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METHOD AND APPARATUS FOR SAMPLING WELL FLUIDS

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3 Sheets-Sheet 2

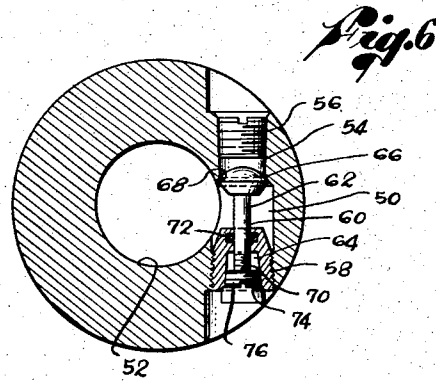
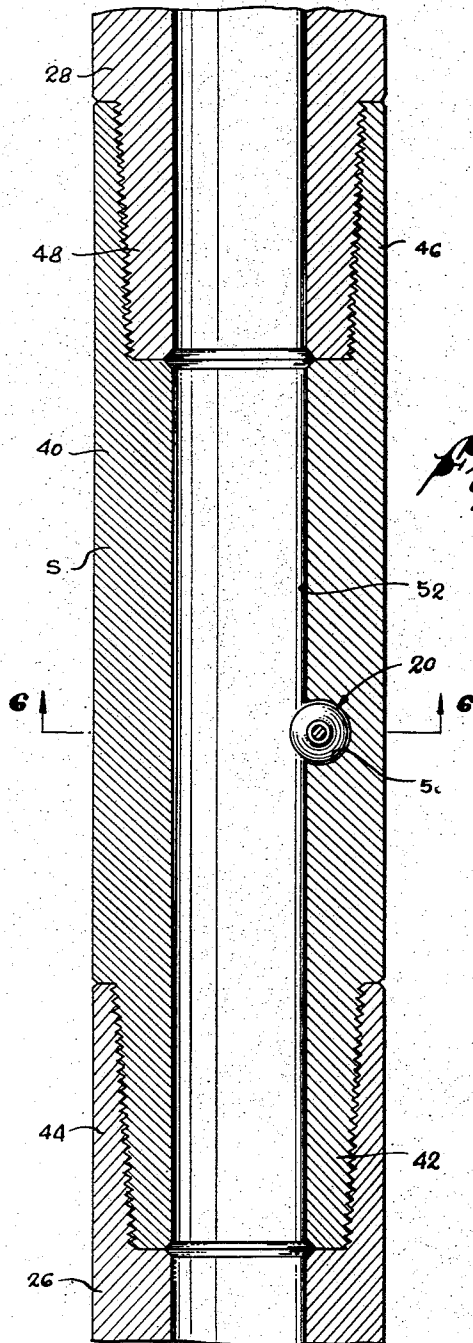


Fig. 7

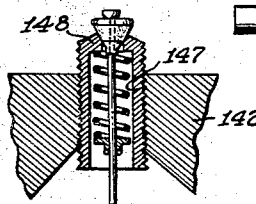
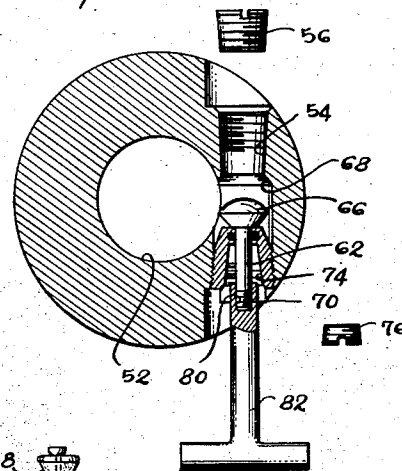


Fig. 8a INVENTOR.
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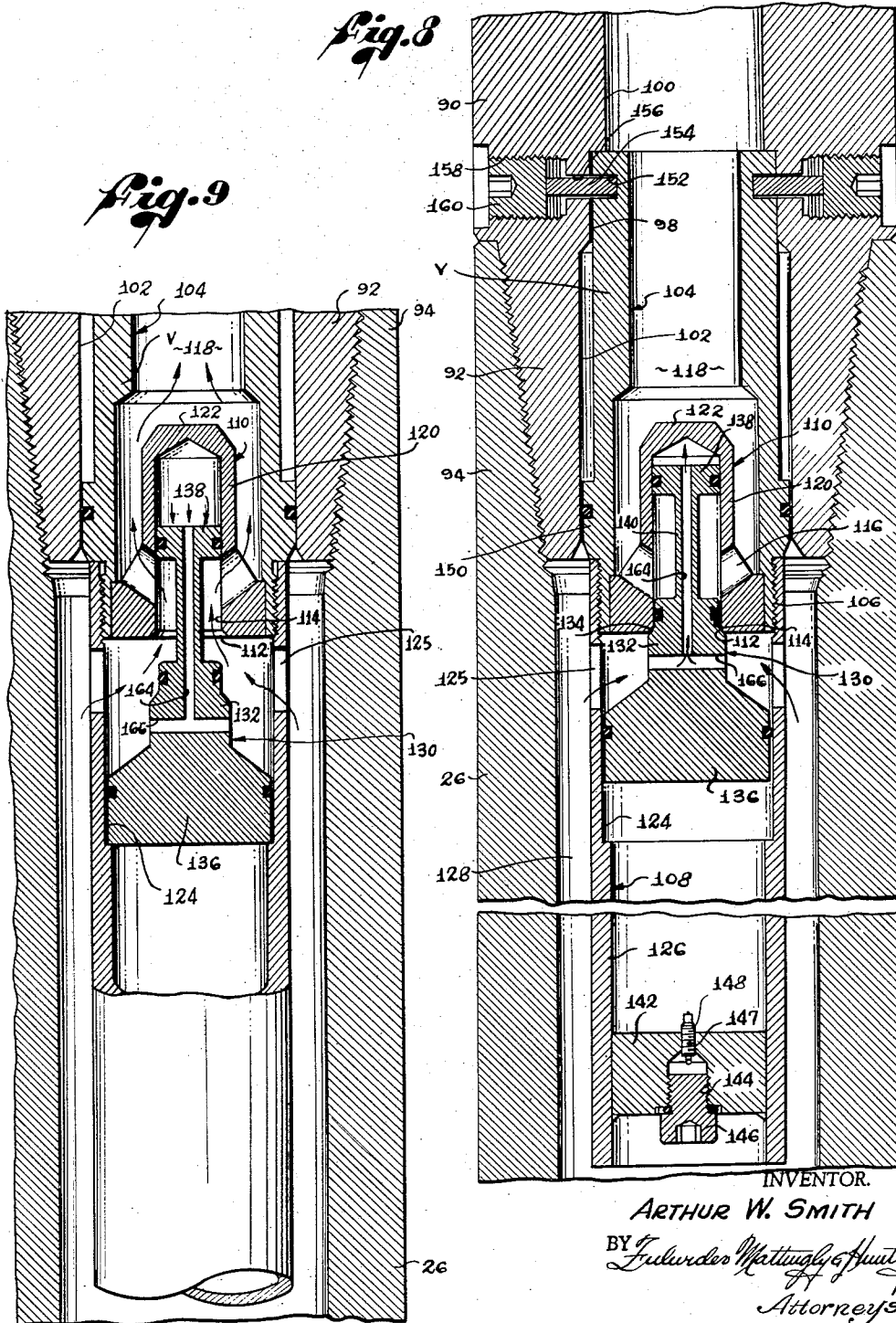
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METHOD AND APPARATUS FOR SAMPLING WELL FLUIDS

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8 Claims. (Cl. 166—3)

The present invention relates generally to the production of petroleum and more particularly to a new and improved method and apparatus for sampling well fluids, such sampling being generally termed "formation testing."

In formation testing a cased or uncased well, formation tester apparatus including a packer is lowered into the well bore on a pipe string such as a drill stem. The packer when properly seated against the wall of the well bore seals off the test interval below the packer from the hydrostatic pressure of the overlying column of drilling fluid and/or well bore fluid in the well. Valve means in the formation tester is then opened so as to place the packed-off test interval in communication with the interior of the pipe string. With the interior of the pipe string at atmospheric pressure, fluid from the test interval is then permitted to flow from the formation below the packer into the pipe string. Where the pressure differential between the test fluid and the interior of the pipe string is high, the well bore fluid will tend to move through the formation tester and into the pipe string at a high velocity. This can readily result in caving or collapsing of the well bore adjacent the formation tester thereby causing the tester to become stuck in the well bore. An expensive and time-consuming fishing operation is then required in order to retrieve the formation tester. In some cases such fishing operations are unsuccessful. Moreover, the stratum being sampled may easily be damaged under such conditions. It is also common for the ports of the formation tester and/or its associated equipment to become clogged where these high pressure differentials are encountered.

In order to overcome such disadvantages, it has been heretofore proposed to reduce such pressure differential when the formation tester is opened by filling the pipe string above the formation tester with water or drilling fluid. This is generally termed "a water cushion" operation. In the use of such cushion an attempt is made to employ sufficient liquid to provide a pressure slightly lower than the expected pressure of the well bore fluid in the test interval. Where too much water is employed a "dry run" will result. If however, an insufficient amount is used, the aforementioned disadvantages resulting from a high pressure differential will result.

A further important reason for the use of a water cushion is that it prevents the internal collapse of the pipe string during a formation testing operation. In this regard, if the interior of the pipe string is maintained at atmospheric pressure it is subject to being collapsed under the influence of high inwardly directed forces produced by high well pressures and the tension to which it is subjected as it is lowered and raised within the well bore. Such collapse can be avoided by filling the pipe with water or drilling fluid.

It is an object of the invention to provide a method and apparatus of sampling well fluids which provide all the advantages of a successful water cushion and elimi-

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ates the disadvantages inherent in the use of such water cushion.

Another very important object of the present invention is to provide a method and apparatus which will restrain collapse of the pipe string during a formation testing operation.

Another object of the invention is to provide a method and apparatus of the aforesaid nature which may be employed with conventional formation testing equipment.

A further object of the invention is to provide a method and apparatus for sampling well fluids which permits the well fluids to reach the surface in an uncontaminated condition. This is an important advantage over the use of the aforesaid water cushion since it is extremely difficult to obtain an uncontaminated test sample where the latter must flow through either water or drilling fluid.

Other objects and advantages of the present invention will become apparent from the following detailed description when taken in conjunction with the appended drawings wherein:

Figures 1 through 4 are diagrammatic illustrations showing the mode of operation of the preferred method and apparatus of the present invention in formation testing a well bore;

Figure 1a is a side elevational view particularly showing a conventional formation tester utilized with said method and operation;

Figure 5 is an enlarged, fragmentary, central vertical sectional view showing a loading sub used in said method and apparatus;

Figure 6 is a horizontal sectional view taken on line 6—6 of Figure 5;

Figure 7 is a view similar to Figure 6 but showing the parts of said loading sub in a different position;

Figure 8 is an enlarged, fragmentary, central vertical sectional view showing a control valve used in said method and apparatus;

Figure 8a is a fragmentary, central vertical sectional view of a conventional one-way valve used with said apparatus, said view being in enlarged scale; and

Figure 9 is a fragmentary view similar to Figure 8, but showing the parts of said control valve arranged in an open position.

Referring to the drawings and particularly Figures 1 through 4 thereof, the method and apparatus of the present invention is employed in conjunction with a conventional formation tester F carried at the lower portion 16 of a pipe string P so as to be lowered into a well bore 18. Manipulation of the pipe string P is effected by conventional equipment (not shown). A loading sub S to be fully described hereinafter is connected to the upper end of lower pipe portion 16. This loading sub S includes gas-receiving means 20. At a point spaced above the loading sub S, there is disposed in the pipe string a control valve V, the details of which are to be fully described hereinafter.

In carrying out the method of the present invention, the control valve V is connected either to the upper end of a length of pipe 26 having its lower end connected to the loading sub S, or alternatively to the upper end of the loading sub S. Next, as indicated in Figure 1, a suitable gas will be introduced into the loading sub S through the gas-receiving means 20 thereof so as to pressurize the lower pipe string portion 16 to a desired value. The use of an inert gas is preferred because it cuts to a minimum the fire hazard present at the well head and even within the well itself. Nitrogen, an inert gas is particularly desired because of its chemical inertness in reference to gases present in earth formations, giving a much better formation gas sample at the casing head during subsequent for-

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mation testing operations. Sufficient nitrogen will be forced through the gas-receiving means 20, as for example by conducting gas into the gas-receiving means from banks of cylinders (not shown) in which it may be conveniently transported to the well as to pressurize the lower portion 16 of the pipe string P to a desired pressure. Thereafter, as indicated in Figure 2, additional lengths 28 of pipe will be connected to the upper end of the control valve V so as to lower the pipe string P within the well bore until the perforated anchor 15 of the formation tester F is disposed adjacent the test interval zone 32 to be tested.

Next, referring to Figure 3, the packer 13 of the formation tester F is seated in the well bore 18 above the test interval 32. The formation tester F will then be opened so as to admit well bore fluids into the lower portion 16 of the pipe string P. A specific example of one form of formation tester which may be employed in connection with the present invention is shown in U.S. Patent No. 2,667,927 to M. O. Johnston, dated Feb. 2, 1954. Thus, packer 13, sub 19, perforated anchor 15, pipe section 21, retaining nut 23, collar 27, connecting sub 29 and compression spring 25 of said patent correspond to the similarly-numbered elements shown in Figures 1 through 4 of the accompanying drawings.

As noted above, the lower portion 16 of the pipe string P will have been pressurized to a desired value. Such value should be adequate to prevent the collapse of such lower pipe string portion under the influence of high inwardly-directed forces produced by high well pressures and/or the tension to which the pipe string is subjected while it is being vertically manipulated within the well bore 18. The precise pressure of the gas in the lower pipe string portion will vary according to the various conditions encountered from well to well.

Referring now to Figure 4, the formation fluid from the test interval 32 will enter the opened formation tester F and the lower portion 16 of the pipe string P gradually and slowly, thereby preventing caving, channeling or other damage to the formation inasmuch as the pressure differential between the test interval 32 and the interior of the lower pipe string portion 16 will be within safe limits. When the pressure of this incoming formation fluid rises above a predetermined value, the control valve V will open in a manner to be fully described hereinafter, so as to permit such formation fluid to rise toward the earth's surface through the upper portion of the pipe string P. The control valve V will, however, automatically close when the pressure within the lower pipe string portion 16 falls below such predetermined value. Hence, the lower pipe string portion 16 will remain pressurized at the predetermined value and thus resistant against collapsing, even while the pipe string P is raised to the surface at the conclusion of the formation testing operation.

Referring now to Figures 5, 6 and 7 there is shown a preferred form of loading sub S which may be employed in carrying out the present invention. The loading sub S includes a tubular body 40 having an outside diameter approximating that of the pipe string P. The lower portion of the body 40 is formed with an externally threaded male coupling member 42 adapted to receive a complementary internally threaded female member 44 formed on the upper end of the pipe section 16. The upper portion of the body 40 is formed with an internally threaded female coupling member 46 that receives a complementary male coupling member 48 formed on the lower end of the upper pipe section 26.

The aforementioned gas-receiving means 20 includes a transversely extending bore 50 formed in the intermediate portion of the body 40 so as to intersect one side of the gas-receiving bore 52 of the loading sub, as particularly shown in Figure 6. The inlet portion 54 of the gas-receiving bore 50 is of reduced diameter and is internally threaded so as to receive a removable plug 56. The opposite end of the gas-receiving bore 50 is likewise internally threaded so as to receive a valve support sleeve 58. The

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valve support sleeve 58 includes a coaxial bore 60 that slidably carries the stem 62 of a poppet valve 64. The head 66 of this poppet valve 64 is adapted to engage a complementary seat 68 formed at the junction of the bore 50 and its inlet portion 54. The opposite end of the stem 62 is externally threaded, as indicated at 70. Preferably, a seal ring 72 will be provided in the valve support sleeve 58 so as to engage the valve stem 62. The valve support sleeve 58 includes a coaxial internally threaded cavity 74. This cavity 74 is adapted to receive a removable plug 76.

Referring now to Figure 7, when it is desired to force gas into the loading sub S, the plugs 56 and 76 are removed from their respective bores. The threads 70 of the valve stem 62 are engaged by complementary threads formed within a blind bore 80 disposed at the free end of a generally T-shaped loading tool 82. During the gas loading operation the poppet valve 64 will be maintained in its position of Figure 7. When the desired volume of gas has been forced into the loading sub S, the loading tool 82 will be employed to force the head 66 of the poppet valve 64 into sealing engagement with the seat 68. Thereafter, the threads formed within the blind bore 70 of the unloading tool 82 are unscrewed from the threads 70 of the valve stem 62. The pressure of the gas will then maintain the valve head 66 in tight sealing engagement with the seat 68. The plug 76 will likewise be reinserted within the cavity 74 of the valve support sleeve 58 so as to engage and thereby positively prevent inadvertent unseating of the poppet valve 64. Finally, the plug 56 will be reinstalled within the inlet portion 54 of the gas-receiving bore 50. The various parts of the gas-receiving means 20 will then remain closed so as to prevent escape of gas despite any rough handling of the loading sub S. While the afordescribed loading sub S has proven to be particularly effective, it should be clearly understood that various other arrangements may be provided for pressurizing the interior of the pipe string P below the control valve V.

Referring now to Figures 8 and 9, there is shown a preferred form of control valve V which may be employed in carrying out the present invention. This control valve V includes a tubular body 90 formed at its lower end with an externally threaded male section 92 adapted to be threadably received by a complementary internally threaded female section 94 on the upper end of the pipe length 26. The lower portion of the sub body 90 is formed with a first counterbore 98 of larger diameter than its main bore 100. The lower end of counterbore 98 merges into a slightly larger second counterbore 102. The upper counterbore 98 longitudinally slidably receives the upper portion of a mounting cylinder, generally designated 104. The lower portion of this mounting cylinder 104 is externally threaded as indicated at 106 so as to receive the internally threaded upper end of a coaxial gas tube generally designated 108. Interposed between the lower portion of the mounting cylinder 104 and the upper portion of the gas tube 108 is a valve seat member, generally designated 110. This valve seat element 110 is coaxially formed at its lower portion with a downwardly-facing valve seat 112. The upper end of this valve seat 112 merges into a coaxial vertical bore 114. This bore 114 constitutes an orifice with respect to the upper end of the gas tube 108. A plurality of radially extending passages 116 connect the lower portion of the bore 114 with the interior 118 of the mounting cylinder 104. The upper portion of the valve seat member 110 is formed with an upstanding balance tube 120 through which extends bore 114 with the upper end of this bore being closed by an integral cap 122.

The upper portion of the gas tube 108 is formed with a counterbore 124 of larger diameter than the inner periphery 126 of the major portion of this gas tube. The upper portion of the gas tube is also formed with a plurality of ports 125. Communication between the annular space 128 separating the exterior of the gas tube

108 and the interior of the pipe length 26 and the interior 118 of the mounting cylinder 104 through ports 125 is controlled by means of an integral, vertically movable pressure-release member, generally designated 130. This pressure release member 130 includes a blocking element 132 formed at its intermediate portion and having an annular sealing surface 134 adapted to engage the valve seat 112 of valve seat member 110. The lower end of this blocking element merges into a main piston 136, the latter being slidably disposed within the counterbore 124 of the gas tube 108. The upper end of the pressure release member 130 is formed with a balancing piston 138 that is slidably arranged within the balance tube 120. The balancing piston 138 and the blocking element 132 are rigidly interconnected by a neck 140. The upper portion of the blocking element 132 above sealing surface 134 is slidably disposed within the lower portion of the bore 114. Conventional O-rings may be provided for effecting sealing between the pressure-release member 130 and the valve seat member 110 and gas tube 108, as shown in Figure 8. The lower end of the gas tube 108 is closed by a disc 142, this disc 142 being securely held in place as by welding. The disc 142 is coaxially formed with an internally threaded bore 144. This bore 144 receives a complementary, externally threaded plug 146. The upper end of the bore 144 merges into a smaller counterbore 147 wherein is affixed a conventional one-way valve fitting 148. The details of such valve fitting are shown in Figure 8a.

Above its threaded lower portion, the mounting cylinder 104 is formed with a radial enlargement 150. This enlargement 150 is slidably disposed within the lower counterbore 102 of the body 90. An O-ring or other sealing means may be provided between the extension 150 and the counterbore 102, as indicated in Figure 8. The upper portion of the mounting cylinder 104 is formed with a pair of radially inwardly directed bores 152. These bores 152 each receive a shear pin 154. The intermediate portion of each shear pin 154 is disposed within a radial bore 156 formed in the body 90 outwardly of the upper counterbore 98. The radially outer end of each bore 156 merges into an internally threaded passage 158. The shear pins 154 are each held in place by an externally threaded plug 160 disposed within threaded passage 158. This arrangement makes it possible to effect the downward removal of the mounting cylinder 104 and the gas tube 108 should such removal become necessary during a formation testing operation. The shear pins 154 can be broken, as by dropping a suitable go-devil down the pipe string, or by applying sufficient downward pump pressure against the control valve V.

The upper end of the body 90 is formed with a coupling member (not shown) permitting it to be connected to the lower end of pipe length 28. In the operation of the aforescribed control valve V, prior to the time this valve is connected to the lower end of the pipe length 28, the interior of the gas tube 108 will have been filled with a suitable gas, preferably nitrogen. Such filling is effected by removing the plug 146 from the disc 142. Thereafter, a conventional gas filling fitting (not shown) is secured to the disc 142 and gas is forced through the fitting 148. The interior of the gas tube 108 is thus pressurized to a predetermined value. This predetermined value will be that at which it is desired to have the pressure release member 130 move downwardly from its closed position of Figure 8 to its open position of Figure 9. When arranged in its open position of Figure 9, the pressure release member 130 will permit formation fluid entering the formation tester F from the test interval 32 to flow upwardly through the annular space 128, inwardly through ports 125 and upwardly through the lower end of bore or orifice 114 and passages 116 into the interior of the mounting cylinder 118. As will be apparent, the interior 118 of the mount-

ing cylinder is in communication with the interior of the pipe string P above the control valve V.

It should be particularly noted that the upwardly-facing surfaces of the main piston 136 are preferably equal to the downwardly-facing area thereof, the latter area being exposed to the pressure within the pressurized gas tube 108. The aforementioned upwardly-facing surfaces are exposed to the pressure within the space 128 separating the gas tube 108 and the pipe section 26. Accordingly, the vertically directed force exerted against the pressure release member 130 at any given moment will be equal to the pressure differential between the interior of the gas tube 108 and the space 128. As noted hereinbefore, the space 128 is initially pressurized with nitrogen by means of the loading sub S to a desired value. The interior of the gas tube 108 will be pressurized at a higher value. Hence, the pressure release member 130 will remain in its closed position of Figure 8 until such time as the pressure within the space 128 exceeds that within the gas tube 108. The pressure release member 130 will then be moved downwardly towards its open position of Figure 9. In order to provide communication between the space 128 and the upwardly-facing area of the pressure release member 130, the upper surface of the balance cylinder 130 is placed in communication with the space 128 by means of a vertical passage 164 and a horizontal passage 166, the latter passage being formed through the blocking element 132 and intersecting the lower end of the vertical passage 164.

With continued reference to Figure 9, when the formation tester F is opened, the formation fluid from the test interval 32 will flow upwardly into the annular space 128. At such time as the pressure existing within annular space 128 exceeds the pressure at which the interior of the gas tube 108 is pressurized, the pressure release member 130 will be moved downwardly to its open position of this figure. Accordingly, the formation fluid will be permitted to rise toward the earth's surface through the upper portion of the pipe string P. When, however, the pressure of this formation fluid falls below that at which the gas tube 108 is pressurized, the pressure release member 130 will automatically be moved upwardly until its sealing surface 134 again engages the valve seat 112. Communication will then be cut off between the annular space 128 and the interior of the pipe string P above the control valve V. It will therefore be apparent that the interior of the lower pipe string portion 16 will always be maintained at a sufficiently high pressure to restrain collapse thereof. This becomes particularly important when the packer 30 of the formation tester F is unseated and the pipe string is raised upwardly thereby placing its lower portion under considerable tension. In this regard, the formation tester F should be closed to communication with the test interval 32 (in a conventional manner) before the pipe string P is withdrawn from the well bore.

It should be noted that various other types of control valves may be employed in carrying out the present invention other than the preferred form shown in detail in Figures 8 and 9. It should also be noted that the method and apparatus of the present invention may be successfully operated utilizing various forms of formation testers and packers other than the types shown and described hereinabove.

Various other modifications and changes may be made with respect to the foregoing description without departing from the spirit of the invention or the scope of the following claims.

I claim.

1. A method of testing a formation penetrated by a well, comprising: providing a conduit having a valved tester and a packer at the lower end thereof; pressuring the interior of a portion of said conduit above said tester but below the earth's surface by introducing gas under a predetermined pressure into said portion, said pressure

being high enough to prevent inward collapse of said portion while the latter is in said well; maintaining said conduit and tester sealed from fluids present in said well until said packer is set; setting said packer while said conduit and tester are sealed to remove the hydrostatic pressure of overlying fluid in said well from the formation to be tested; providing an opening in said tester when said packer is set to permit the flow of fluid from said formation through said opening into said pressurized conduit portion; and effecting communication between said pressurized conduit portion and the interior of said conduit thereabove to permit a rise of said formation fluid through said opening and into the interior of said conduit above said pressurized conduit portion only when the fluid pressure within said pressurized conduit portion rises above said predetermined pressure whereby said pressurized conduit portion will remain resistant against collapsing during said testing.

2. A method of testing a formation penetrated by a well, comprising: providing a conduit having a valved tester and a packer at the lower end thereof; selecting a gas that is substantially chemically inert with respect to fluids found in said formation; pressuring the interior of a portion of said conduit above said tester but below the earth's surface by introducing said gas under a predetermined pressure into said portion, said pressure being high enough to prevent inward collapse of said portion while the latter is in said well; maintaining said conduit and tester sealed from fluids present in said well until said packer is set; setting said packer while said conduit and tester are sealed to remove the hydrostatic pressure of overlying fluid in said well from the formation to be tested; providing an opening in said tester when said packer is set to permit the flow of fluid from said formation through said opening into said pressurized conduit portion; and effecting communication between said pressurized conduit portion and the interior of said conduit thereabove to permit a rise of said formation fluid through said opening and into the interior of said conduit above said pressurized conduit portion only when the fluid pressure within said pressurized conduit portion rises above said predetermined pressure whereby said pressurized conduit portion will remain resistant against collapsing during said testing.

3. A method of testing a formation penetrated by a well, said method utilizing a pipe string and a packer and formation tester at the lower part of said pipe string, with said method including the steps of: extending said pipe string downwardly into said well with said packer and formation tester at the lower part thereof; pressuring the interior of a portion of said pipe string above said tester but below the earth's surface by introducing gas under a predetermined pressure into said portion, said pressure being high enough to prevent inward collapse of said portion while the latter is in said well; maintaining said pipe string and tester sealed from fluids present in said well until said packer is set; setting said packer while said pipe string and tester are sealed to remove the hydrostatic pressure of overlying fluid in said well from the formation to be tested; opening said tester when said packer is set to permit the flow of fluid from said formation through said opening into said pressurized pipe string portion; and effecting communication between said pressurized pipe string portion and the interior of said pipe string thereabove to permit a rise of the formation fluid through said opening into the interior of said pipe string above said pressurized pipe string portion only when the fluid pressure within said pressurized pipe string portion rises above said predetermined pressure whereby said pressurized pipe string portion will remain resistant against collapsing during said testing.

4. A method of testing a formation penetrated by a well, said method utilizing a pipe string and a packer and formation tester at the lower part of said pipe string,

with said method including the steps of: extending said pipe string downwardly into said well with said packer and formation tester at the lower part thereof; selecting a gas that is substantially chemically inert with respect to fluids found in said formation; pressuring the interior of a portion of said pipe string above said tester but below the earth's surface by introducing said gas under a predetermined pressure into said portion, said pressure being high enough to prevent inward collapse of said portion while the latter is in said well; maintaining said pipe string and tester sealed from fluids present in said well until said packer is set; setting said packer while said pipe string and tester are sealed to remove the hydrostatic pressure of overlying fluid in said well from the formation to be tested; opening said tester when said packer is set to permit the flow of fluid from said formation through said opening into said pressurized pipe string portion; and effecting communication between said pressurized pipe string portion and the interior of said pipe string thereabove to permit a rise of the formation fluid through said opening into the interior of said pipe string above said pressurized pipe string portion only when the fluid pressure within said pressurized pipe string portion rises above said predetermined pressure whereby said pressurized pipe string portion will remain resistant against collapsing during said testing.

5. A method of testing a formation penetrated by a well, comprising: providing a conduit having a valved tester and a packer at the lower end thereof; pressuring the interior of a portion of said conduit above said tester but below the earth's surface by introducing gas under a predetermined pressure into said portion, said pressure being high enough to restrain inward collapse of said portion while the latter is in said well; maintaining said conduit and tester sealed from fluids present in said well until said packer is set; setting said packer while said conduit and tester are sealed to remove the hydrostatic pressure of overlying fluid in said well from the formation to be tested; providing an opening in said tester when said packer is set to permit the flow of fluid from said formation through said opening into said pressurized conduit portion; effecting communication between said pressurized conduit portion and the interior of said conduit thereabove to permit a rise of said formation fluid through said opening and into the interior of said conduit above said pressurized conduit portion only when the fluid pressure within said pressurized conduit portion rises above said predetermined pressure whereby said pressurized conduit portion will remain resistant against collapsing during said testing; and finally closing said opening and withdrawing said conduit upwardly through said well while continuing to maintain said pressurized conduit portion pressurized at a minimum value equal to substantially said predetermined pressure.

6. A method of testing a formation penetrated by a well, comprising: providing a conduit having a valved tester and a packer at the lower end thereof; selecting a gas that is substantially chemically inert with respect to fluids found in said formation; pressuring the interior of a portion of said conduit above said tester but below the earth's surface by introducing said gas under a predetermined pressure into said portion, said pressure being high enough to restrain inward collapse of said portion while the latter is in said well; maintaining said conduit and tester sealed from fluids present in said well until said packer is set; setting said packer while said conduit and tester are sealed to remove the hydrostatic pressure of overlying fluid in said well from the formation to be tested; providing an opening in said tester when said packer is set to permit the flow of fluid from said formation through said opening into said pressurized conduit portion; effecting communication between said pressurized conduit portion and the interior of said conduit thereabove to permit a rise of said formation fluid through said opening and into the interior of said con-

duit above said pressurized conduit portion only when the fluid pressure within said pressurized conduit portion rises above said predetermined pressure whereby said pressurized conduit portion will remain resistant against collapsing during said testing; and finally closing said opening and withdrawing said conduit upwardly through said well while continuing to maintain said pressurized conduit portion pressurized at a minimum value equal to substantially said predetermined pressure.

7. Apparatus for use with a pipe string that extends to the earth's surface in testing a well formation, said apparatus comprising: a formation tester carried at the lower part of said pipe string; a control valve disposed in the lower portion of said pipe string above said formation tester, said control valve having a body formed with a passage permitting fluid communication through the interior of said pipe string, a blocking element in said body movable between a first position wherein it blocks fluid flow through said passage and a second position wherein it permits fluid flow through said passage, and biasing means in said body normally urging said blocking element towards said first position with a desired force, said biasing means permitting said blocking element to be moved to said second position when the fluid pressure within said lower pipe string portion exceeds a predetermined value whereby formation fluid entering said formation tester may flow upwardly through said control valve passage and pipe string to the earth's surface; and a loading member interposed in said pipe string below said control valve, with the interior of said loading member being in communication with the interior of said pipe string below said control valve, said loading member having gas-receiving means to admit a gas under super-atmospheric pressure into the interior of said loading member before said formation tester is placed in communication with said well formation.

8. Apparatus for use with a pipe string that extends to the earth's surface in testing a well, comprising: a formation tester carried at the lower end of said pipe

string; a control valve member having a body formed with a passage; means on said body for mounting said body in the lower portion of said pipe string above said formation tester; valve means in said body controlling the flow of fluid through said passage and including a pressure release member movable between a closed position and an open position, said pressure release member being formed with a surface exposed to the interior of the lower portion of said pipe string above said formation tester; biasing means in said body urging said pressure release member towards its closed position, the force of said biasing means being temporarily overcome when said formation tester is opened and the pressure within said lower pipe string portion exceeds a predetermined value so as to permit said pressure release member to be moved towards its open position and effect temporary communication between said lower pipe string portion and the remainder of said pipe string whereby formation fluid entering said formation tester may flow upwardly through said control valve passage and pipe string to the earth's surface; and a loading member disposable in said pipe string below said control valve, said loading member having gas-receiving means for admitting gas under super-atmospheric pressure into the interior of said lower pipe string portion before said formation tester is placed in communication with said well formation.

References Cited in the file of this patent

UNITED STATES PATENTS

2,033,563	Wells	Mar. 10, 1936
2,132,072	Johnston	Oct. 4, 1938
2,137,296	MacReady	Nov. 22, 1938
2,176,240	Bandy	Oct. 17, 1939
2,203,577	O'Neil et al.	June 4, 1940
2,214,551	Edwards	Sept. 10, 1940
2,661,802	Johnston	Dec. 8, 1953
2,830,667	Walstrom	Apr. 15, 1958
2,850,097	Bloom	Sept. 2, 1958