

March 16, 1965

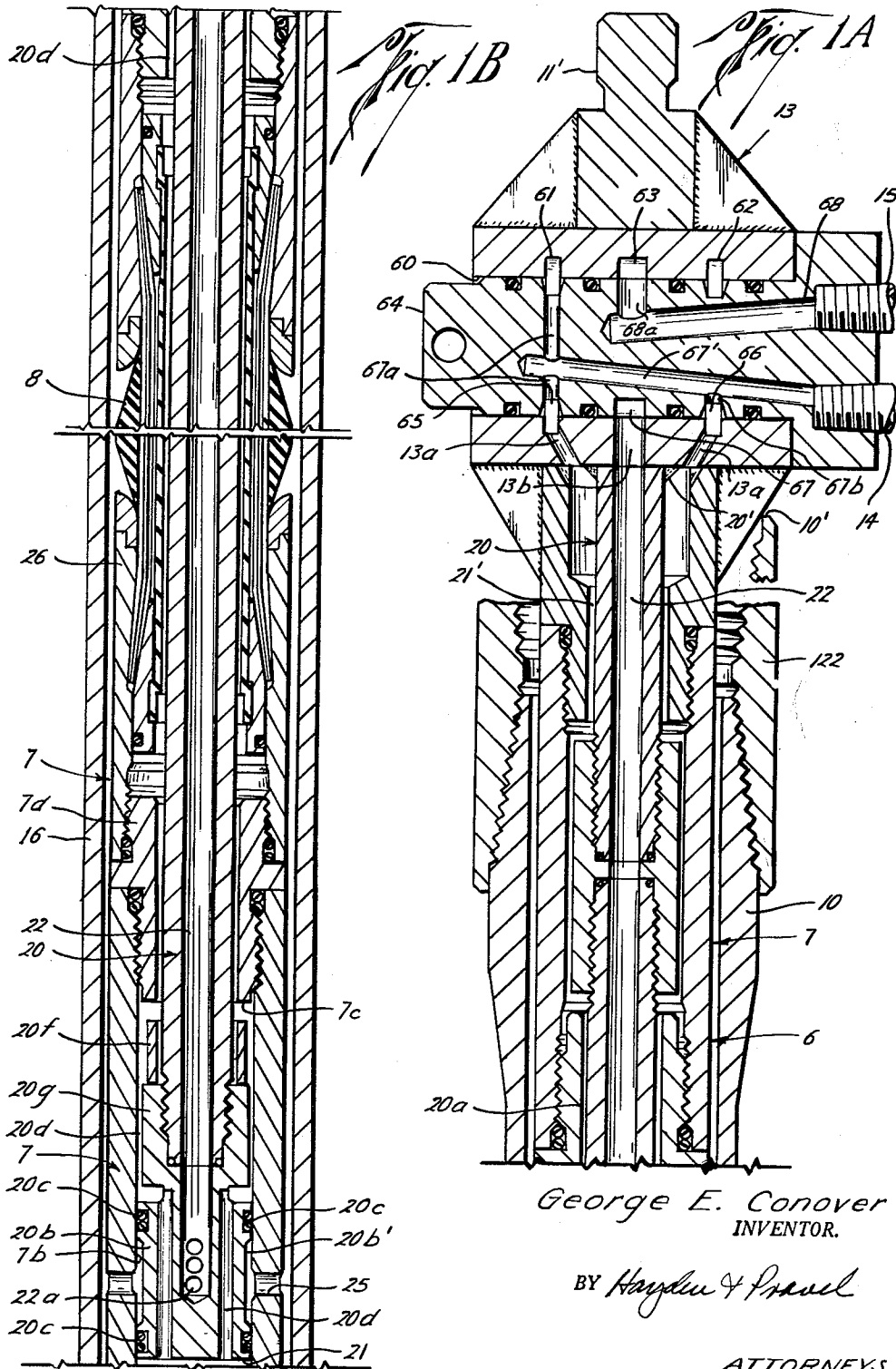
G. E. CONOVER

3,173,290

WELL TOOL

Filed June 2, 1960

3 Sheets-Sheet 1



March 16, 1965

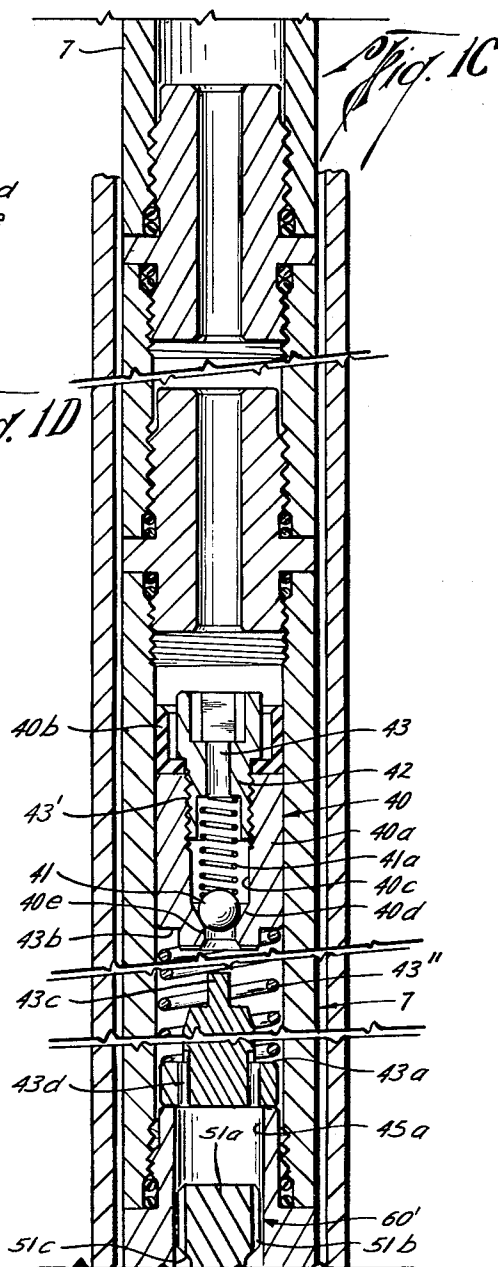
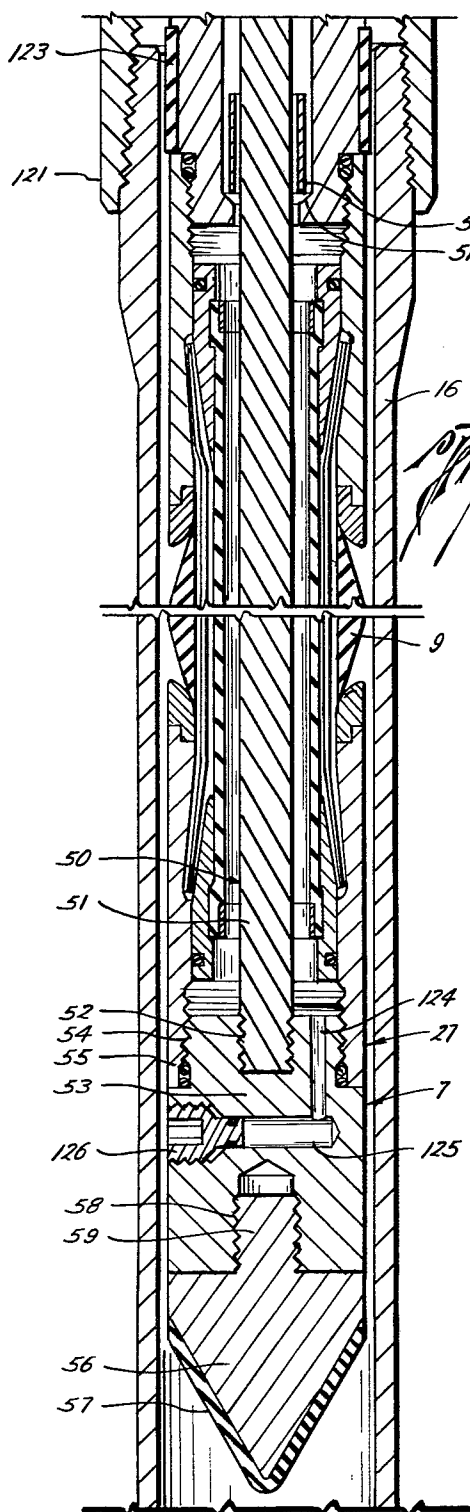
G. E. CONOVER

3,173,290

WELL TOOL

Filed June 2, 1960

3 Sheets-Sheet 2



George E. Conover
INVENTOR.

BY Hayden & Pravel

ATTORNEYS

March 16, 1965

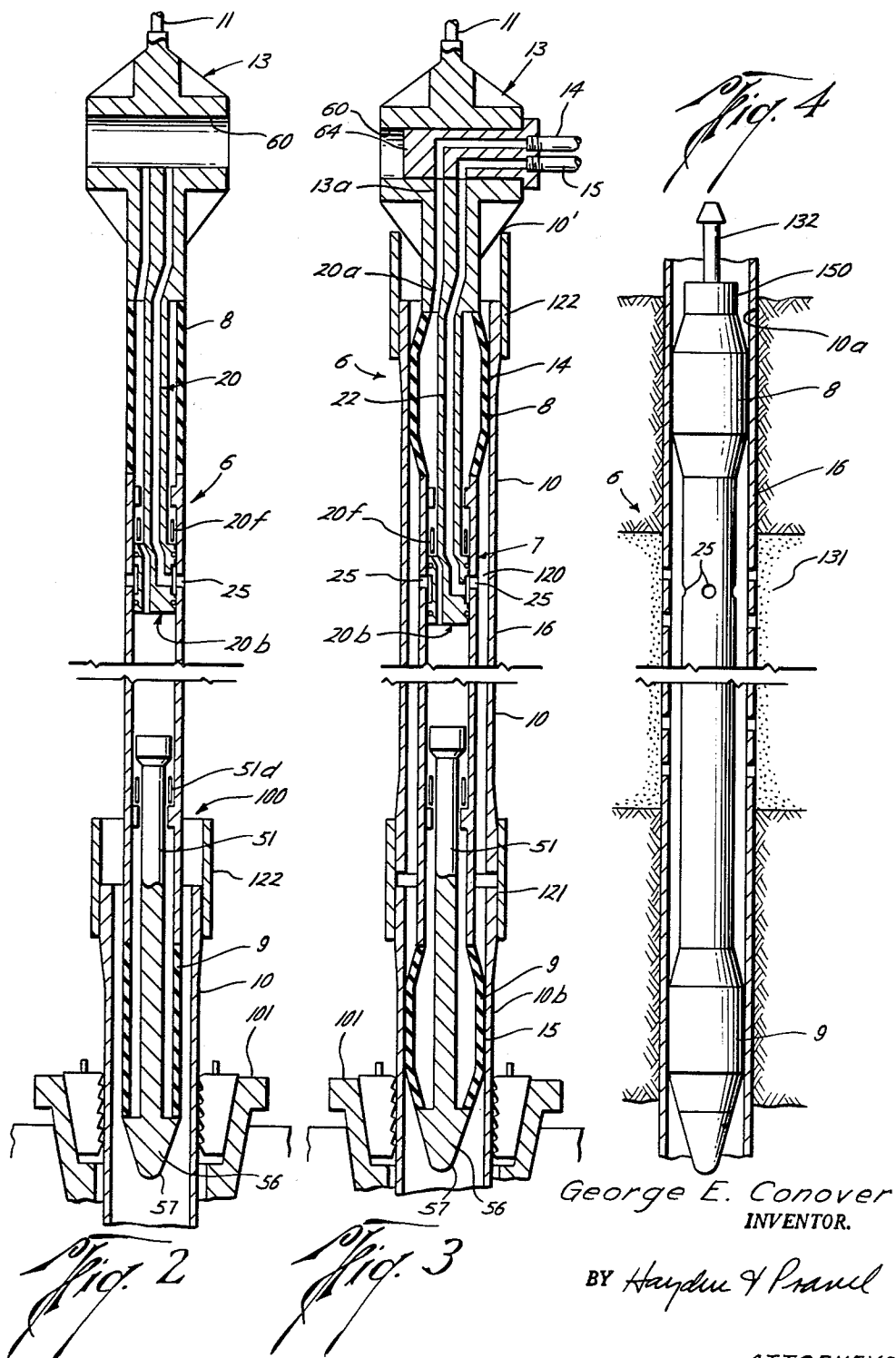
G. E. CONOVER

3,173,290

WELL TOOL

Filed June 2, 1960

3 Sheets-Sheet 3



1

3,173,290
WELL TOOL

George E. Conover, Houston, Tex., assignor to
Lynes, Inc., a corporation of Texas
Filed June 2, 1960, Ser. No. 33,555
12 Claims. (Cl. 73—40.5)

The present invention relates to a well tool incorporating inflatable elements thereon and adapted to be positioned in an annulus, and more particularly to a well tool with inflatable elements for sealing off in a tubular member or open well bore which tool can be actuated with a minimum of manipulation of the support member which positions the tool in the tubular member or well bore.

It is desirable at times to seal off a portion of a tubular member in order that the tubular member may be tested for leaks, and such testing may occur when the tubular members are stacked, or it may be conducted as the tubular members are being lowered into or removed from a well bore, or it may be conducted with the tubular members in situ in a well bore.

In other situations it is desirable to position a tool in an open well bore, or in a well bore having conduits therein for flowing well fluids to the earth's surface, and in which well bore it is desirable to obtain well fluids from several producing zones or areas.

The location of the tool either for test purposes, or for purposes of aiding in flowing fluids from various producing zones in a well bore should be accomplished with a minimum of manipulation of apparatus connected to the tool and extending to the earth's surface. In some situations the accessibility to the well opening in which the tool is to be positioned is relatively limited, such as in water covered areas, or in other situations, and for this and other reasons, it is desirable in certain situations to provide a well tool having inflatable elements thereon, which can be inflated and positioned in the tubular member to accomplish its desired function without manipulating at a remote location, such as the earth's surface a supporting member upon which the well tool may be positioned. Thus, the tool can be positioned in the well bore and the well head secured in position so that the normal producing of the well may begin.

The present invention provides a well tool including inflatable elements thereon which may be inflated without manipulating the member upon which it is supported, and the well tool incorporates means for communicating exteriorly of the tool between the spaced inflatable elements and with at least one end of the tool body without interfering with the inflating operations of the inflating elements.

An object of the present invention, therefore, is to provide a tool with inflatable elements which may be inflated without manipulating the member upon which it may be supported and with a minimum of effort.

Yet another object of the present invention is to provide a tool incorporating spaced inflatable elements, which tool may be positioned in a tubular member for isolating the tubular member between the spaced inflatable elements without manipulating the well tool, or the support member upon which the well tool is supported.

Yet a further object of the present invention is to provide a well tool incorporating spaced inflatable elements which may be inflated without manipulating the tool body, or the support member upon which the well tool is carried, and means for selectively communicating exteriorly of the well tool body between the spaced inflatable elements and through at least one of the elements without interfering with the inflating operations of the spaced inflatable elements.

2

Still another object of the present invention is to provide a well tool incorporating spaced inflatable elements which is adapted to be positioned in a tubular member on a support member, and means for inflating the inflatable elements without manipulating the tool body or the support member, and additional passage means for communicating the well body exteriorly thereof between the spaced inflatable elements and through at least one of the elements.

Yet a further object of the present invention is to provide a well tool incorporating inflatable elements thereon which well tool is constructed and arranged so that inflating fluid may be conducted to the inflating elements to seal the inflating elements in a tubular member and for communicating with the tubular member between the spaced inflatable elements, the communication between the spaced inflatable elements being isolated from the inflating fluid at all times but not interfering with the expansion and setting of the inflating elements, and subsequent longitudinal contraction of the tool body as the elements expand.

Still another object of the present invention is to provide in a well tool incorporating longitudinally extending and spaced inflatable elements thereon, means secured to said body above the upper of said elements and extending through said element and terminating above the lower of said inflatable elements to act as a means for catching the part of the tool below the upper of said elements in the event of separation thereof, and an additional means secured to said tool body below the lower of said inflatable elements and extending therethrough and terminating above said lower element and below the upper of said elements and adapted to engage the tool body upon separation of the lower element to prevent loss of the lower part of the tool body below the lower element in the event of separation thereof.

Yet a further object of the present invention is to provide a well tool including inflatable elements thereon and means to close off the lower of said elements to the flow of inflating fluid until a predetermined pressure of inflating fluid is present in the body.

Yet a further object of the present invention is to provide a well tool including spaced longitudinally extending inflatable elements on a tubular body adapted to be positioned in a tubular member and the inflatable elements inflated for sealing off in the tubular member whereupon a fluid may be conducted through said body to the tubular member between said inflatable elements to test for leaks in the tubular member between said inflatable elements.

Still another object of the present invention is to provide a well tool with spaced longitudinally extending inflatable elements thereon adapted to seal off in a tubular member for isolating that portion of the tubular member between the spaced inflatable elements from the rest of the tubular member.

A further object of the invention is to provide a tool for testing for leaks in tubular members which is constructed so that even minute leaks in the pipe may be detected.

Yet a further object of the present invention is to provide a tool for testing for leaks in tubular members which provides means whereby the tool may seal off in the tubular member to be tested, and passage means isolated from the means which seals off the tool in the tubular member, but which communicates between a sensitive gauge and the sealed off portion of the tubular member with no valves interposed between whereby a drop in pressure as indicated on the gauge indicates leaks in the member.

Other objects and advantages of the present invention

will become more readily apparent from a consideration of the following description and drawings wherein:

FIG. 1A is a vertical sectional view of the upper end of the tool of the present invention;

FIG. 1B is a vertical sectional view illustrating a continuation of the tool shown in FIG. 1A;

FIG. 1C is a sectional view similar to FIGS. 1A and 1B and is a continuation of the tool shown in FIG. 1B;

FIG. 1D illustrates the lower end of the tool and is a continuation of the tool shown in FIG. 1C;

FIG. 2 is a schematic illustration showing the tool of the present invention in position being lowered into the tubular member;

FIG. 3 represents the tool positioned in a tubular member with the inflatable elements inflated and fluid conducted to the tubular member between the inflatable elements for testing for leaks in the sealed off portion of the tubular member; and,

FIG. 4 illustrates an alternate embodiment of the invention positioned in a well bore.

Attention is first directed to FIG. 3 of the drawings wherein the invention is schematically illustrated and there represented generally by the numeral 6. A tubular body designated generally by the numeral 7 includes the spaced, longitudinally extending inflatable elements 8 and 9 thereon, the body 7 and its inflatable elements 8 and 9 being of a size for inserting into a tubular member as illustrated at 10 in FIG. 2 and into the well bore 10a illustrated in FIG. 4. Suitable means are provided for supporting the body 7 in the tubular member 10 and for lowering it into position in the tubular member 10 and for removal of the tubular body 7 from the member 10 when desired. In the drawings the support means is illustrated as being in the form of a cable 11 which is connected to the upper end of body 7; however, it can be appreciated that the support means or support member may be in the form of a tubular member which is secured to the upper end of the tool by any suitable means whereby the tool may be positioned as desired in the tubular member 10.

A control head designated generally by the numeral 13 is provided whereby inflating fluid may be conducted to the inflatable elements 8 and 9 so as to expand them to engage and seal off in the tubular member 10 as illustrated at 14 and 15 of FIG. 3. When the elements 8 and 9 are sealed off in the tubular member 10, the portion 16 of the tubular member 10 between the elements 8 and 9 is then isolated relative to the portion of the tubular member above the element 8 and below the element 9. The control head 13 incorporates means for communicating with the isolated portion 16 through the tool body 7 without communicating with the elements 8 and 9 whereby fluid may be conducted to the portion 16 when the tool is to be used as a test tool to test the portion 16 for leaks, and to provide a means for conducting fluid from the portion of the well bore between the elements 8 and 9 when the tool is to be used for the purpose of flowing well fluids from a strata or production zone in a well bore such as illustrated at 131 in FIG. 4.

It should be noted that when the inflatable elements 8 and 9 expand to engage the tubular member 10, the tubular body 7 will move longitudinally, and the construction and arrangement of the tool is such that the fluid may be conducted to the inflatable elements 8 and 9 so as to inflate them without interfering with the other intended functions of the tool, as will be described in greater detail herein.

When the support means 11 is a cable, then the elements 8 and 9 may be inflated by any suitable means such as a hose 14 communicated with the elements 8 and 9 through the control head 13 and the tubular body 7. Similarly, communication may be established with the portion 16 of the tubular member 10 by means of a hose 15 which is also communicated through the control head 13 and tubular body 7. When the tool 6 is to be lowered into a well bore for positioning therein in order to isolate

producing formations from each other and to produce oil therefrom as represented in FIG. 4, the hoses 14 and 15 may be of sufficient length to extend from the earth's surface to the tool in the well bore, or they may be eliminated and in which event the inflatable elements 8 and 9 could be inflated by a self-contained fluid unit mounted on the tubular body 7 so as to communicate with the inflatable elements 8 and 9 at a predetermined time. When used in this manner the control head 13 would of course be slightly modified so that communication from the portion 16 in the tubular member in which the tubular body 7 is seated would be communicated up through the control head 13 so as to flow well fluids upwardly thereabove and into the well bore to the earth's surface.

FIGS. 1A-1D inclusive illustrate the present invention adapted for use with tubular members such as flexible hoses or the like which are to be communicated with the control head designated generally at 13. A suitable arrangement is illustrated at 11' in FIG. 1A whereby the support means or member 11 may be secured to the tool body 7 as shown in FIG. 2. As previously noted, the tubular body 7 of the tool 6 may be supported in tubular member 10 by any suitable means such as a cable or tubing. As represented in FIG. 1A the control head 13 is positioned on the upper end of tubular body 7, and the body 7 is illustrated in FIGS. 1A-1D inclusive as extending from the upper end 10' of the tubular member 10 downwardly thereinto a sufficient distance to perform its intended function. The invention is illustrated in detail in performing the function of testing the tubular member 10 in the portion 16 between the inflatable elements 8 and 9 for leaks; however, as previously noted the invention accomplishes other functions and the detailed explanation in regards to pipe testing is only for purposes of illustration.

The tubular body 7 may be of any suitable extent depending upon the use of the invention. For example, where the invention is to be used as a testing tool for testing leaks in tubular members it may be anywhere from approximately 30 or 40 feet up to 100 or 120 feet depending upon the length of the tubular member in which the tool is to be inserted and tested. Where the invention is to be used as a production packer for separating or isolating production zones in a well bore, the tubular body 7 may be of sufficient length so that the inflatable members 8 and 9 are positioned to span the production zone and separate or isolate them in the well bore as desired. The tubular body 7 is formed by joining a plurality of tubular sections by suitable means such as threads to form the body of the desired length. Seals are provided for preventing fluid leakage from the tool.

In the modification illustrated in the drawings, the control head 13 is illustrated as being positioned at the top of the tool, and secured to the control head 13 and depending therefrom longitudinally is a means designated generally by the numeral 20 which terminates at a position represented at 21 in FIG. 1B below the upper inflatable element 8 on the tubular body 7. The means 20 defines a passage means illustrated at 21' for communicating fluid through the control head 13 and internally of the tubular body 7 to the inflatable elements 8 and 9 for inflation thereof. The means 20 also defines separate passage means 22 which communicates through the control head 13 and the tubular body 7 to the port means 25 in the tubular body 7 intermediate the inflatable elements 8 and 9. The means 20 also performs the function of acting as a safety catch to catch the part or portion 26 of the tubular body 7 below the inflatable element 8 if the inflatable element 8 separates during operation of the tool and thereby prevents the part 26 of the tool from falling down in the tubular member or in the well bore in such event. This will be described in greater detail hereinafter.

Where the extent of the body 7 is substantial, it can be appreciated that a head of liquid of substantial extent

exists within the tubular body 7 and exerts a pressure which would tend to inflate lower inflatable element 9. In some circumstances it may be desirable to provide a means for supporting this head of liquid in the tubular body 7 in a manner so that it will not act on the inflatable element 9 until desired. In order to accomplish this function a compensator designated generally by the numeral 40 is provided in the tubular body 7 and acts to prevent the column of liquid within the tubular body 7 from acting on the lower inflatable element 9 until a predetermined occurrence, as will be described in greater detail hereinafter.

A safety means for catching the portion 27 of the tubular body 7 below lower element 9 is provided in the event the inflatable element 9 separates, such safety means being designated generally by the numeral 50 and including the rod 51 which is secured by suitable means such as threads 52 in the collar 53 which collar 53 is in turn connected by any suitable means such as threads 54 to the lower end of the tubular element 55 which forms a sleeve for aiding in securing packer element 9 on body 7. A stabbing nose 56 has a protective covering 57 thereon to inhibit damage to the tubular member 10 as the tool is positioned therein. The nose 56 is secured by any suitable means such as threads 58 on stem 59 to the lower end of collar 53 as more clearly seen in FIG. 1D of the drawings. The rod 51 extends longitudinally of the tubular body 7 and terminates at a position represented by the numeral 60' above the lower inflatable element 9 as seen in FIG. 1D and the bottom of FIG. 1C of the drawings.

As illustrated in FIG. 1A of the drawings the control head 13 includes the opening 60 which is provided with the peripheral grooves 61, 62 and 63. A plug or fitting 64 is adapted to be received within the opening 60 and includes grooves 65, 66 and 67. When the plug 64 is inserted as illustrated in FIG. 1A of the drawings, the plug groove 65 coincides with the opening groove 61, the plug groove 66 coincides with the opening groove 62, and the plug groove 67 coincides with the opening groove 63 and it should be noted that the plug 64 can be inserted into the opening 60 as shown in FIG. 1A, or it may be inserted from the left as viewed in FIG. 1A. In the latter event the groove 65 of plug 64 will then match groove 62, the groove 66 in plug 64 will match groove 61 in the opening 60 and the groove 67 in the plug 64 will again match with the central groove 63 in the opening 60.

A longitudinal passage 67' in the plug 64 communicates with the grooves 65 and 66 through ports 67a and 67b respectively, whereby fluid may be communicated from suitable means such as a hose 14 threadedly secured in the end of passage 67' to grooves 65, 66 and their matching grooves 61 and 62. A passage 68 communicates hose 15 through plug 64 with central groove 67 and its matching groove 63 by means of port 68a.

It will be noted that the means 20 previously described as secured to the lower end of control head 13 may be formed of a plurality of tubular sections which are joined together by couplings, or may be formed of an integral rod which is hollowed to form the passage 22 therein. The means 20 may be secured to the control head 13 by any suitable means such as welding or the like as illustrated at 20' and is proportioned externally relative to the internal diameter of the tubular body 7 so that it defines passage means 20a for communicating internally of the tubular body 7 with the inflatable elements 8 and 9. The passage 20a communicates at its upper ends with the passage 13a extending through the control head 13 and terminating in the peripheral grooves 61 and 62 of the opening 60 of control head 13.

It will be noted that the means 20 previously described as being formed of a plurality of sections joined together by a coupling, or being formed of an integral rod like member and extending longitudinally within the tubular

body 7 and terminating at a position 21 below the upper packer 8 includes an enlarged head 20b at its termination within the tubular body 7. The enlarged head 20b of the means 20 is of sufficient extent so that it spans the port means 25 in tubular body 7 at all times. Seal means 20c are provided between the enlarged portion 20b of the means 20 and the inner wall 7b of the tubular member 7 so that port means 25 is isolated from the passage means 20a defined in the tubular body 7 which communicates inflating fluid to the elements 8 and 9. In the drawings, seal means 20c is shown as being carried on the enlarged portion 20b, but they could as easily be carried by body 7 so as to abut the enlargement 20b. In order that the inflating fluid in passage 20a may bypass the enlargement 20b and flow to the inflatable element 9 positioned therebeneath as illustrated in the form of the invention show in the drawings, suitable passage means extend longitudinally of the enlargement 20b as shown at 20d which communicate at their upper end with the passage 20a, and open at their lower ends internally of the tubular body 7 whereby well fluid may be conducted through the enlargement 20b from the passage 20a into the inflatable element 9 in the lower part of the tubular body 7.

The passage 22 defined by the means 20 communicates with the port means 25 in the tubular body 7 by means of the ports or passages 22a in the lower end thereof which extend laterally through the enlargement 20b and communicate with the recessed area 20b' extending longitudinally on the periphery of the enlargement 20b. The passage 22 communicates at its upper end with the port 13b in the control head 13 which port in turn communicates with hose 15 through the central groove 67 and central groove 63 in the opening 60.

The arrangement of the means 20 in the tubular body 7 provides a means whereby inflating fluid may be conducted to the inflatable elements 8 and 9 for inflation thereof to seal the tubular body 7 in the tubular member 10 and thereafter permits communication of the portion of the well bore or tubular member between the tubular members 8 and 9, while retaining it isolated from the inflating fluid in elements 8 and 9.

Such arrangement enables the inflatable elements 8 and 9 to expand to sealing engagement in the well bore or in the tubular member 10 as described herein, and as the elements 8 and 9 expand radially there is some longitudinal contraction of the tubular body 7. The construction of the means 20 and its arrangement in the tubular body 7 accommodates this slight longitudinal contraction of the tubular body 7 without interfering with the normal function and operation of the tool.

As previously noted the tubular body 7 may be of any suitable extent so that any length of well bore or any length of pipe may be sealed off between the inflatable elements 8 and 9. The well tool of the present invention may be filled with liquid prior to its insertion into the tubular member 10, and it can be appreciated that where the tubular body 7 is of substantial extent the weight of the liquid column within the tubular body 7 may become excessive so that it tends to expand the lower inflatable element 9 as previously noted herein. If desired suitable means to prevent this column of liquid from becoming effective on the lower inflatable element 9 may be provided, such means being illustrated in the bottom part of FIG. 1C and previously identified generally by the reference numeral 40 and termed the compensator.

The compensator includes the carrier 40a mounted in body 7 and which has the cup seal 40b on the upper end thereof. The carrier 40a has a longitudinal port 40c therethrough which is provided with a seat 40d at the lower end thereof on which is seated the ball check valve 41. The ball check valve is urged to seating position on the seat 40d by the spring 41a, which spring extends longitudinally of the passage 40c and is retained therein by means of the retainer 42 which is secured in the carrier 40a by any suitable means such as threads 43'. The

retainer 42 is ported as illustrated at 43 whereby fluid discharged from the longitudinal passage 20d of enlargement 20b may be received therethrough and into the passage 40c above the check valve 41. From the above, it can be appreciated that the check valve 41 as described normally prevents the flow of inflating fluid therebelow so that the column of liquid above the check valve 41 is supported in the tubular body 7 without exerting any inflating influence on the inflatable element 9. When inflating fluid pressure is exerted through the hose 14 and into passage 20a in tubular body 7 so that such inflating fluid acts against the rubber seal element 40b, the carrier 40a moves longitudinally of the tubular body 7, and downwardly as illustrated in FIG. 1C of the drawings, against the tension of spring 43" which spring extends longitudinally of housing 7 and rests on collar 43a at its lower end and abuts the carrier 40a as illustrated at 43b at its upper end. The spring 43" is sufficiently strong so that it will support carrier 40a and the liquid column thereabove in tool body 7, as illustrated in the drawing; however, as the pressure of fluid in body 7 is increased through hose 14, the spring 43" will collapse whereupon the carrier 40a will move downwardly in tool body 7.

The collar 43a includes the central upstanding projection 43c which is of a size to move through the opening 40e in the lower end of the carrier 40a and engage ball valve 41 to move it off its seat 40d when carrier 40a has been forced downwardly by the pressure thereon whereupon inflating fluid may pass therearound and through passages 43d in collar 43a and thence flow through the passage identified as 45a in the tubular body 7 to act on inflatable element 9.

As long as fluid pressure is maintained on the packers through hose 14, the carrier 40a will remain in its lowermost position, but when fluid pressure on the packers is relieved, the spring 43" will move the carrier 40a toward its original position. This causes the inflating pressure fluid to be relieved from the packer element therebelow, so that the tool can be removed from its seated position. The volume within the tool body 7 below compensator 40 will always be greater than the volume of fluid required to fill packer 9, so that as the carrier 40a moves toward its original position, sufficient space is present in the tool for receiving the volume of fluid from packer 9.

The compensator 40 may be eliminated if desired, and its elimination will not affect the normal function of the tool, but may aid in relieving the pressure of inflatable element 9 when the length of tubular body 7 is of substantial extent.

As previously noted a safety means 50 includes the rod 51, which rod is secured in the lower end of the tubular body 7 as previously described and extends longitudinally up through the lower element 9 to terminate in the enlarged head 51a. The enlarged head 51a is provided with longitudinal grooves 51b for the free flow of inflating fluid therethrough. The enlarged head 51a is provided with a tapered lower edge 51c. If the inflatable element 9 should rupture or separate when the tool is positioned in the tubular member 10, the lower portion designated generally at 27 below the lower inflatable element 9 would normally fall downwardly in the tubular member 10; however, the annular tapered lower edge 51c of the enlargement 51a would engage with the collar 51d provided in the tubular housing 7 as shown at the top of FIG. 1D. Thus, such construction would prevent the lower part 27 of the tool 6 from separating and falling down through the tubular member 10 if the inflatable element 9 should separate.

In order to cushion the shock of impact in such event, the collar 51d may be formed of a relatively soft metal, such as copper. The collar 51d rests on the annular surface 51e, so that the tapered edge 51c of enlargement 51a would engage against the copper collar which would yield and thereby afford the function of a shock absorber.

Similarly, a collar 20f is provided in the tubular body

7 and rests on the upper end of the collar 20g integrally connected with the enlargement 20b so that if the inflatable element 8 separates the portion 26 of the tool therebeneath falls whereupon, the copper collar 20f engages the shoulder 7c of the coupling 7d in the tubular body 7 and thereby prevents the tool body portion 26 from falling in the tubular member or well bore.

As previously noted, the present invention has application in sealing off a portion of a tubular member for testing thereof, and it also has application as a production tool to separate producing zones in a well bore.

It will be described, for purposes of illustration only, in detail in its functioning as a testing tool to test tubular members for leaks. It can be appreciated that the invention can be used for testing tubular members stacked either at the drilling location or in a store yard, or it may be used to test tubular members for leaks after they are positioned in the well bore, or as they are being lowered into position in the well bore, or as they are being removed from the well bore. For purposes of description, the present invention will be described in its use in testing tubular members such as tubing as it is being lowered into position in a well bore.

In FIG. 2 of the drawings, the tubular member 10 is supported in slip bowl 101 and the upper end, or part 100 of the tubular member extends above the slip bowl 101. The manner of positioning and lowering tubing into a well bore is well known in the art, and it is believed unnecessary to give a detailed description of this step. As shown in FIG. 2 the upper end 100 of the tubing has a coupling 122 thereon and is ready to receive another joint of tubing therein, and prior to securing the next joint of tubing in position in the coupling 122 the tool illustrated generally by the numeral 6 may be lowered into position in the tubing so as to test the section of tubing for leaks. In some situations the tubing which is to be tested for leaks will be tested as it is suspended in the well bore, but extended above the slip bowl designated generally by the numeral 101. This manner of testing is represented in FIG. 3 of the drawings. In other words, the tool 6 may be lowered through the upper end 100 of the tubular member 10 and suspended therein along with the tubular member 10 in the slip bowl and extended downwardly into the earth's surface, and then by means of elevators, the tubing, or tubular member 10 being tested and the tool 6 therein is raised so that the portion of tubular member 10 which is to be tested for leaks extends upwardly into the air above the slip bowl 101. At any event, whether the testing operation is carried out with the tubular member 10 extending upwardly into the air above the slip bowl 101, or whether the testing operation is carried out with the tool 6 suspended in the tubular member 10 and extending downwardly into the well bore in the earth, the testing procedures are generally the same, insofar as the function of the present invention is concerned.

After the tubular member 10 has been positioned in the slip bowl 101, the support member 11 is operated by suitable power means (not shown) so as to lower the tool 6 into the tubular member 10. The plug 64 is then inserted in opening 60 and thereafter, the tubular member 10 and the tool 6 are elevated by elevators (not shown) above the slip bowl 101 for conducting the testing operations. When the pipe 10 is raised to a position above the slip bowl 101 so that the portion of the tubular member to be tested is extended above the bowl 101, a suitable power source (not shown) may be used for supplying inflated fluid through the hose 14 so as to communicate inflating fluid through the grooves 66 and 65 in the plug 64 and through the grooves 62 and 61 and port means 13a in the control head to the passage 20a extending longitudinally of the tubular body 7. The fluid will flow downwardly in the tubular body 7 and will act to inflate the inflatable elements 8 and 9. In the compensator 40 is provided in the tool, then the fluid

will act on the carrier 40a whereupon fluid will flow into the lower element 9.

After the packers 8 and 9 have been once inflated and then deflated, it can be appreciated that the fluid from packer 9 will remain in the tool body 7 below compensator 40. Thus, when fluid pressure is conducted through hose 14 to inflate packer 8, it also acts to move carrier 40a downwardly. This will move the fluid therebeneath from body 7 and into packer 9 to inflate it.

When the compensator 40 is not used, then of course the fluid will flow through the passage 20a and around the enlargement 20b on the lower end of means 20 and then flow directly to the lower element 9 for inflation thereof. As the elements inflate as more clearly illustrated in FIG. 3, the tool will contract longitudinally, and the construction of the present invention is such that this contraction may be accomplished without interfering with the normal function and operation of the tool. After the inflatable elements 8 and 9 have been inflated to seal off in the tubular member 10, fluid may be communicated through the hose 15 and passage 68 in plug 64 to the passage 22 in the means 20 and thence flow outwardly of the port means 25 so as to create a pressure in the annulus 120 between the tubular body 7 and the tubular member 10 intermediate the inflated elements 8 and 9. After the annulus 120 has been subjected to a fluid pressure, a pressure gauge in the conduit 15 will indicate such pressure, and any loss of pressure as noted on the pressure gauge (not shown) will in turn indicate a leak in the portion of the tubular member 10 between the inflatable elements 8 and 9. It will be noted that the upper inflatable element 8 is above the coupling 121 which joins the tubular members 10 and 10b together, while the inflatable element 9 is below the coupling 121, so that not only is the tubular member 10 between elements 8 and 9 tested for leaks, but the coupling 121 and its connection to members 10 and 10b is also tested for leaks. Quite frequently improper threading of the coupling 121 is responsible for leaks in the tubing, and of course this arrangement of inflatable elements 8 and 9 across the couplings will aid in determining if any leaks exist therein.

If no leak exists in the joint of pipe being tested, the packers are deflated by relieving the pressure on line 14, and the tool is then removed by means of cable 11, the pipe 10 lowered to its original position as shown in FIG. 2 of the drawings whereupon the next joint of pipe is secured in the coupling 122 at the top of the tubular member 10 and tubular member 10 is then lowered into the well bore so that the joint of tubing connected at its upper end extends above the slip bowl 101 in the manner as described with regard to tubular member 10. The testing operation is repeated in the manner as above described so that coupling 122 and the tubular member is tested for leaks. When a leak is found in a joint of pipe, the joint is removed from the well string and an alternate joint used therein.

The size of body 7 and the size of the tubular members being tested is such that very little volume exists in the annulus 120 being tested, thus increasing the sensitivity of the present invention, so that even minute leaks may be determined, by noting loss of pressure on the gauge (not shown) connected to hose 15. Also, there is a direct fluid connection between the annulus and gauge, with no valves interposed therebetween, thus greatly increasing the accuracy of determining the presence of leaks.

As previously noted the present invention may be used to test two or three or even more joints of pipe which are connected together, in which event the body 7 may be made of sufficient length to accomplish the desired testing thereof.

The control system and method employed in using the present invention is described in my application for Method and Apparatus for Hydrostatic Testing of Tubu-

lar Members, filed on September 19, 1960 and bearing Serial No. 56,749. It is therefore believed unnecessary to give a detail description of the inflatable elements 8 and 9 herein.

It will be noted that the tubular body 7 may be provided with rubber collars 123 at spaced intervals therealong to inhibit damage to the internal periphery of the tubular member in which the tool 6 is positioned.

It may be desirable to fill the tool 6 with liquid prior to its use in the manner as above described, and in such event a bleed hole 124 is provided at the lower end of the tool which communicates with passage 125 normally closed off by cap or screw 126. As the tool is filled with liquid, air may pass through the bleed hole 124, through passage 125 and out of the tool. The filling operation is continued until liquid appears in the passage 125 whereupon the cap or plug 126 is inserted therein to seal off further passage of liquid.

In FIG. 4, the invention is represented as being positioned in a well bore 10a, which may be cased, or uncased, for selectively flowing from the producing formation 131 adjacent which the tool is positioned. The control head 13 may include an inflating chamber of a suitable fluid for inflating the elements 8 and 9 as desired, or the hose 14 may extend from the earth's surface, or a tubing may be connected at 150 for filling the elements 8 and 9, whereupon the tubing may be disconnected from the tool by providing a safety joint (not shown) connection between the tool and tubing. After the elements 8 and 9 are inflated to seal off the producing formation 131, the well may be flowed through the port means 25 and the passage 22 of the means 20, and flow up through control head 13, which of course would be modified so that well fluids discharging from passage in control head 13, could be discharged upwardly into cased well bore 10a. Of course, if desired the elements 8 and 9 could be inflated by means of a hose connected to the tool, such as hose 14, as previously described. A fishing neck 132 is provided so that the tool 6 could be retrieved from the well bore when desired. The fishing neck 132 communicates passage 20a with the exterior of the tool when it is pulled upwardly so that the inflating pressure may thereby escape from elements 8 and 9 so that the tool 6 may then be retrieved from the well bore. Any fishing tool of a well-known type may be used to grasp fishing neck 132 and retrieve the tool from the well bore.

From the foregoing description it can be appreciated that the present invention provides a well tool having inflatable elements which may be positioned in a tubular member for testing thereof, or it may be positioned at any level in a well for receiving fluid from one or more producing formations. More particularly, the setting of the tool in the tubular member 10 or in the well bore 10a may be accomplished without manipulating the support means, which has been described as the cable 11, or without manipulating of a support pipe or flow pipe if one be secured thereto. This may be extremely advantageous in certain uses and environments.

Broadly the invention relates to a well tool, and more particularly to a tool with inflatable elements which elements may be inflated without manipulating the operating pipe or support pipe or member which positions the tool in the well pipe.

What is claimed is:

1. A tool for testing tubular members for leaks comprising a body to be inserted in the tubular member to be tested, said body including a pair of spaced inflatable elements to seal off in the tubular member to be tested, a control head on said body, a plug adapted to slidably fit in said head, said head and plug having passage means for communicating fluid to inflate said inflatable elements and an additional passage means in said plug, head, and in said body for communicating fluid into the tubular member to be tested between said elements and means secured to the lower end of said body and extending longi-

11

tudinally thereof to a position above the lowermost of said inflatable elements to catch said body below said lowermost element in the event of separation of said lowermost element.

2. A tool for testing tubular members comprising, a body to be inserted in the tubular member to be tested, said body including a pair of spaced inflatable elements to seal off in the tubular member to be tested, a control head on said body, a plug adapted to slidably fit in said head, said head and plug having passage means for communicating inflating fluid into said body and elements thereon to inflate said elements against the tubular member to be tested, said body having passage means communicating with said plug and head for communicating fluid into the tubular member to be tested between said elements, check valve means in said body between said elements, a movable carrier supporting said check valve means, spring means supporting said check valve carrier, an upstanding projection spaced below said check valve carrier, said check valve normally closing off flow to said lowermost of said inflatable elements, and said carrier movable in said body when inflating fluid is directed therein to urge said check valve against said upstanding projection and open it whereupon inflating fluid is communicated to the lowermost of said inflatable elements for inflation thereof.

3. A tool for testing tubular members comprising, a body to be inserted in the tubular member to be tested, said body including a pair of spaced inflatable elements to seal off in the tubular member to be tested, a control head on said body, said head having passage means for communicating inflating fluid into said body and elements thereon to inflate said elements against the tubular member to be tested, said body having passage means communicating with said head for communicating fluid into the tubular member to be tested between said elements, check valve means in said body between said elements, a movable carrier supporting said check valve means, spring means supporting said check valve carrier, an upstanding projection spaced below said check valve carrier closing off flow to said lowermost of said inflatable elements, said carrier movable in said body when inflating fluid is directed therein to urge said check valve against said upstanding projection and open it whereupon inflating fluid is communicated to the lowermost of said inflatable elements for inflation thereof, said control head having an additional passage means for communicating fluid to said body, passage means in said body for communicating fluid from said last named passage means into the tubular member to be tested, and means secured to the lower end of said body and extending longitudinally thereof to a position above the lowermost of said inflatable elements to catch said body below said lowermost element in the event of separation of said lowermost element.

4. A tool for testing tubular members comprising, a body to be inserted in the tubular member to be tested, said body including upper and lower spaced inflatable elements to seal off in the tubular member to be tested, a control head on said body, a plug adapted to slidably fit in said head, a hollow tubular member extending longitudinally in said body from said control head to a position in said body below said upper element, fluid seal means sealing off said hollow tubular member in said body below said upper element, port means in said hollow tubular member between said seal means, port means in said body for communicating with said hollow tubular member port means, said plug and control head having passage means for communicating fluid in said body and exteriorly of said hollow tubular member to inflate said elements, said tubular member having longitudinally extending passage means for by-passing inflating fluid around said seal means thereon and to said lower element, and additional passage means in said plug and control head and communicating with said hollow tubular member for discharging fluid through said port means and into the

12

tubular member to be tested, and means secured to the lower end of said body and extending longitudinally thereof to a position above the lowermost of said inflatable elements to catch said body below said lowermost element in the event of separation of said lowermost element.

5. A tool for sealing off in a tubular member comprising, a body to be inserted in the tubular member to be tested, said body including upper and lower spaced inflatable elements to seal off in the tubular member, a control head on said body, a plug adapted to slidably fit in said head, port means in said body between said elements, means secured to said head and extending through said upper element to a position in said body intermediate said upper and lower elements to define a passage means for directing fluid from said plug and head to said port means in said body between said elements and for directing fluid from said head to inflate said elements, said plug and control head having passage means to conduct fluid to said body and passage defining means to inflate said elements and to conduct fluid to said port means in said body between said elements, said passage defining means and said body having seal means therebetween on each side of said body port means to isolate said body port, said passage in said control head and said passage in said passage defining means being communicated with said body port means separately from said passage in said passage defining means which communicates with said control head passage for passing inflating fluid to said elements, whereby inflating fluid may be conducted to said elements independently of fluid flow between said body port means and the interior of said body and without manipulating said body and passage defining means.

6. A tool for sealing off in a tubular member comprising a support member, a body supported thereon, inflatable upper and lower elements thereon, port means in said body between said elements, means supported longitudinally in said body for communicating said port means between said elements and exteriorly of said body to one side of said elements, said means defining passage means in said body which is isolated from said port means whereby inflating fluid may be conducted through said body to said inflatable elements, said means including a control head mounted on said body and having passages therein for selectively communicating fluid to said inflatable elements and for communicating said body port means to one side of said elements without manipulation of said support member and body supported thereon, and means secured to the lower end of said body and extending longitudinally thereof to a position above the lowermost of said inflatable elements to catch said body below said lowermost element in the event of separation of said lowermost element.

7. A tool for sealing off in a tubular member comprising, a body to be inserted in the tubular member to be tested, said body including upper and lower spaced inflatable elements to seal off in the tubular member, a control head on said body, port means in said body between said elements means secured to said head and extending through said upper elements to a position in said body intermediate said upper and lower elements, to define a passage means for directing fluid from said head to said port means in said body between said elements and for directing fluid from said head to inflate said elements said control head having passage means to conduct fluid to said body and passage defining means to inflate said elements and to conduct fluid to said port means in said body between said elements, said passage defining means and said body having seal means therebetween on each side of said body port means to isolate said body port, said passage in said control head and said passage in said passage defining means being communicated with said body port means separately from said passage in said passage defining means which communicates with said control head passage for passing inflating fluid to said ele-

ments, whereby inflating fluid may be conducted to said elements independently of fluid flow between said body port means and the interior of said body and without manipulating said body and passage defining means, and means secured to the lower end of said body and extending longitudinally thereof to a position above the lowermost of said inflatable elements to catch said body below said lowermost element in the event of separation of said lowermost element.

8. A tool for sealing off in a tubular member comprising, a body, means for securing a support member thereon for positioning said body in the tubular member, said body including spaced inflatable longitudinally extending elements to seal off in the tubular member, port means in said body between said inflatable elements, a control head on said body, said head having passage means for communicating fluid to inflate said inflatable elements and an additional passage means in said head and body for communicating said port means through said body to an end thereof, and means secured to the lower end of said body and extending longitudinally thereof to a position above the lowermost of said inflatable elements to catch said body below said lowermost element in the event of separation of said lowermost element.

9. A tool for sealing off in a tubular member comprising, a body, means for securing a support member thereon for positioning said body in the tubular member, said body including spaced inflatable longitudinally extending elements to seal off in the tubular member, port means in said body between said inflatable elements, a control head on said body, said head having passage means for communicating fluid to inflate said inflatable elements and an additional passage means in said head and body for communicating said port means through said body to an end thereof, means secured to the lower end of said body and extending longitudinally thereof to a position above the lowermost of said inflatable elements to catch said body below said lowermost element in the event of separation of said lowermost element, and additional means in said body against which said last named means is adapted to strike and which absorbs the initial shock of fall of said last named means.

10. In a tool for testing tubular members wherein, a body is to be inserted in the tubular member to be tested, said body including a pair of spaced inflatable elements to seal off in the tubular member to be tested, and a control head on said body with said head having passage means for communicating inflating fluid into said body and elements thereon to inflate said elements against the tubular member to be tested, the invention comprising check valve means in said body between said elements, fluid passage means in said body for communicating fluid from said head into the tubular member to be tested between said elements, a movable carrier supporting said check valve means, spring means supporting said check valve carrier, an upstanding projection spaced below said check valve carrier, said check valve normally closing off flow to said lowermost of said inflatable elements, said carrier movable in said body when inflating fluid is directed therein to urge said check valve against said upstanding projection and open it whereupon inflating fluid is communicated to the lowermost of said inflatable elements for inflation thereof, said control head having a laterally extending opening, and a plug slidably fitting therein and having passage means for communicating fluid

into said passage means communicating with said inflatable elements.

11. A tool for testing tubular members comprising, a body to be inserted in the tubular member to be tested, said body including upper and lower spaced inflatable elements to seal off in the tubular member to be tested, a control head on said body, a hollow tubular member extending longitudinally in said body from said control head to a position in said body below said upper element, fluid seal means sealing off said hollow tubular member in said body below said upper element, port means in said hollow tubular member between said seal means, port means in said body for communicating with said hollow tubular member port means, said control head having passage means for communicating fluid in said body and exteriorly of said hollow tubular member to inflate said elements, said tubular member having longitudinally extending passage means for by-passing inflating fluid around said seal means thereon and to said lower element, additional passage means in said control head and communicating with said hollow tubular member for discharging fluid through said port means and into the tubular member to be tested, said control head having a laterally extending opening, and a plug slidably fitting therein and having passage means for communicating fluid into said passage means communicating with said inflatable elements, and having additional passage means communicating with said additional passage means which communicates with said port means.

12. A tool for testing tubular members comprising, a body to be inserted in the tubular member to be tested, said body including upper and lower spaced inflatable elements to seal off in the tubular member to be tested, a control head on said body, a hollow tubular member extending longitudinally in said body from said control head to a position in said body below said upper element, fluid seal means sealing off said hollow tubular member in said body below said upper element, port means in said hollow tubular member between said seal means, port means in said body for communicating with said hollow tubular member port means, said control head having passage means for communicating fluid in said body and exteriorly of said hollow tubular member to inflate said elements, said tubular member having longitudinally extending passage means for by-passing inflating fluid around said seal means thereon and to said lower element, valve means for controlling the flow to said lower element, additional passage means in said control head and communicating with said hollow tubular member for discharging fluid through said port means and into the tubular member to be tested, and a rubber collar on said body to inhibit damage to the tubular member in which said body is inserted.

References Cited in the file of this patent

UNITED STATES PATENTS

2,751,016	Watzlavick	June 19, 1956
2,793,524	Badger	May 28, 1957
2,807,955	Loomis	Oct. 1, 1957
2,824,612	Lynes	Feb. 25, 1958
2,851,111	Jones	Sept. 9, 1958
2,953,919	Potts	Sept. 27, 1960
2,981,331	Arterbury	Apr. 25, 1961
2,982,125	Gilreath	May 2, 1961
2,998,721	Gawlik	Sept. 5, 1961