

[54] MEANS FOR FLOW CONTROLLING
HYDRAULIC CHECK VALVE
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166/224

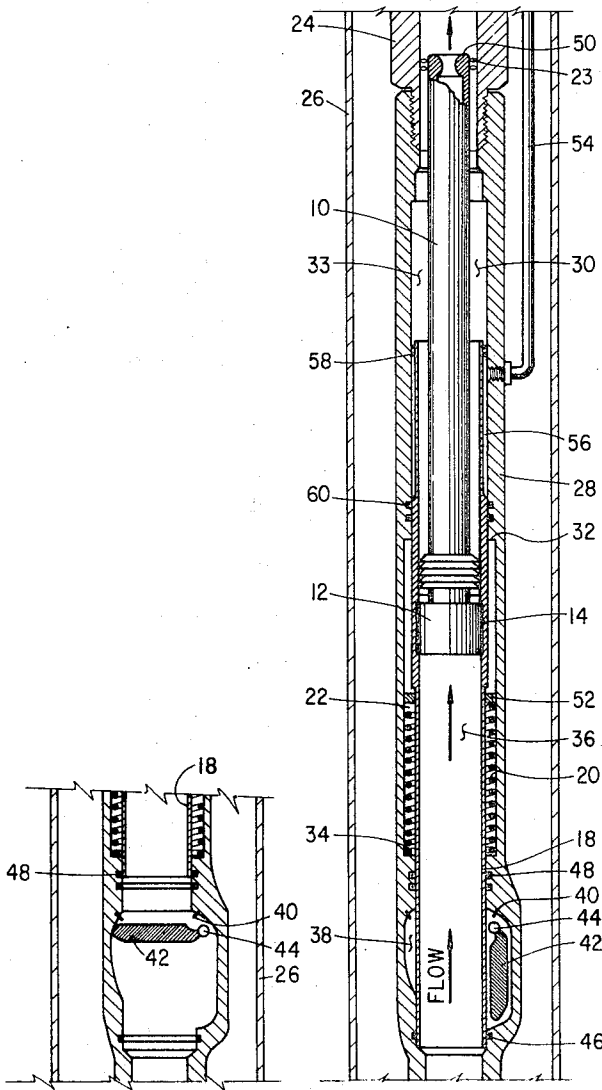
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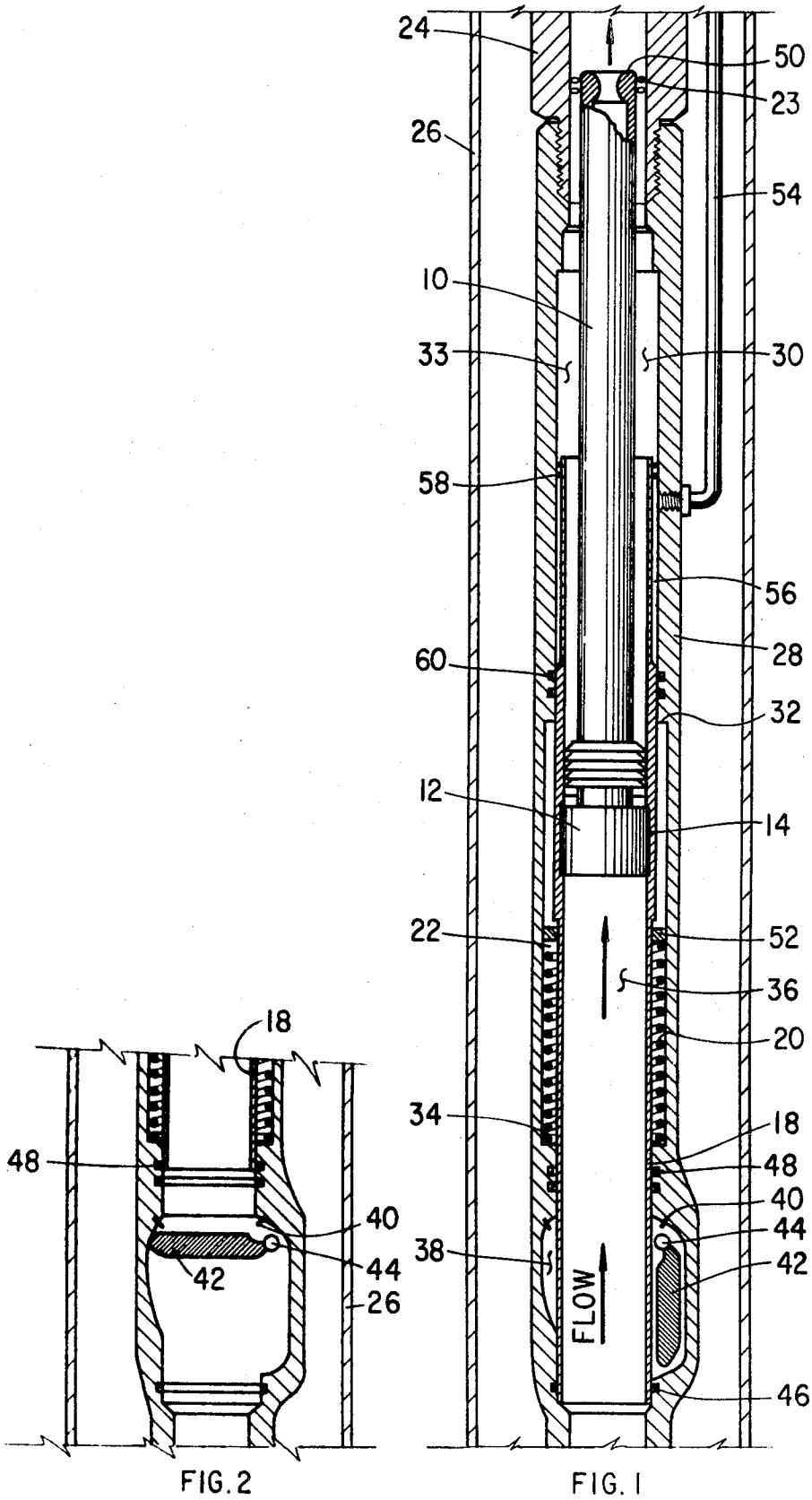
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[57] ABSTRACT

This valve includes a special tubular section inserted within a tubing string. The lower end of the section has a main flow control valve which closes upwardly by force of flowing fluid, but is held open by a sleeve mounted in the section which is slideable between an upper and lower position. Inside the sleeve is a wireline retrievable orifice. Hydraulic fluid pressure holds the sleeve in its lower position. The sleeve is urged upwardly by combination of a spring and the pressure drop across the orifice. When the sleeve is in its upper position, the flow valve closes. Means are provided such that the valve is responsive to flow rate as well as to changes in the applied hydraulic pressure.

4 Claims, 2 Drawing Figures





MEANS FOR FLOW CONTROLLING HYDRAULIC CHECK VALVE

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a special subsurface adjustable storm valve for use in a well bore.

2. Setting of the Invention

Oil and gas are commonly produced through wells which are bored into the earth until they encounter a petroleum-bearing formation. These wells are lined with a large casing, e.g., 10 inches in diameter, and cemented in place. The casing has holes perforated in it adjacent the petroleum-bearing formation. The production is usually obtained through a string of tubing, which is really small diameter pipe, which is suspended within the casing. A packer is ordinarily set on the tubing just above the perforations sealing the annulus between the casing and the tubing string. The lower end of the tubing is open to receive the production. Many of these wells are drilled in offshore areas. In these wells the top of the casing and tubing usually extends to a platform which is supported 50-100 feet above the water by piles driven in the ocean bed. Both safety precautions and government regulations require that there be storm chokes placed in the tubing string at an elevation below the mud line. These valves are designed such that if the tubing is broken or damaged above the flood line the storm choke, which is, in reality, a valve, will close and stop the flow of fluid.

There are many so-called storm choke types commercially available. However, there are two basic types. In one type the pressure drop caused by excessive flow across the choke (as caused for example by breaking of lines, etc., at the surface) causes the valve to close. In theory, these should work fine and in some cases do. However, there is a problem especially in those cases where the wells are normally flowing at their maximum capacity. If the wellhead should break at the surface, the flow through the choke would not increase significantly and the valve would stay open.

Another type safety valve is the one held open by application of hydraulic pressure which is supplied from the surface through a hydraulic line. In this arrangement, if the hydraulic pressure is released, the valve closes. However, in this latter type valve, the valve is not responsive to excessive flow through the valve. The valve of my present invention is responsive to flow rate through the valve mechanism as well as changes in the applied hydraulic pressure. My valve described herein thus has the desirable features of each of the two above-described type valves.

BRIEF DESCRIPTION OF THE INVENTION

This valve includes a special tubular section inserted within a tubing string. The lower end of the section has a main flow control valve which closes upwardly by the flowing fluid, but is held open by a sleeve mounted in the section which is slideable between an upper and lower position. Inside the sleeve is a wireline retrievable orifice. Hydraulic fluid pressure holds the sleeve in its lower position. The sleeve is urged upwardly by combination of a spring action and the pressure drop across the orifice. When the sleeve is in its upper position the flow valve closes. The valve is thus responsive to flow rate as well as changes in the applied hydraulic pressure. The pressure drop of the flow of fluid through

the orifice attached to the sleeve plus the spring force on the sleeve acts against the hydraulic pressure applied to the top of the sleeve. Whether the upward force or downward force is the greatest determines whether the valve is opened or closed. The sleeve of the valve is responsive to flow rate as well as changes in the applied hydraulic pressure; thus, if I wish to increase my desired flow rate without having the valve closed I can merely increase the hydraulic fluid pressure. I can also change the size of the orifice by wireline equipment and thus further increase my range of operability.

BRIEF DESCRIPTION OF THE DRAWINGS

A better understanding of the invention and its operation can be had with the following description taken in conjunction with the drawings in which:

FIG. 1 illustrates, mostly in section, my valve assembly positioned in a casing downhole;

FIG. 2 illustrates the lower end of the assembly with the flow valve closed.

DETAILED DESCRIPTION OF THE INVENTION

Attention is directed to FIG. 1 which illustrates a tubing string 24 suspended in a casing 26 which is set in a well bore in a conventional manner. The assembly illustrated in FIG. 1 typically would be placed in an offshore well at an elevation below the mud line. A tubular section 28 is connected into tubing string 24. Tubular section 28 has a bore 30 comprising an upper portion 33 and a lower portion 36 which extends throughout the section. The upper part of bore 30 identified as 33 is of slightly smaller diameter than the lower bore portion 36. Lower bore portion 36 has a lower upwardly facing shoulder 34 and an upper downwardly facing shoulder 32.

A sleeve 18 is slideably positioned within section 28. It is shown in FIG. 1 in its lower position. An annular space 22 is formed between sleeve 18 and section 28. The lower end of tubular section 28 is provided with a chamber 38 which has valve seat 40 at the upper end thereof. Also provided within chamber 38 is a flapper valve 42 with pivot 44 at the upper edge. Lower seals 46 and upper seals 48 cooperate with sleeve 18 when in its lower position to seal chamber 38, seats 40 and valve 42 from the flowing fluid in the tubing. This, of course, prevents any eroding of the valve or its seat.

Mounted within sleeve 18 is wireline retrievable orifice means 10. Orifice means 10 has an orifice 50 at its upper end and its lower end includes latching means 12 which latch within recess 14 in the inner wall of sleeve 18. Means for releasing this latch and retrieving the orifice assembly with wire-line equipment are well known. For an example of a typical means, reference is made to U.S. Pat. No. 2,795,952, entitled, "Retrievable Pressure Recording Bomb and Choke," issued June 18, 1957, in the name of D. M. Stewart. Sand cups 23 are provided at the upper end of the orifice means to prevent sand from falling between orifice means 10 and the inside wall of the tubing.

The orifice means 10 is sealed within sleeve 18 and any fluid flowing upwardly must flow through orifice 50. The pressure drop across orifice 50 is dependent upon its size and the flow rate. The pressure drop across the orifice then causes an upward force to be exerted against sleeve 18. There is a second force acting upwardly on sleeve 18 and that is spring 20 which is placed in annulus 22 between sleeve 18 and tubular

section 28. The lower end of spring 20 acts against shoulder 34 of the tubular section and the upper end of the spring acts against shoulders 52 which are secured to sleeve 18. The downward force on sleeve 18 is applied in the form of hydraulic pressure which is applied through line 54 from the surface. Hydraulic line 54 is connected to annular cylinder 56 which is formed between the upper end of sleeve 18 and tubular member 28. Seals 58 and 60 confine the fluid to within cylinder 56.

In operation, the tubular section 28 and its associate parts are connected into the tubing string 24 and lowered into position. Orifice 50 has been selected so that the upward force caused by the pressure drop across the orifice and the force of the spring can be offset by a reasonable and suitable pressure in hydraulic line 54 to hold sleeve 18 in its open position so that valve 42 is maintained in an open position for a selected flow rate. The hydraulic set pressure is determined by reducing the hydraulic pressure in line 54 until the upward force of the spring and the pressure drop across the orifice causes sleeve 18 to move up closing the device. After observing the pressure at which the valve closed a few more pounds pressure can be applied through hydraulic line 54 to maintain the valve in an open position. This permits a small increase in pressure drop across orifice 50 caused by a small increase in flow to cause sleeve 18 to move upward to close valve 42.

The flow rate of fluid from the well is usually controlled at the surface by a surface choke. If this surface choke is eroded or there becomes a leak at the surface the flow rate through the tubing increases. This increased flow rate causes an increased pressure drop across orifice 50. If this pressure drop is sufficient it can cause the sleeve to shift up, thus closing valve 42. The well can be put back on production quite easily. All that has to be done is to repair the surface choke or leak after equalizing the pressure across valve 42 and reapply hydraulic pressure through hydraulic line 54.

All subsurface safety valves should be checked periodically to be sure they are operating properly. This is done quite easily with my valve. All I have to do is reduce the hydraulic pressure in line 54, sleeve 18 will move up and valve 42 will close, as it is spring loaded to close. The force of flowing fluid will also aid in closing the valve after sleeve 18 is moved up.

If my operations change such that I need to change the size of orifice 50 it can be done very easily by using wireline equipment.

If I need to do remedial work in the well I can do this simply by removing orifice means 10. I can still apply hydraulic pressure to sleeve 18 and maintain it in an open position so that the wireline tools can be inserted therethrough.

While the above invention has been described with considerable detail, it is possible to make many modifications thereof without departing from the spirit or scope of the invention.

I claim:

1. A flow controlling valve for use in controlling the flow of fluids from a subsurface formation through a string of tubing which comprises:

a tubular section inserted within said tubing string; a sleeve within said tubular section and slideable between an upper and a lower position in said tubular section;

a valve in the lower part of said tubular section which is biased toward a closed position and held open by said sleeve when said sleeve is in its lower position; flow restricting means in said sleeve;

means biasing said sleeve in an upward direction;

hydraulic control means for applying a downward force on said sleeve, said force including means at the surface for controlling the magnitude of said force.

2. An apparatus as defined in claim 1 in which said flow restricting means is an orifice means held to the inner wall of said sleeve by wireline releaseable latching means.

3. A flow controlling valve for use in controlling the flow of fluids from a subsurface formation through a string of tubing which comprises:

a. a tubular section having an elongated recess therein providing an upper downward facing shoulder and a lower upward facing shoulder;

b. a chamber in the lower end of said tubular section below said recess;

c. a sleeve slideable within said tubular section between an upper position and a lower position;

d. a valve seat in the upper part of the said chamber in said tubular section;

e. a flapper-type valve in said chamber biased toward a closed position, said chamber and said valve being sized such that said sleeve can extend through the chamber portion of said tubular section, thus holding said valve open;

f. an upper facing exterior annular shoulder fixed to and near the upper end of said sleeve;

g. sealing means between said sleeve and the interior of said tubular section to form a power fluid cylinder to cooperate with said exterior annular shoulder;

h. conduit means connecting said power fluid cylinder to the surface;

i. flow restricting means releaseably latched to the interior of said sleeve;

j. an annular exterior shoulder fixed to and near the upper end of said shoulder;

k. a spring in the said recess of said tubular section and positioned against the annular shoulder of element (j) urging said sleeve in an upward direction.

4. A flow control valve for use in controlling the flow of fluids from a subsurface formation from a string of tubing which comprises:

a. a lower valve biased to a closed position and positioned in a lower portion of said string of tubing;

b. control means to open or close said valve;

c. first means for applying a force on said control means acting to close said valve in response to fluid flow through said tubing string;

d. means operable from the surface to apply a force on said control means to cause said control means to open said valve means.

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