

March 26, 1957

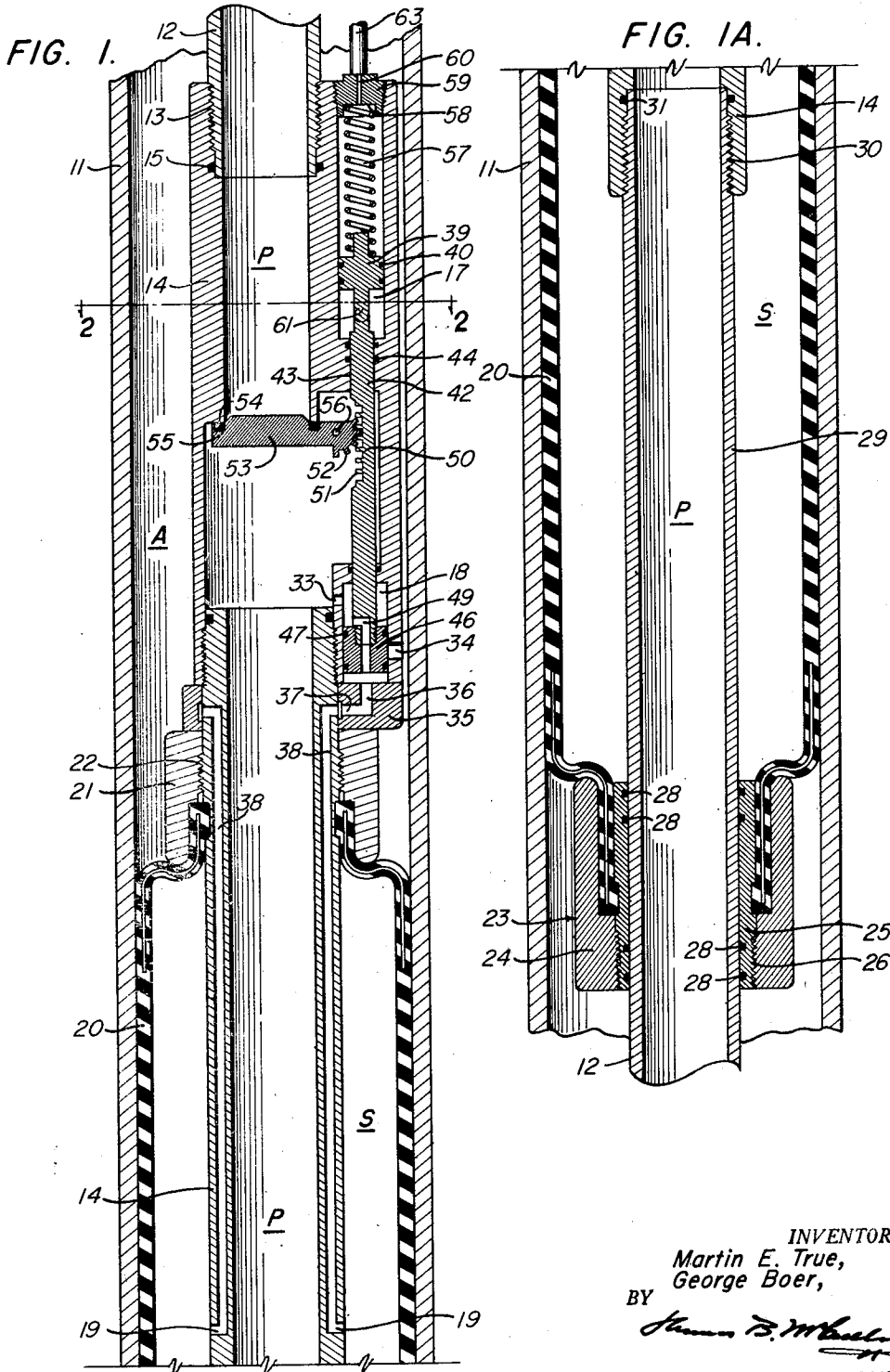
G. BOER ET AL

2,786,535

SUBSURFACE BLOWOUT PREVENTER

Filed Dec. 21, 1954

2 Sheets-Sheet 1



INVENTORS.
Martin E. True,
George Boer,
BY *James B. McDaniel*
ATTORNEY.

March 26, 1957

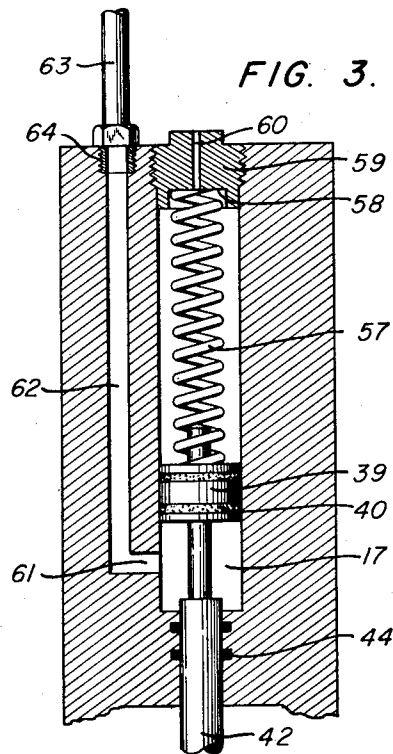
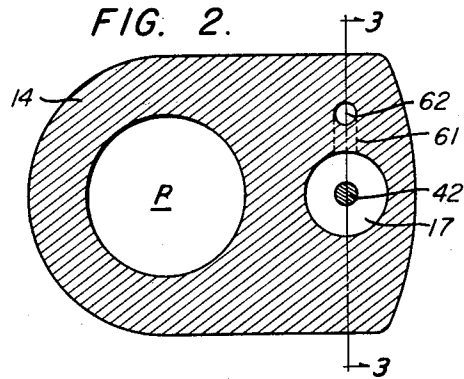
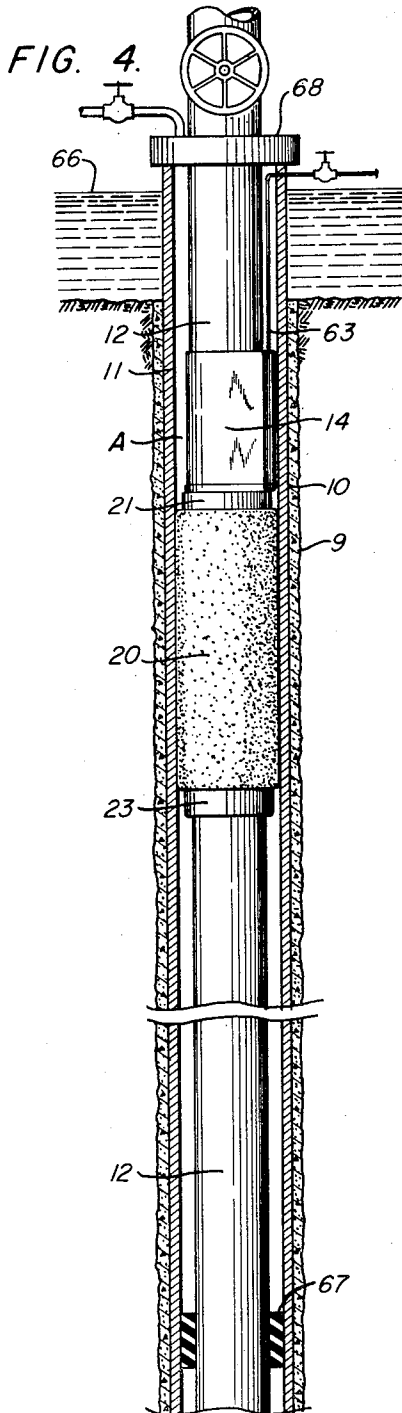
G. BOER ET AL

2,786,535

SUBSURFACE BLOWOUT PREVENTER

Filed Dec. 21, 1954

2 Sheets-Sheet 2



INVENTORS.
 Martin E. True,
 George Boer,
 BY
James B. McCallister
 ATTORNEY.

1

2,786,535

SUBSURFACE BLOWOUT PREVENTER

George Boer and Martin E. True, Houston, Tex., assignors, by mesne assignments, to Esso Research and Engineering Company, Elizabeth, N. J., a corporation of Delaware

Application December 21, 1954, Serial No. 476,708

10 Claims. (Cl. 166—187)

The present invention is directed to a blowout preventer. More particularly, the invention is directed to a subsurface tubing and casing blowout preventer for use in wells. In its more specific aspects, the invention is directed to an automatically operated subsurface tubing and casing blowout preventer for arrangement in a well at a level substantially below the level from which the operations are conducted.

The present invention may be briefly described as a subsurface blowout preventer adapted to be connected in a well tubing arranged in a well casing. The blowout preventer comprises a tubular packer mandrel provided with a pressure chamber and a valve chamber and having at least one port fluidly communicating the interior of the packer mandrel with the exterior surface of the packer mandrel. A deformable packing member is mounted on and affixed to the packer mandrel to enclose the port. A piston member is arranged in the pressure chamber which is normally biased to a second position. Attached to the piston member is a piston arm which extends into the valve chamber. The valve chamber fluidly communicates with the port and with the interior of the packer mandrel for inflating the packing member. A first valve member is arranged in the valve chamber and is operatively connected to the arm for expanding and collapsing the packing member. A second valve is arranged in the mandrel and is operatively connected to the piston arm for closing and opening the packer mandrel. Movement of the piston to a first position by imposing pressure on the pressure chamber closes said second valve and opens said first valve to expand said packing member and to close off said tubing and the annulus between the tubing and the casing.

The piston member in the pressure chamber is normally biased to a second position by a biasing means, such as a helical coil spring. The piston arm is provided with rack teeth intermediate its ends which engages with a gear segment on the second valve arranged in the tubular mandrel.

The piston arm also extends into the valve chamber and is connected to the first valve which suitably is a piston valve element provided with a fluid passageway for controlling fluid and expanding and collapsing the deformable packing member.

The deformable packing member is suitably attached to the packer mandrel and may be affixed thereto by rigid connections or may be affixed thereto by a rigid connection on a first end and a slidable connection on the second end such that the slidable connection will move on the mandrel as the deformable packing member is expanded.

The present invention is of considerable utility and may be used in oil wells drilled in water locations, especially offshore operations, such as, for example, in the Gulf of Mexico. In such operations, it is essential to provide means to prevent blowouts in the event the surface equipment is damaged or broken off by storms or

2

floating objects. In the present invention, a valve or closure means is arranged in the tubing string and lowered into the well below the water level. Also mounted on the tubing string is a packer arrangement which automatically sets, sealing the tubing-casing annulus. The operation of the packer and the valve in the tubing is simultaneous and is effected at least in part by the fluid pressure which is to be controlled.

The present invention will be further illustrated by reference to the drawing in which:

Fig. 1 and Fig. 1-A are a front sectional view of the apparatus in the operative position;

Fig. 2 is a sectional view of Fig. 1 taken along the lines 2—2;

Fig. 3 is a front sectional view of Fig. 2 taken along the lines 3—3; and

Fig. 4 is an elevation, partly in section, of the device shown in Figs. 1 to 3, inclusive, positioned in a cased borehole.

Now, turning to the drawing, numeral 11 designates a well casing arranged in a well bore drilled from the earth's surface such as, for example, from a water location where the term "earth's surface" will be used in the significance of "sea level." Arranged in the casing 11 is a tubing string 12 to which is attached by mating threads 13 a packer mandrel 14. A suitable seal, such as a packing means 15, is provided between the tubing 12 and the mandrel 14. The mandrel 14 is provided with a pressure chamber 17 and a valve chamber 18 and also has a plurality of ports 19 which communicate with the space S enclosed by a deformable packing member 20 attached to the packer mandrel 14 at an upper end by an annular sleeve 21 which is connected to the mandrel 14 by mating threads 22.

The lower end of the deformable packing member 20 is slidably connected to the packer mandrel 14 by a sleeve member 23 composed of an outer sleeve 24 and an inner sleeve 25 which are connected by mating threads 26. The sleeve 25 is provided with a plurality of sealing members 28 to provide a fluid-tight seal between the mandrel 14 and the sleeve member 23. The lower portion of the mandrel 14 may suitably be a part of the tubing string 12 and suitably may be a tubing joint, for example, a tubing joint 29 which is threadably connected by mating threads 30 to the mandrel 14, the tubing joint 29 and the mandrel 30 being suitably sealed against leakage by a sealing member 31.

The valve chamber 18 communicates with the passageway P of the mandrel 14 by means of a port 33 and communicates with the annulus A between the casing 11 and the tubing 12 by a port 34.

An annular member 35 arranged on the mandrel 14 is provided with longitudinal and lateral passageways 36 and 37 which communicate fluidly with longitudinally extending passageway 38 in the mandrel 14 which latter passageway in turn fluidly communicates with chamber S through port 19.

Arranged in the pressure chamber 17 is a piston member 39, provided with sealing rings 40, to which is attached a piston arm 42 which extends through an opening 43 in the mandrel 14, the piston arm 42 being suitably sealed against leakage by means of sealing rings or sealing members 44. The piston arm 42 is connected to a valve member 46 in valve chamber 18, the valve member 46 acting like a piston and being provided with sealing means or piston rings 47, the piston arm 42 and the piston valve member 46 being provided with a passageway 49 which allows fluid to pass from the chamber 18 through the valve member 46 to the passageway 36.

Intermediate the piston member 39 and the valve member 46 on the piston arm 42 is rack 50 provided with a

plurality of teeth 51. Operatively connected to the rack teeth 51 by a gear segment 52 is a valve member 53 provided with a sealing means 54 in a recess 55 which serves to close off the passageway P in the mandrel 14 and tubing 12, the valve member 53 being pivotally connected by a pivot 56 to the mandrel 14.

The pressure chamber 17 has a biasing means, such as a helical coil spring 57, arranged therein between the piston 39 and an internal shoulder 58 of a closure member 59 of the chamber 17. The closure member 59 is provided with an exhaust orifice 60.

Fluidly communicating with the chamber 17 below the piston 39 is a lateral passageway 61 which connects into a longitudinal passageway 62, as shown more clearly in Figs. 2 and 3. A conduit 63 connects to the passageway 62 by threaded connection 64. The conduit 63 is adapted to extend to the earth's surface to a source of fluid pressure, not shown.

Turning now to Fig. 4, the device of the present invention is shown positioned in the casing 11 of a borehole 9 cemented in place with primary cement 10 which penetrates a producing formation, not shown, and extends above the water or sea level 66. Casing 11 encloses a string of production tubing 12 which is provided with a packer 67 to close off the annulus A below. Enclosing the top of the casing 11 and tubing 12 is a conventional wellhead assembly 68. The device as illustrated in Figs. 1 through 3 is shown positioned in the tubing string adjacent its upper end, but it will be understood that the device could be positioned at any depth above the packer 67.

The apparatus of the present invention operates in the following manner:

For example, the device is shown in an operative position with the packing member 20 extended to seal off the annulus A and the clapper valve 53 in the closed position closing off the passageway P. When it is desired to open the valve 53 and provide a full opening tubing, pressure is applied in the tubing 12 above the valve 53 in excess of the tubing pressure below the valve 53 which equalizes pressure and allows pressure which is then exerted through conduit 63 to move the piston 39 upwardly overcoming the spring 57. This opens the valve 53 and closes off fluid communication between passageway P and chamber 18 through port 33 by the valve member 46 moving upwardly with the piston arm 42. At the same time, the port 34 communicating the annulus A with the passageway 36 is opened allowing the pressure from the space S to be relieved through the port 19, passageway 38, passageway 37 and passageway 36 to chamber 18 and thence by port 34 to the annulus A.

When it is desired to close off the annulus A all that is necessary is to release the pressure from the chamber 17. When this takes place, the spring member 57 forces the piston 39 downwardly and carries the arm 42 downwardly. This causes the rack teeth 51 to pivot the gear segment 52 and close the valve 53. At the same time the valve member 46 has moved downwardly closing off port 34 and opening port 33 allowing communication between the passageway P through the chamber 18, passageway 49, passageway 36, passageway 37 and passageway 38 and thence through port 39 into the space S to expand the packer 20 into engagement with the interior wall of the casing 11 and sealing off the annulus.

It is to be noted that the lower end of the packer 20 is shown slidably connected to the tubing point 29 which may be part of the mandrel 14. This type of connection compensates for longitudinal stretch of the packing member 20. Also, it is to be noted that each end of the packing element 20 may be suitably reinforced such as by metallic or fabric cords and the like.

The present invention, as has been pointed out, is of considerable utility in controlling wells and is very useful in offshore marine operations where oil and gas wells and the like are drilled in water locations. However,

the invention is not to be restricted to such operations since it is useful in many operations where it is desired to control a well from a level below the normal surface operational level.

The nature and objects of the present invention having been completely described and illustrated, what we wish to claim as new and useful and to secure by Letters Patent is:

1. A subsurface blowout preventer for cased and tubed wells adapted to close off the annulus between said tubing and casing and to close off said tubing, comprising a mandrel connected in said tubing and having spaced apart pressure and valve chambers formed thereon, a piston slidably arranged in said pressure chamber having first and second positions and provided with a piston arm, said piston arm being provided with a rack intermediate its length, biasing means arranged in said pressure chamber adapted to urge said piston to said first position, a first valve member pivotally secured to said mandrel and having teeth thereon engaging with said rack, said valve member being adapted to close off said mandrel from fluid flow therethrough when said piston is in said first position, a conduit connected to said mandrel fluidly communicating said pressure chamber with a source of fluid pressure, an inflatable packer surrounding said mandrel and said tubing secured at one end to said mandrel and slidably arranged at the other end on said tubing, said mandrel having a first passageway therein fluidly communicating with the interior of said packer member, a second valve member arranged in said valve chamber and connected to said piston arm for movement therewith, said second valve member having a second passageway therethrough fluidly communicating with said first passageway, said valve chamber having a first port fluidly communicating the interior of said mandrel and said first passageway when said piston is in said first position, and having a second port fluidly communicating the exterior of said mandrel and first passageway when said piston is in said second position.

2. A subsurface blowout preventer for cased and tubed wells adapted to close off the annulus between said tubing and casing and to close off said tubing, comprising a mandrel connected in said tubing and having a pressure and a valve chamber formed thereon, a piston slidably arranged in said pressure chamber having first and second positions and provided with a piston arm, said piston arm being provided with a rack intermediate its length, biasing means arranged in said pressure chamber adapted to urge said piston to said first position, a valve member pivotally secured to said mandrel and having teeth thereon engaging with said rack, said valve member being adapted to close off said mandrel from fluid flow therethrough when said piston is in said first position, a conduit connected to said mandrel fluidly communicating said pressure chamber with a source of fluid pressure, an inflatable packer surrounding said mandrel and said tubing secured at one end to said mandrel and slidably arranged at the other end on said tubing, said mandrel having a first passageway therein fluidly communicating with the interior of said packer member, said valve chamber having a first port fluidly communicating said valve chamber and the interior of said mandrel and a second port fluidly communicating said valve chamber and the exterior of said mandrel, and valve means arranged in said valve chamber and connected to said piston arm adapted to fluidly communicate the interior of said mandrel and said first passageway when said piston member is in said first position and to fluidly communicate the exterior of said mandrel and said first passageway when said piston member is in said second position.

3. A subsurface blowout preventer for cased and tubed wells adapted to close off the annulus between said tubing and casing and to close off said tubing, comprising a mandrel connected in said tubing and having a pressure and a valve chamber formed thereon, a piston slidably

5

arranged in said pressure chamber having first and second positions and provided with a piston arm, said piston arm being provided with a rack intermediate its length, biasing means arranged in said pressure chamber adapted to urge said piston to said first position, a valve member pivotally secured to said mandrel and having teeth thereon engaging with said rack, said valve member being adapted to close off said mandrel from fluid flow therethrough when said piston is in said first position, means connected to said mandrel fluidly communicating said pressure chamber with a source of fluid pressure for supplying fluid pressure to said pressure chamber to actuate said piston against the bias of said biasing means, inflatable packer means arranged on said mandrel and said tubing adapted to seal off the annulus between said casing and said tubing, said mandrel having a first passageway therein fluidly communicating with the interior of said packer means, and valve means arranged in said valve chamber and connected to said piston arm adapted to fluidly communicate the interior of said mandrel and said first passageway when said piston member is in said first position and to fluidly communicate the exterior of said mandrel and said first passageway when said piston member is in said second position.

4. A subsurface blowout preventer for cased and tubed wells adapted to close off the annulus between said tubing and casing and to close off said tubing, comprising a mandrel connected in said tubing and having a pressure and a valve chamber formed thereon, a piston slidably arranged in said pressure chamber having first and second positions and provided with a piston arm, said piston arm being provided with a rack intermediate its length, biasing means arranged in said pressure chamber adapted to urge said piston to said first position, first valve means pivotally connected to said mandrel and provided with means for operatively engaging said rack whereby said first valve means is opened and closed thereby permitting and preventing fluid flow through said mandrel upon movement of said piston, means connected to said mandrel fluidly communicating said pressure chamber with a source of fluid pressure for supplying fluid pressure to move said piston against the bias of said biasing means, inflatable packer means arranged on said mandrel, and said tubing adapted to seal off the annulus between said tubing and casing, said mandrel having a first passageway therein fluidly communicating with said packer means, and second valve means arranged in said valve chamber and connected to said piston arm adapted to fluidly communicate the interior of said mandrel and said first passageway when said piston member is in said first position and to fluidly communicate the exterior of said mandrel and said first passageway when said piston member is in said second position whereby said packer means is inflated and deflated, respectively.

5. A subsurface blowout preventer for cased and tubed wells adapted to close off the annulus between said tubing and casing and to close off said tubing, comprising a mandrel connected in said tubing and having a pressure and a valve chamber formed thereon, piston means arranged in said pressure chamber having first and second positions and having means biasing said piston means to said first position, first valve means pivotally connected to said mandrel and operatively connecting with said piston means whereby movement of said piston means opens and closes said valve thereby permitting and preventing fluid flow through said mandrel, means connected to said mandrel fluidly communicating said pressure chamber with a source of fluid pressure for supplying fluid under pressure to said pressure chamber for actuating said piston means against said bias thereof, inflatable packer means arranged on said mandrel and said tubing adapted to seal off the annulus from said tubing and casing, said mandrel having a first passageway therein fluidly communicating with said packer means, and second valve means arranged in said valve chamber and connected to

6

said piston means adapted to fluidly communicate the interior of said mandrel and said first passageway when said piston member is in said first position and to fluidly communicate the exterior of said mandrel and said first passageway when said piston is in said second position thereby inflating and deflating said packer means, respectively.

6. A subsurface blowout preventer for tubed wells adapted to close off said tubing, comprising a mandrel connected in said tubing and having a pressure chamber formed thereon, a piston slidably arranged in said pressure chamber having first and second positions and provided with a piston arm, said piston arm being provided with a rack intermediate its length, biasing means arranged in said pressure chamber adapted to urge said piston to said first position, a valve member pivotally secured to said mandrel and having teeth thereon engaging with said rack, said valve member being adapted to close off said mandrel from fluid flow therethrough when said piston is in said first position, and a conduit connected to said mandrel fluidly communicating said pressure chamber with a source of fluid pressure for moving said piston member against the bias of said biasing means.

7. A subsurface blowout preventer for tubed wells adapted to close off said tubing, comprising a mandrel connected in said tubing and having a pressure chamber formed thereon, a piston slidably arranged in said pressure chamber having first and second positions and provided with a piston arm, said piston arm being provided with a rack intermediate its length, biasing means arranged in said pressure chamber adapted to urge said piston to said first position, valve means pivotally connected to said mandrel and provided with means operatively engaging said rack for closing and opening said mandrel upon movement of said piston, and means connected to said mandrel fluidly communicating said pressure chamber with a source of fluid pressure for supplying fluid to move said piston member against the bias of said biasing means.

8. A subsurface blowout preventer for tubed wells adapted to close off said tubing, comprising a mandrel connected in said tubing and having a pressure chamber formed thereon, piston means slidably arranged in said pressure chamber having first and second positions and having biasing means urging said piston means to said first position, valve means pivotally secured to said mandrel and operatively connecting with said piston means whereby said valve means is actuated to open and close said mandrel upon movement of said piston means, and means connected to said mandrel fluidly communicating said pressure chamber with a source of fluid pressure for supplying fluid under pressure to said chamber to move said piston against the said bias thereof.

9. A subsurface blowout preventer for cased and tubed wells adapted to close off the annulus between said tubing and casing and to close off said tubing, comprising a mandrel connected in said tubing, first valve means connected to said mandrel adapted to close off fluid flow through said mandrel, actuating means operatively engaging with said first valve means having first and second positions whereby movement of said actuating means from said first to said second position moves said first valve means from an open to a closed position and vice versa, fluid inflatable means arranged on said mandrel adapted to close off the annulus between said tubing and casing, second valve means operatively connected to said actuating means adapted to fluidly communicate the interior of said mandrel and said packer means when said actuating means is in said first position and to fluidly communicate the exterior of said mandrel and said packer means when said piston is in said second position thereby inflating and deflating said packer means, respectively, means for moving said actuating means from said first to said second position, and means for moving said actuating means from said second to said first position.

7

10. A subsurface blowout preventer for tubed wells adapted to close off said tubing, comprising a mandrel connected in said tubing and having a chamber formed thereon, piston means slidably arranged in said chamber and having first and second positions, biasing means arranged in said chamber adapted to urge said piston means to said first position, valve means secured to said mandrel and operatively connecting with said piston means whereby said valve means is actuated to open and close said mandrel upon movement of said piston means, and means connected to said mandrel fluidly communicating said chamber with a source of fluid pressure for supplying

8

fluid under pressure to said chamber to move said piston against the bias of said biasing means.

References Cited in the file of this patent

UNITED STATES PATENTS

2,080,610	Humason -----	May 18, 1937
2,104,660	Long et al. -----	Jan. 4, 1938
2,157,263	Johnson -----	May 9, 1939
2,207,944	Richardson -----	July 16, 1940
2,504,006	Davis -----	Apr. 11, 1950
2,592,325	Otis et al. -----	Apr. 8, 1952