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[56]

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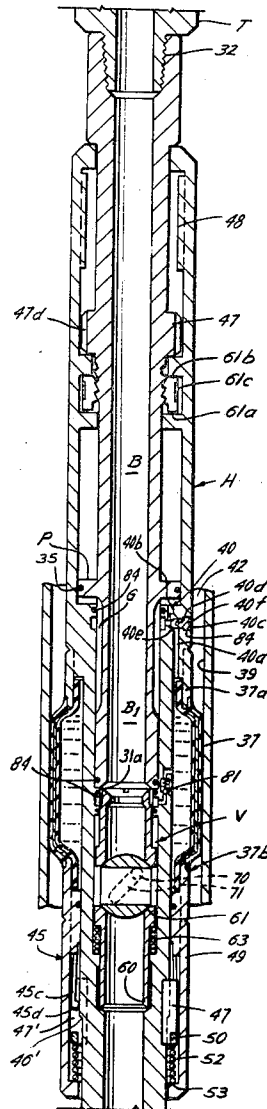
Primary Examiner—Ian A. Calvert

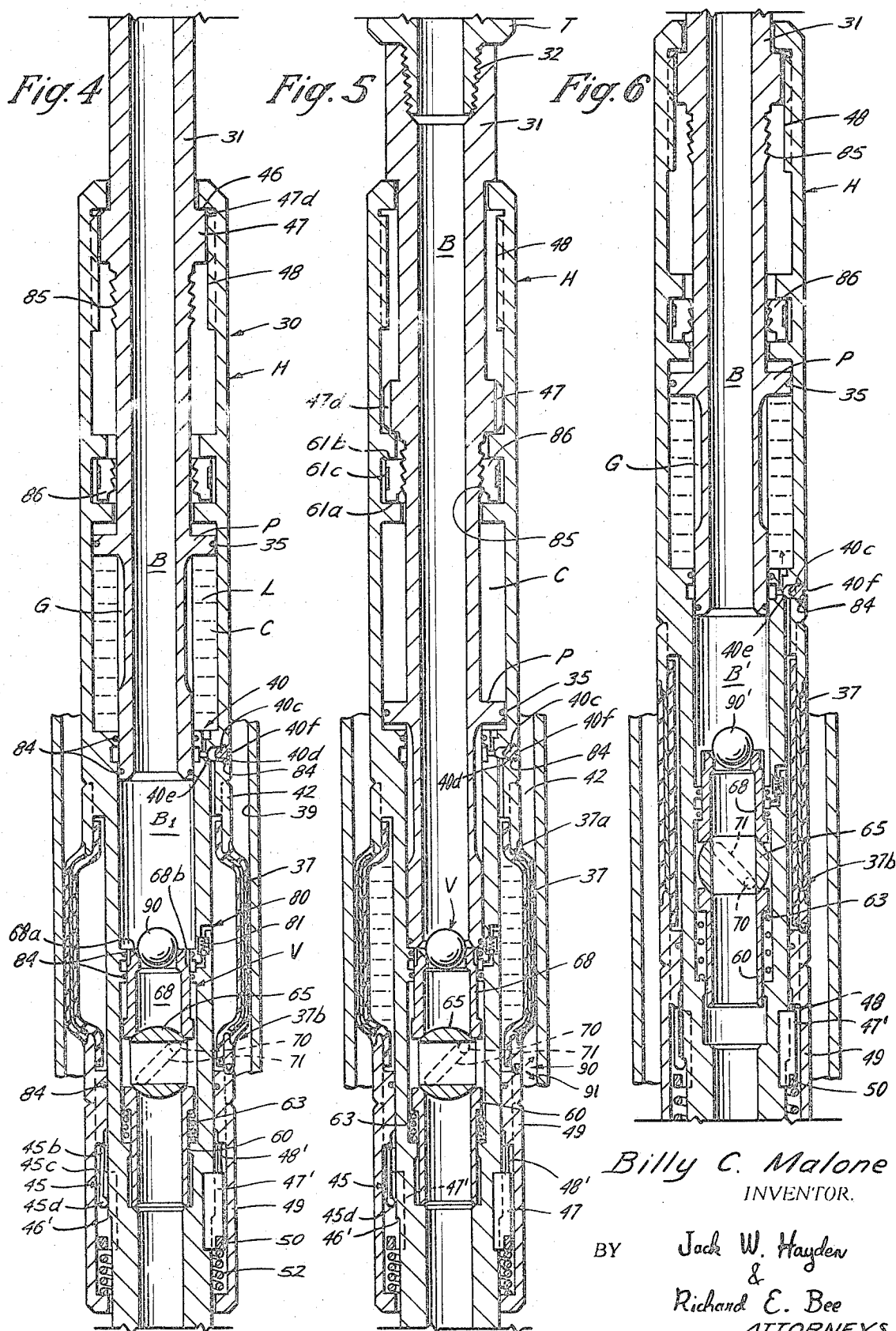
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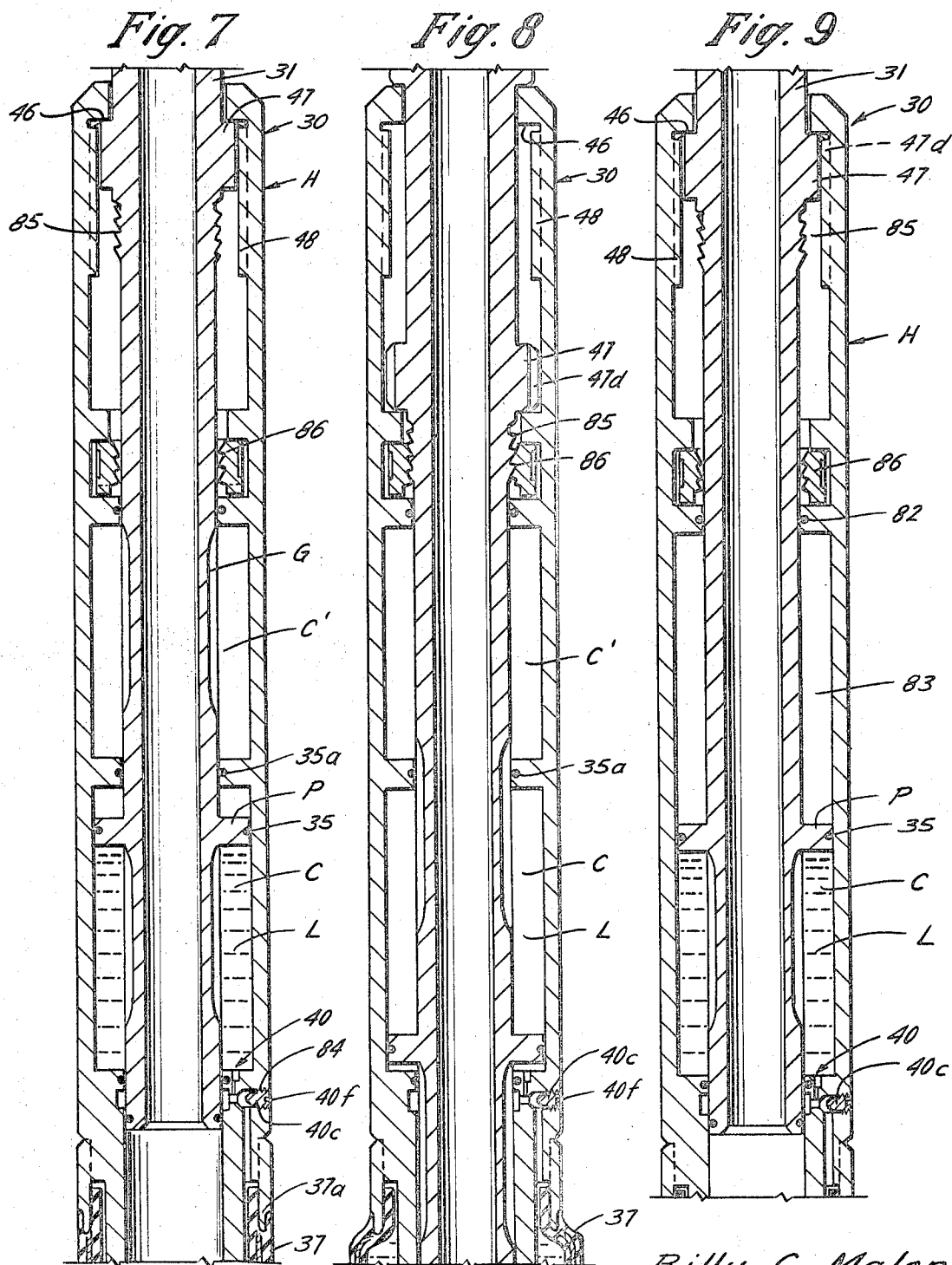
[54] **CLOSEOFF TOOL FOR BORES OR OTHER OPENINGS**
28 Claims, 13 Drawing Figs.

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[51] Int. Cl..... E21b 33/127
[50] Field of Search..... 166/126,
128, 142, 152, 187, 188, 196, 224, 226; 277/34,
34.6, 116.4

ABSTRACT: A bore or other opening closeoff tool for inclusion in a tubular string which extends within the bore or other opening, the tool including valve means to close off internally of the tool and tubular string and reinforced inflatable element means which can be expanded to seal off within the surrounding bore or other opening.

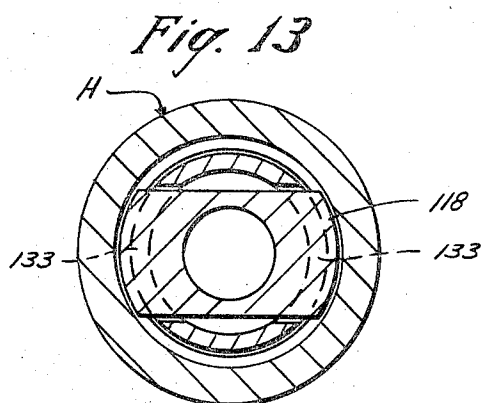
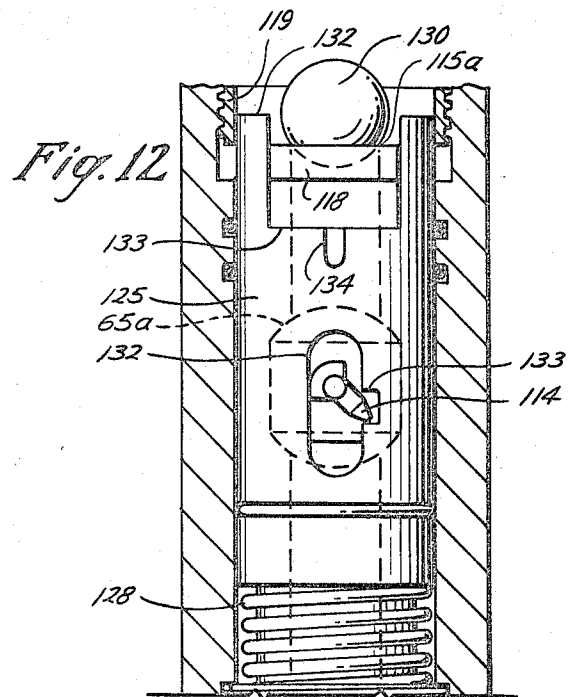
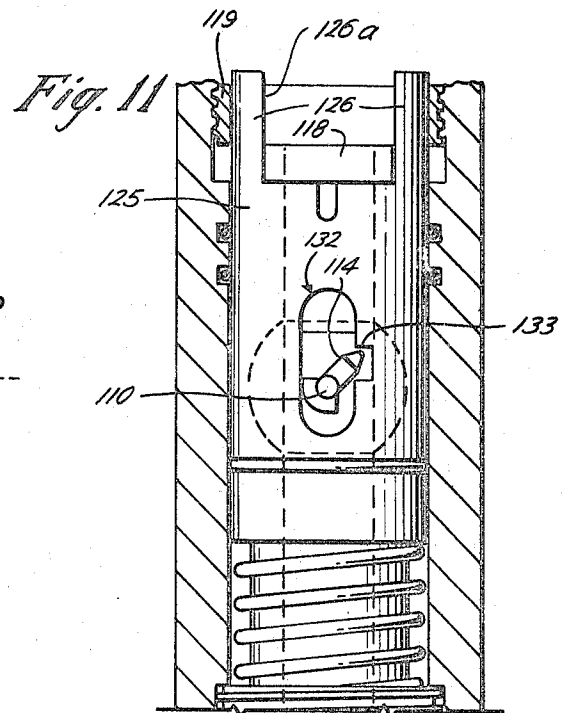
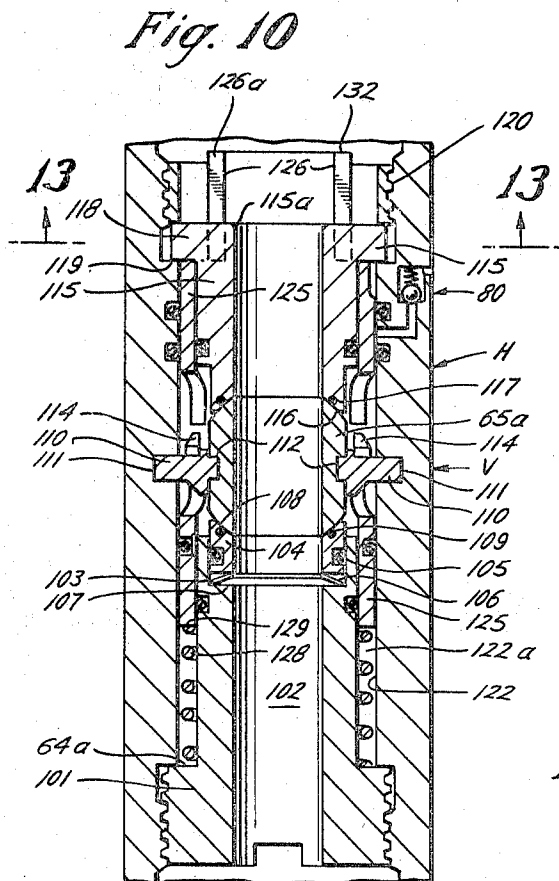






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CLOSEOFF TOOL FOR BORES OR OTHER OPENINGS

CROSS-REFERENCE TO RELATED APPLICATION

The present application is an improvement over my copending application, Ser. No. 761,150 filed Sept. 20, 1968 for "Inflatable Safety Shut-Off For Well Bores Or Other Openings," now U.S. Pat. No. 3,527,296.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a tool for closing and for sealing off in an opening surrounding a tubular string which carries the tool. It may be used in earth-boring operations such as in mining, drilling of oil, gas or water wells, or where any type opening is being drilled or has been drilled in the earth, or other substance. The invention includes a mandrel having means at one end for connection with a tubular string.

In the form of the invention described, valve means and a reinforced inflatable element are carried by a housing, which housing is, in turn, supported by the mandrel and has means at one end for connection with the tubular string. A piston is formed on the mandrel and carried in a chamber formed in the housing. The chamber is adapted to be filled with liquid and the tool incorporates passage means for conducting liquid from the chamber to the inflatable element when the piston moves within the chamber upon relative longitudinal movement between the mandrel and housing to force liquid from the chamber and into the reinforced inflatable element to expand it and seal off a bore or opening. The valve means may be selectively opened and closed to close off or permit flow through the tool and tubular string.

2. Description of the Prior Art

One prior art patent is that to E. E. Warrington, U.S. Pat. No. 3,283,823 which shows an inflatable packer for sealing off with the wall of a surrounding opening and a packer for closing off internally of the tool. However, the Warrington patent discloses a construction wherein the tubular string is set on the bottom of the borehole to actuate the device to close the annulus and the tool. In some situations it is neither desirable nor possible to set the tubular string on the bottom of a borehole before conditions occur which dictate the desirability of sealing off the well bore opening and the opening in the tubular string in the well bore.

SUMMARY OF THE INVENTION

The present invention has many applications, several of which are described herein, by way of example only.

For example, while drilling in the earth's surface, the present invention may be connected in the drill string beneath the blowout preventer and can be actuated to seal off the well bore and drill string beneath the blowout preventers to enable the blowout preventers to be repaired or replaced.

Also, the present invention can be connected in the drill string either in the riser pipe or surface pipe beneath the blowout preventers to function as a safety shutoff when needed, during drill stem testing operations.

Also, the present invention can be connected in the drill string during ordinary drilling operations for closing off the drill string and well bore when desired. In effect, it functions as a down hole blowout preventer and can be actuated whether the tubular string in which it is connected is on bottom or not.

A primary object of the present invention is to provide a tool that can be connected in a well string to close off the annulus in a well bore and to close off internally of the tool which does not require the well string to be set on bottom before the tool can be actuated.

It can be appreciated that in like manner the invention has application in other fields such as mining, or in any situation where an opening is bored, or is being bored, or drilled in the earth's surface and a tubular string positioned therein either during or after the opening has been formed.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a diagrammatic, sectional view, showing one form of the tool and showing it connected in a tubular string that is positioned in a cased opening;

FIG. 2 is a view similar to FIG. 1 but illustrating the form of the invention shown in FIG. 1 after it has been actuated so that the reinforced inflatable element is expanded to seal off the opening after the valve means has been actuated to close off the tool internally;

FIG. 3 is a diagrammatic, sectional view illustrating the relative position of the tool components after the tool has been deactivated and returned to its open position as shown in FIG. 1;

FIG. 4 is a diagrammatic, sectional view, partly in elevation, illustrating another form of the invention connected in a tubular string that is positioned in a cased opening with the reinforced inflatable element expanded to seal off the opening and the valve means actuated to close off the tool internally;

FIG. 5 is a diagrammatic, sectional view partly in elevation of the invention shown in FIG. 4 and showing the same relationship of the components of the tool after it has been actuated to seal off an opening and close the tool and diagrammatically illustrating one means for releasing liquid from the reinforced inflatable element;

FIG. 6 is a diagrammatic, sectional view partly in elevation after the invention of FIG. 4 has been deactivated so that the tool and well bore annulus are open;

FIG. 7 is a diagrammatic, sectional view illustrating the upper portion of still another form of the invention. The lower part of FIG. 7 which is not shown is identical to the lower part of FIG. 1;

FIG. 8 is a diagrammatic, sectional view illustrating the relationship of the components of the upper part of the present invention shown in FIG. 7 after it has been actuated;

FIG. 9 is a diagrammatic, sectional view illustrating still another embodiment of the present invention. The lower part of the tool which is not shown is identical to the lower part of FIG. 1;

FIG. 10 is a sectional view illustrating another form of valve means including details for actuation thereof;

FIG. 11 is a side view view of FIG. 10 with the outer portion in half-section and illustrating further details of the means for rotating or actuation of the ball valve means;

FIG. 12 is a view similar to FIG. 11 but showing a ball as a closure seated in the housing to close off fluid flow therethrough whereby fluid pressure increase engages the sleeve means with a crank arm to actuate and close the ball valve means; and

FIG. 13 is a sectional view of the line 13-13 of the FIG. 10 embodiment to illustrate the further details of construction.

DESCRIPTION OF THE PREFERRED EMBODIMENT

In FIG. 1, the tool is represented generally by the numeral 30 and is shown in this form as including the mandrel 31 which is provided at its upper end with threads 32 (FIG. 2) or other suitable means for connection with the tubular string T. It will be noted that the tubular string T as well as the mandrel 31 are each provided with an internal, longitudinal bore, which bores communicate with each other.

A housing H is carried by the mandrel 31 and in cooperation with a portion of the mandrel 31 which is telescopically received within the housing forms an annular ring-shaped chamber C therein for receiving liquid designated by the letter L.

The lower end of the housing H is provided with suitable means (not shown) for connection with the portion of the tubular string T which extends therebeneath (not shown). Thus, the invention 30 is connected in and forms a part of the tubular string. As noted previously, the internal bore which extends through the mandrel 31 designated by the letter B also communicates with the internal bore B₁ extending through the

housing H; these bores in turn form a continuous bore through the mandrel 31 and housing H which communicates with the tubular string. A piston P is formed or carried on the mandrel 31 and is provided with a suitable seal as illustrated at 35 for sealingly engaging the outer wall of the chamber C.

The housing H supports and carries a reinforced inflatable element 37, the reinforcing being diagrammatically represented at 38 and comprises an annular sheath which is suitably impregnated with an elastomeric compound that is yieldable when the piston P moves downwardly within the chamber C to force the liquid designated at L therein through the passage means represented generally at 40 and formed in the tool and into the reinforced inflatable element 37 to expand it as illustrated in FIG. 2 to engage the wall 39 of the well bore, pipe or opening 42 which surrounds the tool and the reinforced inflatable element.

The passage means 40 includes the generally T-shaped passage 40a with functions side of the T extending outwardly through the housing to receive a plug valve 40c, which plug valve is provided with suitable means such as rubber or the like at 40d on its nose for seating on the seat 40e formed within the passage means 40 to close off the passage means. The other side of the T extends inwardly through the housing H. The restricted passage 40b connects passage 40a with the liquid-filled chamber C when valve 40c is unseated. The restricted passage 40b functions as a dashpot and restricts movement of liquid L from chamber C when the tool is actuated so as to delay expansion of the reinforced inflatable element 37.

Additionally suitable means such as the Allen locknut 40f may be integrally formed on the outer end of the plug 40c so that the plug valve 40c may be moved towards and away from the seat 40e. The plug valve 40c will normally be positioned inwardly on the seat 40e until shortly prior to the time that the tool is positioned within the tubular member.

It will be noted that the upper end 37a of the reinforced inflatable element is secured to the housing H while the lower end thereof represented generally by the number 37b is arranged so that it may move longitudinally relative to the housing H to accommodate radial expansion of the reinforced element 37. The element 37 is also mounted on the housing H to prevent relative rotational movement therebetween, as the tubular member T is rotated during boring or drilling operations. However, the lower end 37b and the housing H may move longitudinally relative to each other to accommodate the expansion of the inflatable element 37.

Additionally, spring means represented generally by the numeral 45 inhibit premature release or wadding of the inflatable element 37 should any portion of the lower end 37b of the reinforced element 37 strike a ledge or projection as it is moved downwardly within the opening 42 either during drilling or boring operations, or as it is being positioned within the opening or bore 42.

The spring means 45 includes the sleeve 45a having a lower portion 45b with longitudinal extending slots to form fingers 45c. The lower end of the portion 45b is provided with an annular inwardly extending projection 45d which abuts the annular shoulder 46' formed on the housing H to aid in preventing premature release or movement of the reinforced inflatable element 37.

A ring 50 is carried on the lower end of lugs 47' and provides an abutting shoulder against which one end of the spring 52 abuts. The other end of the spring rests on shoulder 53 of outer sleeve 49. The spring 52 tends to maintain the inflatable reinforced element 37 in extended position as shown in FIG. 1, and thus also aids in preventing premature release of the element 37.

The arrangement of the fingers 45c in contact with shoulder 46', and the spring 52 tend to prevent premature release of the element 37 should the lower end of the housing H strike or rub against a ledge or the surrounding wall opening.

The circumferentially spaced lugs 47' are mounted in the housing H as shown (only two lugs being shown), and the lugs

fit within grooves 48' extending longitudinally of the outer sleeve 49 which is connected by suitable means to the sleeve 45a. The sleeve 45a is in turn connected with the lower end 37b of the reinforced element 37.

The lugs 47' fitting within the grooves 48' prevent relative rotation between the reinforced inflatable element 37 and the housing H on which it is carried, while permitting relative longitudinal movement therebetween.

In the form of the invention shown, the housing H is provided adjacent its upper end with a shoulder as shown at 46 which rests on the upper end of the annular enlarged portion 47 formed on the mandrel 31. The portion 47 is provided with grooves longitudinally thereof, shown at 47d and longitudinally extending keys 48 formed on the housing H as shown fit within the grooves 47d. This arrangement accommodates relative longitudinal movement between the mandrel 31 and housing H while preventing relative rotation therebetween.

The housing H also supports valve means designated generally at V which includes a sleeve 60 having a valve seat 61 formed on its upper end. A shoulder 62 on sleeve 60 abuts one end of a spring 63 and the other end of spring 63 is seated on the shoulder 64 of housing H.

A ball valve 65 with opening 66 rests on the valve seat 61 as shown in FIG. 1, and an upper sleeve 68 is provided with a valve seat 69 which also abuts the ball valve 65.

The upper sleeve 68, ball valve 65 and sleeve 60 are retained within bore B₁ by the spring 63 and by the shoulder 71 in housing H which acts as a stop for upper sleeve 68 by contact with shoulder 72 on sleeve 68.

In order to lock the piston P in the position of FIG. 2, a buttress thread 85 is provided on the mandrel 31 for engaging the segmented buttress-threaded nut 86 carried by housing H. When it is desired to release the mandrel and housing, rotation may be applied to the tubular string T and mandrel 31 to disengage the buttress thread 85 from the segmented nut 86. The segmented nut 86 is retained within the housing H by the shoulders 61a and 61b and is urged radially inwardly by the spring 61c which surrounds the segmented nut 61 so that when the threaded surface 85 on the mandrel 31 moves downwardly into engagement with the segmented buttress-threaded nut 86, it will be locked together.

In the form of the invention shown in FIGS. 1—3, it may be positioned in the well string, such as a drill string to position it either in the riser pipe (where the drilling operation is in a water covered area) or conductor or surface pipe. If it becomes desirable to seal off the well bore annulus or opening 42 either in cased pipe or open hole the tubular string of is lowered to set on the bottom of the well bore or other opening and continued movement telescopes the mandrel 31 into the housing H. As this occurs liquid L from the chamber C is discharged through restricted passage 40b and passage 40a into the interior of inflatable element 37. As the mandrel 31 moves down, the piston P begins to move downwardly within the chamber C, but the restricted passage 40b will restrict the flow of liquid from the chamber C so there will be some delaying action insofar as radial expansion of the reinforced inflatable element 37 is concerned until the longitudinally extending and circumferentially spaced grooves designated by G formed in the mandrel wall and which extend within the chamber C, but are spaced from each end of the chamber as shown in FIGS. 1 and 2 of the drawings, communicate with the passage 40a. After the mandrel 31 has moved down so that the grooves G therein are in communication with the passage 40a, the liquid from the chamber C is supplied in a greater quantity so that the reinforced inflatable element then moves outwardly to seal the opening 42, as seen in FIG. 2.

Continued downward movement of mandrel 31 engages its lower end 31a against the top of the upper sleeve 68 and moves the upper sleeve, ball valve, and lower sleeve 61 to compress spring 63 as shown in FIG. 2. A pin is shown in dotted line at 70 which is fixed in housing H and engages groove or opening 71, also shown in dotted line, formed in the

outer surface of ball valve 65. Therefore, as the valve 65 moves down, it is also rotated from the open position shown in FIG. 1 to the closed position shown in FIG. 2.

Suitable seals 84 are provided as indicated to inhibit fluid or liquid leakage in the tool.

From the foregoing, it can be seen that not only is the opening or well bore annulus 42 closed off, but the interior of the tool 30 is closed to prevent communication of the tubular string T beneath the tool (not shown) with the tubular string T connected above the tool 30.

When it is desired to unset or deactivate the tool 30, the tubular string T and mandrel 31 and connected tubular string T are rotated to unlock surface 85 from segmented nut 86. The string T and mandrel 31 connected thereto are then raised or elevated, whereupon the upward movement of piston P withdraws the inflating liquid L from element 37 and back into chamber C. Also, spring 63 urges sleeve 60 against ball valve 65 to move the sleeve and rotate the valve to its open position. Normal drilling, or other operations, can then be continued.

The construction of the invention as shown in FIGS. 4, 5, and 6 is generally similar to that shown in FIGS. 1 and 3, and corresponding parts bear the same numerals. However, the form of the invention of FIGS. 4-6 includes an additional passage means to the reinforced inflatable element. Again, the tubular string is represented by the letter T (FIG. 2) and the mandrel of the tool 30 by the numeral 31. The tubular string T is connected with the mandrel 31 at its upper end by suitable means such as threads 32 or the like and the bore of the tubular string communicates with mandrel bore B and also communicates with the bore B, extending through the housing H. As in FIGS. 2 and 3 the bore B, communicates with the bore in the housing H and in tubular string T (not shown) below the tool 30. The piston P on mandrel 31 is arranged within the chamber C formed between the housing H and a portion of the mandrel which extends into the housing H, and as in FIGS. 2 and 3, the housing H and mandrel 31 cooperate to define an annular, ring-shaped chamber C for receiving a liquid designated as L therein. A seal 35 is provided on the piston P for sealingly engaging with the outer periphery of the chamber C as the piston P moves downwardly therein.

It will be noted that the shoulder 46 is again formed on the housing H which engages the annular enlarged portion 47 formed on the mandrel 31. Grooves 47d extend longitudinally of portion 47 and are circumferentially spaced thereabout. Engaged within the grooves 47d are longitudinally extending keys 48 that are, in turn, circumferentially arranged and circumferentially spaced within a portion of the housing to thereby accommodate relative longitudinal movement between the mandrel 31 and housing H and at the same time preventing relative rotational movement therebetween. Again, spring means 45 is provided adjacent the lower movable end 37b of the reinforced inflatable element 37 which is secured at its upper end 37a to the housing H as previously described with regard to the FIGS. 2 and 3 modification.

The passage means 40 in the tool in the FIGS. 4 and 5 modification is similar in construction and arrangement to that described with regard to FIGS. 1-3.

In the operation of the invention shown in FIGS. 4-6, a ball 90 or other closure is dropped or pumped down the tubular string T to seat on seat 68a on sleeve 68. By increasing the pressure of the fluid in bore B and tubular string T, the valve means V moves to the position of FIG. 4. In this position the reduced portion 68b at the top provides a passageway for liquid or fluid to inflate the element 37.

The passage 68b communicates with passage 80 formed in housing H which in turn communicates with the interior of inflatable element 37. Thus, fluid from the tubular string is conducted through passages 68b and 80 to expand and seal element 37 within opening 42. At the same time the valve means V is closed, in a manner as previously described, to seal off the tool 30 and tubular string 30 internally. The passage 80

includes a one-way check valve 81 to prevent escape of the inflating fluid through passage 80.

In the form of the invention shown in FIGS. 4-6 inclusive, the element 37 can be expanded and the valve means V actuated at any elevation in a bore hole or other opening. The tubular string need not be first set on the bottom of the bore hole or other opening before the well bore and tubular string are closed off. FIGS. 4-6 also includes means for discharging the well fluid from the inflated reinforced element 37 and replacing it with liquid L from the chamber C formed in the tool. A relief, or spring-loaded check valve is diagrammatically illustrated at 90 which can be set to open at any desired predetermined pressure. For example, it may be set so that it will open at approximately 1,500 p.s.i.

When it is desired to replace the well liquid with the the liquid L from chamber C the tubular string T and mandrel 31 are lowered so as to telescope the mandrel 31 into housing H, thus moving piston P downwardly in chamber C. This forces the liquid through opening 40 and eventually through grooves G into the inflated element 37. As this occurs, the well liquid is dumped from element 37 through relief valve 90 and into the well bore or opening 42 is represented by the arrows 91.

In order to unset the element 37 in FIGS. 4-6 forms, the threads 85 and segmented nut 86 are disengaged by rotating string T. Pressure is released internally of the tubular string T to permit valve means V to move upwardly to the position shown in FIG. 6. The tubular string T and mandrel 31 are then elevated and the piston P withdraws liquid L from the element 37. Thereafter ball or other closure means 90 may be removed from the tubular string T by reverse circulation through the string T.

Attention is now directed to FIG. 7 of the drawings wherein the mandrel is represented by the numeral 31 and the housing by the letter H. The tubular string T which is connected above and below the tool 30 is not shown. The shoulder 46 on the housing H rests on the annular enlarged portion 47 on the mandrel 31. Grooves 47d extend longitudinally of and are circumferentially spaced, in which fit the radially projecting and circumferentially spaced longitudinal keys of 48 on the housing H. The mandrel 31 is again connected at its upper end by suitable means (not shown) to the tubular string T (not shown) and the housing H is connected at its lower end by any suitable means (not shown) to the portion of the tubular member T which extends beneath the tool.

A chamber C for receiving liquid L is formed between the housing H and the mandrel 31, as previously described, and a piston P having a seal means 35 is mounted on the mandrel and positioned within the liquid chamber C as shown in the drawings.

An additional chamber formed between the housing H and the mandrel 31 is referred to as C'. The chamber C' is adapted to receive a gas under pressure, preferably an inert gas such as nitrogen. The passage means in the tool from the liquid chamber C to the inflatable element 37 is designated by the number 40 and is similar in construction to that shown in FIGS. 1-6. The reinforced inflatable element 37 is secured at its upper end 37a to the housing H and its lower end 37b (not shown) is constructed and arranged so that longitudinal movement between the housing H and the lower end of the reinforced inflatable element will accommodate radial expansion of the reinforced inflatable element, as described with regard to FIGS. 1-3. A plug 40c and Allen nut 40f are also provided as described with regard to FIGS. 1-6. Also, a buttress thread 85 on mandrel 31 and segmented nut 86 is carried by housing H, as described with regard to FIGS. 1-6.

In the modification shown in FIG. 7 when tension is relieved from the tubular member T or compression applied thereto, the piston P is moved down within the chamber C. It will be noted that seal means 35a are provided for sealing off around the mandrel 31 and between the chamber C and C' and that grooves G are formed on the mandrel 31 portion which extends longitudinally within the chamber C' but are apaced from each end thereof. This serves as a delaying action in

communicating the nitrogen gas from chamber C' to one side of the piston P and thereby force it down; however, after the grooves G have moved beyond the seal 35a nitrogen gas from chamber C' is communicated freely to chamber C to act against one side of the piston P and force the liquid on the other side thereof through the passage means 40 and into the interior of the reinforced inflatable element 37 carried by the housing.

The lower portion of the tool 30 which is not shown in FIGS. 7-9 is identical to that shown in FIGS. 1-3. Thus the opening in which the tool is positioned, and the tubular string in which the tool is connected may be sealed off as described with regard to the form of the invention shown in FIGS. 1-3. The tubular string and mandrel may be locked with the housing H by means of the buttress thread 85 on mandrel 31 and segmented buttress thread nut 86 carried by housing H as previously described. Release between the housing H and mandrel 31 is effected by rotation of the tubular string to unscrew 85 from 86 and then the tubular string can be raised to withdraw the liquid from the inflated element as previously described.

In the form of the invention shown in FIG. 9, the tubular string T (not shown) is again connected to the mandrel 31 by any suitable means. The mandrel 31 is again telescopically received within the housing H and the shoulder 46 of the housing H rests on enlarged portion 47 of the mandrel. Grooves 47d in the portion 47 and keys 48 on housing H prevent relative rotation when they are engaged in the position shown in FIG. 9, as is true with the form shown in FIG. 7. The housing H and the mandrel 31 form a chamber C for receiving liquid L therein as previously described with regard to the other forms of the invention. A piston P is formed on the mandrel 31 within the chamber C and is provided with seal means 35 as previously described for engaging the annular wall of the chamber C as it moves downwardly to force liquid through the passage means designated generally by the numeral 40. Again, the bore of the tubular string above the tool or invention 30 communicates with the bore of the mandrel within the housing and with the bore of the housing, as well as the tubular string connected therebeneath. The passage-conducting means between the chamber C includes the plug valve 40c previously described in detail with regard to FIGS. 1-3. The buttress threads 85 and segmented nut 86 may be provided, if desired, so that when liquid has been conducted from the chamber C into the reinforced inflatable element 37, the mandrel 31 and housing H will be retained in locked position, and the inflatable element expanded to seal against the wall of the surrounding opening.

In this form of the invention gas under pressure is placed in the portion of the chamber C represented at 83 on the top side of the piston P. Seal 82 between the mandrel 31 and housing H prevent escape of the gas and liquid from the chamber C.

The form of the invention described in FIG. 9 can be employed quite satisfactorily in connection with a tubular string T where the tubular string T is a production string of an oil, gas or water well, except that it might be desirable to eliminate the buttress threads 85 and segmented nut 86. The tubular string T is anchored in the wellhead by any suitable means well known in the art and it can be appreciated that in some instances the well head might be knocked off or otherwise disconnected from the production string, in which event the weight of the tubular string T above the invention 30 would be relieved, thereby enabling the compressed gas in the portion 83 of chamber C to expand and to act on the upper end of the piston P to move it down in chamber C and thereby force the liquid L through the passage means 40 to radially expand the inflatable element 37. Of course, as previously mentioned, the plug valve 40c is normally retained in closed position until the tool is inserted in the well string at which time it is opened to open the passage means 40 to enable communication of liquid L to the interior of the inflatable element 37 when tension is relieved from or compression

applied to the tubular member T. Also as the piston P moves down, the valve means V would be closed as previously described to seal off the production string internally and prevent escape of oil, gas or whatever is produced therethrough.

Thereafter the production string could be engaged by a grapple or fishing tool, well known in the art and necessary repairs made.

In some instances, the pressure in the annulus 42 below the tool 30 connected in the production string may be subjected to pressure to cause it to corkscrew, or move upwardly. When this occurs, the tool 30 would be actuated, if sufficient force were involved to disconnect the wellhead and production string and thereby relieve the tension in the production string to actuate the tool as above described. Again, the buttress thread 85 and segmented nut 86 could be eliminated.

Of course, the form of the invention shown in FIG. 9 could also be used in a drill string, or in any other tubular string.

FIGS. 10-13 show an alternate form of valve means V which is carried in the tool and more specifically within the housing designated H. In the form of the invention shown in FIGS. 10-13 a shoulder 64a is formed in the housing when the tubular member 101 is threadedly engaged in the housing H as shown in FIG. 10. A bore 102 through the tubular member 101 communicates with the bore B in the mandrel (not shown) and the tubular string T therebeneath (not shown). A counterbore 103 is formed in the tubular member 101 at the upper end thereof and receives an annular seat member 104 therein, there being suitable seal means 105 between the seat member 104 and the tubular member 101.

If desired stable spring means such as a Belleville spring 106 may be provided on the shoulder 107 at the end of the counterbore for receiving the seat member 104, the seat member 104 having a seat 18 formed on the upper end thereof for receiving the ball valve means 65a. If desired, suitable seal means as shown at 19 may be provided on the seat 108 for sealing between the ball valve means 65a and seat 108 formed on member 104. The ball valve means 65a is carried within the tool and more particularly is positioned or carried, as shown in the present form of the drawings within the housing H, on the pair of pivot pin means 110 which pivot pin means each extend at one of their respective ends within one of the openings 111 formed in diametrically opposed relationship within the housing H as shown in FIG. 10. The other end of the pivot pin means 110 fits within the opening 112 formed in the ball valve means 65a on each side thereof. The pivot pin means 110 includes a crank arm 114 which is integral therewith and extends generally laterally therefrom as better viewed in FIG. 11 of the drawings.

The ball valve means 65a is retained in position within the housing H by the seat means 104 as well as the upper seat or sleeve means 115 which is provided with a seating surface 116 thereon for abutting against the ball valve 65a. Suitable seal means 117 in 116 seals with the surface of ball valve 65a. The upper seat or sleeve means 115 is provided with ledges 118 which rests on shoulder 119 and is retained in position by fitting between upstanding portions 126 of sleeve 125 and abut against surfaces 133 of sleeve 125. The nut 120 which is threadedly engaged within the housing as shown in FIG. 10 of the drawings retains sleeve 115, sleeve 125 and ball valve 65a in position.

It will be noted that the tubular member 101 is reduced in outer diameter relative to the diameter of bore 122 formed within the housing H and similarly the upper seat or sleeve means 115 is also reduced in diameter relative to the diameter bore 122 to provide a space 122a for receiving the movable sleeve 125. It will be noted that the sleeve 125 is provided with opposed projections 126 at its upper end as shown in FIGS. 10 and 11 of the drawings. The sleeve 125 extends longitudinally of the housing H within the space 122a defined between the tubular member 101, the ball valve means 65a and the upper seat means 115 as shown in FIG. 10 of the drawings. Spring 128 at its upper end abuts the lower end 129 of sleeve 125 and

its lower end rests on shoulder 64a so as to tend to urge the sleeve means 125 towards the position as shown in FIG. 10 of the drawings and against nut 120—in which position the ball valve means 65a is in an open position.

The sleeve means 125 is provided with slot means 132 which extends longitudinally on each side thereof and is shaped so as to receive the end of the crank arm within a laterally extending portion 133 thereof.

The sleeve means 125 may be moved longitudinally relative to the housing H in several ways. As shown in FIG. 12, a ball 130 has been dropped or pumped down the tubular string T and through the bore B of the mandrel 31 to rest on the upper end 115a of the upper seat means 115. It will be noted as more clearly seen in FIG. 13 of the drawings and as previously noted that the ledges 118 of the upper seat means 115 is shaped to fit between the upstanding portions 126 of the sleeve 125, the portions 126 being formed by the recess 126a formed in the upper end of the sleeve 125.

When the closure 130 has been seated as shown in FIG. 12 of the drawings, further fluid communication between the tubular string T above the tool 30 and the tubular string T (not shown) beneath the tool 30 is closed off so that an increase in fluid pressure acts upon the exposed surfaces 132 and 133 of the sleeve means 125 to force it downwardly. When this occurs the lateral portion 133 of each of the slots 132 will engage its respective crank arm 114 and rotate it from the position shown in FIG. 11 to the position shown in FIG. 12 to thereby close the ball valve 65a and close off flow through the housing and the tubular string T above the tool 30 and beneath the tool 30. In this position the spring 128 is in collapsed position as illustrated in FIG. 12 of the drawings.

When the ball valve 65a is rotated and sleeve 125 lowered as shown in FIG. 12, fluid is then communicated from the tubular string T through grooves 134 (only one being shown in FIG. 12) to passage means 80 and to inflatable element 37 (not shown). The passage means 80 is similar to that previously described with regard to FIGS. 4—6 inclusive.

If desired, the sleeve 125 may be moved relative to the housing H by engaging the upper end of the projections 126 when the mandrel 31 is lowered after the packer has been inflated as described with regard to the FIGS. 1—3 modifications to close the ball valve means 65a.

It can be appreciated that the foregoing constructions seal off the annulus or opening of the well bore as well as the tubular string internally to inhibit the passage of any liquids in a water-covered area into the annulus and at the same time prevent escape of fluids from the annulus and well string and into the surrounding water, or ground surface, where the well bore is not in a water-covered area.

Since the mandrel 31 and housing H are constructed and arranged at their upper end so that no relative rotational movement can occur therebetween, and since the lower end of the inflatable element 37 is arranged so that no relative rotational movement can occur therebetween and the housing H, it can be appreciated that when the present invention is used in connection with boring or drilling operations, the entire tool 30 will rotate with the rotating drill string, or tubular member T.

The present invention has been described in detail in connection with its use in drilling operations where the well bore may be provided with a casing or conductor pipe; however, it will function in uncased or "open-hole" in the same manner to seal it off.

Similarly, the tool can be used in many operations such as mining, trenching, boring or in any situation where it may be desired to seal off the annulus surrounding a tubular member.

The foregoing disclosure and description of the invention is illustrative and explanatory thereof and various changes in the size, shape, and materials, as well as in the details of the illustrated construction, may be made within the scope of the appended claims without departing from the spirit of the invention.

I claim:

1. A bore closeoff tool for inclusion between two portions of a tubular string in the bore comprising;

- a. a mandrel for connection with one portion of the tubular string;
- b. a housing carried by said mandrel, said housing in cooperation with said mandrel forming a chamber for receiving liquid therein;
- c. means on said housing for connection with the other portion of the tubular string;
- d. a reinforced inflatable element carried by said housing;
- e. piston means on said mandrel and positioned within said chamber;
- f. there being passage means in the tool for conducting liquid from said chamber to said inflatable element;
- g. said piston movable within said chamber upon relative longitudinal movement between said mandrel and housing to force liquid from said chamber into said reinforced inflatable element to expand said reinforced inflatable element and seal off the bore;
- h. said mandrel and said housing having a continuous central bore for communicating with the well string; and
- i. ball valve means rotatably mounted within the bore in said housing operable to close off the continuous central bore in said mandrel and housing from communication with the tubular string.

2. The invention of claim 1 including cooperating means on said mandrel and housing to accommodate relative longitudinal movement between said housing and mandrel while preventing relative rotation therebetween.

3. The invention of claim 1 wherein a restriction is formed in said passage means which restricts flow of liquid from said chamber to said inflatable element and thereby functions as a delaying means for inflation of said element.

4. The invention of claim 3 including longitudinally extending grooves in said mandrel which terminate at points spaced from the end of said chamber and which serve to communicate liquid from said chamber to said inflatable element upon a predetermined amount of relative movement between said mandrel and housing.

5. The invention of claim 1 including lock means for retaining said inflatable element inflated.

6. The invention of claim 5 wherein said lock means includes a buttress-threaded surface on said mandrel, a segmented nut carried by said housing, spring means normally urging said segmented nut radially inwardly and said segmented nut having buttress threads formed thereon for engaging with the buttress-threaded surface on said mandrel to retain said mandrel and housing in a predetermined relative longitudinal position.

7. The invention of claim 1 including externally accessible valve means carried by said housing for closing said passage means in the tool.

8. The invention of claim 1 including means carried by said housing and inflatable element to accommodate relative longitudinal movement between one end of said element and said housing while preventing relative rotation therebetween.

9. The invention of claim 8 wherein said means include cooperating keys and longitudinally extending keyways acting between one end of said inflatable element and said housing.

10. The invention of claim 8 including spring means acting between said housing and one end of said inflatable element to restrain relative longitudinal movement of said element and housing until a predetermined amount of inflating force is exerted by said inflating liquid within said element.

11. The invention of claim 10 wherein said spring means includes spring fingers carried by said inflatable element and a groove formed in said housing within which said spring fingers are received.

12. The invention of claim 1 wherein said chamber on one side of said piston means is adapted to receive a gas under pressure which acts against one side of said piston means to move it and thereby inflate said inflatable element when tension is relieved from the tubular member.

13. The invention of claim 12 including lock means for retaining said inflatable element inflated.

14. The invention of claim 13 wherein said lock means includes a buttress-threaded surface on said mandrel, a segmented nut carried by said housing, spring means normally urging said segmented nut radially inwardly and said segmented nut having buttress threads formed thereon for engaging with the buttress-threaded surface on said mandrel to retain said mandrel and housing in a predetermined relative longitudinal position.

15. The invention of claim 12 including externally accessible valve means carried by said housing for closing said passage means in the tool.

16. The invention of claim 1 including an additional chamber formed in said housing for receiving a gas under pressure, means for communicating said gas under pressure to one side of said piston means and thereby force it to move liquid from said chamber into said inflatable element.

17. The invention of claim 16 including cooperating means on said mandrel and housing to accommodate relative longitudinal movement between said housing and mandrel while preventing relative rotation therebetween.

18. The invention of claim 16 wherein a restriction is formed in said passage means which restricts flow of liquid from said chamber to said inflatable element and thereby functions as a delaying means for inflation of said element.

19. The invention of claim 16 including longitudinally extending grooves in said mandrel which terminate at points spaced from the end of said additional chamber and which serve to communicate gas from said additional chamber to one side of said piston means upon a predetermined amount of relative movement between said mandrel and housing.

20. The invention of claim 16 including lock means for retaining said inflatable element inflated.

21. The invention of claim 20 wherein said lock means includes a buttress-threaded surface on said mandrel, a segmented nut carried by said housing, spring means normally urging said segmented nut radially inwardly and said segmented nut having buttress threads formed thereon for engaging with the buttress-threaded surface on said mandrel to retain said mandrel and housing in a predetermined relative longitudinal position.

22. The invention of claim 16 including externally accessible valve means carried by said housing for closing said passage means in the tool.

23. The invention of claim 1 including spring means for urging said inflatable element towards an extended position.

24. The invention of claim 1 including cooperating means on said ball valve means and tool to rotate said ball valve means and close it upon relative movement between said ball valve means and tool.

25. The invention of claim 24 wherein said cooperating means includes:

- a. pin means carried by said housing; and
- b. said ball valve means having an opening in its surface in which said pin means is received.

26. The invention of claim 1 wherein said ball valve means includes:

- a. a spring supported sleeve having a valve seat on its upper end;
- b. a ball valve on said seat;
- c. pin means carried by said housing;
- d. said ball valve having a groove in its surface in which said pin means is received;
- e. slidable sleeve means above said ball valve and having a seat abutted against said seat;
- f. said ball valve being rotatable by coaction between said pin and groove when said slidable sleeve is forced downwardly thereagainst to move the ball valve to a closed position.

27. The invention of claim 24 wherein said cooperating means includes:

- a. pin means supporting said ball valve means for rotation in said housing;
- b. said pin means having a crank arm thereon;
- c. sleeve means surrounding said ball valve means and having slot means formed therein; and
- d. spring means supporting said sleeve means whereby said sleeve may move longitudinally relative to said housing whereupon said slot means engages and rotates said crank arm and closes said ball valve means.

28. The invention of claim 24 wherein said cooperating means includes:

- a. pivot pin means supporting said ball valve means for rotation within said housing;
- b. a crank arm extending from said pivot pin means; and
- c. sleeve means having at least one slot formed therein for engaging said crank arm upon relative movement between said sleeve means and said housing whereby said ball valve means may be rotated to open and close it.

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UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3,575,237

Dated April 20, 1971

Inventor(s) BILLY C. MALONE

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 1, line 52, change "preventer" to --preventers--.
Column 2, line 43, change "aside" to --a side--.
Column 2, line 43, cancel "view" first occurrence.
Column 2, lines 62 and 63, change " bore, which bores communicate" to --bore which communicates--.
Column 2, line 67, change "ring-shaped" to --ring shaped--.
Column 3, line 18, change "functions" to --one--.
Column 3, line 25, change "liquid-filled" to --liquid filled
Column 4, line 34, change "buttress-threaded" to --buttress threaded--.
Column 4, line 49, change "of" to --T--.

Column 6, line 11, change "spring-loaded" to --spring loaded
Column 6, line 74, change "apaced" to --spaced--.
Column 7, line 42, change "passage-conducting" to --passage conducting--.
Column 8, line 32, change "stable" to --suitable--.
Column 8, line 35, change "18" to --108--.
Column 8, line 37, change "19" to --109--.
Column 10, line 48, change "buttress-threaded" to --buttress threaded--.
Column 11, lines 4, 8, 37, and 41, change "buttress-threaded" to --buttress threaded--.

Signed and sealed this 2nd day of November 1971.

(SEAL)
Attest:

EDWARD M. FLETCHER, JR.
Attesting Officer

ROBERT GOTTSCHALK
Acting Commissioner of Patents