

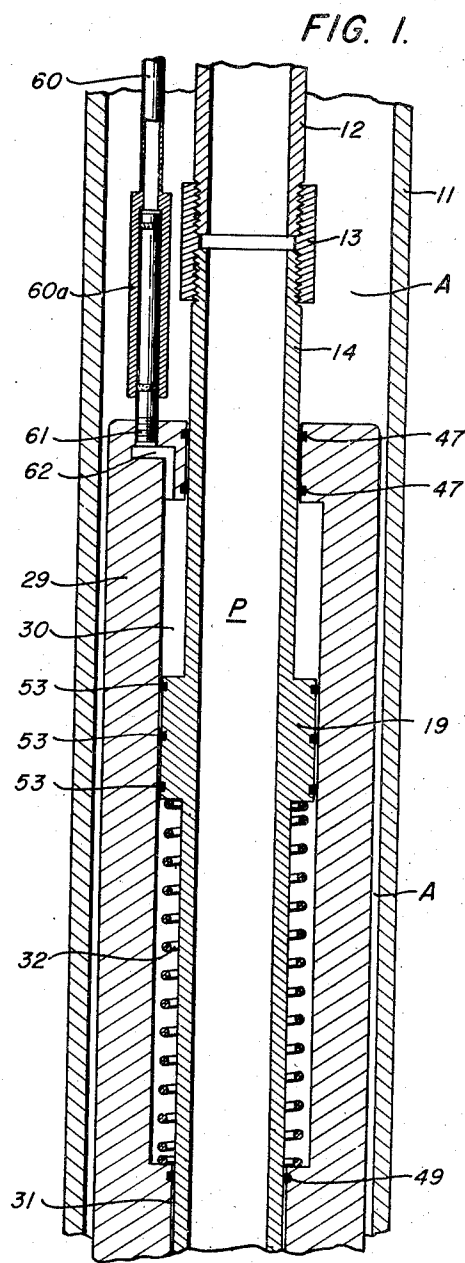
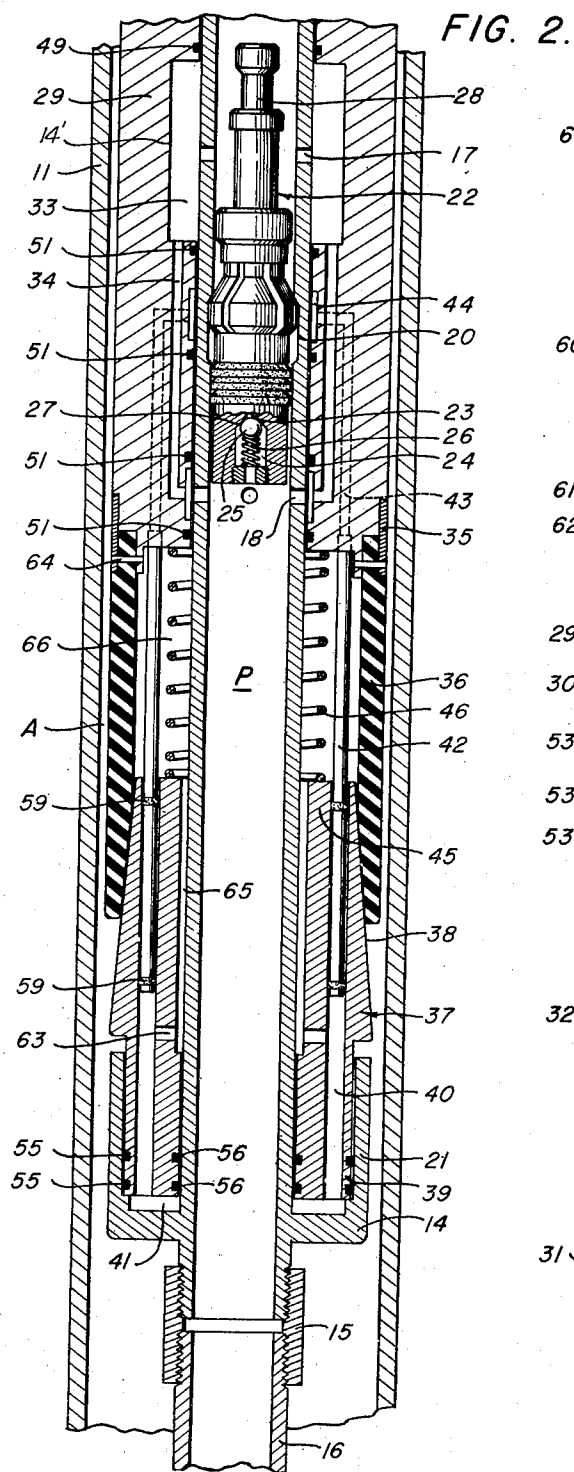
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BLOWOUT PREVENTER FOR ARRANGEMENT IN WELLS

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1

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BLOWOUT PREVENTER FOR ARRANGEMENT IN WELLS

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The present invention is directed to a subsurface blowout preventer. More particularly, the invention has to do with a blowout preventer adapted to be arranged in a tubing string and located in a well below the normal level from which operations are conducted. In its more specific aspects, the invention has to do with a subsurface blowout preventer which will operate automatically to close off the tubing and the annulus between the tubing and the casing.

The present invention may be briefly described as a subsurface blowout preventer which is adapted to be connected in a tubing string in a well casing arranged in a well drilled from the earth's surface. The blowout preventer of the present invention comprises a first tubular mandrel adapted to form part of and to be connected into a tubing string. The first mandrel has a second mandrel slidably mounted thereon or carried coaxially which is normally biased to a first position. The mandrels define a pressure chamber therebetween which is supplied with fluid pressure through a conduit which is adapted to extend to a source of pressure at the earth's surface.

The first mandrel is provided with spaced apart ports and adapted to be arranged within the first mandrel between the spaced apart ports is a closure means such as a retrievable or removable tubing plug which has a longitudinal passageway therein in which is arranged a valve which will permit fluid to be pumped down the tubing but which will resist passage of fluid upwardly through the longitudinal passageway.

The second or slidable mandrel is provided with longitudinal passageways for fluidly communicating fluid from below the plug to above the plug in the tubing. Mounted on the slidable mandrel is an expansible cup-type packer member which is adapted to be expanded into position by movement of a tapered member, the tapered member being adapted to move upwardly on application of pressure supplied through a longitudinal passageway in the slidable mandrel which communicates with the interior of the tubing through the lower of the spaced apart ports. The second mandrel is normally biased to a first position by a biasing means and the tapered member is also normally biased to a first position by a biasing means, both biasing means being arranged on the first mandrel and between the first and second mandrels.

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

Fig. 1 is a sectional view of the upper portion of the device of the present invention; and

Fig. 2 is a sectional view of the lower portion of the device shown in Fig. 1.

Referring now to the drawing, numeral 11 designates a well casing arranged in a well bore drilled in the earth's surface. A tubing string 12 is arranged in the casing 11 and has attached thereto, by tubing coupling 13, a mandrel 14. The lower end of the mandrel 14 is connected by tubing coupling 15 to the lower portion 16 of the tubing string 12. The mandrel 14 is provided with spaced apart

2

ports 17 and 18 for fluid communication through the passageway P in the mandrel 14 and the tubing 12. The mandrel 14 has an outwardly extending shoulder 19, a landing seat 20, and an upwardly extending annular cup-shaped member 21.

Adapted to be arranged in the mandrel 14 and seating in the seating member 20 is a retrievable or removable plug 22 which has a longitudinal passageway 23 therethrough which enlarges in the lower portion thereof to form a valve chamber 24 provided with a spherical valve member 25 biased by a biasing means 26 against a valve seat 27. The upper end of the retrievable plug 22 has a fishing neck 28 for retrieving the plug 22 from the tubing when desired.

Mounted coaxially in sliding relationship to the mandrel 14 is a slidable or movable mandrel 29 which forms a pressure chamber 30 with the exterior surface of the mandrel 14. Arranged between the outwardly extending shoulder 19 of the mandrel 14 and the inwardly extending shoulder 31 of the mandrel 29 is a biasing means 32, such as a helical coil spring, which normally biases the mandrel 29 to a first position as shown in the drawing. A recess 14' in mandrel 29 provides a chamber 33 with the mandrel 14 which is in fluid communication with port 17. The space 33 fluidly communicates with ports 18 by means of a multiplicity or plurality of passageways 34.

Connected to the mandrel 29 by an annular member 35 is a cup-type packer 36 which is suitably constructed of deformable material, such as synthetic or natural rubber. In operative engagement with the cup packer 36 is an expander member 37 which has a tapered or conical surface 38 which is embraced by the lower end of the packer 36. The expander member 37 has its lower end 39 arranged within the annular cup-shaped member 21.

The tapered or expander member 37 has a plurality of longitudinally extending passageways 40 extending therethrough into a chamber 41 in the cup-shaped member 21. Arranged within the longitudinal passageways 40 are tubular members 42 which are attached to conduits or passageways 43 in the mandrel 29 and communicate with a chamber 44 defined by the mandrel 29 and the mandrel 14. The upper end 45 of the expander member 37 and the lower end of the mandrel 29 has a biasing means, such as a helical coil spring 46, arranged therebetween which normally biases the expander member 37 into a first position as shown in the drawing.

The slidable or movable mandrel 29 is provided with sealing members 47, sealing members 49 and sealing members 51 to provide a pressure-type seal for the mandrel 14. The mandrel 14 has sealing members 53 which provide a seal with the mandrel 29. A seal is provided between the cup-shaped member 21 and the lower end 39 of the expander member 37 by sealing members 55 and 56.

The tubular members 42 which are slidably arranged in the passageway 40 are each provided with annular sealing rings 59 to provide a pressure-type seal with the walls of passageway 40.

Pressure is supplied to the pressure chamber 30 by a conduit 60 which is adapted to extend to the earth's surface and which is connected to the mandrel 29 by a threaded connection 61 and to a passageway 62 which communicates with the chamber 30. Conduit 60 may be provided with sealed slip joint 60a to compensate for travel of mandrel 49. Passageways 63 and 64 allow pressure to be bled off from chamber 41 through annular space 65 and space 66 through which tubes 42 extend and which contains the spring 46.

In the figures of the drawing the blowout preventer is shown as an integral part of the tubing string and in an inoperative position. In this position the passageways 34 serve to maintain fluid communication between the ports

17 and 18 and allow fluid passage from below the closure member or plug 22 through the ports 18, passageways 34 into chamber 33 and through ports 17 back into passageway P.

When it is desired to conduct operations down the passageway P without removing the plug 22, fluid may be flowed downwardly therethrough by pumping fluid down the passageway P and unseating the valve member 25 from the seat 27 by the pressure overcoming the spring 24.

In the operations of the subsurface blowout preventer, the desired pressure is applied to the pressure chamber 30 through the conduit 60 to move the mandrel 29 upwardly relative to the mandrel 14 and to compress the spring 32. In this position of the mandrel 29 the ports 18 are opposite and adjacent the passageway 34 and passage of fluid is possible to the chamber 33 and thence upwardly through the ports 17 into the passageway P. The spring member or biasing means 46 is normally extended to retain the expander member 37 in its lowermost position to permit the packer 36 to remain in an unexpanded condition so that communication may be obtainable, if desired, through the tubing-casing annulus A.

When pressure is reduced in the chamber 30, either by mishap to surface facilities or deliberately by manipulation, the spring or biasing means 32 expands against the shoulder 19 of the mandrel 14 to move the mandrel 29 downwardly relative to the mandrel 14. This downward movement rearranges the porting system so that flow through the ports 18 of the mandrel 14 is isolated from the passageways 34 by the intermediate of the seals 51 and flow is then directed into the alternate flow passage 43. Downward movement of the mandrel 29 causes initial expansion of the packer 36 on the conical surface 38 of the packer expander member 37 and positions the tubular members 42 from the flow passages 43 such that the pressure relief ports 63 are isolated between the packing rings 59 on the tubing 42. Flow from the well is thus introduced through the ports 18 of the mandrel 14 into the passageways 43 and into the chamber 41 through the passageway 40. This pressure works against the lower end 39 of the packer expander member 37 as a piston and moves the member 37 slidably upwardly to expand the packer member 36 into sealing engagement with the interior walls of the casing 11. This provides an effective seal in the tubing-casing annulus A and prevents uncontrolled flow inside the tubing.

If it is desired to pump into the well bore beneath the subsurface blowout preventer, this may be accomplished by pumping down through the passageway 23 unseating the valve 25 from the seat 27.

The subsurface blowout preventer is restored to normal production arrangement by exerting pressure through the tubing or conduit 60 to the chamber 30. The piston action of the mandrel 29 causes same to move upwardly with respect to the mandrel 14 compressing the spring 32. In this upward movement, the tubular members 42 follow the mandrel 29 and uncover the pressure relief ports 63 permitting release of the pressure entrapped in the chamber 41 of the cup-shaped member 21. The flow path of pressure released from the chamber 41 is into the passageway 40 through port 63 and thence through annular space 65 into the annular space 66 and then into the annulus A through the ports 64.

As pressure is released from the chamber 41, the spring member 46 extends to its normal position and returns the packer expander member 37 to its lowermost position allowing the packer 36 to retract for re-establishment of communications through the tubing-casing annulus A. Upward movement of the mandrel 29 with respect to the inner mandrel 14 restores the porting system so that again the flow passages 34 are opposite and adjacent the ports 18 of the mandrel 14 and normal production is established as has been described heretofore.

If a full-opening tubing is desired, the retrievable plug

22 may be removed by engagement with a wire line fishing tool.

It will be seen from the foregoing description taken with the drawing that an automatically operating subsurface blowout preventer has been provided. It will be further seen that the pressure below the device serves to maintain a seal with the packer 36 and thus effectively serves to control itself.

In the foregoing description and in the claims where the term "earth's surface" is used, this is meant to include sea level or where operations are conducted from marine locations and especially offshore operations where it is desirable and necessary to control wells, such as oil and gas wells, by means located below the mud and/or water level.

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 be secured by Letters Patent is:

1. A blowout preventer for cased and tubed wells adapted to seal the annulus between said casing and said tubing comprising a first tubular mandrel connected in said tubing and having an outwardly extending shoulder, a second mandrel slidably arranged on said first mandrel and movable between first and second positions and being formed to provide an internally recessed portion, said shoulder being positioned in said recessed portion and sealingly engaging said second mandrel to provide a pressure chamber on one side of said shoulder, a conduit fluidly interconnecting said pressure chamber and a source of fluid pressure, biasing means arranged in said recessed portion on the other side of said shoulder adapted to urge said second mandrel to said second position, an expander member arranged on said first mandrel and having a tapered packer engaging surface, and an expandable packer member secured to said second mandrel and engaging with said tapered surface adapted to close off said tubing-casing annulus upon movement of said second mandrel from said first to said second position.

2. A blowout preventer for cased and tubed wells adapted to seal the annulus between said casing and said tubing comprising a tubular mandrel connected in said tubing and having an outwardly extending shoulder arranged thereon intermediate its length, fluid pressure movable means slidably arranged on said mandrel and movable between first and second positions, biasing means arranged on said mandrel adapted to urge said fluid pressure movable means to said second position, means connected to said fluid pressure movable means fluidly communicating said fluid pressure movable means and a source of fluid pressure for supplying fluid pressure to said fluid pressure movable means to move said fluid pressure movable means against the urging of said biasing means, an expanded member arranged on said mandrel and having a tapered packer engaging surface, and an expandable packer member secured to said fluid pressure movable means and engaging with said tapered surface adapted to close off said tubing-casing annulus when said fluid pressure movable means moves from said first to said second position.

3. A blowout preventer for cased and tubed wells adapted to seal the annulus between said casing and tubing and to close off fluid flow through said casing comprising a first tubular mandrel connected in said tubing and having an outwardly extending shoulder and a landing nipple arranged thereon intermediate its length, a second mandrel slidably arranged on said first mandrel and movable between first and second positions and provided with an internally recessed portion, said shoulder being positioned in said recessed portion and sealingly engaging said second mandrel to provide a pressure chamber on one side of said shoulder, a conduit fluidly inter-connecting said pressure chamber and a source of fluid pressure, biasing means arranged in said recessed

5

portion on the other side of said shoulder adapted to urge said second mandrel to said second position, an expander member arranged on said first mandrel and having a tapered packer engaging surface, an expansible packer member secured to said second mandrel and engaging with said tapered surface adapted to close off said tubing-casing annulus when said second mandrel moves from said first to said second position and removable closure means arranged on said landing nipple adapted to close off fluid flowing upwardly through said tubing.

4. A blowout preventer for cased and tubed wells adapted to seal the annulus between said casing and tubing and to close off fluid flow through said tubing comprising a tubular mandrel connected in said tubing and having an outwardly extending shoulder and a landing nipple arranged thereon intermediate its length, fluid pressure movable means slidably arranged on said mandrel and movable between first and second positions, biasing means arranged on said mandrel adapted to urge said fluid pressure movable means to said second position, fluid conducting means connected to said fluid pressure movable means fluidly communicating said fluid pressure movable means and a source of fluid pressure for supplying fluid pressure to said fluid pressure movable means to move said fluid pressure movable means against the urging of said biasing means, an expander member arranged on said mandrel and having a tapered surface, an expansible packer member secured to said fluid pressure movable means and engaging with said tapered surface adapted to close off said tubing-casing annulus when said fluid pressure movable means is in said second position, and removable closure means arranged on said landing nipple adapted to close off fluid flowing upwardly through said tubing.

5. A blowout preventer for cased and tubed wells adapted to seal the annulus between said casing and said tubing comprising a first tubular mandrel connected in said tubing and having an annular cup-shaped member, an outwardly extending shoulder and vertically spaced apart ports arranged thereon intermediate its length; a second mandrel slidably arranged on said first mandrel and movable between first and second positions and provided with an internally recessed portion, a first passageway and a second passageway, said shoulder being positioned in said recessed portion and sealingly engaging said second mandrel to provide a first pressure chamber on one side of said shoulder; a first conduit fluidly communicating said first pressure chamber and a source of fluid pressure; first biasing means arranged in said recessed portion on the other side of said shoulder adapted to urge said second mandrel to said second position; a movable expander member movable between first and second positions arranged in said cup-shaped member and having a tapered packer engaging surface, a third passageway and a fourth passageway, said fourth passageway fluidly communicating with said third passageway intermediate its ends and also fluidly communicating with said annulus, said expander member sealingly engaging said cup-shaped member to provide a second pressure chamber in said cup-shaped member; a second conduit open at both ends connected to said second mandrel and extending into said third passageway in said expander member fluidly communicating said second passageway and said second pressure chamber; said second and fourth passageways being in fluid communication through said second conduit when said second mandrel is in said first position; packing rings on said second conduit for sealing off between said third passageway wall and said second conduit adapted to seal off fluid communication between said fourth passageway and said third passageway below said fourth passageway when said second mandrel is in said second position; an expansible packer member secured to said second mandrel and engaging with said tapered surface adapted to close off said tubing-casing

6

annulus, said first passageway fluidly communicating said spaced apart ports when said second mandrel is in said first position, said second passageway fluidly communicating one of said spaced apart ports and said second pressure chamber when said second mandrel is in said second position; and second biasing means positioned between said second mandrel and said expander member adapted to urge said expander member to said first position.

6. A blowout preventer for cased and tubed wells adapted to seal the annulus between said casing and said tubing comprising a tubular mandrel connected in said tubing and having an annular cup-shaped member, an outwardly extending shoulder and vertically spaced apart ports arranged thereon intermediate its length; fluid pressure movable means slidably arranged on said mandrel and movable between first and second positions; first biasing means arranged on said mandrel adapted to urge said fluid pressure movable means to said second position; fluid conducting means connected to said fluid pressure movable means fluidly communicating said fluid pressure movable means and a source of fluid pressure for supplying fluid pressure to said fluid pressure movable means to move said fluid pressure movable means against the urging of said first biasing means; an expander member movable between first and second positions and arranged in said cup-shaped member and having a tapered packer engaging surface, a third passageway and a fourth passageway, said fourth passageway fluidly communicating with said third passageway intermediate its ends and also fluidly communicating with said annulus, said expander member sealingly engaging said cup-shaped member to provide a pressure chamber in said cup-shaped member, a conduit open at both ends connected to said fluid pressure movable means and extending into said third passageway fluidly communicating said second passageway and said pressure chamber; said second and fourth passageway being in fluid communication through said conduit when said fluid pressure movable means is in said first position; packing rings on said conduit for sealing off between said third passageway wall and said conduit adapted to seal off fluid communication between said fourth passageway and said third passageway below said fourth passageway when said fluid pressure movable means is in said second position; and an expansible packer member secured to said fluid pressure movable means and engaging with said tapered surface adapted to close off said tubing-casing annulus, said first passageway fluidly communicating said spaced apart ports when said fluid pressure movable means is in said first position, said second passageway fluidly communicating one of said spaced apart ports and said conduit when said fluid pressure movable means is in said second position; and second biasing means positioned between said fluid pressure movable means and said expander member adapted to urge said expander member to said first position.

7. A blowout preventer for cased and tubed wells adapted to seal the annulus between said casing and said tubing comprising a tubular mandrel connected in said tubing and having an annular cup-shaped member and vertically spaced apart ports arranged thereon intermediate its length; first fluid pressure movable means slidably arranged on said mandrel movable between first and second positions; first biasing means arranged on said mandrel adapted to urge said first fluid pressure movable means to said second position; fluid conducting means connected to said first fluid pressure movable means fluidly communicating said fluid pressure movable means and a source of fluid pressure for supplying fluid pressure to said first fluid pressure movable means to move said first fluid pressure movable means against the urging of said first biasing means; a second fluid pressure movable means having first and second positions arranged in said cup-shaped member, said second fluid pressure movable means being provided with a tapered packer engaging

surface, a third passageway and a fourth passageway, said fourth passageway fluidly communicating with said third passageway intermediate its ends and also fluidly communicating with said annulus; means interconnecting said first and second fluid pressure movable means fluidly communicating said second passageway and said second fluid pressure movable means, said interconnecting means being provided with sealing means adapted to seal off between said third passageway wall and said interconnecting means to seal off fluid communication between said fourth passageway and said third passageway below said fourth passageway when said first fluid pressure movable means is in said second position, and an expansible packer member secured to said first fluid pressure movable means and engaging with said tapered surface adapted to close off said tubing-casing annulus, said first passageway fluidly communicating said spaced apart ports when said first fluid pressure movable means is in said first position, said second passageway fluidly communicating one of said spaced apart ports and said second fluid pressure movable means when said first pressure movable means is in said second position.

8. A blowout preventer for cased and tubed wells adapted to seal the annulus between said casing and tubing and to close off fluid flow through said casing comprising a first tubular mandrel connected in said tubing and having an annular cup-shaped member, an outwardly extending shoulder, vertically spaced apart ports, and a landing nipple arranged thereon intermediate its length; a second mandrel slidably arranged on said first mandrel and movable between first and second positions and provided with an internally recessed portion, a first passageway and a second passageway, said shoulder being positioned in said recessed portion and sealingly engaging said second mandrel to provide a first pressure chamber on one side of said shoulder; a first conduit fluidly communicating said first pressure chamber and a source of fluid pressure; first biasing means arranged in said recessed portion on the other side of said shoulder adapted to urge said second mandrel to said second position; a movable expander member movable between first and second positions arranged in said cup-shaped member and having a tapered packer engaging surface, a third passageway and a fourth passageway, said fourth passageway fluidly communicating with said third passageway intermediate its ends and also fluidly communicating with said annulus, said expander member sealingly engaging said cup-shaped member to provide a second pressure chamber in said cup-shaped member; a second conduit open at both ends connected to said second mandrel and extending into said third passageway in said expander member fluidly communicating said second passageway and said second pressure chamber; said second and fourth passageways being in fluid communication through said second conduit when said second mandrel is in said first position; packing rings on said second conduit for sealing off between said third passageway wall and said second conduit adapted to seal off fluid communication between said fourth passageway and said third passageway below said fourth passageway when said second mandrel is in said second position; an expansible packer member secured to said second mandrel and engaging with said tapered surface adapted to close off said tubing-casing annulus, said first passageway fluidly communicating said spaced apart ports when said second mandrel is in said first position, said second passageway fluidly communicating one of said spaced apart ports and said second pressure chamber when said second mandrel is in said second position; second biasing means positioned between said second mandrel and said expander member adapted to urge said expander member to said first position and removable closure means arranged on said landing nipple adapted to close off fluid flowing upwardly through said tubing.

9. A blowout preventer for cased and tubed wells adapted to seal the annulus between said casing and tubing and to close off fluid flow through said tubing comprising a tubular mandrel connected in said tubing and having an annular cup-shaped member, an outwardly extending shoulder, vertically spaced apart ports and a landing nipple arranged thereon intermediate its length; fluid pressure movable means slidably arranged on said mandrel and movable between first and second positions; first biasing means arranged on said mandrel adapted to urge said fluid pressure movable means to said second position; fluid conducting means connected to said fluid pressure movable means fluidly communicating said fluid pressure movable means and a source of fluid pressure for supplying fluid pressure to said fluid pressure movable means to move said fluid pressure movable means against the urging of said first biasing means; an expander member movable between first and second positions arranged in said cup-shaped member and having a tapered packer engaging surface, a third passageway and a fourth passageway, said fourth passageway fluidly communicating with said third passageway intermediate its ends and also fluidly communicating with said annulus, said expander member sealingly engaging said cup-shaped member to provide a pressure chamber in said cup-shaped member; a conduit open at both ends connected to said fluid pressure movable means and extending into said third passageway fluidly communicating said second passageway and said pressure chamber; said second and fourth passageway being in fluid communication through said conduit when said fluid pressure movable means is in said first position; packing rings on said conduit for sealing off between said third passageway wall and said conduit adapted to seal off fluid communication between said fourth passageway and said third passageway below said fourth passageway when said fluid pressure movable means is in said second position; and an expansible packer member secured to said fluid pressure movable means and engaging with said tapered surface adapted to close off said tubing-casing annulus, said first passageway fluidly communicating said spaced apart ports when said fluid pressure movable means is in said first position, said second passageway fluidly communicating one of said spaced apart ports and said conduit when said fluid pressure movable means is in said second position; second biasing means positioned between said fluid pressure movable means and said expander member adapted to urge said expander member to said first position and removable closure means arranged on said landing nipple adapted to close off fluid flowing upwardly through said tubing.

10. A blowout preventer for cased and tubed wells adapted to seal the annulus between said casing and tubing and to close off fluid flow through said tubing comprising a tubular mandrel connected to said tubing and having an annular cup-shaped member, vertically spaced apart ports and a landing nipple arranged thereon intermediate its length; first fluid pressure movable means slidably arranged on said mandrel movable between first and second positions; first biasing means arranged on said mandrel adapted to urge said first fluid pressure movable means to said second position; fluid conducting means connected to said first fluid pressure movable means fluidly communicating said fluid pressure movable means and a source of fluid pressure for supplying fluid pressure to said first fluid pressure movable means to move said first fluid pressure movable means against the urging of said first biasing means; a second fluid pressure movable means having first and second positions arranged in said cup-shaped member, said second fluid pressure movable means being provided with a tapered packer engaging surface, a third passageway and a fourth passageway, said fourth passageway fluidly communicating with said third passageway intermediate its ends and also fluidly communicating with said annulus; means inter-

connecting said first and second fluid pressure movable means fluidly communicating said second passageway and said second fluid pressure movable means, said interconnecting means being provided with sealing means adapted to seal off between said third passageway wall and said interconnecting means to seal off fluid communication between said fourth and said third passageways below said fourth passageway when said first fluid pressure movable means is in said second position, an expandible packer member secured to said first fluid pressure movable means and engaging with said tapered surface adapted to close off said tubing-casing annulus, said first passageway fluidly communicating said spaced apart ports

when said first fluid pressure movable means is in said first position, said second passageway fluidly communicating one of said spaced-apart ports and said second fluid pressure movable means when said first pressure movable means is in said second position and removable closure means arranged on said landing nipple adapted to close off fluid flowing upwardly through said tubing.

References Cited in the file of this patent

UNITED STATES PATENTS

1,801,353	Lane	Apr. 21, 1931
2,370,832	Baker	Mar. 6, 1945
2,715,943	True	Aug. 23, 1955