

Jan. 16, 1962

R. H. MAGILL ETAL

3,016,955

FLUID PRESSURE ACTUATED WELL SHUT-OFF VALVE

Filed July 1, 1957

2 Sheets-Sheet 1

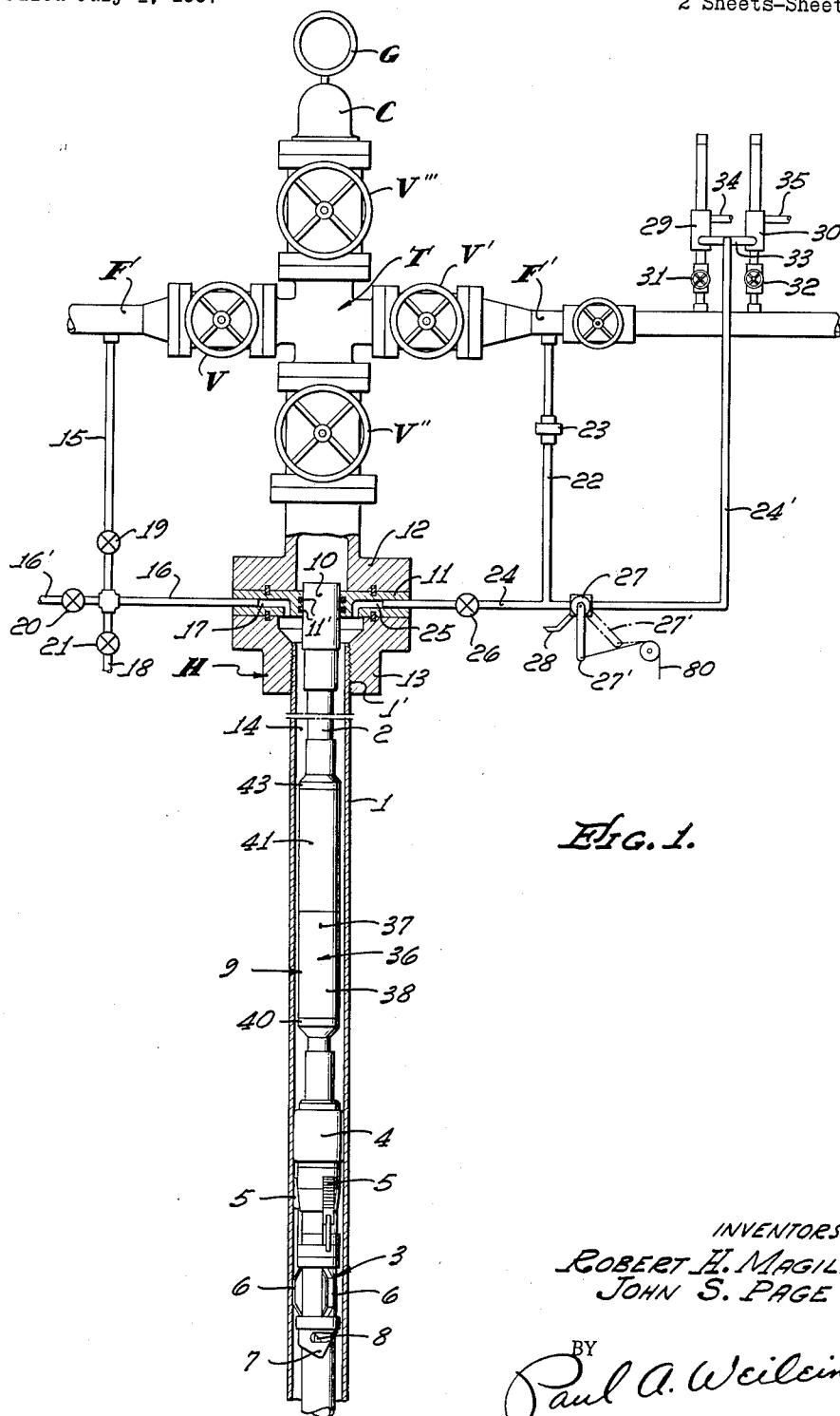


Fig. 1.

INVENTORS;
ROBERT H. MAGILL
JOHN S. PAGE

BY
Paul A. Weilein
ATTORNEY.

Jan. 16, 1962

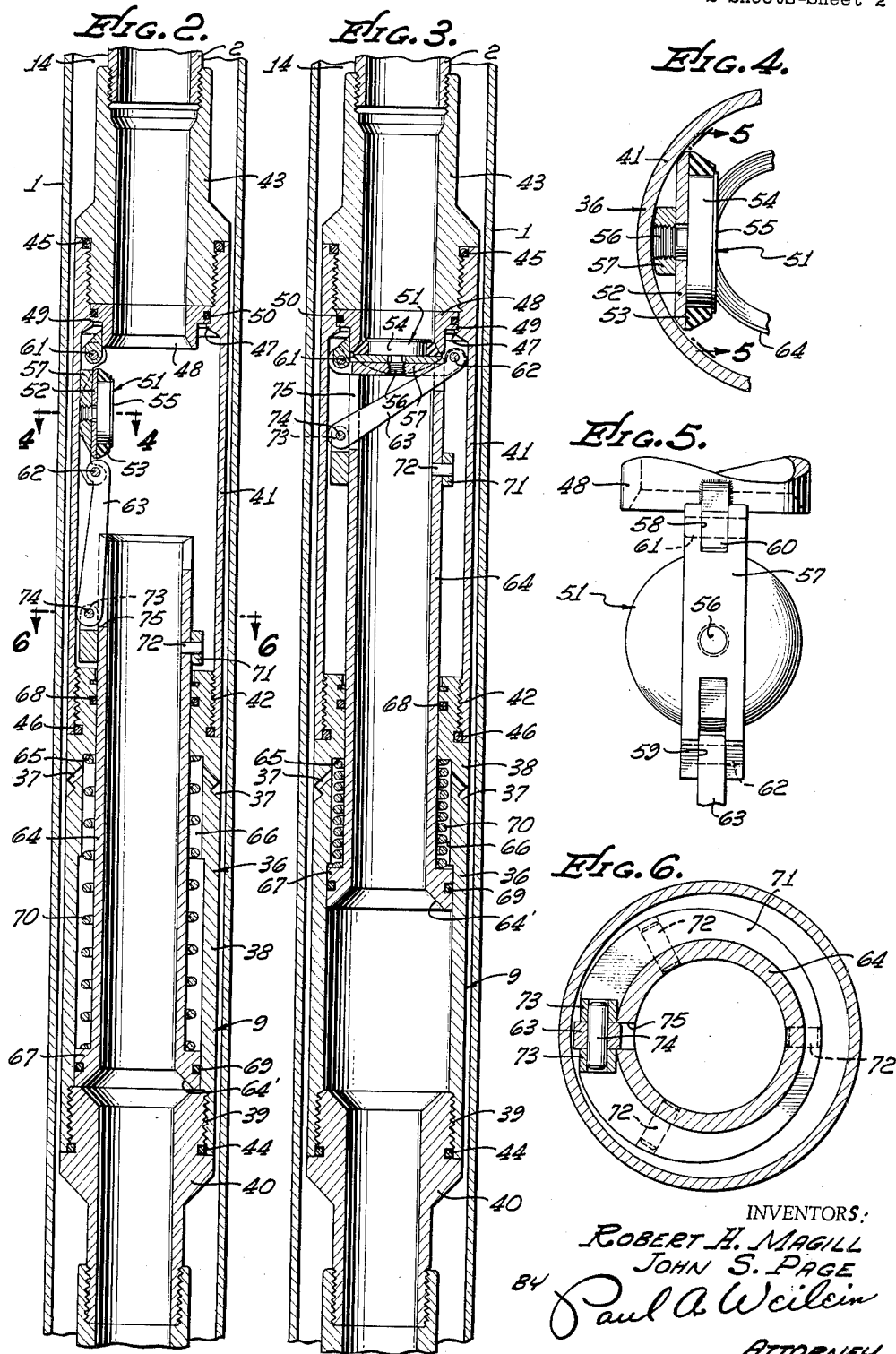
R. H. MAGILL ETAL

3,016,955

FLUID PRESSURE ACTUATED WELL SHUT-OFF VALVE

Filed July 1, 1957

2 Sheets-Sheet 2



INVENTORS:

ROBERT H. MAGILL

JOHN S. PAGE

BY Paul A. Weilein

ATTORNEY

1

3,016,955

FLUID PRESSURE ACTUATED WELL SHUT-OFF VALVE

Robert H. Magill and John S. Page, Long Beach, Calif.,
assignors to Page Oil Tools, Inc., Long Beach, Calif.,
a corporation of California

Filed July 1, 1957, Ser. No. 669,012

11 Claims. (Cl. 166-224)

The present invention relates to well flow controlling apparatus, and more particularly to novel and improved means for controlling the flow of production fluid from a well responsive to such flow.

In the oil and gas well field, it is often desirable to shut off the flow of production fluid from the well under certain conditions, for instance, to enable the performance of various down hole well operations. In addition, it is sometimes necessary to shut off the flow in the event of certain conditions such as over pressure, under pressure, disruption of the well head equipment or the like.

Conventionally, however, valves for controlling the flow of such wells have been located at the well head, where damage to the well head equipment may cause damage to the flow controlling valve, or to the conventional blow-out preventer at the well head, or such control devices have required certain tubing manipulations or other manual control.

In copending application, Serial No. 669,043 filed July 1, 1957, there are disclosed an improved method of and apparatus for controlling the flow of production from a well, wherein pressure is imposed upon fluid in the annulus between the casing and the production tubing to operate a valve assembly located in a tubing string down in the well, and wherein a reduction in such pressure for any reason will serve to permit the valve to be closed automatically responsive to the flow of production fluid.

The present invention more particularly concerns a novel valve for use in the method and apparatus of the aforementioned copending application.

An object of the present invention is to provide a valve assembly adapted to be disposed in a string of production tubing at a point spaced downwardly from the well head, said valve assembly including fluid pressure operated valve means adapted to be held open responsive to production fluid pressure, and adapted to be closed at will or automatically upon a drop in pressure in the annulus as the result of an excessive rise or decline in production pressure, or as the result of the casing head being displaced or damaged for any reason to such an extent as to allow leakage.

Oftentimes flowing wells are left untended for substantial periods of time, especially in the case of offshore wells, and as a consequence should an emergency arise at the well, such as a break in the casing or casing head, rupture of a flow line, or the like, shutting off of the well flow is highly desirable, since otherwise the production will be lost and a fire hazard may be produced. Countless barrels of oil may be lost, as the fluid runs off on the ground or flows into the water from an offshore well. In the case of the latter type of well the well may be inaccessible because of a storm, and indeed, the entire platform, if a platform be employed, may be destroyed or severely damaged and the tubing and casing ruptured under water thus substantially hampering shutting off or controlling the flow.

A further problem is involved where excessive pressures are produced above the capacity of the tubing, well head equipment or the like, whereupon the well head equipment may be blown off or damaged and the well will blow out. In the alternative, flow pressure may be abnormally reduced to a dangerously low point where flow should be temporarily halted. Otherwise the well

2

may cease production, following which swabbing of the well may be required in order to cause resumption of production. The valve hereof, in accordance with the preceding objective, obviates these problems.

A further object is to provide well flow controlling apparatus, including means for packing off the annulus between a string of production tubing and well casing below the valve assembly hereof, and means for imposing production fluid pressure on fluid filling the annulus above the packer, the valve being so constructed as to be held held open responsive to pressure in the annulus, and being adapted to be closed responsive to production fluid flow upon reduction of the annulus fluid pressure.

Another object is to provide a valve assembly and valve for installation in a string of production tubing, said valve being so constructed that the valve offers no obstruction to the flow of fluid through the tubing or to the passage therethrough of any type of tool which may be run into the well on a wire line, such as perforating guns, fracturing tools, cementing tools, testers or the like

In accordance with the preceding objective, it is a further object to provide a valve assembly including an elongated hollow housing, means defining an actuator cylinder including a sleeve in said housing, said housing having a port for admitting fluid into the actuator cylinder to shift the sleeve axially relative to the housing, a valve seat in said housing, and a valve shiftably disposed in the housing and movable towards said seat by said sleeve.

Still another object is to provide a valve assembly according to the next preceding objective, wherein the assembly includes a pivoted gate type valve, the valve being pivotally mounted for seating engagement in a seat formed in the housing and being adapted to be moved to an open position where it is recessed in the housing so that there is no restriction of the passageway through the valve assembly to prevent the passage therethrough of well tools on a wire line, the passageway through the valve assembly being at least as large in cross sectional area as the minimum cross-sectional area of the tubing string and couplings.

Yet another object is to provide a valve assembly according to the foregoing objectives, wherein the gate valve is operatively connected to the fluid pressure operated sleeve, so that movement of said sleeve in opposite directions will effect closing and opening of said valve.

Another object is to provide a valve in accordance with the next preceding objective, wherein the sleeve is axially extended for engagement with the valve gate so as to aid in maintaining the gate properly seated irrespective of play in the gate mounting.

Other objects and advantages will be hereinafter described as will become apparent to those skilled in the art and the novel features of the invention will be defined in the appended claims.

In the accompanying drawings:

FIG. 1 is a diagrammatic view showing well head equipment, together with casing and tubing strings extending downwardly into a well, and a valve assembly in the tubing embodying the present invention;

FIG. 2 is an enlarged detail view in vertical section, with certain of the parts shown in elevation, of a full open gate valve in accordance with the invention;

FIG. 3 is an enlarged detail view similar to FIG. 2, but showing the valve in a closed position;

FIG. 4 is a fragmentary view in transverse section, as taken on the line 4—4 of FIG. 2;

FIG. 5 is a fragmentary detail view in elevation, showing the valve gate mounting, this view being taken substantially on the line 5—5 of FIG. 4; and

FIG. 6 is a transverse sectional view as taken on the line 6—6 of FIG. 2.

Like reference characters in the several views of the

3

drawings and in the following detailed description designate corresponding parts.

Referring particularly to FIG. 1, well apparatus is shown, including a casing 1 disposed in a well, with a tubing string 2 concentrically disposed in the casing. The tubing may be suspended in the casing at a point spaced substantially downwardly from the top of the casing by suitable means such as a tubing anchor (not shown). Above the anchor is a suitable packer. A hook-wall packer assembly 3 may be advantageously used thus eliminating the need for a separate anchor in some cases. The hook-wall packer 3 need not be described in detail in that it is a known type of packer. Generally, however, the packer assembly 3 includes a packer element 4 adapted to seal off the annulus between the casing and the tubing. Means such as a plurality of casing wall engaging slips 5 are employed for securing the packer in place. Operatively connected to the slips 5 is a plurality of friction pads 6 engageable with the casing to set the slips 5 and prevent relative movement of the packer assembly 3 and the tubing 2 in one direction. Depending from the packer assembly is a suitable number of hooks 7 adapted for engagement with a similar number of lugs 8 carried by the tubing 2, whereby relative movement of the packer assembly 3 and the tubing 2 in the other direction, is precluded.

Interposed in the tubing string 2 between the hook-wall packer assembly 3 and the upper end of the tubing is a novel fluid pressure operated valve assembly generally designated 9 which will be more specifically described as the description progresses.

As previously noted, the valve assembly is adapted to be subjected to fluid pressure. Such pressure is preferably derived from the production fluid through well head equipment. This well head equipment includes a safety landing sub 10 carried by the upper end of the tubing string 2. Removably mounted on the upper end of the landing sub 10 as by a slip fit is an annular landing flange 11 which is interposed between upper and lower sections 12 and 13, respectively, of casing head means generally designated H. At its inner periphery, the landing flange is provided with suitable seals or packing rings 11', so that the landing flange constitutes an upper barrier between the casing 1 and tubing 2 for preventing the direct flow of fluid from the tubing into the casing. In addition, the casing head section 13 is sealingly engaged at the upper extremity of the casing 1 as by a threaded connection 1'.

Disposed above the casing head H is a conventional Christmas tree T having flow line F, F' each having a flow valve V and V', respectively. The Christmas tree T also comprises a valve V'' between the casing head H and the flow lines F, F' and a valve V''' disposed above the flow lines F, F'. At the top of the Christmas tree is a cap C which may advantageously be fitted with a gauge G or the like.

In accordance with the invention hereof, the fluid pressure operated valve assembly 9 is adapted to be maintained open, that is, in a condition enabling the well to flow or produce through the tubing 2, responsive to fluid pressure in the annulus 14 between the casing 1 and the tubing 2. Such fluid pressure may be derived from a number of sources.

For example, in FIG. 1, fluid communication is established between the flow lines F, F' and the annulus 14. In this connection, a line 15 is tapped into the flow line F. This line 15 is joined with a line 16 which is connected with the landing flange 11, the landing flange having a passage 17 leading to the annulus 14. In addition the line 16 is extended as at 16' for connection to a pump or other source of pressure fluid (not shown), and a vent line 18 is also connected to the line 16. Each of the lines 15, 16' and 18 is provided with a control valve and valves being respectively designated 19, 20 and 21.

At the other side of the Christmas tree T and com-

4

municating with the flow line F' is a pressure line 22 preferably having an orifice union 23 therein for limiting the rate of flow of fluid from the flow line F'. The line 22 is connected with a line 24 which establishes fluid communication with the annulus H through a passage 25 in the landing flange 11.

The line 24 has a manual valve 26 and a multiway valve 27 therein. The multiway valve 27 is adapted to selectively establish communication between the line 24 and a vent 28 and between the line 24 and an extension 24' of the latter, the flow from line 24 to extension 24' being interrupted by the valve 27 upon venting of the line 24. Valve 27 may be of any desired construction but is preferably operable by a lever 27' for a purpose which will be hereinafter more fully described.

Also connected to flow line F' is a pair of pilot valves 29 and 30, a manual valve preferably being interposed between each pilot valve 29 and 30 as at 31 and 32, respectively, and the line F'. A cross line 33 establishes communication between line 24' and the pilot valves 29 and 30, and each of said pilot valves is provided with a vent 34 and 35, respectively. The details of the pilot valves are not germane and they may be of any desired construction, whereby one of the pilot valves, say pilot valve 29, is responsive to a drop in pressure in the line F' below a predetermined valve to vent line 24' to the atmosphere through vent 34, whereas the other pilot valve 30 is responsive to pressure in line F' above a predetermined value to vent line 24' through vent 35.

As has been previously stated, the valve assembly 9 is adapted to be maintained open responsive to fluid pressure in the annulus 14. Accordingly, the valve assembly 9 includes a cylindrical housing 36 having a suitable number of ports 37 leading from the annulus 14 into the housing.

Referring particularly to FIGS. 2 and 3, it will be seen that the housing 36 preferably includes a lower section 38 constituting a pressure cylinder and threadedly connected as at 39 with a coupling 40 adapted to be connected with the depending tubing string. An upper housing section 41 is threaded to the lower section 38 as at 42, and at its upper end the housing 41 is threaded to a coupling 43 adapted to be connected to the tubing string above the valve 9. Suitable sealing means are employed for preventing the passage of fluid between the couplings 40 and 43 and the ends of the housing sections 38 and 41, respectively, such as O-ring or other sealing elements 44 and 45. Another sealing element or O-ring 46 is interposed between the threaded ends of the housing sections at the connection 42 thereof.

At a point spaced below the lower extremity of the upper coupling 43, the upper housing section is provided with an annular shoulder 47 projecting radially inwardly. A valve seat 48 having a radial flange 49 is supported on the shoulder 47, with the flange 49 clamped between the shoulder 47 and the lower extremity of the coupling 43. Preferably, an O-ring 50 or other sealing means is interposed between the inner periphery of the housing section 41 and the flange 49 to prevent flow of well fluid around the seat. The seat 48 has a tapered or beveled face adapted to be engaged by an annular complementary tapered or beveled gate valve 51.

Gate valve 51 comprises a disc-like base 52 on which is secured an annular tapered valve washer 53 which may be composed of "Teflon," rubber, or other suitable material. The washer 53 is secured in place by a circular disc 54 having a marginal flange 55 overlying the washer 53, this disc 54 having a threaded stem 56 which projects through a central opening in the base 52 into threaded engagement with a cross member 57. At its opposite ends, the cross member 57 is bifurcated as at 58 and 59, and the cross member is pivotally supported on an ear 60 depending from one side of the valve seat 48 and disposed in the bifurcated end 58 of the cross member 57, a pivot pin 61 extending through the interengaged ear and bifurcations.

At its other end, the cross member 57 is pivotally connected by a pin 62 with an end of a longitudinally extended link 63, said link being connected at its other end to fluid pressure operated means for shifting the link in opposite directions so as to close and open the valve.

Such fluid pressure operated means comprises a sleeve 64 reciprocably disposed in the lower housing section 38 and projecting upwardly into the upper housing section 41. It will be observed that housing section 38 projects radially inwardly to provide a shoulder 65 and an annular space 66 is defined between the sleeve 64 and the housing section 38, into which space fluid may flow from the annulus 14 through the ports 37. At its lower end the sleeve 64 is formed with a radially projecting flange 67 constituting a piston. Sealing means such as an O-ring 68 and an O-ring 69 are respectively interposed between the upper end of sleeve 64 and the inner periphery of the housing section 38 and between the piston 67 and said housing section 38, so that fluid admitted to the space 66 can not escape therefrom. A coiled compression spring 70 is interposed between the shoulder 65 and the piston 67 so as to normally bias the sleeve 64 to the position shown in FIG. 2. At its lower extremity the sleeve 64 is provided with a bevelled surface 64' which is responsive to the pressure of production fluid to effect upward movement of sleeve 64.

Means are provided for interconnecting the link 63 previously referred to with the sleeve 64. Such means preferably comprises a collar 71 disposed about the sleeve 64 and fixed thereon as by pins or keys 72. As is best seen in FIG. 6, in order to facilitate assembly, the collar 71 is bored eccentrically and provides an enlarged link supporting portion at one side thereof having upstanding ears 73, between which the lower end of the valve operating link 63 is connected as by means of a pivot pin 74. The upper end of the sleeve 64 is axially slotted or recessed as at 75, so that upon upward movement of the sleeve 64 the link 63 is free to span the sleeve through the slot 75 and assume the position shown in FIG. 3, thus closing the valve.

As is best seen in FIGS. 2 and 3, the inner diameter of the upper valve housing section 41 is substantially greater than the minimum inside diameter of the couplings 40 and 43. Accordingly, when the valve 51 is full open as shown in FIGS. 2 and 4, it is effectively recessed in the housing section 41 and maximum fluid flow through the valve assembly is permitted, limited only by the inside diameter of the coupling 40 and 43.

A further advantage in this structure is the fact that wire line tools (not shown) of any desired type may be run into the well. The valve assembly 9 offers no obstruction to the passage of such wire line tools as may be employed in perforating, fracturing, cementing, testing or other operations. Instead, as an extremely advantageous feature of the present construction, the annulus 14 may be pressurized to open the valve, as will hereinafter more fully appear, during such wire line operations.

As has been previously described, the multi-way valve 27 in line 24 has a lever 27' for effecting operation of the valve. Since, an important feature of the present invention is the fact that the valve 9 may be automatically shut off if the well head equipment should be subjected to damage, such as for instance from tide or wind driven objects, in the case of an offshore well, the lever 27' has an end of a safety cable 80 connected to its free end (see FIG. 1). Accordingly, the valve 27 may be operated by pulling the cable 80 responsive to certain emergency conditions.

The structure heretofore described, will automatically shut off flow from the well, or if desired such flow may be interrupted manually, and a number of safety shut offs are provided.

In this connection, assuming that the well is in condition for production but requires swabbing, the valves 19 and 21 in line 15 may be opened, while sweet oil or

the like is pumped into the annulus 14 through lines 16' and 16, so as to fill the annulus 14 and the annular space 66 in the valve assembly 9. When these spaces are filled with sweet oil or the like, such oil will commence to flow through valve 26 which may then be closed. Continued operation of the sweet oil pumping means (not shown) will build up pressure in the annulus so as to cause the transmission of such fluid pressure through the ports 37 in the lower valve housing section 38, into the annular space 66 behind the piston 67 on sleeve 64. Such fluid pressure will assist the spring 70 in maintaining the valve open as shown in FIG. 2. Under such circumstances the valve assembly is full open and a swab (not shown) may be run down on a line to the producing zone. The well may then be swabbed into production flow as is customary.

When the well is flowing, the valve V''' will be closed off, while production fluid passes through either or both of flow lines F and F' through flow valve V and V'. Assuming that flow is passing through both of lines F and F', valve 20 in line 16' will be closed off, as will be vent valve 21 and vent 28 through multi-way valve 27, but valves 19, 26, 31 and 32 will be open. Accordingly, pressure from the production fluid will be imposed on the sweet oil in the annulus 14 and in the annular space 66 in the valve assembly 9.

As long as the well is producing normally under predetermined pressure, vents 34 and 35 of under and over pressure pilot valves 29 and 30 will remain closed. However, should production pressure exceed or fall below the pressure which the pilot valves are set for, flow between line 24 and flow line F' will automatically be vented to the atmosphere. This will relieve fluid pressure in the annulus 14 and annular valve space 66; whereupon the further flow of production fluid will act upon lower end surface 64' of sleeve 64, thus shifting the sleeve 64 to the position of FIG. 3 to close the valve gate 51 on the seat 48. It will be noted in FIG. 3, that the sleeve 64 extends upwardly into engagement with the gate 51 when the latter is closed so as to aid in preventing leakage past the valve. Except for the slot 75, the sleeve 64 has annular bearing contact with the gate 51, with the result that seating of the valve is positively effected over the entire annular valve seat face 58.

Accordingly, the well is automatically shut in upon excessive or diminished flow pressures. The same result may be accomplished by opening vent valve 21, which will relieve the fluid in the annulus 14 from production pressure. Thus, manual flow control is effected.

Of course, in the event that the casing head H, which has a slip fit with the casing and tubing should be inadvertently separated from the casing as by reason of a collision of some object with the platform or with the well head equipment, or in the absence of an over pressure pilot valve such as that indicated at 30, should be blown off, the pressure in the annulus will also be reduced. Thereupon, the valve 9 will function as a sub-surface blowout preventer.

It will now be apparent, that, in accordance with the objectives stated at the commencement hereof, the invention provides means for shutting off well flow, which comprises, broadly, a fluid pressure responsive valve disposed in a tubing string and adapted to be closed by production fluid pressure, said valve communicating with the annulus between the tubing and well casing above a packer; whereby upon pressurizing the annulus above the packer the valve will be opened, and upon depressurizing the annulus responsive to one or more of a number of different occurrences at the well head, the valve will be closed and prevent further flow. These occurrences at the well head, as has been previously mentioned, may be purely manual, as in the case of opening vent valve 21, or on the other hand, such occurrences may be automatic such as blowing off of the well head, opening of over or under pressure vents, opening of a vent responsive to collision or the like.

Other means for depressurizing the annulus 14, and other situations under which closure of the valve may be desirable will be apparent to those skilled in the art, but changes and alterations may be resorted to without departing from the spirit of the invention as defined in the appended claims.

We claim:

1. A flow control valve for wells, comprising: a housing adapted to be installed in a tubing string in a well; said housing having a flow passage therethrough; a valve seat in said housing circumscribing said passage; a gate valve pivotally mounted at one side of said seat and movable towards and away from said seat; operating means in said housing for moving said gate valve as aforesaid, said operating means including a fluid pressure operated actuator; means interconnecting said actuator with said gate valve; said actuator including a sleeve coaxially disposed in and radially spaced from said housing; means on said sleeve forming a piston slidably engaged with said housing; said sleeve and said housing being sealingly engaged in axially spaced relation to said piston and a fluid pressure inlet for admitting fluid into the space between said sleeve and said housing.

2. A flow control valve for wells, comprising: a housing adapted to be installed in a tubing string in a well; said housing having a flow passage therethrough; a valve seat in said housing circumscribing said passage; a gate valve pivotally mounted at one side of said seat and movable towards and away from said seat; operating means in said housing for moving said gate valve as aforesaid; said operating means including a fluid pressure operated actuator; means interconnecting said actuator with said gate valve; said actuator including a sleeve coaxially disposed in and radially spaced from said housing; means on said sleeve forming a piston slidably engaged with said housing; said sleeve being slidably engaged with said housing in axially spaced relation to said piston and forming a space therebetween; a fluid pressure inlet for admitting fluid into the space between said sleeve and said housing; and a spring disposed in the space between said sleeve and piston and normally urging said sleeve in one direction.

3. A flow control valve for wells, comprising: a housing adapted to be installed in a tubing string in a well; said housing having a flow passage therethrough; a valve seat in said housing circumscribing said passage; a gate valve pivotally mounted at one side of said seat and movable towards and away from said seat; and operating means including a sleeve shiftably disposed in said housing for moving said gate valve as aforesaid; and a link pivotally connected to said sleeve and to said gate valve; said sleeve extending axially beyond the connection of the sleeve to the link towards said gate valve and engaging said gate valve when the latter is closed.

4. A flow control valve for wells, comprising: a housing adapted to be installed in a tubing string in a well; said housing having a flow passage therethrough; a valve seat in said housing circumscribing said passage; a gate valve pivotally mounted at one side of said seat and movable towards and away from said seat; operating means including a sleeve shiftably disposed in said housing for moving said gate valve as aforesaid; and a link pivotally connected to said sleeve and to said gate valve; said sleeve extending axially beyond the connection of the sleeve to the link towards said gate valve and engaging said gate valve when the latter is closed; said sleeve being slotted axially for receiving said link when the sleeve is engaged with said gate valve.

5. A flow control valve for wells, comprising: a housing adapted to be installed in a tubing string in a well; said housing having a flow passage therethrough; a valve seat in said housing circumscribing said passage; a gate valve pivotally mounted at one side of said seat and movable towards and away from said seat; operating means on said housing for moving said gate valve as aforesaid;

said operating means including a fluid pressure operated actuator; and means interconnecting said actuator with said gate valve; said actuator including a sleeve coaxially and shiftably disposed in said housing at the opposite side of said gate valve from said seat; means defining a chamber between said sleeve and housing including a flange on said sleeve; said flange constituting a piston; said housing having an inlet for admitting pressure fluid to said chamber for shifting said sleeve in a direction to open said gate valve; said sleeve having an extension projecting toward said seat from said interconnection of said interconnecting means to said sleeve for engagement with said gate valve when the latter is seated.

6. A flow control valve for wells, comprising: a housing adapted to be installed in a tubing string in a well; said housing having a flow passage therethrough; a valve seat in said housing circumscribing said passage; a gate valve pivotally mounted at one side of said seat and movable towards and away from said seat; and operating means on said housing for moving said gate valve as aforesaid; said operating means including a fluid pressure operated actuator; and means interconnecting said actuator with said gate valve; said actuator including a sleeve coaxially and shiftably disposed in said housing; means defining a chamber between said sleeve and housing including a flange on said sleeve; said sleeve being sealingly engaged with said housing in axially spaced relation to said flange and forming a space therebetween; said flange constituting a piston; said housing having an inlet for admitting pressure fluid to said chamber; for shifting said sleeve in one direction; said sleeve having an end area subjected to the flow of fluid through said passage for shifting the sleeve in the other direction.

7. A flow control valve including: a housing; said housing having a flow passage therethrough; a valve seat in said housing circumscribing said passage; a gate valve pivotally mounted at one side of said seat and movable towards and away from said seat; and operating means in said housing for moving said gate valve as aforesaid; said operating means including a fluid pressure operated actuator; and means interconnecting said actuator with said gate valve; said actuator having an extension projecting toward said seat from the connection of said interconnecting means to said actuator for engagement with said gate valve when the valve is closed.

8. A flow control valve, including: a housing; said housing having a flow passage therethrough; a valve seat in said housing circumscribing said passage; a gate valve pivotally mounted at one side of said seat and movable towards and away from said seat; and operating means in said housing for moving said gate valve as aforesaid; said operating means including a fluid pressure operated actuator; a link interconnecting said actuator and said gate valve; and means for normally opening said valve; said actuator having an extension projecting towards said seat from the connection of said link to said actuator for engagement with said gate when the valve is closed.

9. A flow control valve, including: a housing; said housing having a flow passage therethrough; a valve seat in said housing circumscribing said passage; a gate valve pivotally mounted at one side of said seat and movable towards and away from said seat; operating means in said housing for moving said gate valve as aforesaid; said operating means including a fluid pressure operated actuator; a link interconnecting said actuator and said gate valve; said link extending across said flow passage when said gate is closed; said actuator having an extension projecting towards said seat from the connection of said link to said actuator for engagement with said gate valve when the valve is closed; and said extension being provided with a recess for the reception of said link when said extension is engaged with said gate valve.

10. A flow control valve for wells, comprising: an elongated housing adapted to be mounted in a string of pipe

9

extending into a well; said housing having a flow passage therethrough; a valve seat at one end of said housing circumscribing said flow passage; a gate valve shiftably mounted adjacent to said seat for pivotal movement into engagement with said seat and to a position closely adjacent to said housing; means for shifting said gate valve including a sleeve shiftably disposed in said housing; a link connected at one end to said sleeve and at the other end to said gate valve; said sleeve having an end portion projecting toward said gate valve from the pivotal connection of said link to said gate valve for engagement with said gate valve when said gate valve is disposed on said seat.

11. Well flow control equipment for shutting off the flow of fluid from a well having a casing therein, comprising: a casing head; a flow line leading from said casing head; production tubing extending into said well from said casing head; packer means forming a seal between said tubing and said casing; a fluid pressure operated valve assembly in said tubing above the packer means; means for conducting production fluid under pressure from said casing head to the space between said casing and said tubing above said packer means; said valve assembly including a housing having an opening communi-

10

cating with said space between said casing and said tubing above said packer means; a sleeve shiftably disposed in said housing and having an annular piston at one end thereof slidably and sealingly engaged with said housing to form a chamber; said opening in said housing being located at one side of said annular piston and leading into said chamber for admitting fluid pressure from the space between said casing and said tubing into said chamber, and the other side of said annular piston being subjected to well fluid pressure in said tubing; a valve seat in said housing; and valve means at one end of said sleeve engageable with said seat to prevent the flow of fluid through said housing when said annular piston surface is subjected to well production pressure overcoming the effect of fluid pressure in said space above said packer upon said annular piston.

References Cited in the file of this patent

UNITED STATES PATENTS

20	2,780,290	Natho	Feb. 5, 1957
	2,785,755	En Dean	Mar. 19, 1957
	2,786,535	Boer et al.	Mar. 26, 1957
	2,812,821	Nelson	Nov. 12, 1957
	2,921,601	Fisher	Jan. 19, 1960