

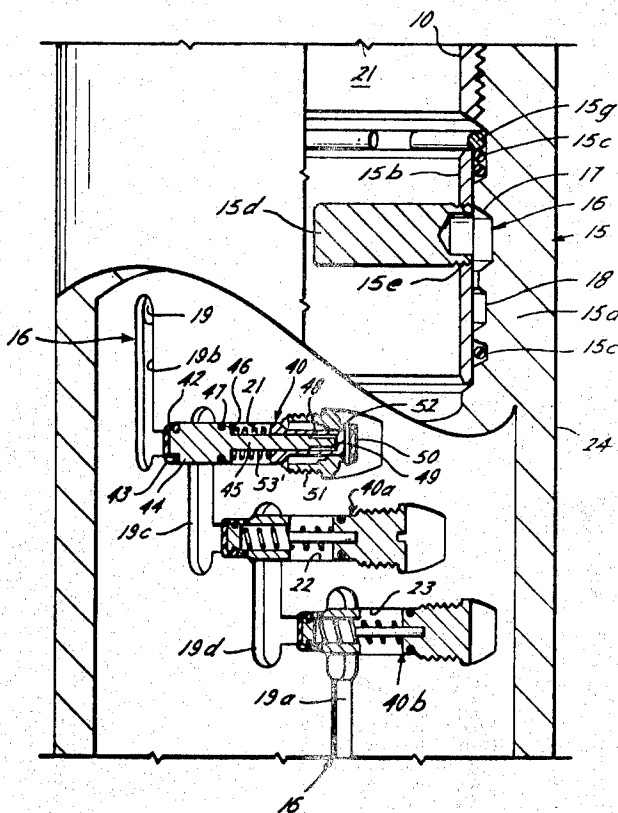
- [21] Appl. No.: 362,586

[58] **Field of Search** 137/70, 71; 166/187;
251/89, 92, 93, 1, 4

3,437,142	4/1969	Conover	166/187
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ABSTRACT

4 Claims, 5 Drawing Figures



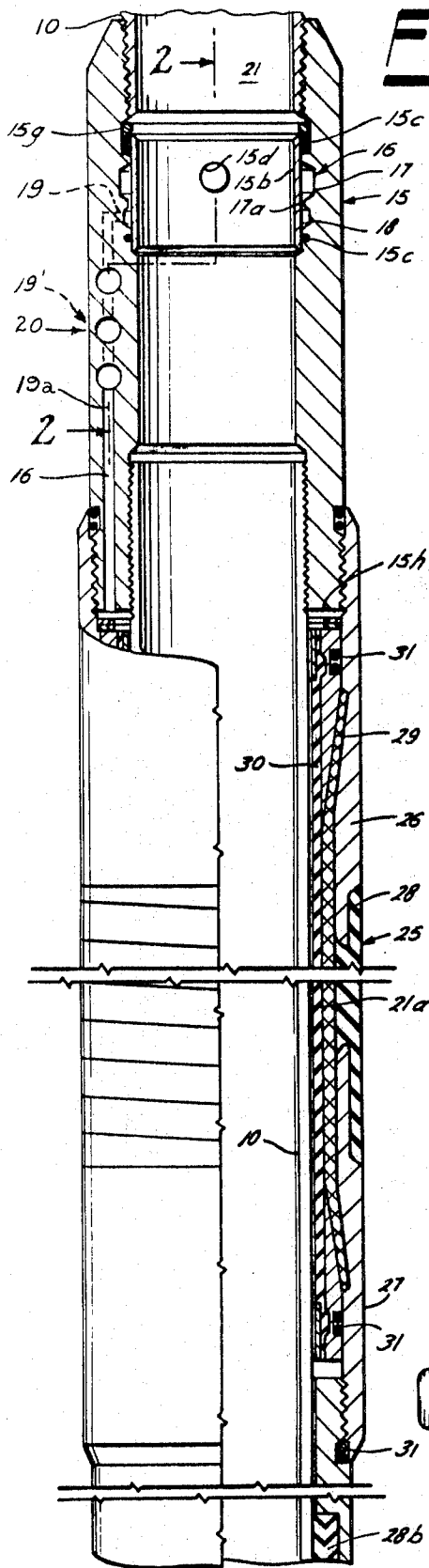


Fig. 1

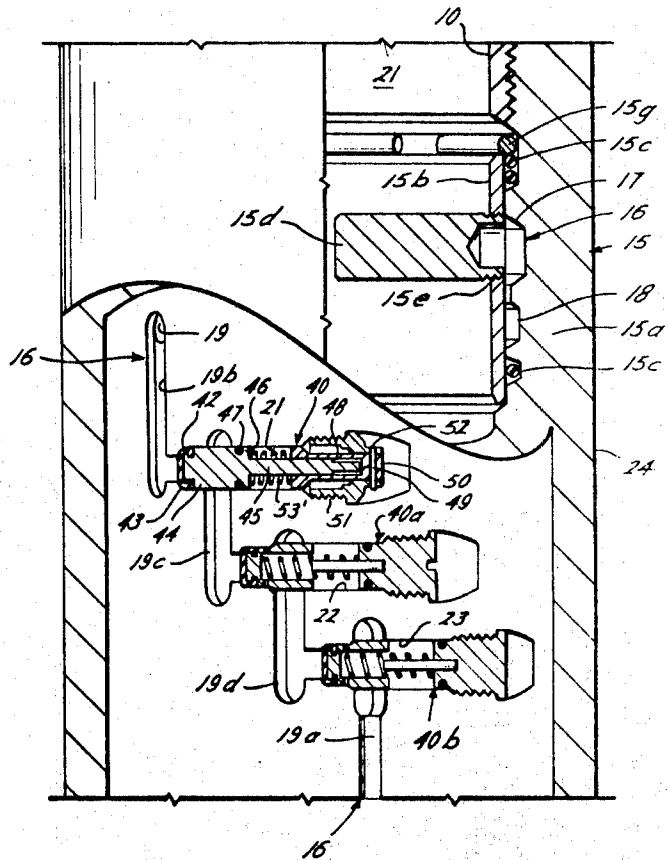


Fig. 2

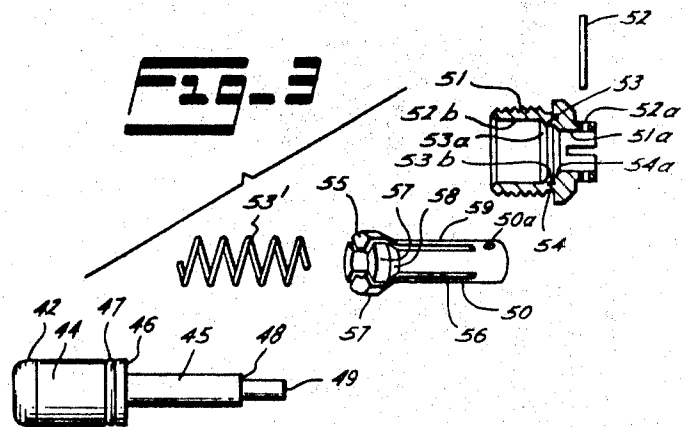


Fig. 3

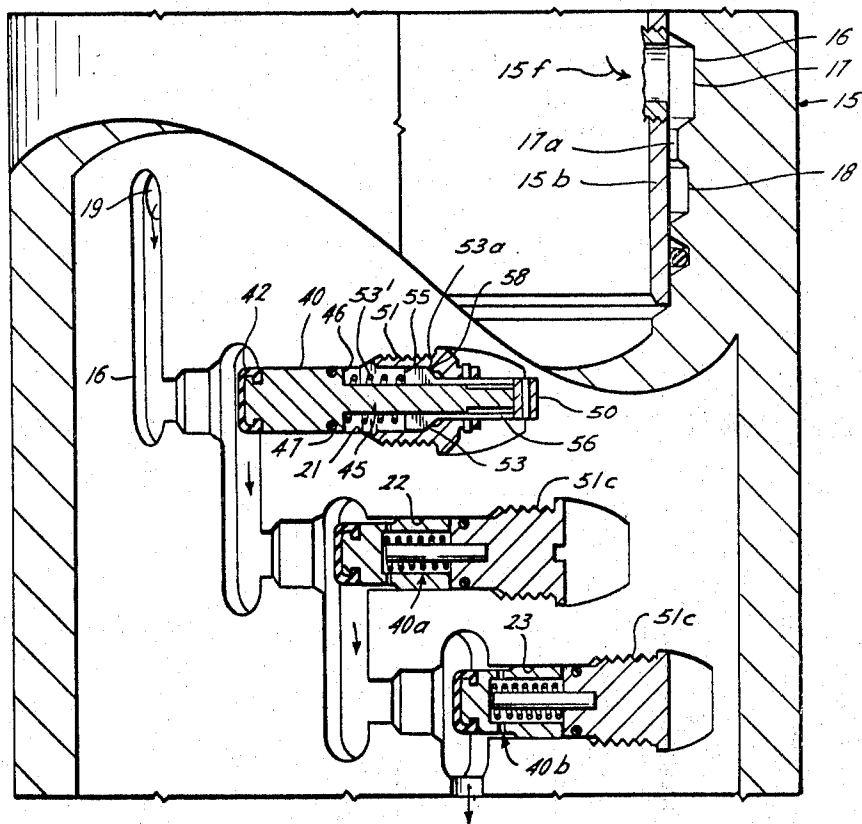


Fig. 4

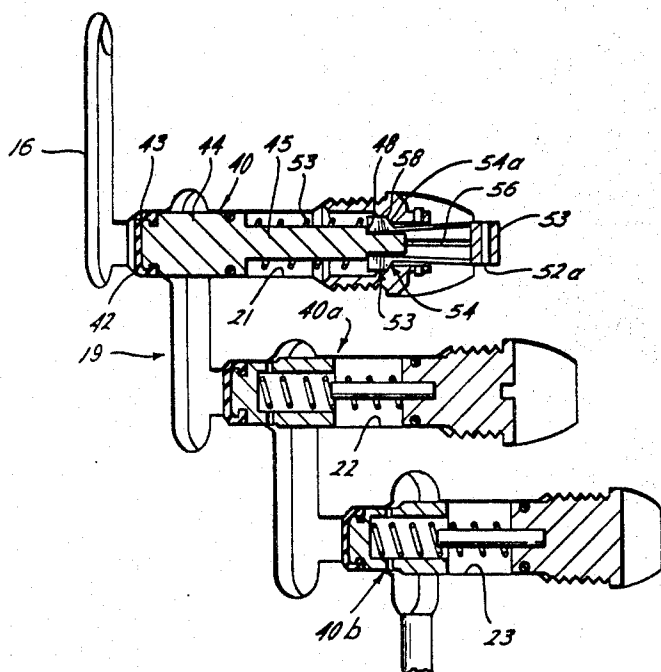


Fig. 5

SAFETY VALVE ARRANGEMENT FOR CONTROLLING COMMUNICATION BETWEEN THE INTERIOR AND EXTERIOR OF A TUBULAR MEMBER

CROSS REFERENCE TO RELATED APPLICATION

This is a division of application, Ser. No. 172,447 filed on Aug. 17, 1971, now U.S. Pat. No. 3,776,308 for Safety Valve Arrangement for Controlling Communication Between the Interior of a Tubular Member and an Inflatable Element Externally on the Tubular Member.

DESCRIPTION OF THE PRIOR ART

In U.S. Letters Pat. No. 3,437,142, there is disclosed an inflatable packer for external use on tubular members such as casing, liners, and the like. A valving arrangement is disclosed therein for containing fluid within the interior of the inflatable member after it has been inflated to prevent its return to the tubular member.

In some instances it is desirable to prevent any further communication between the interior of the tubular member and the interior of the inflatable element after the inflatable element has been inflated and set in a well bore. For example, should the packer rupture or should a leak occur therein, the valving arrangement of the above-identified patent will not necessarily preclude the possibility of fluid communication internally of the tubular member to the exterior thereof through the damaged inflatable element. Even in those instances, where an inflatable element is set with cement therein or some other type of substance such as a plastic, this still would not preclude communication to the exterior of the tubular member into the surrounding well bore through the damaged or ruptured inflated element.

While the valving arrangement of the above-identified invention is satisfactory for the purposes intended as disclosed therein, in those instances where it is desired to prevent communication between the interior and exterior of the tubular member on which the inflatable element is carried, the present invention may be employed to permit inflation of the inflatable element and to thereafter seal off communication between the interior of the tubular member and the interior of the inflatable element carried on the exterior of the tubular member to reduce, if not eliminate, the possibility of any fluid communication should any damage or leakage later occur in the inflated element externally positioned on the tubular member.

SUMMARY OF THE INVENTION

Briefly, the present invention relates to a valving arrangement for use primarily in connection with an external inflatable element such as disclosed in U.S. Letters Pat. No. 3,437,142. It can be appreciated, however, that the present invention may be employed in connection with any well tool wherein it is desired to control communication between the interior of the tubular member and externally thereof.

The present invention is constructed and arranged so that valve means remains seated to prevent communication between the interior of the tubular member and the interior of an inflatable element carried on the exterior of the tubular member until a predetermined pres-

sure has been reached. This reduces the possibility of premature inflation of the inflatable element by sudden changes or pressure surges which may occur within the tubular member as the tubular member is being positioned in a well bore.

After the valve arrangement of the present invention has been opened to accommodate fluid passage from the interior of the tubular member to the interior of the inflatable element positioned on the exterior of the tubular member, it is constructed and arranged so that when a predetermined pressure relationship between the interior of the tubular member and the exterior thereof is reached, the valve will move towards seated position, and means are provided for locking the valve in seated, closed position to prevent any further communication in the fluid passage between the interior of the tubular member and the interior of the inflatable element carried on the exterior thereof. This closes off the passage to any fluid communication between the interior and exterior of the tubular member.

An object of the present invention is to provide a valving arrangement for communicating fluid from the interior of a tubular member to the exterior thereof including means to maintain the valve closed until the application of a predetermined pressure thereof, means to urge the valve towards reseating when the pressure differential between the interior of the tubular member and exterior thereof reaches a predetermined amount, and means for locking the valve in seated position when the pressure differential between the interior and exterior of the tubular member reaches a predetermined amount.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a sectional view partly in elevation illustrating the form of the valve arrangement of the present invention in connection with its use with an inflatable element positioned on the exterior of a tubular member;

FIG. 2 is an enlarged partial cutaway view on the line 2—2 of FIG. 1 illustrating in greater detail the preferred form of the valving arrangement of the present invention;

FIG. 3 is an exploded view illustrating the components of the portion of the valve means employed with the present invention;

FIG. 4 is a view similar to FIG. 2 but illustrates the position of the valving means after having moved towards open position to accommodate fluid flow from the interior of the tubular member to the interior of the well tool such as the inflatable element as illustrated in FIG. 1 positioned externally of the tubular member; and

FIG. 5 is a schematic representation showing the position of the valve means after the valve means have been reseated and locked in position to prevent any further fluid communication between the interior and exterior of the tubular member through the fluid passage means.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Attention is first directed to FIG. 1 of the drawings wherein a tubular member 10 such as a casing or the like is illustrated. A valve housing referred to generally by the numeral 15 is secured by suitable means such as threads as illustrated in FIG. 1 with the tubular member

10 and incorporated therein is an arrangement illustrated generally at 20 for communicating fluid from the interior 21 of the tubular member 10 and valve housing 15 to the interior 21a of the reinforced inflatable element referred to generally at 25 carried externally on the tubular member.

The present invention is described in detail in connection with its use wherein it is desired to communicate fluid from the interior 21 of the tubular member 10 to the interior 21a of the inflatable element 25 positioned externally on the tubular member 10. The inflatable element includes the spaced annular heads 26 and 27, the head 26 being secured to the valve housing 15 at its upper end and the inflatable element 25 extends between the heads 26 and 27. The inflatable element may be of any suitable length and is provided with an elastomer outer cover 28, a reinforcing 29, and an inner tube 30 which extend between the spaced annular heads 26 and 27. The tubular member 10 is connected to the lower end of the valve housing 15 by suitable means such as threads and extends downwardly through the inflatable element 25 as shown in FIG. 1. Suitable seal means as illustrated at 31 are provided in the head 27 of inflatable element 25 to inhibit leakage therefrom.

A first fluid passage means identified generally at 16 is formed on the valve housing 15 and includes the annular groove 17 formed on the inner surface of the valve housing 15; the annular groove 18 in the valve housing; the annular passage 17a between grooves 15 and 18; the port 19 extending partially through the wall of the valve housing 15; and the passage portions 19' and 19a which extend through the valve housing 15 between the inner and outer walls thereof as generally illustrated in FIGS. 1 and 2 of the drawings.

The portion 19' of first passage means 16 includes a first portion 19b, a second portion 19c, and a third portion 19d which extend as shown in FIG. 2 and are circumferentially spaced in the wall 15a of valve housing 15. The passage portion 19b communicates with the port 19; passage portion 19c communicates with portion 19b and portion 19d; and passage portion 19d communicates with passage portion 19a.

As illustrated, a plurality of second passage means 21, 22, and 23 each extends partially through the wall 15a of the valve housing from the exterior surface thereof represented at 24 and interrupt the fluid passage 16 at the portion 19 thereof at spaced intervals as illustrated in FIG. 2. Valve means referred to generally at 40, 40a, and 40b are provided in each of the second passage means 21, 22, and 23, respectively.

The valve means 40 arranged in second passage means 21 includes an end portion 42 provided with an elastomer for engaging on the seat 43 formed between passage portions 19b and 19c of first passage means 16. The valve body 44, as illustrated, is cylindrical in configuration and is reduced in size at a point spaced from the end portion 42 to form a valve stem 45 and a first shoulder 46 on the valve stem at the juncture of the valve body and the valve stem 45. Suitable seal means 47 are arranged on the valve body 44 between the end portion 42 and first shoulder 46 for sealing with the second passage means 21 as shown in FIG. 2 of the drawings.

A second shoulder 48 is provided on the valve stem spaced from the shoulder 46 and from the end 49 of the valve stem 45. A collet 50 better illustrated in FIG. 3

of the drawings surrounds the valve stem adjacent one end with the end 49 of the valve stem abutting the inner end of the collet 50.

Means are provided for retaining the valve means 40 in the second passage means 21, such means being illustrated in the form of an annular retainer housing 51 which may be secured in the outer end of the second passage means by any suitable means such as threads or the like as illustrated in the drawings.

A shear pin 52 extends through the end of the retainer housing means 51 and the end of the collet means as shown in FIG. 2 to retain valve means 40 in seated position on the seat 43 to block off fluid flow in passage means 16 from the interior 21 of the tubular member 10 to the interior 21a of the inflatable element 25. Spring means 53 surround valve stem 45 with one end of the spring abutting the shoulder 46 and its other end abutting the end 55 of the collet, such spring means being forced to a collapsed position as illustrated when the valve means 40 is in the position as illustrated in FIG. 2 of the drawings.

As more clearly seen in FIG. 3 of the drawings, the shear pin 52 is adapted to be received through an opening 52a formed in the retainer housing means 51, and an opening 50a in collet 50 and the strength of shear pin 52 will determine the amount of fluid pressure necessary in passage 16 to unseat the valve 40 and permit fluid flow through the passage means 16 from the interior of the tubular member 10 to the interior of the inflatable element 25. The retainer housing 51 is provided with a bore 51a extending from one end for receiving the end of the collet 50 which surrounds the stem 45, and also includes an enlarged counterbore 52b extending from the other end of the collet. At the end of the counterbore 52b there is formed a first shoulder 53 having an inwardly tapered surface 53a as shown in FIG. 3. At the inner end of the surface 53a there is a second counterbore 53b of reduced diameter relative to counterbore 52b, but larger than bore 51a. This second counterbore along with annular inwardly tapered surface 54a which extends from second counterbore 53b form a second shoulder 54 immediately adjacent one end of bore 51a. Thus, the second shoulder 54 is spaced radially inwardly towards the longitudinal center line through the counterbore 52b and opening 51a of the retainer housing 51 relative to first shoulder 53 for a purpose as will be described in greater detail hereinafter.

The collet 50 includes a plurality of longitudinal slots 56 which extend from a point spaced from one end of the collet 50 to the other end. Enlarged cylindrical ends 57 are provided on the other end of the collet 50, and each of the cylindrical ends 57 has a sloping surface 58 sloping downwards towards the cylindrical surface 59 of the collet 50. The longitudinally extending slots 56 are wide enough to permit the collet to collapse or to flex inwardly relative towards the valve stem 45 for a purpose to be described hereinafter.

It will be noted that the valve housing 15 is provided with a cylindrical bore and suitable sleeve means 15b are provided within the bore to retain the seals 15c in position to inhibit leakage into the passage means 16. The sleeve 15b may be retained by spring 15g. The first fluid passage means 16 may be closed off by any suitable means such as the plug 15d which may be threaded in the opening 15e of the sleeve 15b adjacent the annular groove 17 in the valve housing 15. When the closure

15d is employed, it can be appreciated that any communication between the interior of the tubular member 10 and the fluid passage means 16 is inhibited. This prevents pressure variations or pressure surges from acting through the passage means 16 and unseating the valve means 40 which might prematurely inflate the element 25.

When it is desired to actuate the device and communicate fluid to the interior 21a of the inflatable member 25 carried on the exterior of the casing, or tubular member 10, any suitable means may be dropped through the casing 10 so as to break or shear the closure 15d to thereby permit fluid communication with the annular groove 17 of the first passage means 16 in the valve housing 15 as illustrated by the arrow 15f in FIG. 4 of the drawings. Thereafter, fluid may be communicated through the groove 17, annular passage 17a, groove 18, and to the passage portion 19, port 19 forming a part of the fluid passage means 16 which, as noted previously, is formed between the inner and outer walls of the valve housing 15. Such fluid pressure then acts upon the end portion 42 of the valve means 40, and the pressure within the tubular member 10 may be increased so as to shear the pin 52 whereupon the valve means 40 moves to the position illustrated in FIG. 4 of the drawings. When this occurs, the valve means 40 moves longitudinally of the second fluid passage means 21 and its valve stem 45 as well as the collet 50 surrounding the end thereof move outwardly through the opening 51a of the valve retaining housing 51 as illustrated in FIG. 2 of the drawings. When this occurs, the sloped surfaces 58 on the collet 50 engage the annular tapered surface 53a of first shoulder means 53 in the valve retaining housing or means 51 as shown in FIG. 3 of the drawings. The movement of the valve 40 also collapses the spring 53 between the shoulder 46 formed at one end of the valve stem 45 and the end 55 of the collet. As illustrated in the drawings, additional valves 40a and 40b are provided in each of the second fluid passage means 22 and 23, respectively. A retainer housing 51c of slightly different configuration is provided for each of the valves 40a and 40b, the valves 40a and 40b being in the form of spring loaded check valves as illustrated.

Since the shear pin 52 retains the valve 40 closed until a predetermined pressure is built up in the passage 16 acting on the end 42, opening of the valve 40 enables the inflatable element to be supplied with a surge of inflating pressure fluid so that it may inflate rapidly. As the inflatable element 25 inflates, the lower annular head 27 moves along the exterior surface of the tubular member 10, and to inhibit leakage of fluid from the interior of the inflatable element, suitable seals as illustrated at 28b are provided in an extension of head 27 for sealing with the exterior surface of the tubular member 10 as expansion of the inflatable element 25 occurs.

Fluid is conducted from tubular member 10 to the interior of the inflatable element 25 until inflation thereof is accomplished.

Valve 40 will remain in open position until the pressure exteriorly of the tubular member 10 approaches the pressure interiorly of the tubular member 10 that is supplied through the fluid passage 16. It will be noted that pressure exteriorly of the tubular member may act on the valve member 40 in conjunction with spring 53 to tend to close it, and when the spring pressure plus

the pressure externally of the tubular member 10 acting on the seal 47 equals or exceeds the pressure within the first fluid passage means 16, the valve means 40 will be moved towards seating position. When this occurs, the spring 53 will act to move the collet 50 longitudinally along the valve stem until the tapered surfaces 58 thereon engage the annular tapered surface 54a of the second shoulder means 54, and when this occurs, the collet means 50 is collapsed radially inwardly as illustrated in FIG. 4 of the drawings so that the end 55 of the collet engages the second shoulder 48 formed on valve stem 45. When this occurs, the valve means 40 is then locked in closed, seated position to prevent any further communication in the passage means 16 from the interior of the tubular member 10 to the exterior of the tubular member 10 and the interior of the inflatable element 25.

It will be noted that the passage portion 19a of first passage means 16 terminates at the end 15h of the valve housing. The fluid from passage portion 19a then passes to the interior of inner tube 30 which surrounds the exterior of tubular member 10 extending from the valve housing 15.

It can be appreciated that if any damage should occur to the inflatable element at a later date so as to cause leakage therefrom, such leakage will be prevented from communicating with the interior of the tubular member 10 since the valve member 40 is locked in seated closed position. Also, no well fluids will be communicated to the interior of the tubular member.

The inflatable element may be inflated with cement, liquid, plastic, or gas, and the present invention will still function to prevent communication should a leak ever occur in the inflated element.

The foregoing disclosure and description of the invention are 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 without departing from the spirit of the invention.

What is claimed is:

1. An arrangement for controlling fluid communication between the interior and exterior of a tubular member comprising:

- a. valve housing means adapted to be supported by the tubular member;
- b. there being passage means in said valve housing for communicating fluid therethrough;
- c. valve means to close off communication through the passage means until the fluid pressure in the passage means exceeds a predetermined amount whereupon said valve means opens; and
- d. valve locking means associated with said valve means for thereafter locking said valve means in closed position to close off communication through said passage means.

2. An arrangement for controlling fluid communication between the interior and exterior of a tubular member comprising:

- a. valve housing means adapted to be supported by the tubular member;
- b. there being passage means in said valve housing means for communicating fluid therethrough;
- c. valve means for controlling fluid flow through the passage means, said valve means including a valve stem;

- d. said valve means including means to close off communication through the passage means until the fluid pressure in the passage means exceeds a predetermined amount whereupon said valve means opens to communicate fluid therethrough; and 5
- e. valve locking means responsive after said valve means has been opened and then moved to closed position for locking said valve in closed position.
3. The invention of claim 2 wherein said valve back- 10
ing means includes:
- a. valve retaining means in said valve housing and having a bore therein;
- b. collet means in the bore of said valve retaining means surrounding said valve stem and abutting an 15
end thereof; and
- c. shear pin means engaging said collet means and said valve retaining means together to hold said valve in closed position.
4. The invention of claim 2 including: 20
- a. valve retaining means in said valve housing and having a bore therein;
- b. first and second shoulders formed in the bore of said valve retaining means with said second shoulder being spaced radially inwardly relative to said 25
first shoulder;

- c. first and second shoulder means on said valve stem;
- d. collet means surrounding said valve stem at one end thereof, said collet means engaging said first shoulder in the bore of said valve retaining means when said valve is opened;
- e. spring means surrounding said valve stem and at one of its ends abutting said first shoulder on said valve stem and at its other end abutting said collet, said spring means being collapsed between said first shoulder on said valve stem and said collet when said valve is opened and said spring means moving said valve means towards seating position when the pressure externally of the tubular member reaches a predetermined relationship relative to the pressure internally of the tubular member and also urging said collet longitudinally of the bore in said valve retaining means to engage said second shoulder in the bore of said valve retaining means thereby collapsing said collet toward said valve stem whereupon it engages said second shoulder on said valve stem when said valve closes to thereby lock said valve in closed position.

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