

Nov. 12, 1957

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2,812,822

BLOWOUT PREVENTER

Filed Dec. 21, 1954

2 Sheets-Sheet 1

FIG. 1.

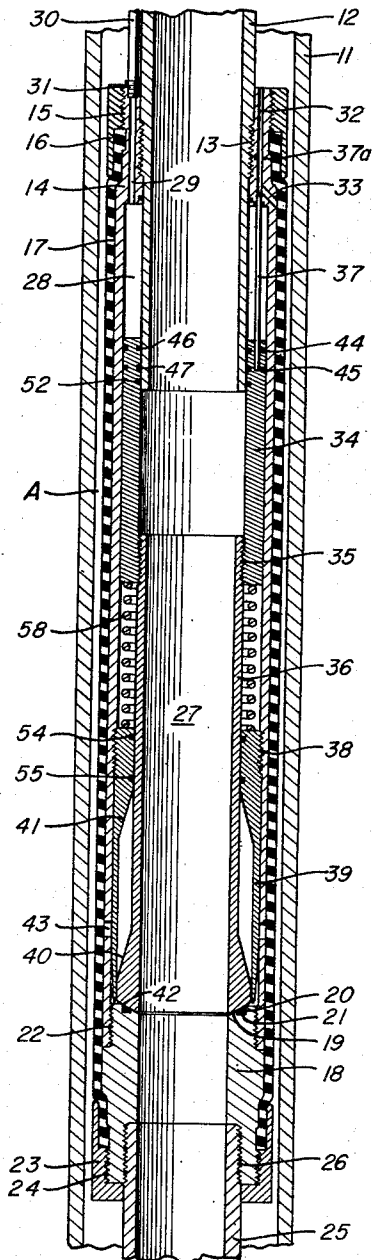
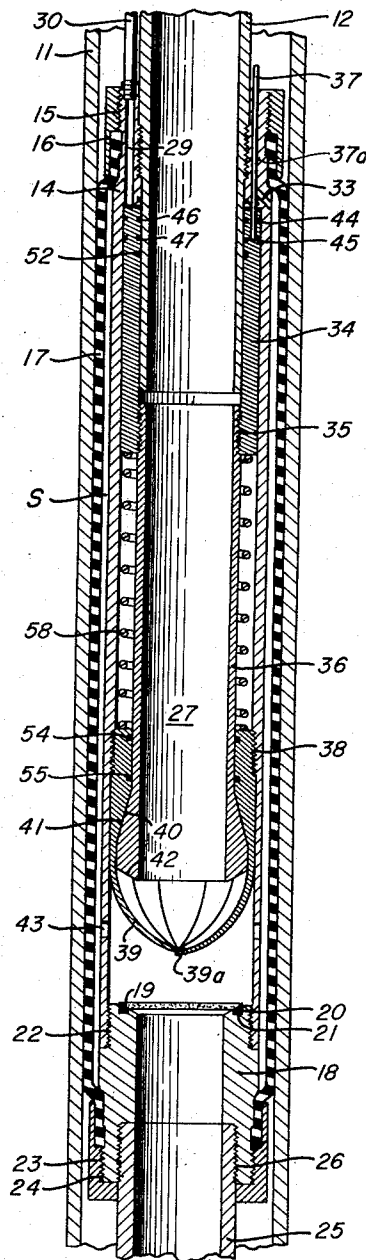


FIG. 2.



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2 Sheets-Sheet 2

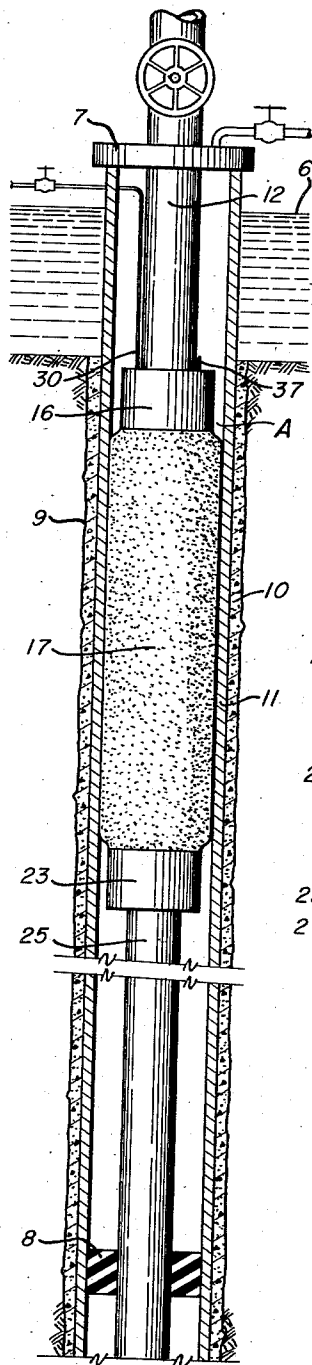


FIG. 5.

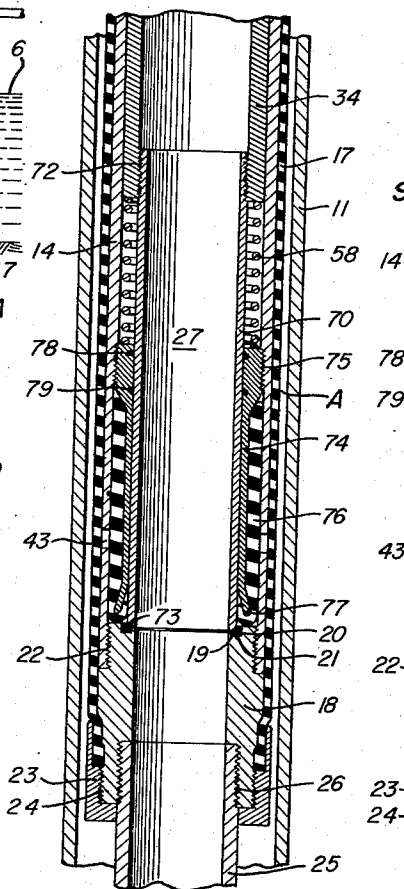


FIG. 3.

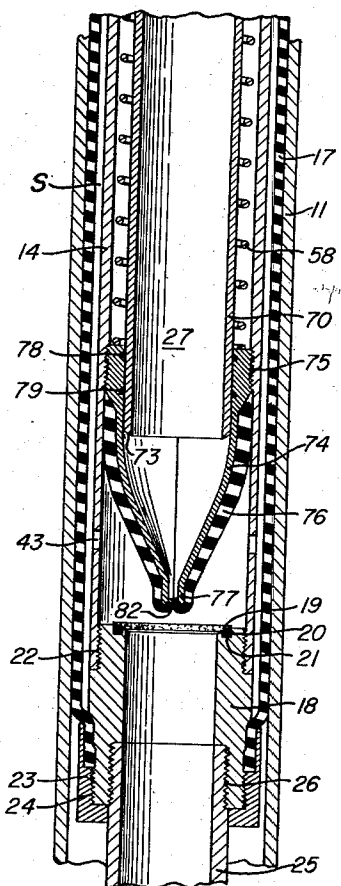


FIG. 4.

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2,812,822

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Application December 21, 1954, Serial No. 476,617

10 Claims. (Cl. 166-224)

The present invention is directed to a blowout preventer. More particularly, the invention is directed to a subsurface blowout preventer for automatically shutting in wells. In its more specific aspects, the invention is directed to a subsurface blowout preventer which will automatically shut in wells at levels in the well substantially below the level from which operations are conducted.

The present invention may be briefly described as a subsurface blowout preventer which is adapted to be arranged in a tubing string in a well casing to seal off the annulus between the tubing and casing and to close the tubing. The invention comprises a tubular mandrel provided with a port intermediate the length thereof arranged in the tubing and a fluid expansible packer means arranged on the mandrel and enclosing the port adapted to seal off the annulus between the tubing and casing. Movable piston means is arranged on the mandrel movable between first and second positions. Movable closure means is connected to the mandrel and is adapted to close off the port when in a first position and to close off the tubing when in a second position. Means is connected to the piston means adapted to move the closure means to the first position when the piston is in the second position. Biasing means is positioned between said piston means and said closure means adapted to urge said piston to the first position. Fluid pressure means is provided for supplying fluid pressure to the piston means to move the piston from the first to the second position and means is arranged on the mandrel for exhausting fluid from the packer means when the piston is in the second position.

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

Fig. 1 is a sectional view of an embodiment with the blowout preventer in inoperative condition;

Fig. 2 shows the blowout preventer of Fig. 1 in sealing relationship with the well casing and the tubing closed;

Fig. 3 is a modification of Fig. 2 showing the blowout preventer in open or in inoperative position;

Fig. 4 is a sectional view of the blowout preventer of Fig. 3 in operative or closed position; and

Fig. 5 is an elevation, partly in section, of the device of Figs. 1 through 3, positioned in a cased borehole.

Referring now to the drawing in which identical numerals will be employed to designate identical parts and particularly to Figs. 1 and 2, numeral 11 designates a well casing in a well having a tubing 12 arranged therein to which is connected by mating threads 13 a packer mandrel 14. Attached to the packer mandrel 14 by mating threads 15 is an annular sleeve 16 which serves to hold a packing member 17 in attached relationship to the packer mandrel 14 at its upper end. A seating member 18 provided with a seating surface 19 having a seal-

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ing member 20 arranged in a recess 21 therein is attached by mating threads 22 to the lower end of the mandrel 14. An annular sleeve member 23 which is similar to sleeve member 16 is threadably connected to the seating member 18 by mating threads 24 and serves to confine the lower end of the packing member 17 into attached relationship to the seating member 18. A tubing section 25 is threadably connected by mating threads 26 to the seating member 18.

It will be seen that the apparatus of the present invention forms an integral part of the tubing string and has a continuous internal passageway 27 therethrough.

The tubing section 12 projects into the mandrel 14 and defines therewith a pressure chamber 28 which is adapted to receive through passageway 29 in the mandrel 14 and through a conduit 30, which extends to the earth's surface, a supply of pressuring fluid, the conduit 30 being threadably attached to the passageway 29 by mating threads 31. It is understood of course that pressure chamber 28 may be formed integrally in mandrel 14.

A passageway 32 in mandrel 14 communicates by lateral passageway 33 with the space between the packing member 17 and exterior of the mandrel 14.

Extending into the pressure chamber 28 is a slidable sleeve or piston 34 to the lower end of which is attached by mating threads 35 a mandrel 36. Attached to the upper end of the sleeve 34 is a sealing stud or pin 37 which projects into the passageway 32 and serves to close off the passageway 33 on upward movement of the slidable sleeve 34. It is desirable to provide a sealing member 37a for the rod member 37.

Attached by mating threads 38 to the mandrel 14 is a plurality of downwardly extending leaf-spring members 39 which are normally biased in an open position by the mandrel 36 as shown in Fig. 1. Spring members 39 may suitably have a sheath of deformable material such as synthetic or natural rubber. The lower end of the mandrel 36 has an upwardly facing taper 40 adapted to matingly engage with a downwardly facing taper 41 of the leaf-spring 39. The mandrel 36 also has a downwardly facing taper 42 which is adapted to seat on the seating surface 19 of the seating member 18, as shown in Fig. 1, and to seal off ports 43 in the mandrel 14 which serve to communicate with the exterior surface of the mandrel 14 and to provide fluid ingress to expand the packer 17.

The springs 39 are designed to engage with each other and overlap to define a curvilinear closure member, such as indicated by the numeral 39a and as shown more clearly in Fig. 2.

The slidable sleeve 34 is provided with sealing members 44 and 45 and 46 and 47, in the upper end of the slidable sleeve 34 to provide a seal between the tubing section 12 and the mandrel 14 on movement of the slidable sleeve. Another sealing member 52 is also provided to seal with the tubing section 12. These several sealing members may suitably be O-rings and the like.

The upper end of the several leaf-springs 39 is also provided with sealing members 54 and 55, for forming a seal with the mandrel 36. Arranged between the lower end of the sleeve 34 and the upper end of the spring 39 and normally urging the sleeve 34 in an upward direction is a biasing means, such as a helical coil spring 58.

Referring now to Figs. 3 and 4, a modification of Figs. 1 and 2 is presented in which a different type of expansible closure means composed of leaf-springs is provided. Similar parts in Figs. 3 and 4 will be designated by identical numerals to those used in Figs. 1 and 2.

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In Figs. 3 and 4 a mandrel 70 is threadably attached by mating threads 72 to the lower end of the slidable sleeve or piston 34. This mandrel 70 is provided with a seating surface 73 on the lower end thereof for seating on the seat 19 of the seating member 18. A plurality of downwardly depending leaf-springs 74 are threadably attached by mating threads 75 to the mandrel 14. These downwardly depending sleeve members 75 are covered with a deformable sheath 76, such as synthetic rubber and the like, which extend over the exterior surface and lap over the ends 77 of the spring members 74. The upper ends of the spring members 74 are provided with sealing members 78 and 79 for sealing with the mandrel 70.

The free ends 77 of the springs 74 are adapted when released to form a conical closure member 82 and form a seal as shown in Fig. 4.

Turning now to Fig. 5 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 6. Casing 11 encloses a string of production tubing 25 which is provided with a packer 8 to close off the annulus A below. Enclosing the top of casing and tubing is a conventional well-head assembly 7. The device as illustrated in Figs. 1 through 4 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 8.

The apparatus of the present invention operates in the following manner with respect to Figs. 1 and 2: in Fig. 1 the device is shown in an open condition with pressure being supplied to the pressure chamber 28 from the earth's surface through conduit 30 forcing the sleeve 34 downwardly overcoming the spring member 58 and causing the mandrel 36 to open the expansible closure members, such as springs 39. The mandrel 36 seats with the surface 42 on the seating surface 19 of seating member 18. Thus the ports 43 are closed off from fluid flowing up the passageway 27.

If, for any reason, such as uncontrolled well flow, it is desired to close off the annulus A between the tubing and casing, pressure is released from the chamber 28 through the conduit 30 which causes the spring member 58 to force the sleeve 34 upwardly into the chamber 28. The rod member 37 moves upwardly into the passageway 32 closing off the lateral passageway 33. As the sleeve 34 moves upwardly by the force of spring 58, the mandrel 36 is also carried upwardly such that the taper 40 matingly engages with the taper 41, allowing the spring members 39 to assume their normal position overlapping, as shown in Fig. 2, to close off the passageway 27 in the tubing. Fluid pressure from the passageway 27 below the closure 39a then passes through port 43 into the space "S" between the expandable packing member 17 and the mandrel 14 causing the packing member 17 to move into sealing engagement with the casing 11. Thus in accordance with the present invention, release of pressure from the chamber 28 causes both the annulus A and the passageway 27 to be closed off automatically.

The device of Figs. 3 and 4 operates similarly with respect to the device of Figs. 1 and 2 in that pressure in chamber 28 forces the sleeve 34 into its lowermost position overcoming the spring 58 and causing the mandrel 70 to seat with its surface 73 on the seat 19 of the seating member 18. On release of pressure from chamber 28, the spring member 58 forces the sleeve 34 to its uppermost position pulling the mandrel 70 upwardly and releasing the spring 74 and causing the same to form a closure 82 of a conical shape, as shown in Fig. 4, the packing member 14 being forced into sealing relationship with the casing 11 by fluid introduced through port 43 into the space "S," thus closing the annulus "A" and the passageway 27.

It will be seen from the foregoing description taken

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with the drawing that there has been provided a new and improved subsurface blowout preventer. Thus when pressure is reduced to a predetermined value in the pressure chamber either through mishap to surface facilities or by deliberate manipulation of pressure release, the spring member expands to raise the mandrel from a seat and seal and cause the device to close automatically. The spring expansion may be assisted by well pressure acting below the sleeve to move the sleeve and the attached mandrel up through the rubber-covered leaf-type closure members composed of the leaf-spring members which close to effect a shutoff of tubing flow. The upward movement of the slidable sleeve closes off the discharge from the interior of the packing member and allows the packing member to be expanded into sealing relationship with the well casing.

The present invention has numerous advantages and is very useful in automatically shutting in wells in water locations below the mud or water level in the event of damage to the surface equipment. While the invention may have greatest utility in water locations or in offshore operations, it has application to any well where it is desired to control the flow of same below the surface from which operations are conducted.

The invention is of great utility in that the pressure which is to be controlled also serves to activate the mechanism.

The device of the present invention also allows pumping through the tubing such as, for example, with mud to kill the well, the closure employed in the tubing being effective to close the tubing from flow upwardly therein. This requires a "squeeze kill" since circulation through the annulus is not possible.

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

1. A subsurface blowout preventer for cased and tubed well bores adapted to close off the annulus between said tubing and casing and to close off said tubing, comprising a first tubular mandrel positioned in said tubing and having at least one port intermediate the length thereof, an inflatable packer member arranged on said first mandrel and enclosing said port, an annular pressure chamber formed by said mandrel and tubing, an annular piston slidably arranged in said pressure chamber movable between first and second positions, a second tubular mandrel connected to said piston and movable therewith, leaf springs secured to said first mandrel adapted to close off and open the bore of said first mandrel below said second mandrel when said piston is in said first and said second positions, respectively, sealing means on said mandrels adapted to close off and open fluid communication between the interior and exterior of said mandrels through said port when said piston is in said second and first positions, respectively, biasing means positioned between said piston and said leaf springs adapted to urge said piston to said first position, a conduit connected to a source of fluid pressure, a first passageway in said first mandrel fluidly communicating said pressure chamber and said conduit whereby application of fluid pressure to said pressure chamber through said passageway moves said piston from said first to said second position against the urging of said biasing means thereby actuating said leaf springs and maintaining the bore of said first mandrel open, a second passageway in said first mandrel extending between said annulus and said pressure chamber, a rod member connected to said piston and movable therewith extending into said second passageway adapted to seal off said pressure chamber from said annulus and a third passageway in said mandrel fluidly communicating said second passageway and the interior of said packer member, sealing means arranged in said second passageway adapted to engage with said rod, said rod closing off fluid communication between said third pas-

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sageway and said annulus when engaged with said sealing means and opening fluid communication between said third passageway and said annulus when disengaged from said sealing means, said sealing means and rod engagement and disengagement occurring when said piston is in said first and second positions, respectively.

2. A subsurface blowout preventer for cased and tubed well bores adapted to close off the annulus between said tubing and casing and to close off said tubing, comprising a first tubular mandrel positioned in said tubing and having at least one port intermediate the length thereof, an inflatable packer member arranged on said first mandrel and enclosing said port, an annular pressure chamber formed by said mandrel and tubing, an annular piston slidably arranged in said pressure chamber movable between first and second positions, a second tubular mandrel connected to said piston and movable therewith, leaf springs secured to said first mandrel adapted to close off and open the bore of said first mandrel below said second mandrel when said piston is in said first and said second positions, respectively, sealing means on said mandrels adapted to close off and open fluid communication between the interior and exterior of said mandrels through said port when said piston is in said second and first positions, respectively, biasing means positioned between said piston and said leaf springs adapted to urge said piston to said first position, a conduit connected to a source of fluid pressure, a first passageway in said first mandrel fluidly communicating said pressure chamber and said conduit whereby application of fluid pressure to said pressure chamber through said passageway moves said piston from said first to said second position against the urging of said biasing means thereby actuating said leaf springs and maintaining the bore of said first mandrel open, a second passageway in said first mandrel extending between said annulus and said pressure chamber, a third passageway in said mandrel fluidly communicating said second passageway and the interior of said packer, sealing means arranged in said second passageway and means connected to said piston adapted to close off fluid communication between said third passageway and said annulus when engaged with said sealing means and to open fluid communication between said third passageway and said annulus when disengaged from said sealing means, said engagement and disengagement occurring when said piston is in said first and second positions, respectively.

3. A subsurface blowout preventer for cased and tubed well bores adapted to close off the annulus between said tubing and casing and to close off said tubing comprising a first tubular mandrel positioned in said tubing and having at least one port intermediate the length thereof, an inflatable packer member arranged on said first mandrel and enclosing said port, an annular pressure chamber formed by said mandrel and tubing, an annular piston slidably arranged in said pressure chamber and movable between first and second positions, a second tubular mandrel connected to said piston and movable therewith, leaf springs secured to said first mandrel adapted to close off and open the bore of said first mandrel below said second mandrel when said piston is in said first and said second positions, respectively, sealing means on said mandrels adapted to close off and open fluid communication between the interior and exterior of said mandrels through said port when said piston is in said second and first positions, respectively, biasing means positioned between said piston and said leaf springs adapted to urge said piston to said first position, a conduit connected to a source of fluid pressure, a first passageway in said first mandrel fluidly communicating said pressure chamber and said conduit whereby application of fluid pressure to said pressure chamber through said passageway moves said piston from said first to said second position against the urging of said biasing means thereby actuating said leaf springs and maintaining the bore of

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said first mandrel open, and fluid conducting means arranged in said mandrel for exhausting fluid from said packer when said piston is in said second position, sealing means arranged in said fluid conducting means and means connected to said piston adapted to close off fluid flow from said exhaust means when engaged with said sealing means, said engagement occurring when said piston is in a first position.

4. A subsurface blowout preventer for cased and tubed well bores adapted to close off the annulus between said tubing and casing and to close off said tubing, comprising a first tubular mandrel positioned in said tubing and having at least one port intermediate the length thereof, an inflatable packer member arranged on said first mandrel and enclosing said port, an annular pressure chamber formed by said mandrel and tubing, an annular piston slidably arranged in said pressure chamber and movable between first and second positions, a second tubular mandrel connected to said piston and movable therewith, leaf springs secured to said first mandrel adapted to close off and open the bore of said first mandrel below said second mandrel when said piston is in said first and said second positions, respectively, sealing means on said mandrels adapted to close off and open fluid communication between the interior and exterior of said mandrels through said port when said piston is in said second and first positions, respectively, biasing means positioned between said piston and said leaf springs adapted to urge said piston to said first position, a conduit connected to a source of fluid pressure, and a first passageway in said first mandrel fluidly communicating said pressure chamber and said conduit whereby application of fluid pressure to said pressure chamber through said passageway moves said piston from said first to said second position against the urging of said biasing means thereby actuating said leaf springs and maintaining the bore of said first mandrel open.

5. A subsurface blowout preventer for cased and tubed well bores adapted to close off the annulus between said tubing and casing and to disclose off said tubing, comprising a first tubular mandrel positioned in said tubing having at least one port fluidly communicating the interior and exterior of said mandrel, an inflatable packer member arranged on said first mandrel and enclosing said port, an annular pressure chamber formed by said mandrel and tubing, an annular piston slidably arranged in said pressure chamber and movable between first and second positions, a second tubular mandrel connected to said piston and movable therewith, leaf springs secured to said first mandrel adapted to close off and open the bore of said mandrel below said second mandrel when said piston is in said first and second positions, respectively, sealing means on said mandrels adapted to close off and open fluid communication between the interior and exterior of said mandrels through said port when said piston is in said second and first positions, respectively, said port being adapted to transmit fluid pressure from said tubing to said packer member to inflate said packer member, biasing means positioned between said piston and said leaf springs adapted to urge said piston to said first position, fluid conducting means connected to said pressure chamber adapted to supply fluid pressure thereto whereby application of fluid pressure to said chamber moves said piston from said first to said second position against the urging of said biasing means thereby actuating said leaf springs and maintaining the bore of said first mandrel open and valve controlled fluid conducting means arranged on said first mandrel for exhausting fluid from said packer member when said piston is in said second position and for preventing exhaust of fluid from said packer member when said piston is in said first position.

6. A subsurface blowout preventer for cased and tubed well bores adapted to close off the annulus between said tubing and casing and to close off said tubing, compris-

ing a first tubular mandrel positioned in said tubing having at least one port fluidly communicating the interior and exterior of said mandrel, an inflatable packer member arranged on said first mandrel and enclosing said port, an annular pressure chamber formed by said mandrel and tubing, an annular piston slidably arranged in said pressure chamber and movable between first and second positions, a second tubular mandrel connected to said piston and movable therewith, closure means secured to said first mandrel adapted to close off and open the bore of said mandrel below said second mandrel when said piston is in said first and second positions, respectively, sealing means on said mandrels adapted to close off and open fluid communication between the interior and exterior of said mandrels through said port when said piston is in said second and first positions, respectively, said port being adapted to transmit fluid pressure from said tubing to said packer member to inflate said packer member, biasing means positioned between said piston and said closure means adapted to urge said piston to said first position, fluid conducting means connected to said pressure chamber adapted to supply fluid pressure thereto whereby application of fluid pressure to said chamber moves said piston from said first to said second position against the urging of said biasing means thereby actuating said closure means and maintaining the bore of said first mandrel open and valve controlled fluid conducting means arranged on said first mandrel for exhausting fluid from said packer member when said piston is in said second position and for preventing exhaust of fluid from said packer member when said piston is in said first position.

7. A subsurface blowout preventer for cased and tubed well bores adapted to close off the annulus between said tubing and casing and to close off said tubing, comprising a tubular mandrel arranged in said tubing having at least one port fluidly communicating the interior and exterior of said mandrel, an inflatable packer member arranged on said mandrel and enclosing said port, an annular pressure chamber formed by said mandrel and said tubing, an annular piston slidably arranged in said pressure chamber and movable between first and second positions, closure means secured to said mandrel adapted to close off and open the bore of said tubing when said piston is in said first and second positions, respectively, means connected to said piston for movement therewith and engaging said closure means adapted to open said closure means when said piston moves from said first to said second position, sealing means on said mandrel adapted to close off fluid communication between the interior and exterior of said mandrel through said port when said connected means engages with said sealing means and adapted to open fluid communication between the interior and exterior of said mandrel through said port when said connected means disengages from said sealing means biasing means positioned between said piston and said closure means adapted to urge said piston to said first position, fluid conducting means connected to said mandrel adapted to supply fluid pressure to said pressure chamber whereby application of fluid pressure to said pressure chamber moves said piston from said first to said second position against the urging of said biasing means and valve controlled fluid conducting means arranged on said mandrel for exhausting fluid from said packer member when said piston is in said second position and for preventing exhaust of fluid from said packer member when said piston is in said first position.

8. A subsurface blowout preventer for cased and tubed well bores adapted to close off the annulus between said tubing and casing and to close off said tubing, comprising a tubular mandrel arranged in said tubing and provided with a port intermediate the length thereof, an inflatable packer means arranged on said mandrel and enclosing said port, piston means arranged on said mandrel

and movable between first and second positions, closure means secured to said mandrel adapted to close off and open the bore of said tubing when said piston means is in said first and second positions, respectively, means connected to said piston means for movement therewith and engaging said closure means adapted to open said closure means when said piston means moves from said first to said second position, sealing means on said mandrel adapted to close off fluid communication between the interior and exterior of said mandrel through said port when said connected means engages with said sealing means and adapted to open fluid communication between the interior and exterior of said mandrel through said port when said connected means disengages from said sealing means biasing means positioned between said piston means and said closure means adapted to urge said piston means to said first position, fluid conducting means connected to said mandrel adapted to supply fluid pressure to move said piston means from said first to said second position against the urging of said biasing means and valve controlled fluid conducting means arranged on said mandrel for exhausting fluid from said packer means when said piston means is in said second position and for preventing exhaust of fluid from said packer means when said piston means is in said first position.

9. A subsurface blowout preventer for cased and tubed well bores adapted to close off the annulus between said tubing and casing and to close off said tubing, comprising a tubular mandrel arranged in said tubing and provided with a port intermediate the length thereof, an inflatable packer means arranged on said mandrel and enclosing said port, piston means arranged on said mandrel and movable between first and second positions, closure means secured to said mandrel adapted to close off and open the bore of said tubing when said piston means is in said first and second positions, respectively, sealing means on said mandrel, means connected to said piston means for movement therewith and engaging said closure means adapted to open said closure means when said piston moves from said first to said second position and engaging with and disengaging from said sealing means to close off and open fluid communication through said port when said piston means is in said second and first positions, respectively, biasing means positioned between said piston means and said closure means adapted to urge said piston means to said first position and means connected to said mandrel adapted to supply fluid pressure to move said piston means from said first to said second position against the urging of said biasing means.

10. A subsurface blowout preventer for cased and tubed well bores adapted to close off the annulus between said tubing and casing and to close off said tubing comprising first valve means positioned in said tubing adapted to open and close said tubing to the passage of fluid therethrough, inflatable packer means arranged on said tubing adapted to close off the annulus upon inflation thereof, said tubing being provided with means adapted to fluidly communicate the interior of said packer means and the interior of said tubing, second valve means connected to said tubing adapted to close off and open fluid communication through said fluid communication means, third valve means mounted on said tubing adapted to exhaust and prevent exhaust of fluid pressure from the interior of said packer means and fluid pressure movable means movable between first and second positions mounted on said tubing adapted when in said second position to actuate said first valve means to open said tubing bore and said second valve means to close off fluid communication between the interior of said packer means and the interior of said tubing and said third valve means to exhaust fluid pressure from the interior of said packer means and adapted when in said first position to actuate said first valve means to close said tubing bore and said second valve means to fluidly communicate the interior

of said packer means and the interior of said tubing and said third valve means to prevent exhaust of fluid pressure from the interior of said packer means, fluid pressure means for moving said fluid pressure movable means from said first to said second position and biasing means arranged on said tubing adapted to move said fluid pressure movable means from said second to said first position.

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