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[54] **WELL PACKER VALVE ARRANGEMENT**

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[73] Assignee: **Completion Tool Company**, Houston, Tex.

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Related U.S. Patent Documents

Reissue of:

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[51] **Int. Cl.**[4] **F16J 15/46**; E21B 33/12

[52] **U.S. Cl.** **277/34**; 277/31; 166/122; 166/187

[58] **Field of Search** ..... 277/3, 30, 31, 34, 34.3, 277/34.6; 166/120, 122, 141, 151, 166, 187, 212, 244 R

[56] **References Cited**

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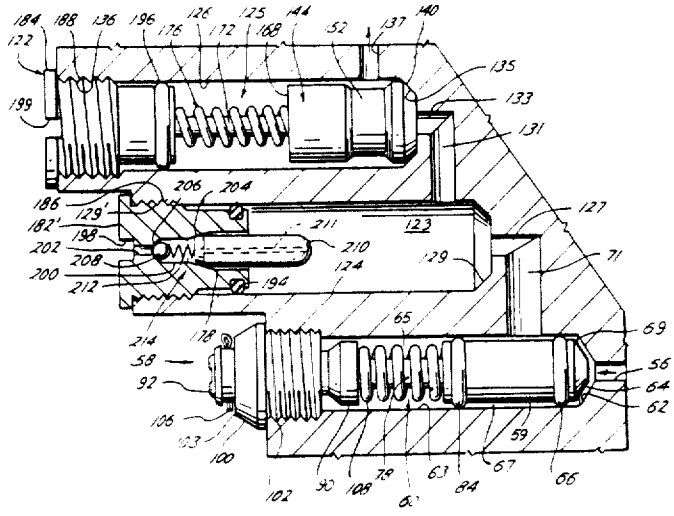
Primary Examiner—Robert S. Ward, Jr.

[57] **ABSTRACT**

A valve system for use in inflating packers mounted on mandrels. The valve system uses one or more valves to permit, through the use of seals, the flow of fluid from the interior of a tubular mandrel to the interior of the inflatable packer when pressure applied in the mandrel exceeds at least a minimum pressure. The differential pressure across reciprocating seals is minimized through exposure of one or both sides, directly or indirectly, to the external pressure of the mandrel and packer, the exposure including the use of a check valve to permit flow from the exterior of the mandrel.

7 Claims, 4 Drawing Figures



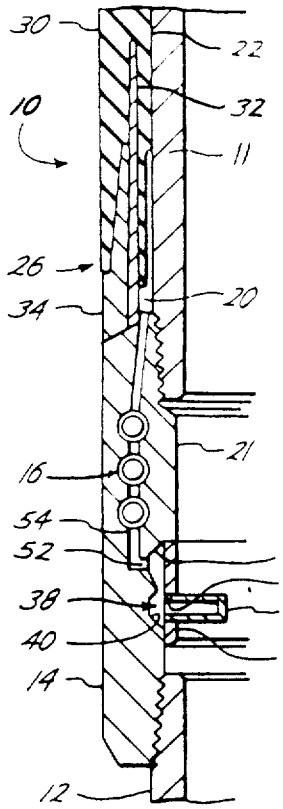


Fig. 1

Fig. 2

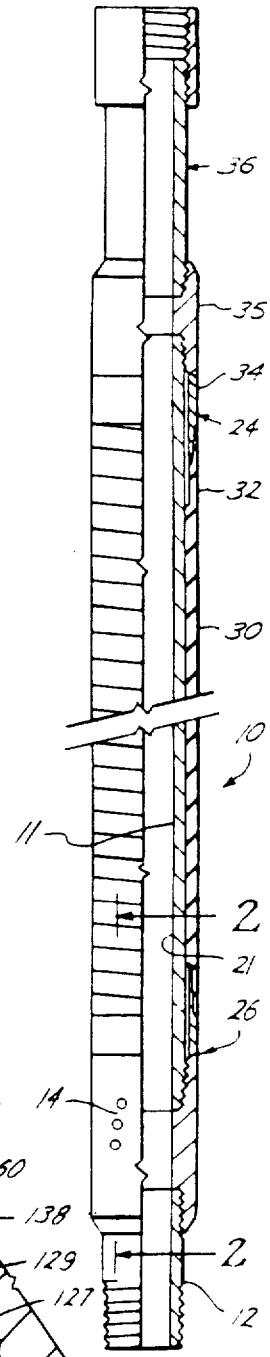
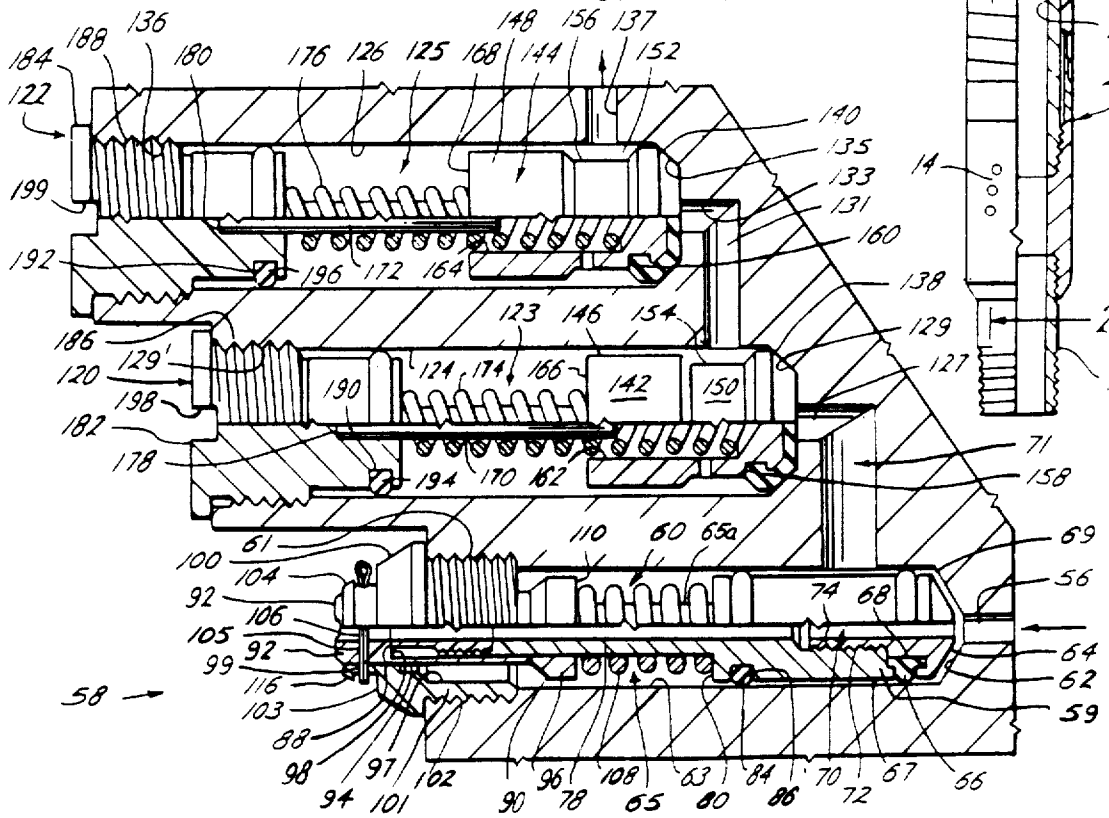


Fig. 3

PRIOR ART



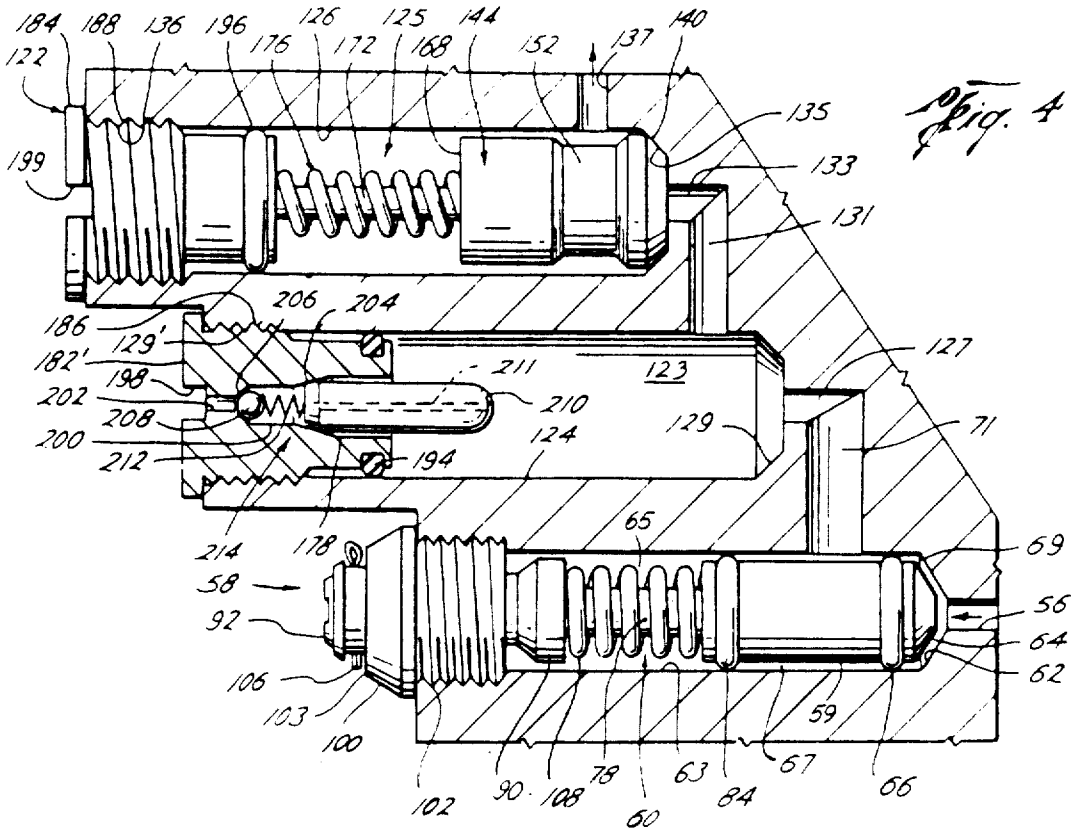

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Fig. 4

WELL PACKER VALVE ARRANGEMENT

Matter enclosed in heavy brackets [ ] appears in the original patent but forms no part of this reissue specification; matter printed in italics indicates the additions made by reissue.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to packer inflation systems and more particularly to the valves which control the inflation of packers.

2. Description of the Prior Art

The control of the inflation of well packers is important to obtain integrity between the packer and the well bore for purposes of working within the bore. It is known in the art to inflate packers by various mechanisms. See, for example, U.S. Pat. No. 3,503,445, issued Mar. 31, 1970, to K. L. Cochran et al., entitled "Well Control During Drilling Operations"; U.S. Pat. No. 3,351,349, issued Nov. 7, 1967, to D. V. Chenoweth, entitled "Hydraulically Expandable Well Packer"; U.S. Pat. No. 3,373,820, issued Mar. 19, 1968, to L. H. Robinson, Jr. et al., entitled "Apparatus for Drilling with a Gaseous Drilling Fluid".

In U.S. Pat. No. 3,437,142, issued Apr. 8, 1969, to George E. Conover, entitled "Inflatable Packers for External Use on Casing and Liners and Method of Use", there is disclosed an inflatable packer for external use on tubular members such as casings, 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.

Arrangements of valving have been known in the prior art to prevent 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. See, for example, U.S. Pat. No. 3,427,651, issued Feb. 11, 1969, to W. J. Bielstein et al., entitled "Well Control"; U.S. Pat. No. 3,542,127, issued Nov. 24, 1970, to Bill C. Malone, entitled "Reinforced Inflatable Packer with Expansible Back-up Skirts for End Portions"; U.S. Pat. No. 3,581,816, issued June 1, 1971, to Bill C. Malone, entitled "Permanent Set Inflatable Element"; U.S. Pat. No. 3,818,922, issued June 25, 1974, to Billy C. Malone, entitled "Safety Valve Arrangement for Controlling Communication Between the Interior and Exterior of a Tubular Member"; and U.S. Pat. No. 3,776,308, issued Dec. 4, 1973, to Bill C. Malone, entitled "Safety Valve Arrangement for Controlling Communication Between the Interior and Exterior of a Tubular Member".

Inflatable packers have also been used in other operations, such as sealing the annular space between a jacket and a piling. See for example U.S. Pat. No. 4,063,427, issued Dec. 20, 1977, to Erwin E. Hoffman, entitled "Seal Arrangement and Flow Control Means Therefor".

The seals that are used in valves, such as in Malone, are usually hardened rubber. Such rubber tends to extrude under extreme pressure differential across the rubber and cause friction between rubber and metal that adversely affects valve operation. None of the prior art, however, provides for mechanism for equalizing pressures across the seals of the valves used to inflate packers to prevent such extrusion.

SUMMARY OF THE INVENTION

The present invention utilizes a unique arrangement of sealing mechanisms in conjunction with a valve or valves to permit the inflation of an inflatable packer element while at the same time equalizing pressure around the rubber seals of the valve or valves to prevent distortion of the seals from undue high differential pressure, and the resulting friction.

The present invention, like the prior art, is constructed and arranged so that the valve or valves remain seated to prevent communication between the interior of a tubular member and the interior of an inflatable element carried on the exterior of the tubular member until at least a predetermined pressure has been reached. This reduces the possibility of premature inflation of the inflatable element by sudden pressure changes or pressure surges which may occur within the tubular member as the tubular member is being positioned within a well bore.

However, the valve arrangement of the inflation system of the present invention includes an appropriate check valve arrangement of a portion of the valve structure to compensate for bore pressure to prevent extrusion from undue high differential pressures across the seals of certain rubber seals which must move in the valving operation.

BRIEF DESCRIPTION OF THE DRAWINGS

For a further understanding of the nature and objects of the present invention, reference should be had to the following detailed description, taken in conjunction with the accompanying drawings, in which like parts are given like reference numerals and wherein:

FIG. 1 is a cross-section of a packer showing the three-valve collar for inflation of the packing;

FIG. 2 is an enlarged cross-section of the valve arrangement of FIG. 1 taken along section line 2—2 of FIG. 1;

FIG. 3 is an enlarged cross-sectional view of the three valves of a three-valve arrangement within the three-valve collar of the prior art; and

FIG. 4 is an enlarged cross-sectional view of three valves of a three-valve arrangement of the present invention within the three valve collar.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

A tubular [member] *inflatable packer* **10** is shown in FIGS. **1** and **2**. This type of [member] *packer* could be used for any of the embodiments of the present invention and is specifically illustrated for embodiments **1** and **2**, [and may be] *as* a casing packer. [Member] *The tubular inflatable packer* **10** includes a short casing joint or casing sub **12** for connection to other tubular members and is secured by suitable means, such as threads as illustrated in FIG. **1**, to a valve collar **14** secured to [the body] *a tubular pipe member or mandrel* **11** [of the tubular member **10**]. It should be noted that *in one aspect of the present invention*, the valve collar **14** could also be and is preferably secured to [the] *a* sub **36** [of] *at the* other end of [body] *the tubular pipe member* **11** [shown in FIG. **1**]. [Valve] *The valve* collar **14** includes *a* valve mechanism **16** *or system of valves and passageways* (*See* FIG. **2**) for [communicating] *placing* fluid [from the interior **21** of tubular member **10** to

the] *in a bore or interior 21 of the pipe member 11 in fluid communication with a* fluid channel *or chamber* **20** (*See* FIG. 2) [leading to the] *under an* inflatable[, or] packing[,] element [**22**] *30* carried externally on *the* tubular *pipe* member [**10**] *11*.

The inflatable *packing* element [**22**] *30* includes spaced apart *upper and lower* annular packer heads **24**, **26**. [Lower] *The lower packer* head **26** is secured to *the* valve collar **14**[. Upper] *while the upper packer* head **24** is secured to *a* top *or upper* collar **35**. [Inflatable] *The inflatable packing* element [**22**] *30* extends between *the packer* heads **24**, **26** and is also secured to [mandrel **28**] *the pipe member 11* which extends along the inside surface of *the packing* element [**22**] *30* between *the* valve collar **14** [to] *and the* upper collar **35** [where mandral **28** is connected by threading or other means]. The inflatable *packing* element *30* may be of any suitable length and is [provided with] an elastomer cover [**30**] and [two sets of] *with upper and lower sets of* steel anti-extrusion ribs **32**. [Ribs] *The ribs* **32** are connected to the *elastomer* cover [**30**,] such as, for example, [vulcanized into the rubber, and extend therein.] *by vulcanizing the elastomer cover to the ribs 32 so that the ribs 32 extend into the ends of the elastomer cover.* Each set of ribs **32** is connected to a steel back-up sleeve **34**, and one set *of ribs* is connected to *the* valve collar **14** while the other set *of ribs* is connected to *the upper valve* collar **35**. [Sleeve] *The back-up sleeve* **34** is also connected to [packing element **22**,] *the elastomer cover,* such as vulcanized with the rubber, and to *the* valve collar **14**. [A] *The tubular* sub **36** is connected to the [other portion of] *upper* collar **35** for use with other tubular members *in a string of pipe or casing (not shown).*

[A] *As shown in FIG. 2, a* first set of *annular* grooves **38** is formed [on] *in the* valve collar **14**. The set of grooves **38** includes internal, circumferential *annular* grooves **40**, **42** [formed in valve collar **14**. Grooves **40**, **42** are partially] *spaced longitudinally apart from one another and* covered by *a* juxtaposed screen sleeve **44**. [Sleeve] *The screen sleeve* **44** includes a hole **46** [covered by] *which receives* a knock-off rod *or plug* **50**, usually *constructed* of plastic, to isolate the valve system from *fluid under* pressure in the [interior] *bore* **21** of the [member **10**] *pipe member 11* during running *of the inflatable packer 10 into a well bore containing fluid.* .

[Groove **42** terminates in] *A* port **52** [extending] *extends* partially through the wall of the valve collar **14** and [connecting to] *connects a* passageway **54**[. Passageway] *to the groove 42. The passageway* **54** extends along the center of *the* valve collar **14** [to] *between a port 56 to a valve in the valve mechanism 16 and* the port [**56** of the valve system] *52 (See FIG. 3).*

—PRIOR ART—

[Shear] *In a prior art valve mechanism as shown in FIG. 3, a shear* valve **58** [(FIG. 3, FIG. 4)] is in fluid communication with *the* port **56** [via insertion of], *the shear* valve **58** *being* in *a valve* pocket **60**[. pocket **60**] *formed by a cylindrical bore 63 in the wall of the valve collar. The shear valve 58 includes a movable valve element or valve body 59 slidably disposed in the valve pocket 60. The valve pocket 60 is* formed in *the* valve collar **14** by drilling [of] *or* other means. [Valve] *One end of the valve* pocket **60** is in fluid communication with *the* port **56**[. Pocket **60** forms] *and this end of the valve pocket 60 has an* angled valve seat **62** [at the end of pocket **60** in direct fluid communication with] *disposed around the* port **56**. The [other] *open* end of *the valve* pocket **60** [is threaded with] *has* threads **61**. [Pocket **60** is cylindrical in shape having upper surface **63** of one] *The movable valve element 59 has a cylindrical first surface 65a with a first* diameter [in] *forming an* upper *or first* chamber **65** *with the surface wall of the valve pocket 60* and [coaxial lower] *has a cylindrical second* surface **67** [of] *with* a second, [smaller] diameter [in] *forming a* lower *or second* chamber **69**[. Upper] *with the surface wall of the valve pocket 60. The lower or second* chamber [**63**] *69* has an opening to *a* lateral passageway **71** [at one end] which extends further into *the* valve collar **14**.

[Valve **58** includes a cylindrical shaped] *The movable valve element or valve* body **59** [with] *defining the cylindrical second surface 67 terminates at* an end portion **64** shaped to [fit in] *compliment the valve* seat **62**. A T-seal, or other suitable seal[,] **66** is [included along] *disposed on* the [circumference **73** of] *second surface 67 the valve* body **59** in *a* groove **68** [of] *near the* end portion **64**. [Seal] *The seal* **66** is adapted to engage the *surface* wall [**67** of] *of the valve pocket in* the lower *or first* chamber **69**[substantially parallel to the circumference **73**]. [A threaded] *The movable valve element or valve body 59 has a* bore **70** [having] *with* internal threads **74** [is formed longitudinally along the lower portion of body **59**. End **64** is connected by] *to connect to the end portion 64 by virtue of* external threads **72**, or other suitable means[, to internal threads **74** of the longitudinal bore **70**]. The *movable valve element or* valve body **59**, as illustrated, is reduced in size at the end opposite to *the* end portion **64** to form a valve stem **78** with a first shoulder **80** [formed at the juncture of valve stem **78** and] *on* the valve body **59**. A suitable seal **84**, such as an O-ring, is arranged in *a* groove **86** on [the upper] *a* portion of *the* valve body **59** between the end portion **64** and *the first* shoulder **80**. [Seal] *The seal* **84** is adapted to seal against the [upper] surface [**63** of upper chamber **65** of pocket **60**] *wall* and *the* groove **86**[.] *and separate the upper or first chamber 65 from the lower or second chamber 69.*

[Valve] *The valve* stem **78** terminates at [its top] *an end* **88** which [is adjacent] *abuts an end surface 98 in a sleeve 94 in a* collet **90**. [Collet] *The collet* **90** has *a* thick top section **92** and an elongated *tubular* sleeve **94** terminating in bell-shaped, lower section **96**. [Sections **92** and **94** form an inner end **98** which abuts stem top **88**. Collet] *The collet* **90**, which abuts *the* valve stem **78** at [its inner end] *the surface* **98**[,] is retained in *the valve* pocket **60** by *an* annular retainer housing **100** which annularly surrounds *the* collet **90**[. Annular] *and a shear pin 106 which interconnects the retainer housing 100 to the collet 90. The annular* retainer housing **100** has a base **101** with threads **102** [formed on the outer circumference thereof. Threads **102**] *which* mate with *the* threads **61** [which secured] *of the valve pocket 60 and secured the retainer* housing **100** to *the valve* pocket **60**. [Housing] *The retainer housing* **100** further has a bore **97** formed through *its* base **101** to receive *the* collet **90** and an opening **116** [at its top] through which *the top* section **92** *of the collet 90* extends.

[A] *The* shear pin **106** extends through a bore **99** in *a* notch **103** in [the] *an* end **104** of the retainer housing **100** and a bore **105** in the end **92** of *the* collet **90** as shown in FIGS. **3** and **4** to retain *the* valve [**58**] *body 59* in the seated position with *its* end portion **64** adjacent *the valve* seat **62** [to] *so that the seal 66 will* block off [fluid flow through] *fluid and pressure from the* port **56** [from] *and* the [interior **18**] *bore 21* of the tubular *pipe* member [**10**] *from access* to the *passageway 71 and*

hence prevent fluid or pressure from reaching the fluid channel **20** leading to the interior of the inflatable *packing* element **30** [via passageway **71**]**30**.

A spring **108** [surrounds] *is disposed on the* valve stem **78** with one end of the spring abutting the shoulder **80** and the other end *of the spring* abutting [the] *an* end **110** of the collet **90**, such spring **108** being forced to a collapsed position as illustrated when the valve *body 59* is in the position as shown in [FIGS. **3** and **4**] *FIG. 3* of the drawings.

The strength of shear pin **106** will determine the minimum amount of fluid [differential] pressure necessary in *the* port **56** to unseat the valve *body 59 and to open the shear valve* **58** and *to* permit fluid flow through the port **56** from the [interior of tubular] *bore 21 of pipe* member [**10**] *11* to the interior of [packer] *packing* element **30**.

[Seals] *The seals* **66**, **84** are positioned *on the valve body 59* such that when the valve [**58**] *body 59* is in the seated position as shown in [FIGS. **3** and **4**] *FIG. 3*, the seals **66**, **84** prevent any fluid flow [from] *or pressure in the* port **56** [to] *from reaching the* pasageway **71**. [They] *The seals 66, 84* also prevent the flow of any fluids *or pressure* from the exterior of *the valve* collar **14** [in contact with] *from reaching the passageway 71. Fluid in* the bore hole [which leak through] *by the* threads **102** and past *the* collet **90** in *the* housing **100** *and* into *the* upper *or first* chamber **65** [to flow into passageway **71**]. In addition, when the valve [**58**] *body 59* is in the seated position, *the* shoulder **80** *on the valve body 59* is separated from *a* bottom **110** *of the collet 90* by a sufficient distance [such] *so* that when the valve [**58**] *body 59* is no longer in the seated position [but] *then the* shoulder **80** is as close to *the* shoulder **110** as the [springs] *spring 108* will allow[,] *and the* seal **66** is positioned above *the* passageway **71**[.] *so that fluid and pressure is admitted to the passageway 71 from the port 56.*

In FIG. **3**, *the check* valves **120** and **122** are substantially identical in construction. [Valves] *The check valves* **120**, **122** are located in *valve* pockets **123**, **125** respectively. Each *valve* pocket **123**, **125** is *formed by a cylindrical bore and is* substantially cylindrical in shape with walls **124**, **126** respectively formed by drilling or other suitable means [of opening with] *and each valve pocket 123, 125 opens at* one end at the exterior outer surface of *the* valve collar **14**. The other end of *the valve* pocket **123** terminates at *a* port **127** *which places the valve pocket 123* in fluid communication with the [pocket **123** and] passageway **71**. [Pocket] *The valve pocket* **123** [forms] *is formed with an* angled valve [seats] *seat* **129** at the end of *the valve* pocket **123** in direct fluid communications with *the* port **127**. The other end of *the valve* pocket **123** is threaded with threads **129'**. [Passageway] *A passageway* **131** also *is* formed in *the* valve collar **14** *and* extends laterally further into valve collar **14** from the wall of *the valve* pocket **123** and is in fluid communication with *the valve* pocket **123**. The other end of *the valve* pocket **125** terminates at *a* port **133** *which is* in fluid communication with the *valve* pocket **125** and *the* passageway **131**. [Pocket] *The valve pocket* **125** [forms] *is formed with an* angled valve [seats] *seat* **135** at the end of *the valve* pocket **125** *and is* in direct fluid [communications] *communication* with *the* port **133**. The other end of *the valve* pocket **125** is threaded with threads **136**. [Passageway] *A passageway* **137** *is* also formed in *the* valve collar **14** *and* extends laterally further into *the* valve collar **14** from the wall *126* of *the valve* pocket **125** and is in fluid communication with *the valve* pocket **125** and *the* fluid channel **20**. (*See FIG. 2*)

Each of the [poppet] *check* valves **120**, **122** includes an end portion **138**, **140** respectively of elastomer *material* for engaging on seats **129**, **135** respectively formed between ports **127**, **133** and the walls of *the valve* pockets **123**, **125** respectively. Each *check* valve **120**, **122** has a *movable* valve body *or element* **142**, **144** respectively. The general shape of each valve body **142**, **144** is cylindrical in configuration. The *valve* body **142**, **144** of each valve *pocket* **123**, **125** has an upper portion **146**, **148** respectively and a lower, smaller diameter portion **150**, **152** respectively with a swage *or annular recess* **154**, **156** respectively separting the upper and lower portions of *a* valve body. The tops of elastomer [ends] *end portions* **138**, **140** are fitted into grooves **158**, **160** respectively formed circumferentially in lower [ends] *portions* **150**, **152** respectively to hold the elastomer [ends] *end portions* on *the* lower portions **150**, **152** respectively. A bore **162**, **164** is formed [through the] *in an* end **166**, **168** respectively of [valves] *the valve bodies* **142**, **144** [facing] *and faces* away from *the* seats **129**, **135** and extends substantially through the valve bodies **142**, **144** respectively. A valve stem **170**, **172** is inserted in [the] *a counter* bore **162**, **164** respectively with a spring **174**, **176** in its [collapsed] *expanded* position circumferentially surrounding *the valve* stems **170**, **172** respectively.

Each valve stem **170**, **172** is received in a bore **178**, **180** respectively in *a* retainer housing **182**, **184** of *the check* valves **120**, **122** respectively. Each retaining housing **182**, **184** is externally threaded with threads **186**, **188** adapted to mate with threads **129'**, **136** respectively of *the valve* pockets **123**, **125** respectively. Each *retaining* housing **182**, **184** also includes [a slot] *an annular groove* **190**, **192** sized to receive a sealing means **194**, **196**, such as an O-ring, to sealingly engage the walls **124**, **126** of *the valve* pockets **123**, **125** and [slots] *the grooves* **190**, **192** respectively. Each *retaining* housing **182**, **184** also includes a [groove] *slot* **198**, **199** respectively cut out in [the head] *each retaining housing* for external access *or removal of valve stems and valve bodies* from *the* valve collar **14**.

In operation, when the rod *or knock-off plug* **50** is still in place, (*See FIG. 2*) any communication of fluid *or pressure* from the [interior] *bore 21* of tubular *pipe* member [**10**] *11* to the fluid port **56** [of any of the prior art or the embodiments] is prevented. This prevents pressure variations or pressure surges from acting through port **56** and unseating the valve *body 59 of the shear valve 58* which might prematurely inflate the *packing* element **30**.

When it is desired to actuate the device [of any of the embodiments] and communicate fluid to the channel **20** of *the* packing element [**22**] *30* carried on the exterior of the casing or tubular member [**10**] *11*, any suitable means (not shown) may be dropped through member [**10**] *11* so as to break or shear the rod **50** to permit fluid communication with the [groove set] *set of grooves* **38**.

Thereafter, fluid may be communicated through the *set of* grooves [**40**, **42**,] *38*, the port **52**, and the passage **54** to the inlet port **56** between the inner and outer walls of the valve collar **14**. The fluid pressure of this fluid acts upon the end portion **64** of the valve [**58**] *body 59*, and the pressure within the tubular member [**10**] *11* may be increased so as to *produce a pressure differential between the fluid in the bore 21 of the tubular member 11 and the fluid exterior to the valve collar 14 and thereby*

shear the pin **106** whereupon the valve body **59** moves to a position where *the* seal **66** no longer obstructs the flow of fluid to *the* passageway **71** from *the* port **56** thereby permitting fluid flow from *the* port **56** through passageway **71** to *the* port **127**. This longitudinal movement of *the valve* body **59** causes the valve stem **78** as well as the collet **90** surrounding the end thereof to move outwardly through the opening **116** of the retainer housing **100**, compressing spring **108** between the shoulder **80** and the end **110** of the collet **90**. The flow of fluid to *the* port **127** builds *up* pressure on *the* end **138** *of the valve body 142*. When the pressure on *the* end *portion* **138** *of the valve body 142* overcomes the break out friction of *the* end *portion* **138** and the force *required* to compress *the* spring **174**, *the* valve body **142** [rises] *moves* so that *the* end *portion* **138** no longer obstructs the flow of fluid from *the* port **127** through *the* passageway **131** to *the* port **133**. The flow of fluid to *the* port **133**, *in turn*, builds *up* pressure on *the* end *portion* **140**[, when] *of the valve body 144. When* the pressure on *the* end *portion* **140** overcomes the break out friction of *the* end *portion* **140** and the force *required* to compress *the* spring **176**, *the* valve body **144** [rises] *moves* so that *the* end *portion* **140** no longer obstructs the flow of fluid from *the* port **133** to *the* passageway **137** to *the* channel **20** and [packer] *fluid supplied to the packing element* **30** inflates *the packing element 30*.

Those skilled in the art would believe that *the* shear pin **106** *in the shear valve 58* would shear at a given pressure at *the* port **56** *relative to the pressure exterior of the valve collar 14* depending only on the strength of the shear pin **106**. However, this is not the case. At the time the tubular *pipe* member [**10**] *11* is lowered into the well, the pressure in *the* passageway **71** is at atmospheric pressure. The same is true of the pressures in *the* upper [pocket] *or first* chamber **65** and the pressure at *the* port **56**. However, as the tubular *pipe* member [**10**] *11* is lowered into the well, the pressure in *the* upper [pocket] *or first* chamber **65** changes to [that of the exterior of] *the pressure in* the well because there is no seal [through] *to prevent well fluid from leaking by the* retainer housing **100** as discussed above. In addition, as pressure within the tubular *pipe* member [**10**] *11* increases, the pressure at *the* valve port **56** increases. However, there is no path for the rising *or increasing fluid* pressure to enter passageway **71** and *to* raise [it] *the pressure in passageway 71* above atmospheric *pressure*. Accordingly, while the valve *body 59* is seated, *the* seals **66**, **84** will tend to extrude toward *the* passageway **71** because of the high differential pressure between the upper [pocket] *or first* chamber **65** and *the* passageway **71**, and *the high differential pressure* between *the* lower [pocket] *or second* chamber **69** and *the* passageway **71**. In such circumstance, the [seal rings] *seals* **66**, **84** [are] *become* locked and the pressure *required in the port 56* to overcome *the* breakout friction to move *the valve* body **59** [then goes] *is* much higher. This is because the O-rings usually used in the prior art [of] *embodiment shown in* FIG. **3** are designed to only hold 4,000 to 5,000 psi of differential pressure. In deep wells, this breakout friction would be very high and normally a discontinuity in breakout [pressure] *friction* is exhibited at wells having a depth which exhibit downhole pressures of 5,000 to 6,000 psi. In addition, [as discussed above, the diameter] *the annulus* of *the* upper [pocket] chamber **65** is larger than *the annulus of the* lower [pocket] chamber **69**. In the prior art, in order to overcome this difference in [diameter] *the annulus*, a sleeve is installed in *the* upper [pocket] chamber **65**. Nevertheless the [sleeves] *sleeve* may not be perfect and the remaining space in the upper [pocket] chamber **65** is elliptical in shape having a major and a minor diameter both larger than the diameter of *the* lower [pocket] chamber **69**. Therefore, the force of the pressure on *the* seal **84** in *the* upper [pocket] chamber **65** is greater than the force by an identical pressure acting on *the* seal **66** from *the* valve port **56**.

Accordingly, as the well [is deeper and] *depth increases*, the pressure in upper [pocket] chamber **65** increases[,] *and* the amount of pressure required at *the* port **56** *to open the valve 58* may be far greater than anticipated [by knowledge of] *with respect to* the shear strength *required* of shear pin **106** in order to cause shear pin **106** to shear *at a selected pressure*.

EMBODIMENT OF THE INVENTION

To avoid the problems of the prior art [of] *embodiment illustrated in* FIG. **3**, the *present invention utilizes a* valve system [is modified] as shown in FIG. **4**. [The modifications include removal of shear valve **58** from pocket **60**. In addition,] *In FIG. 4 as compared to FIG. 3, the check* valve **120** is [also] removed[. After shear] *from the valve pocket 123. When the shear* valve **58** is removed from *the valve* pocket **60**[. All] *all* grease is removed from *the* O-ring *seal* **84** and *the* T-seal ring **66**. The shear valve *58* is then lubricated with Baker Tubing Seal Grease Number 499-26 which is not reactant with the O-ring seal **84** or the T-seal **66** at elevated temperatures[. The shear valve **58** is] *and* then replaced in *the valve* pocket **60** in the manner known in the prior art. [Pocket] *The valve pocket* **123** is then filled, preferably with water or other suitable substance, although it could be left unfilled. *The shear valve 58 thus has a reciprocating valve element or valve body member 59 with seals 66 and 84 which prevent flow of fluid to the passage 71 (part of the passageway means) and stop means in the form of the shear pin 106 which prevent reciprocation of the reciprocating valve member prior to the application of a predetermined pressure difference.*

[A modified] *As shown in FIG. 4, a* retainer housing **182'** is [then] installed in *the valve* pocket **123**. The [modified] retainer housing **182'** includes a bore **200** of smaller diameter than *the* bore **178** [drilled coaxially through bore **178**. Housing] *The housing* **182'** [is] further [modified to include] *includes a* counter bore **202** coaxial with and of smaller diameter than *the* bore **200** *and is* formed by drilling or other means through the approximate center of *a transverse* groove **198**. The disparity of diameters causes *an* downwardly, outwardly, sloping shoulder **204** to be formed between *the* bore **178** and *the* bore **200** and *an* downwardly, outwardly sloping shoulder **206** to be formed between *the* bore **200** and *the* bore **202**. A ball **208** is located within *the retainer* housing **182'** in close proximity to the opening of *the* bore **202** facing *the* bore **200**. [Ball] *The ball* **208** is held against *the* shoulder **206** by *a* compressed spring **212**. [Spring] *The spring* **212** is compressed by *a* rod **210** which contains an internal longitudinal fluid passageway **211** extending therethrough and opening at each end. [Rod] *The rod* **210** is inserted into *the* bore **178** by hammering or other means to force the rod **210** into the entry of *the* bore **200** where it is held by friction with *the* spring **212** and *the* ball **208** extending into *the* cocurrent bore **200** such that *the* ball **208** abuts the shoulder **206** and the rod **210** extends substantially into the shoulder **204** forming a check valve assembly **214**.

The flow passage or port 56 is independent of the seals 84 and 66 for permitting flow of fluid from the interior or bore of the pipe member 11 to one side of the seal 66 and the retainer housing 100 is independent of the seals 84 and 66 for permitting the flow of fluid from the exterior of the valve collar 14 and the pipe member 11 to an oppositely facing surface of the seal 84.

The structure in the valve pocket 123 comprises means independent of the seals 84 and 66 for permitting the flow of fluid via passage 71 at the pressure exterior to the pipe member 11 and the valve collar 14 to the other side of each of the seals to equalize the pressure across the seals 66 and 84.

In operation, *when the valve system of FIG. 4, is installed in* the [member **10** of the first embodiment FIG. **4**, when] *valve collar 14 and* lowered into the bore hole, [will cause] the pressure in *the* passageway **71** [to] *will* be approximately the same as the pressure in upper [pocket] chamber **65** of [bore] *the valve pocket* **60**. This is effected by the check valve assembly **214** *in the valve pocket 123*. As pressure from the bore hole acts on *the* tubular *pipe* member [**10**] *11*, and particularly on [modified] *the retainer* housing **182'**, fluid will flow from *the* counter bore **202** through *the* bore **200** to *the* bore **178**, around *the* ball **208**, through *the* passageway **211** in *the* hollow rod **210** and thence to *the valve* pocket **123**, *the* port **127** and *the* passageway **71**. This will permit the fluid in *the valve* pocket **123** to be maintained at the pressure approximately that surrounding the tubular member [**10**] *11* which is substantially the pressure in the upper [pocket] chamber **65**. Accordingly, the differential pressure between *the* upper [pocket] chamber **65** *in the valve pocket 60* and *the pressure in the* passageway **71** across *the* seal **84** will be very small. Further, the pressure at *the* port **56** will also initially be approximately that of the *well* bore so that the differential pressure across *the* seal **66** will be very small. In addition, as the pressure in port **56** [increases, and] *is increased to shear* pin **106** [shears, causing] *and cause the valve* body **59** to move [such that], *the* seal **66** moves to a position longitudinally above passageway **71**[,] *and* the pressure in *the valve* pocket **123** will increase causing *the* ball **208** to seat on the shoulder **206** thereby stopping further fluid communication between *the* bore **200** and *the* bore **202**. Therefore, the pressure in *the* passageway **71** [will] *can* continue to rise *or increase* causing *the check* valve **122** to unseat and permitting fluid flow to *the* passageway **137**.

The [modified] port plug **182'** is usually covered with Shell Darina Grease Number 2 or other suitable lubricant to prevent plugging of the check valve **214**.

In addition, because multiple packers are usually run along a tubular string comprised of tubular *pipe* members [**10**] *11* and other tubular members, the seal diameters should be measured and an indication of such be made, such as on the valve collar **14**. In this manner the packer with the smallest upper seal **84** area will be run closest to the bottom of the hole to minimize distortion caused by different areas between *the* seals **84** and **66** since the devices of the prior art always have a larger area for *the* seal **84** than for *the* seal **66**.

Although the system described in detail above is most satisfactory and preferred, many variations in structure and method are possible.

Because many varying and different embodiments may be made within the scope of the inventive concept herein taught and because modifications may be made in accordance with the descriptive requirements of the law, it should be understood that the details herein are to be interpreted as illustrative and not in a limiting sense.

What is claimed as invention is:

1. A tubular system for use in packing off a well bore, comprising:

a [hollow] tubular mandrel;

[a packer] *an inflatable packing element* attached to said mandrel at one end of said mandrel;

a valve collar mounted on the other end of said mandrel, the other end of said [packer] *packing element* being attached to said *valve* collar [and], *said valve collar* having a passageway *means* therethrough, [and] *said passageway means in* said *valve* collar being in fluid communication with *the interior of* said [packer] *packing element* and the interior and exterior of said mandrel [by said passageway];

at least two valve pocket means in said passageway means in said valve collar;

[said passageway having enlarged portions in said collar;

a valve system mounted in said enlarged portions, said valve system including three valves;]

[the first of said valves being mounted in the first of said portions and having] *first valve means in a first valve pocket means and including* a reciprocating *valve* member and [a] stop means for preventing reciprocation of said reciprocating *valve* member *from a first position to a second position* prior to the application of at least a predetermined difference in pressure between one [side] *end* of said reciprocating *valve* member and the other [side,] *end of said reciprocating valve member,* said reciprocating *valve* member being located *in said first position* at one *open* end of a first part of said passageway *means* when said stop means prevents reciprocation and having at least two *spaced apart* seals [thereon] *which are disposed so that the one open end is between said seals* for preventing the flow of fluid from either end of said reciprocating *valve* member around *the seals on* the *reciprocating valve* member to said [first] *one open end of the first part of said* passageway [part] *means;*

said first valve *pocket means* being in fluid communication [with a second part of said passageway in fluid communication] with [said] *the* interior of said mandrel [on] *and* one side [of] *of one seal on* said reciprocating *valve* member;

said first valve *pocket means* being in fluid communication with [said] *the* exterior of said mandrel [on the other] *and one* side of *the other seal on* said reciprocating *valve* member; and

[the second of said valves having check means] *second valve means in a second valve pocket means* for permitting the flow of fluid *in one direction* from [said] *the* exterior of said mandrel to said *one open end of the* first part of said passageway [when the pressure exterior of said mandrel exceeds the pressure in said second portion] *means between the seals;*

said second [portion includes] *valve pocket means including* a first bore [opening] *which opens* to [said] *the* exterior of said mandrel and [said second] *check* valve [is] *means* located in said first bore;

said second valve [includes] *pocket means having*

a [head adapted to connect] *retainer housing connected* to said first bore,

a seal mounted on said [head] *retainer housing* and sealingly engaging the [walls] *wall* of said first bore and said [head] *retainer housing*,

[and] said check *valve* means [is] *being* mounted in said [head] *retainer housing*;

said check *valve* means [includes] *including*:

a second bore through said [head and] *retainer housing* substantially coaxial with said first bore;

a third bore through a portion of said [head] *retainer housing* substantially coaxial with said first and second bores, said third bore being of a greater diameter than said second bore and forming a shoulder therewith;

a ball adapted to seal against said shoulder; and

mounting means for reciprocably mounting said ball in said third bore.

2. The system of claim 1 wherein said mounting means includes:

a rod, said rod being wedged into an end of said third bore;

a spring, said spring being mounted in said third bore and abutting said ball and one end of said rod.

3. The system of claim 2 wherein said rod has a hollow longitudinal fluid passage therethrough.

4. A tubular system for use in packing off a well bore, comprising:

a tubular mandrel;

an inflatable packing element attached to said mandrel at one end of said mandrel;

a valve collar mounted on the other end of said mandrel, the other end of said packing element being attached to said valve collar, said valve collar having a passageway means coupling the interior of said packing element and the exterior of said mandrel in fluid communication with the interior and exterior of said mandrel;

at least two valve pocket means in said passageway means in said valve collar;

first valve means in a first valve pocket means and including a reciprocating valve member and stop means for preventing reciprocation of said reciprocating valve member from a first position to a second position prior to the application of at least a predetermined difference in pressure between one end of said reciprocating valve member and the other end of said reciprocating valve member, said reciprocating member being located in said first position at one open end of a first part of said passageway means when said stop means prevents reciprocation and having at least two spaced apart seals which are disposed so that the one open end is between said seals for preventing the flow of fluid from either end of said reciprocating valve member around the seals on the reciprocating valve member to said one open end of said passageway means;

said first valve pocket means being in fluid communication with a second part of said passageway means where said second part of said passageway means is in fluid communication with the interior of said mandrel and one side of one seal on said reciprocating valve member;

said first valve pocket means being in fluid communication with the exterior of said mandrel on one side of the other seal on said reciprocating valve member; and

second valve means in a second valve pocket means for permitting the flow of fluid in one direction from the exterior of said mandrel to said one open end of the first part of said passageway means between said seals.

5. The system of claim 4, wherein said second valve means includes:

a retainer housing for enclosing said second valve pocket means, said retainer housing having an opening therethrough;

a seal mounted on said retainer housing and sealingly engaging the wall of said second valve pocket means and said retainer housing; and

check valve means in the opening of said retainer housing.

6. The system of claims 4 or 5 wherein the said first part of said passageway means is filled with a liquid.

7. The system of claim 4 wherein;

there are at least three valve pocket means,

third valve means in a third valve pocket means,

said third valve means being in fluid communication by said passageway means (a) with said exterior of said mandrel (b) with said second valve pocket means and (c) with the interior of said packing element;

first seal means on said second valve means for preventing fluid communication between second valve pocket means and said exterior of said mandrel, and

said third valve means in said third valve pocket means having

second seal means for preventing fluid communication between said second pocket means and said interior of said packing element when the pressure in said interior of seal packing element is greater than the pressure in said second valve pocket means.

* * * * *