tubing string and also through the tubing-casing annulus.

The specific safety valve J illustrated in the drawings includes an inner tubular member 15 threadedly or otherwise suitably secured to the seal assembly L, which is attached to the body 10 of the packer K. It is telescoped upwardly within an outer tubular member 16, the upper end of which is threadedly secured to a sub 17, which is, in turn, threadedly attached to the lower end of the tubing string H that extends to the top of the well bore. The inner tubular member 15 has a plurality of side ports 18 extending therethrough to permit fluid to pass between its interior and the tubing-casing annulus M. The inner tubular member also has a central passage 19 extending therethrough which opens into the upper portion of the outer tubular member 16, and which communicates with the central passage 20 through the tubing string thereabove.

The inner tubular member 15 is made in two sections, a lower section 21 being threadedly secured to an upper section 22, the latter having a side seal ring 23 thereon for slidably sealing against the inner wall of the outer tubular member 16. A ball valve element 24 is rotatably mounted in a cavity 25 provided between the upper and lower sections 21, 22 and is in sealing engagement with a valve seat 26 at the lower end of the upper section of the inner tubular member. A suitable seal ring 27 may be provided in this valve seat to seal against the outer surface of the ball or sphere 24. The valve seat 26 and the opposed portion 28 of the lower section 21 are formed as surfaces of a sphere having substantially the same radius as the ball member so that the ball can rotate and seat properly against the valve seat 26 and against the seal ring 27 disposed therein.

The ball or sphere has a passage 29 therethrough conforming in diameter to the passage 19 through the inner tubular member 15, and when in the open position illustrated in FIG. 2, a straight-through passage is provided through the inner tubular member and the ball, the ball providing no restrictions to the flow of fluids through the inner tubular member. However, when the ball 24 is turned through 90 degrees, such as disclosed in FIGS. 5 and 8, the passage 19 through the inner tubular member 15 is fully closed, since a solid portion 30 of the ball is then disposed across the passage 19 and in sealing engagement with the valve seat 26 and its seal ring 27.

The outer tubular member 16 is also made of a plurality of sections, its lower section 31 being constituted as a head having one or more seal rings 32 therein for slidably sealing against the periphery of the lower section 21 of the inner tubular member 15. The head is threadedly attached to a connector sleeve portion 33 of the outer tubular member, which is, in turn, threadedly secured to the main or uppermost section 34 of the outer tubular member. The uppermost section 34 of the outer tubular member has a pair of opposed elongate arcuate grooves 35 therein, in each of which an arcuate ball actuating sleeve segment 36 is disposed. The lower end of each segment has an inwardly directed flange 37 received within an elongate peripheral groove 38 in the lower section 21 of the inner tubular member, this flange being engageable with a stop shoulder 39 of the inner tubular member thereabove. The lower ends of the ball actuating segments 36 are adapted to be engaged with the upper end 40 of the connector sleeve 33 when the sleeve segments are to be shifted upwardly along the inner tubular member 15. When the segments are to be shifted downwardly along the inner tubular member, they are engaged by shoulders 41 of the outer tubular member at the upper ends of its arcuate grooves 35.

The longitudinal movement of the actuator segments 36 along the inner tubular member 15 is transmitted to the

valve ball or sphere 24 through pins 42. Thus, a pin 42 is secured to each segment 36 non-radially of the ball, that is, offset from the diameter of the ball, and this pin extends through a longitudinal slot 43 in the lower section 21 into a socket or recess 44 in the ball, the pin being able to engage the sides 45 of the socket, which, when the ball is in its open or in its closed position, are inclined to the direction of movement of the ball actuator segments 36 and of the pins, such as disclosed most clearly in FIGS. 7 and 8. When the ball actuating segments 36 are in their upper position along the inner tubular member 15, as illustrated in FIG. 2, the ball 24 is in its open position, and when the opposed segments 36 move downwardly, the opposed pins 42 move downwardly therewith, the pins engaging the inclined walls 45 of the ball sockets 44 and pivoting the ball 24 about its transverse or horizontal axis to its closed condition, as illustrated in FIG. 5. The pins shift through longitudinal slots 43 provided in the lower section of the inner tubular member in moving between their upper and lower positions, illustrated in FIGS. 2 and 5.

The longitudinal movement of the outer tubular member 16 relative to the inner tubular member 15 will effect a closing of the side ports 18 and also a closing of the central passage 19 through the inner tubular member. To insure that the side ports will be closed, and in view of the relative small movement required to shift the ball valve member 24 between open and closed positions, a lost motion connection is provided between the outer tubular member 16 and the ball actuating segments 36. As disclosed in FIG. 2, the valve is in its open condition with the head 31 disposed above the side ports 18, and with the upper shoulders 41 of the outer tubular member spaced a substantial distance above the upper ends 50 of the segment. As the tubular member 16 shifts downwardly, the ball 24 remains in its fully open condition until the outer tubular member 16 has moved downwardly to bring its shoulders 41 into engagement with the arcuate segments 36. At this time, however, the valve head 31 will have been shifted downwardly to a substantial distance across the side ports 18 (FIG. 3). Continued downward movement of the outer tubular member 16 will now cause the segments 36 to shift downwardly with it, the downward movement of the segments being transmitted through the pins 42 to the ball 24 in order to rotate the latter. The additional downward movement shifts the valve head 31 further downwardly along the inner tubular member 15, the extent of downward movement being limited by engagement of the lower end of the head with an upper end 51 of the seal assembly L secured to the well packer K, or by engagement of the lower end of the sub 17 with the upper end of the inner member 15. When such engagement occurs, the ball 24 will have been rotated through 90 degrees to its fully closed position illustrated in FIG. 5, and the seals 32 on the head will be disposed below the side ports 18 in sealing engagement with the exterior of the inner tubular member 15.

When the valve is to be shifted to open position, the outer tubular member 16 is elevated, which will first effect elevation of the seal head 31 without moving the ball actuator segments 36, pins 42, and the sphere 24, in view of the lost motion which exists between the upper end 40 of the connector sleeve 33 and the lower ends of the segments 36, the head 31 moving to a substantial extent along the inner tubular member 15 and its side ports 18 before the connector sleeve 33 engages the actuator segments 36. Continued upward movement of the outer tubular member 16 will shift the segments 36 upwardly along the inner tubular member 15 and cause the pins 42 to turn the ball 24 through 90 degrees, or back to its fully opened condition disclosed in FIG. 2, at which time the valve head 31 is disposed above the side ports 18, which are then in their fully open condition.

Rotation of the ball through 90 degrees can be definitely limited by engagement of the internal segment

5

flanges 37 with the external stop flanges 39 on the inner tubular member, as shown in FIG. 2, and by engagement of the lower end of the head 31 with the upper end 51 of the seal assembly, which will support the load of the tubular string H, as disclosed in FIG. 5.

As stated above, the packer K is preferably set immediately above a production zone, which may have been depleted and in which it is desired to store gas, the tubing string H extending upwardly through the casing A to the top of the well bore. The tubing string may have radial centering vanes 60 at its upper portion to hold it substantially centered in the well casing, the tubing string extending upwardly through the master valve D, spool E, and through the upper cylinder F to a position thereabove. The cylinder F constitutes a portion of a power mechanism for holding the tubing string H elevated in the casing, and the outer tubular member 16 is its elevated or extended position relative to the inner tubular member 15, in which both the side ports 18 and the central passage 19 through the inner tubular member are fully open. A piston 61 is secured to the upper end of the tubing string H and is slidable in the cylinder F, there being a suitable piston ring 62 to prevent leakage of fluid between it and the cylinder wall. A pressure or lift chamber 63 is present below the piston 61, the lower end of the cylinder being effectively closed by a cylinder head, in the form of a rubber or rubber-like seal member 64, which has its outer end suitably secured between the lower end of the cylinder F and the spool E, and with its inner end 65 slidably and sealingly engaging the periphery of the tubing string. Thus, the introduction of fluid under pressure to the cylinder below the piston 61 will exert a lifting force on the piston and on the tubing string H.

The fluid pressure for lifting the piston 61 may be derived from the gas in the tubing-casing annulus M. As shown, a line 66 has its inlet opening into the tubing-casing annulus M within the spool E and its outlet into the lift chamber 63. The upper end of the spool is closed by a rubber or rubber-like seal member 67, the outer end of which is suitably secured to the spool E and the lower end 68 of which is slidably and sealingly engageable with the periphery of the tubing string. The fluid under pressure flows through the line 66 and into the tubing lift cylinder 63, and if such pressure is sufficient, it will lift the piston 61 in the tubing string so that the safety valve J is in its fully open position, as disclosed in FIGS. 1 and 2.

A valve 69 may be incorporated in the gas lift line 66. Fluid under pressure from another or external source can also be connected to the cylinder F and into the lift chamber 63 through another line 70, this other line also having a suitable control valve 71 therein. In the absence of sufficient or any fluid pressure in the tubing-casing annulus M, the valve 69 in the line leading therefrom can be closed and the other valve 71 opened to conduct fluid pressure through the control lines 70, 66 into the lift chamber 63 and hold the tubing string H in its upward position and the valve J in its open condition. At any time that it is desired to close the valve J, the fluid under pressure can be bled from the lift chamber 63, allowing gravity to lower the tubing string H and the outer tubular member 16 along the inner tubular member 15, closing the side ports 18 and shifting the ball 24 to its closed position, as disclosed in FIG. 5. There may be an absence of sufficient pressure in the tubing-casing annulus M in the event gas is being injected through the tubing string H into the depleted production zone below the packer K, in which event the fluid pressure can be fed into the lift chamber 63 through the control line 70, as described above, but if there is sufficient fluid pressure in the tubing-casing annulus M, the pressure can be fed therefrom through the line 66 into the lift chamber, the control line valve 71 being closed.

In the event of damage to the surface connections, the tubing at its upper portion 80 may be disrupted, or one of the lines feeding gas into the lift chamber may be broken, thereby dissipating the pressure in the lift chamber 63.

6

This will allow gravity to drop the tubing string H and the outer tubular member 16 to close both the side ports 18 and the passages 19 through the inner tubular member 15, shutting off all flow through the apparatus. In the event of a major blow being struck on the surface equipment, which might come from a lateral direction, it will disrupt the tubing string at the top of the hole and allow it to drop. To insure such disruption, the tubing string may be provided with longitudinally spaced, circumferential weakening grooves 81 along an extended length, at which the tubing string will break, whereupon the force of gravity will act thereon, allowing it to drop the short distance necessary to bring the valve head 31 into engagement with the upper end of the seal assembly L (which will close the side ports 18 and which will also operate through the actuating segments 36 and the pins 42 to rotate the sphere 24 to its central passage closing position disclosed in FIG. 5.

It is evident that the valve J will close automatically in the event of loss of pressure in the lift chamber 63, which may be purposeful, or which may occur accidentally, or in the event of mechanical damage to the tubing string tending to bend it laterally. The grooved portion 80 of the tubing string H is preferably made of a material which is relatively frangible so that it will break at one of the weakening grooves 81 when a severe blow is struck thereagainst, tending to bend the surface equipment.

It is to be noted that there are large flow areas through the valve apparatus J, both through the central ball passage and through the side ports 18 in the inner tubular member 15. Accordingly, large volumes of gas flowing at a relatively high rate can be secured from the storage reservoir, both through the tubing string H and through the tubing-casing annulus M therearound. Because of the large areas available, there is very little restriction to the flow of the gas to the top of the well bore, and, consequently, a minimum of pressure drop through the apparatus develops. Thus, gas can be withdrawn from the reservoir at a very high rate.

The passage 29 through the ball or sphere is full opening, that is, it has a diameter substantially equal to the diameter of the passage 19 through the inner tubular member 15. The passage diameter is such that other tools, such as logging or surveying instruments, can be lowered through the tubing string H, the safety valve mechanism J, and the well packer K into the well bore below the latter for the performance of any desired operation or for the gathering of required information. There are no restrictions on which such tools can snag or hang up in passing through the valve apparatus.

In the absence of pressure in the lift chamber 63, the safety valve J can be shifted to open position at any time by connecting a suitable pulling device (not shown) to the upper portion of the tubing string H, and elevating the latter a required distance to open the side ports 18 and rotate the ball 24 to its passage opening position.

We claim:

1. In a valve apparatus adapted to be disposed in a well bore: upper and lower tubular members telescoped one within the other; said upper member having means for connecting said upper member to a tubular string extending to the top of the well bore; said members having a first passage through which fluid can flow between the tubular string and the lower tubular member; said members having a second passage through which fluid can flow between the interior of said members and the exterior of said members; means on said members for closing said first and second passages when said upper member is in a lower position along said lower member; said passages being open when said upper member is in an upper position along said lower member.

2. In a valve apparatus adapted to be disposed in a well bore: upper and lower tubular members telescoped one within the other; said upper member having means for connecting said upper member to a tubular string

extending to the top of the well bore; said members having a passage through which fluid can flow between the tubular string and the lower member; one of said members having one or more side ports through which fluid can flow between the interior of said members and the exterior of said members; means on said members for closing said passage and said one or more ports when said upper member is in a lower position along said lower member; said passage and one or more side ports being open when said upper member is in an upper position along said lower member.

3. In a valve apparatus adapted to be disposed in a well bore: a lower tubular member; an upper tubular member telescoped over said lower tubular member and adapted to be connected to a tubular string extending from said upper member to the top of the well bore; said members having a first passage through which fluid can flow between the tubular string and the lower member; said members having a second passage through which fluid can flow between the interior of said members and the exterior of said members; means on said members for closing said first and second passages when said upper member is in a lower position along said lower member; said passages being open when said upper member is in an upper position along said lower member.

4. In a valve apparatus adapted to be disposed in a well bore: a lower tubular member; an upper tubular member telescoped over said lower tubular member and adapted to be connected to a tubular string extending from said upper member to the top of the well bore; said members having a passage through which fluid can flow between the tubular string and said lower member; said lower member having one or more side ports through which fluid can flow between the interior of said lower member and the exterior of said members; means on said members for closing said passage and said one or more side ports when said upper member is in a lower position along said lower member; said passage and one or more side ports being open when said upper member is in an upper position along said lower member.

5. In safety apparatus for controlling the flow of fluid in a well bore: upper and lower tubular members telescoped one within the other and having a passage through which fluid can flow; coengageable means on said members closing said passage when said upper member is in a lower position along said lower member; said passage being open when said upper member is in an elevated position along said lower member; a running-in string connected to said upper member and extending to the top of the well bore; means connected to said running-in string at the top of the well bore and movable axially of the well bore and non-rotationally for elevating said running-in string and upper member to open said passage and to hold said passage open, said means connected to said running-in string constituting the sole instrumentality retaining said running-in string in an elevated position whereby said passage remains open; said connecting means being releasable to allow said running-in string to drop suddenly in the well bore and lower said upper member along said lower member and close said passage.

6. In safety apparatus for controlling the flow of fluid in a well bore: upper and lower tubular members telescoped one within the other and having a passage through which fluid can flow; coengageable means on said members closing said passage when said upper member is in a lower position along said lower member; said passage being open when said upper member is in an elevated position along said lower member; a running-in string connected to said upper member and extending to the top of the well bore; fluid pressure operated means connected to said running-in string at the top of the well bore for elevating said running-in string and upper member to open and hold said passage open, said fluid pressure operated means constituting the sole instrumentality

retaining said running-in string in an elevated position whereby said passage remains open; release of fluid pressure allowing said running-in string to drop suddenly in the well bore and lower said upper member along said lower member and close said passage.

7. In safety apparatus for controlling the flow of fluid in a well bore: upper and lower tubular members telescoped one within the other and having a passage through which fluid can flow; coengageable means on said members closing said passage when said upper member is in a lower position along said lower member; said passage being open when said upper member is in an elevated position along said lower member; a running-in string connected to said upper member and extending to the top of the well bore; fluid pressure operated means connected to said running-in string at the top of the well bore and communicating with the well bore to be responsive to the fluid pressure therein for elevating said running-in string and upper member to open and hold said passage open; lessening of fluid pressure in the well bore allowing said running-in string to drop in the well bore and lower said upper member along said lower member and close said passage.

8. In safety apparatus for controlling the flow of fluid in a well bore: upper and lower tubular members telescoped one within the other and having a passage through which fluid can flow; coengageable means on said members closing said passage when said upper member is in a lower position along said lower member; said passage being open when said upper member is in an elevated position along said lower member; a running-in string connected to said upper member and extending to the top of the well bore; means connected to said running-in string at the top of the well bore for elevating said running-in string and upper member to open said passage and to hold said passage open; the portion of said running-in string at the top of the well bore being substantially weaker than the running-in string in the well bore to provide one or more regions at which said running-in string can disrupt and allow said running-in string in the well bore to drop and lower said upper member along said lower member and close said passage.

9. In safety apparatus for controlling the flow of fluid in a well bore: upper and lower tubular members telescoped one within the other and having a passage through which fluid can flow; coengageable means on said members closing said passage when said upper member is in a lower position along said lower member; said passage being open when said upper member is in an elevated position along said lower member; a running-in string connected to said upper member and extending to the top of the well bore; fluid pressure operated means connected to said running-in string at the top of the well bore for elevating said running-in string and upper member to open and hold said passage open; release of fluid pressure allowing said running-in string to drop in the well bore and lower said upper member along said lower member and close said passage; the portion of said running-in string at the top of the well bore being substantially weaker than the running-in string in the well bore to provide one or more regions at which said running-in string can disrupt and allow said running-in string in the well bore to drop and lower said upper member along said lower member and close said passage.

10. In safety apparatus for controlling the flow of fluid in a well bore: a packer anchored in the well bore; upper and lower tubular members telescoped one within the other; means securing said lower member to said packer; said members having a passage through which well bore fluid flowing through the packer can pass; coengageable means on said members closing said passage when said upper member is in a lower position along said lower member; said passage being open when said upper member is in an elevated position along said lower member; a running-in string connected to said

upper member and extending to the top of the well bore; means connected to said running-in string at the top of the well bore and movable axially of the well bore and non-rotationally for elevating said running-in string and upper member to open said passage and to hold said passage open, said means connected to said running-in string constituting the sole instrumentality retaining said running-in string in an elevated position whereby said passage remains open; said connecting means being releasable to allow said running-in string to drop suddenly in the well bore and lower said upper member along said lower member and close said passage.

11. In safety apparatus for controlling the flow of fluid in a well bore: a packer anchored in the well bore; upper and lower tubular members telescoped one within the other; means securing said lower member to said packer; said members having a passage through which well bore fluid flowing through the packer can pass; coengageable means on said members closing said passage when said upper member is in a lower position along said lower member; said passage being open when said upper member is in an elevated position along said lower member; a running-in string connected to said upper member and extending to the top of the well bore; fluid pressure operated means connected to said running-in string at the top of the well bore and communicating with the well bore and responsive to the fluid pressure therein for elevating said running-in string and upper member to open and hold said passage open; lessening of fluid pressure in the well bore allowing said running-in string to drop in the well bore and lower said upper member along said lower member and close said passage.

12. In safety apparatus for controlling the flow of fluid in a well bore: a packer anchored in the well bore; upper and lower tubular members telescoped one within the other; means securing said lower member to said packer; said members having a passage through which well bore fluid flowing through the packer can pass; coengageable means on said members closing said passage when said upper member is in a lower position along said lower member; said passage being open when said upper member is in an elevated position along said lower member; a running-in string connected to said upper member and extending to the top of the well bore; means connected to said running-in string at the top of the well bore for elevating said running-in string and upper member to open said passage and to hold said passage open; the portion of said running-in string at the top of the well bore being substantially weaker than the running-in string in the well bore to provide one or more regions at which said running-in string can disrupt and allow said running-in string in the well bore to drop and lower said upper member along said lower member and close said passage.

13. In safety apparatus for controlling the flow of fluid in a well bore: upper and lower tubular members telescoped one within the other; a tubular string connected to said upper member and extending to the top of the well bore; said members having a first passage through which fluid can flow between the tubular string and the lower tubular member; said members having a second passage through which fluid can flow between the interior of said members and the exterior of said members; means on said members for closing said first and second passages when said upper member is in a lower position along said lower member; means connected to said tubular string at the top of the well bore for elevating said tubular string and upper member to open and hold said passages open; said connecting means being releasable to allow said tubular string to drop in the well bore and lower said upper member along said lower member and close said passages.

14. In safety apparatus for controlling the flow of fluid in a well bore: a lower tubular member; an upper tubular member telescoped over said lower tubular

member; a tubular string connected to said upper member and extending to the top of the well bore; said members having a first passage through which fluid can flow between the tubular string and the lower tubular member; said members having a second passage through which fluid can flow between the interior of said members and the exterior of said members; means on said members for closing said first and second passages when said upper member is in a lower position along said lower member; means connected to said tubular string at the top of the well bore for elevating said tubular string and upper member to open and hold said passage open; said connecting means being releasable to allow said tubular string to drop in the well bore and lower said upper member along said lower member and close said passages.

15. In safety apparatus for controlling the flow of fluid in a well bore: a lower tubular member; an upper tubular member telescoped over said lower tubular member; a tubular string connected to said upper tubular member and extending to the top of the well bore; said members having a passage through which fluid can flow between the tubular string and said lower member; said lower member having one or more side ports through which fluid can flow between the interior of said lower member and the exterior of said members; means on said members for closing said passage and said one or more side ports when said upper member is in a lower position along said lower member; means connected to said tubular string at the top of the well bore for elevating said tubular string and upper member to open and hold said passage and one or more side ports open; said connecting means being releasable to allow said tubular string to drop in the well bore and lower said upper member along said lower member and close said passage and said one or more side ports.

16. In safety apparatus for controlling the flow of fluid in a well bore: upper and lower tubular members telescoped one within the other; a tubular string connected to said upper member and extending to the top of the well bore; said members having a first passage through which fluid can flow between the tubular string and the lower tubular member; said members having a second passage through which fluid can flow between the interior of said members and the exterior of said members; means on said members for closing said first and second passages when said upper member is in a lower position along said lower member; means connected to said tubular string at the top of the well bore for elevating said tubular string and upper member to open and hold said passages open; the portion of said tubular string at the top of the well bore being substantially weaker than the tubular string in the well bore to provide one or more regions at which said tubular string can disrupt and allow said tubular string in the well bore to drop and lower said upper member along said lower member and close said passages.

17. In safety apparatus for controlling the flow of fluid in a well bore: a lower tubular member; an upper tubular member telescoped over said lower tubular member; a tubular string connected to said upper tubular member and extending to the top of the well bore; said members having a passage through which fluid can flow between the tubular string and said lower member; said lower member having one or more side ports through which fluid can flow between the interior of said lower member and the exterior of said members; means on said members for closing said passage and said one or more side ports when said upper member is in a lower position along said lower member; means connected to said tubular string at the top of the well bore for elevating said tubular string and upper member to open and hold said passage and one or more side ports open; said connecting means being releasable to allow said tubular string to drop in the well bore and lower said upper

member along said lower member and close said passage and said one or more side ports; the portion of said tubular string at the top of the well bore being substantially weaker than the tubular string in the well bore to provide one or more regions at which said tubular string can disrupt and allow said tubular string in the well bore to drop and lower said upper member along said lower member and close said passage and said one or more side ports.

18. In apparatus for controlling the flow of fluid in a well bore: a packer anchored in the well bore; upper and lower tubular members telescoped one within the other; means securing said lower member to said packer; a tubular string connected to said upper member and extending through the well bore to the top thereof; said members having a first passage through which well bore fluid flowing through the packer can pass to the lower tubular member; said members having a second passage through which well bore fluid flowing through said packer can pass between the interior of said members and the exterior of said members; means on said members for closing said first and second passages when said upper member is in a lower position along said lower member; means connected to said tubular string at the top of the well bore for elevating said tubular string and upper member to open said passages and to hold said passages open; said connecting means being releasable to allow said tubular string to drop in the well bore and lower said upper member along said lower member to close said passages.

19. In safety apparatus for controlling the flow of fluid in a well bore: a lower tubular member; an upper tubular member telescoped over said lower tubular member; a tubular string connected to said upper tubular member and extending to the top of the well bore; said members having a passage through which fluid can flow between the tubular string and said lower member; said lower member having one or more side ports through which fluid can flow between the interior of said lower member and the exterior of said members; means on said members for closing said passage and said one or more side ports when said upper member is in a lower position along said lower member; means connected to said tubular string at the top of the well bore for elevating said tubular string and upper member to open and hold said passage and one or more side ports open; said connecting means being releasable to allow said tubular string to drop in the well bore and lower said upper member along said lower member and close said passage and said one or more side ports; the portion of said tubular string at the top of the well bore being substantially weaker than the tubular string in the well bore to provide one or more regions at which said tubular string can disrupt and allow said tubular string in the well bore to drop and lower said upper member along said lower member and close said passage and said one or more side ports; a packer anchored in the well bore below said lower tubular member; and means securing said lower member to said packer, whereby well bore fluid can flow through the packer and into said lower member.

20. In a valve apparatus adapted to be disposed in a well bore: inner and outer tubular members telescoped one within the other; a valve member rotatably mounted in said inner member and having a passage alignable with said inner member passage when said valve member is in open position, said valve member being rotatable in said inner member to a closed position across said inner member passage; and means interconnecting said outer member and valve member to turn said valve member between open and closed positions in response to relative longitudinal movement between said tubular members.

21. In a valve apparatus adapted to be disposed in a well bore: inner and outer tubular members telescoped one within the other and having a first passage through

which fluid can flow, said members having a second passage through which fluid can flow between the interior and exterior of said members; a valve member rotatably mounted in said inner member and having a third passage alignable with said first passage when said valve member is in open position, said valve member being rotatable in said inner member to a closed position across said first passage; means on said tubular members for closing said second passage when said tubular members are in one relative telescoped position; and means interconnecting said outer member and valve member to turn said valve member from open to closed position upon shifting of said tubular members to said one relative telescoped position.

22. In a valve apparatus as defined in claim 21; wherein said interconnecting means includes a lost motion connection.

23. In safety apparatus for controlling the flow of fluid in a well bore: upper and lower tubular members telescoped one within the other; a tubular string connected to said upper member and extending through the well bore to the top thereof; said tubular members having a first passage through which fluid can flow into said tubular string; said members having a second passage through which fluid can flow between the interior and exterior of said members; a valve member rotatably mounted in the inner of said members and having a third passage alignable with said first passage when said valve member is in open position, said valve member being rotatable in said inner member to a closed position across said first passage; means on said tubular members for closing said second passage when said upper tubular member is in a lower position along said lower tubular member; means interconnecting the outer of said tubular members and valve member to turn said valve member from open to closed position upon downward movement of said upper member along said lower member; means connected to said tubular string at the top of the well bore for elevating said tubular string and upper member to open said second passage and to rotate said valve member to open position; said connecting means being releasable to allow said tubular string to drop in the well bore and lower said upper member along said lower member and close said second passage and rotate said valve member to closed position.

24. In safety apparatus for controlling the flow of fluid in a well bore: upper and lower tubular members telescoped one within the other; a tubular string connected to said upper member and extending through the well bore to the top thereof; said tubular members having a first passage through which fluid can flow into said tubular string; said members having a second passage through which fluid can flow between the interior and exterior of said members; a valve member rotatably mounted in the inner of said members and having a third passage alignable with said first passage when said valve member is in open position, said valve member being rotatable in said inner member to a closed position across said first passage; means on said tubular members for closing said second passage when said upper tubular member is in a lower position along said lower tubular member; means interconnecting the outer of said tubular members and valve member to turn said valve member from open to closed position upon downward movement of said upper member along said lower member; fluid pressure operated means connected to said tubular string at the top of the well bore for elevating said tubular string and upper member to open said second passage and rotate said valve member to open position and to hold said second passage and valve member in open position; release of fluid pressure allowing said tubular string to drop in the well bore and lower said upper member along said lower member and close said second passage and rotate said valve member to closed position.

25. In safety apparatus for controlling the flow of fluid in a well bore: upper and lower tubular members telescoped one within the other; a tubular string connected to said upper member and extending through the well bore to the top thereof; said tubular members having a first passage through which fluid can flow into said tubular string; said members having a second passage through which fluid can flow between the interior and exterior of said members; a valve member rotatably mounted in the inner of said members and having a third passage alignable with said first passage when said valve member is in open position, said valve member being rotatable in said inner member to a closed position across said first passage; means on said tubular members for closing said second passage when said upper tubular member is in a lower position along said lower tubular member; means interconnecting the outer of said tubular members and valve member to turn said valve member from open to closed position upon downward movement of said upper member along said lower member; means connected to said tubular string at the top of the well bore for elevating said tubular string and upper member to open said second passage and to rotate said valve member to open position; the portion of said tubular string at the top of the well bore being substantially weaker than the tubular string in the well bore to provide one or more regions at which said tubular string can disrupt and allow said tubular string in the well bore to drop and lower said upper member along said lower member and close said second passage and rotate said valve member to closed position.

26. In safety apparatus for controlling the flow of fluid in a well bore: upper and lower tubular members telescoped one within the other; a tubular string connected to said upper member and extending through the well bore to the top thereof; said tubular members having a first passage through which fluid can flow into said tubular string; said members having a second passage through which fluid can flow between the interior and exterior of said members; a valve member rotatably mounted in the inner of said members and having a third passage align-

able with said first passage when said valve member is in open position, said valve member being rotatable in said inner member to a closed position across said first passage; means on said tubular members for closing said second passage when said upper tubular member is in a lower position along said lower tubular member; means interconnecting the outer of said tubular members and valve member to turn valve member from open to closed position upon downward movement of said upper member along said lower member; fluid pressure operated means connected to said tubular string at the top of the well bore for elevating said tubular string and upper member to open said second passage and rotate said valve member to open position and to hold said second passage and valve member in open position; release of fluid pressure allowing said tubular string to drop in the well bore and lower said upper member along said lower member and close said second passage and rotate said valve member to closed position; the portion of said tubular string at the top of the well bore being substantially weaker than the tubular string in the well bore to provide one or more regions at which said tubular string can disrupt and allow said tubular string in the well bore to drop and lower said upper member along said lower member and close said second passage and rotate said valve member to closed position.

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CHARLES E. O'CONNELL, *Primary Examiner.*

JAMES A. LEPPINK, *Examiner.*