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[54] **DOWNHOLE GAS DETECTOR SYSTEM**[75] Inventor: **William T. Ilfrey**, Houston, Tex.[73] Assignee: **Exxon Production Research Company**, Houston, Tex.[22] Filed: **Feb. 28, 1973**[21] Appl. No.: **336,568**[52] U.S. Cl. **73/151**[51] Int. Cl. **E21b 47/06**[58] Field of Search 73/151, 152, 155, 19;
166/264, 100[56] **References Cited****UNITED STATES PATENTS**

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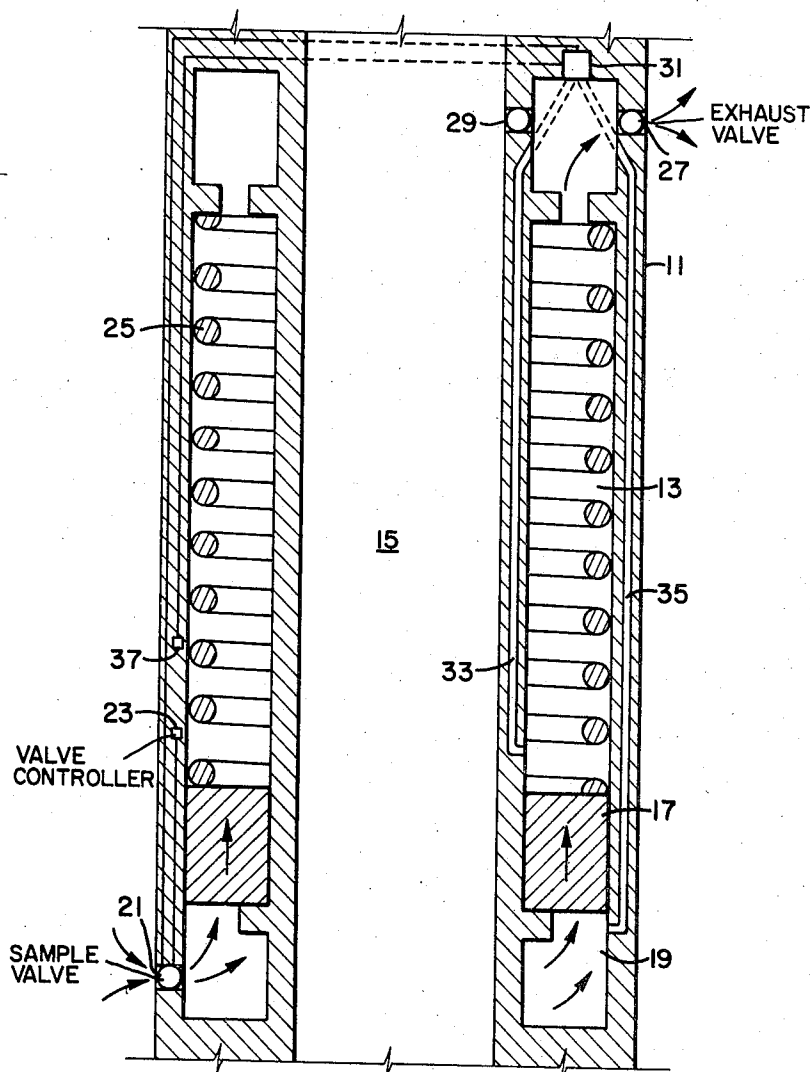
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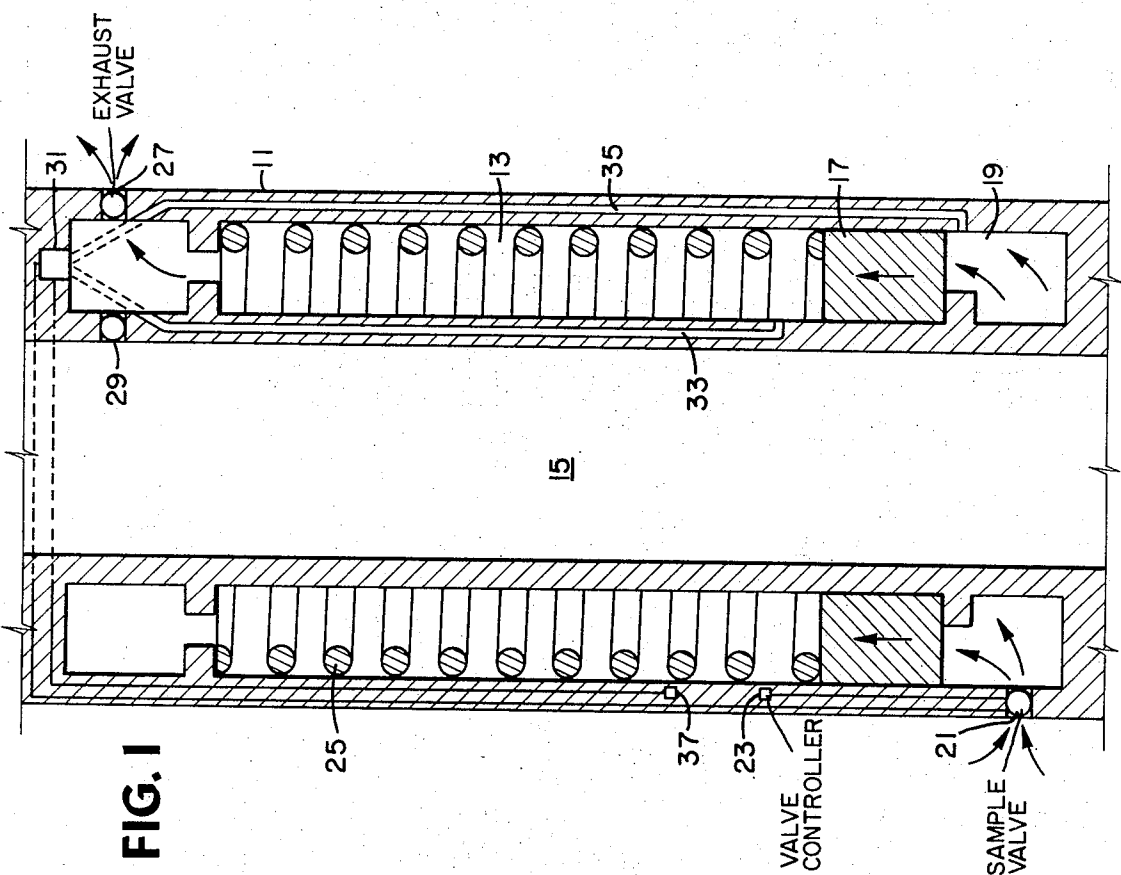
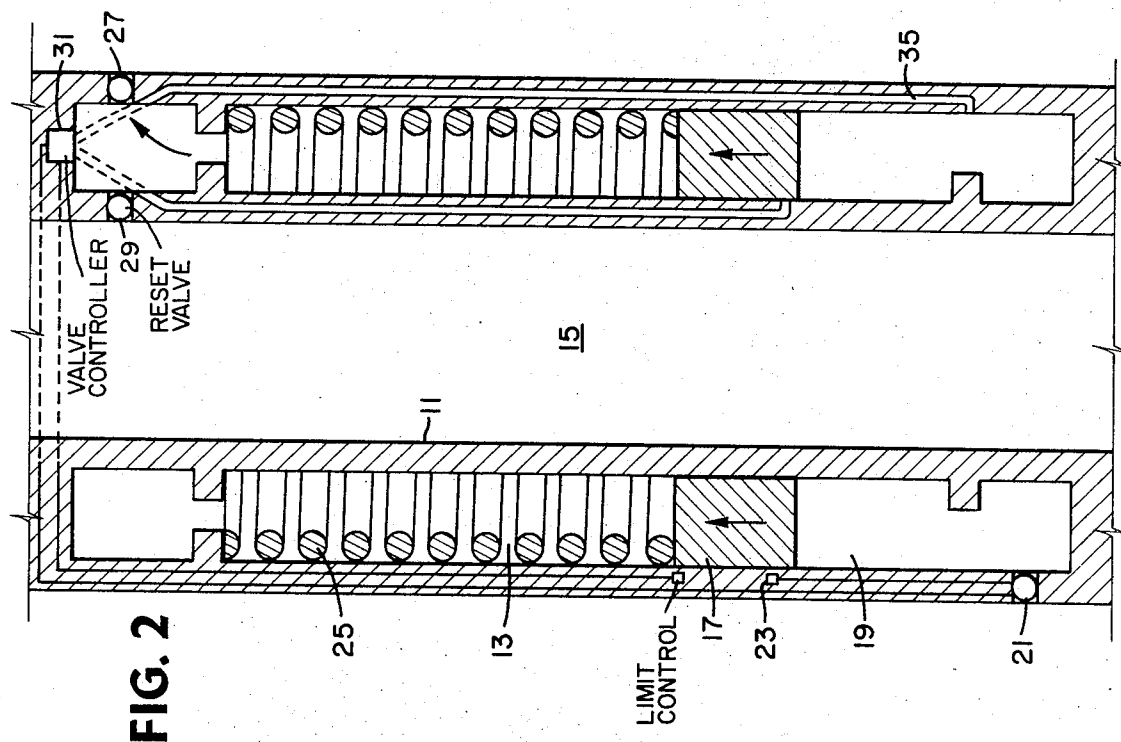
Attorney, Agent, or Firm—James E. Gilchrist

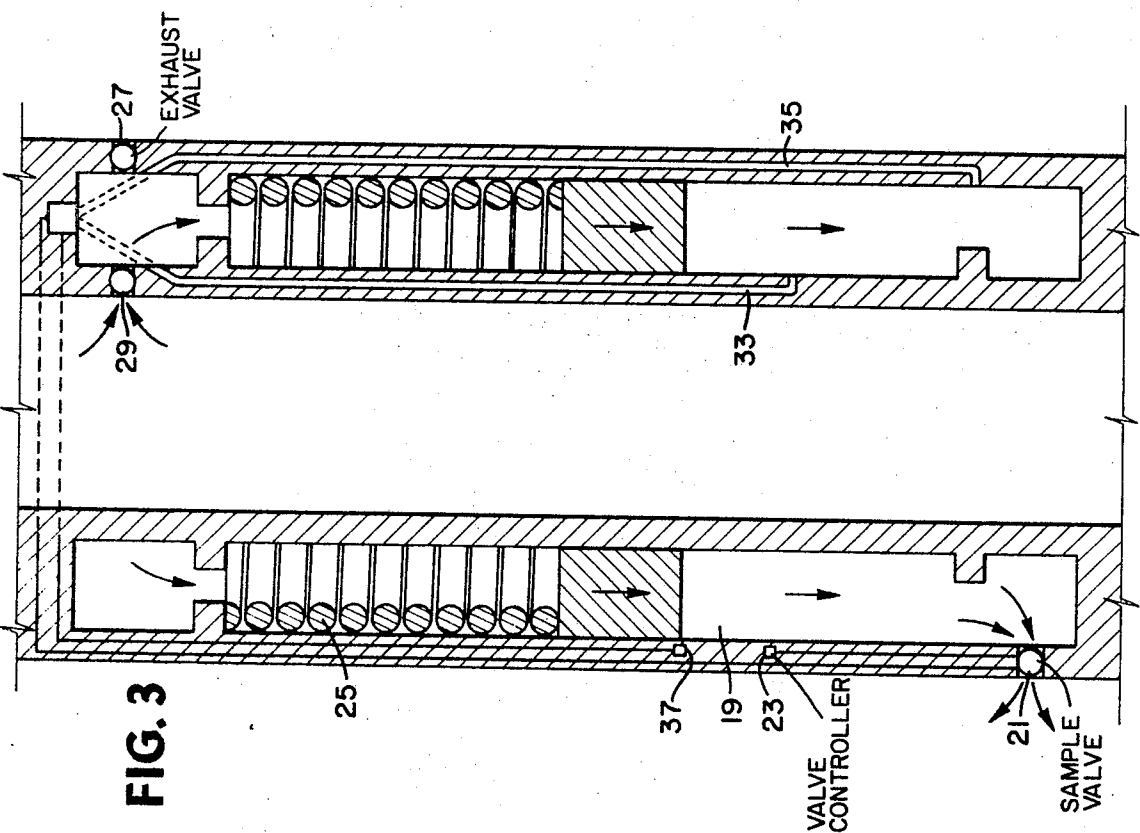
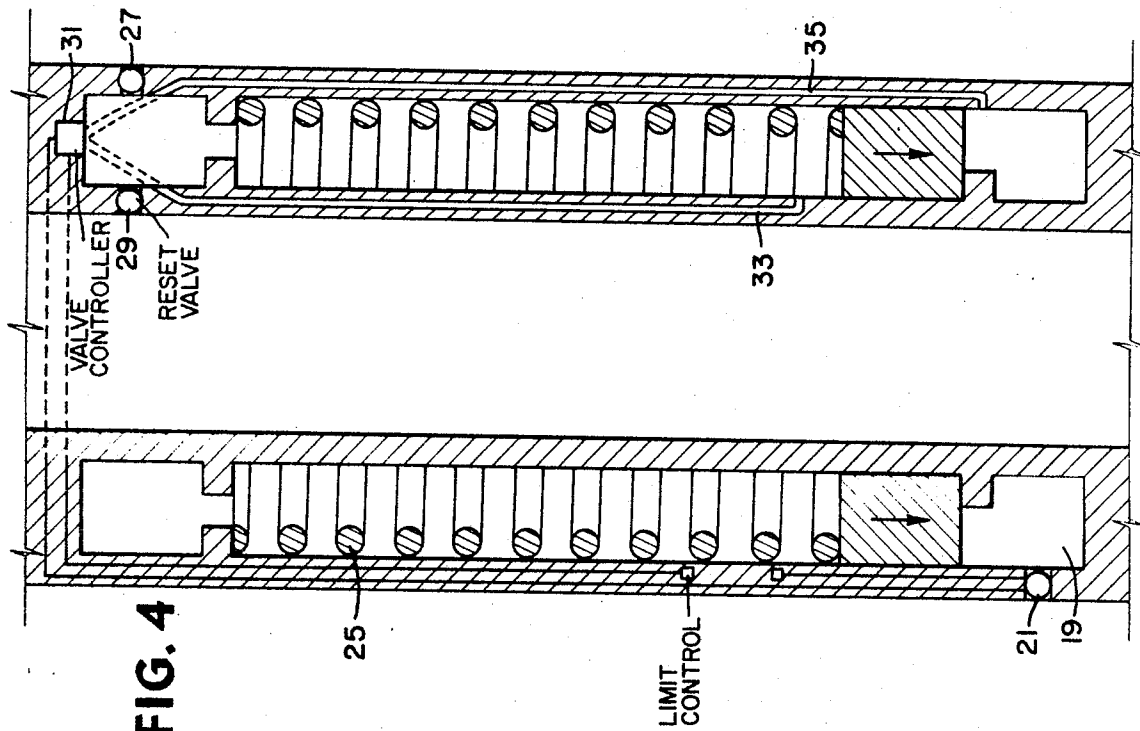
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ABSTRACT

This specification discloses improved methods and apparatus for use in drilling operations to detect the entry of gas into the wellbore. The system is particularly useful in floating drilling operations, i.e., where a drilling vessel is situated at the surface of a body of water and the drill string extends downward from the vessel into a borehole in the floor beneath the body of water. The system includes method and apparatus for withdrawing a downhole sample of drilling fluid from the drill string/borehole annulus, isolating it within a sample chamber, and then expanding the sample. A signal, which is detectable at the vessel, is generated whenever the behavior of the expanding sample indicates the presence of gas in the drilling fluid. The sample chamber is then purged and the test cycle repeated without requiring intervention from the earth's surface.

9 Claims, 7 Drawing Figures





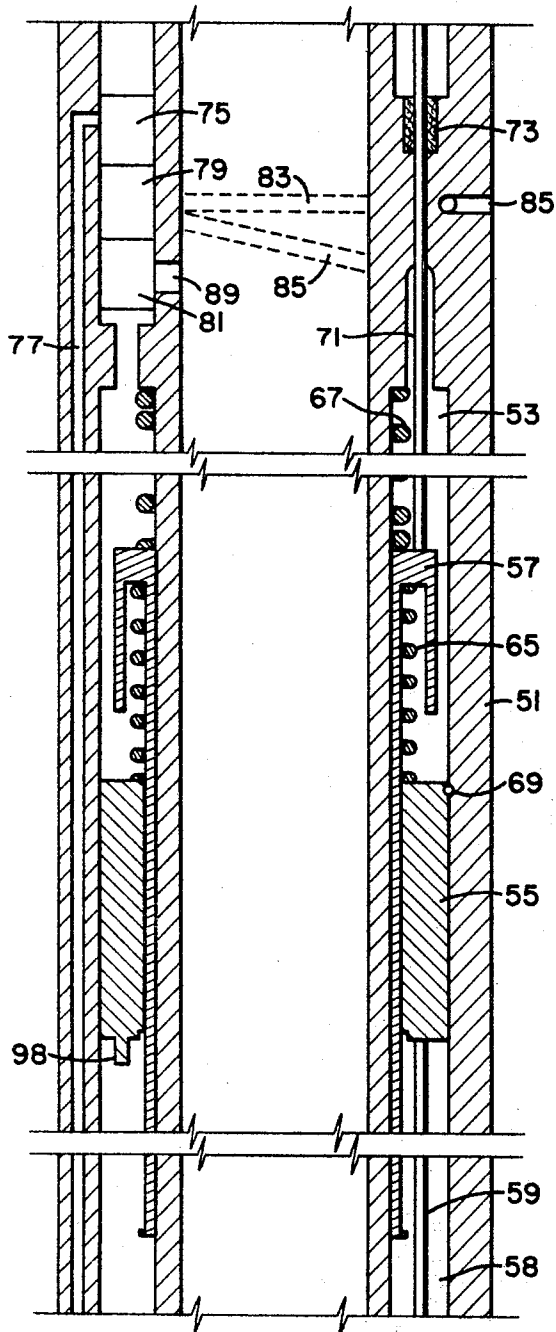


FIG. 5A

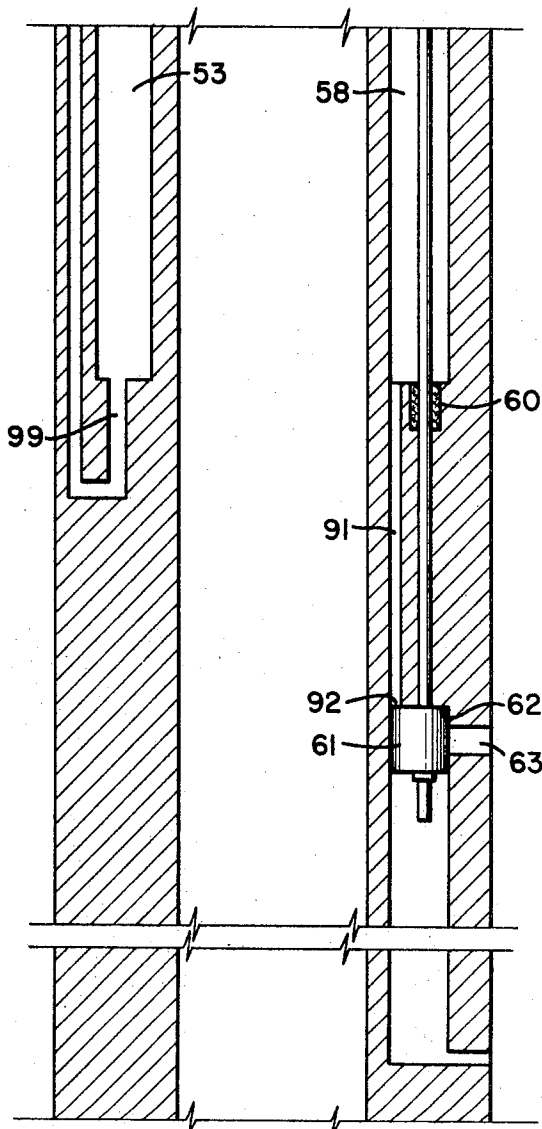


FIG. 5B

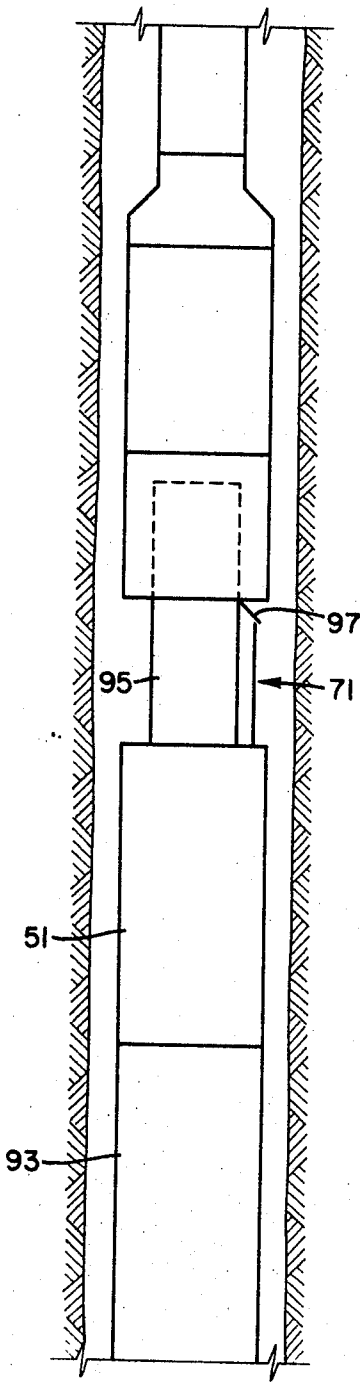


FIG. 6

DOWNHOLE GAS DETECTOR SYSTEM

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention pertains to methods and apparatus for downhole detection of the entry of formation fluids into the borehole during drilling operations.

2. Description of the Prior Art

Detection and control of the entry of formation fluids into the borehole is an important aspect of any drilling safety program. Early detection of these fluid kicks is particularly critical in offshore drilling operations where the wellhead and blowout preventers are positioned on the floor of the body of water. Because of their distance from the drill rig and their principle of operation, the subsea preventers have a reaction time, i.e., time required to close in the well, that may be substantially greater than that required onshore. Early detection is additionally important in floating drilling operations because the drilling riser, an extension of the borehole from wellhead to vessel, is a large diameter conduit and normally will not withstand well pressure. Thus, it is important to detect and control pressurized fluids well before the fluids reach the equipment positioned at the water surface.

One method used for kick detection onshore is to periodically measure the volume of fluid in the mud pits to detect any change between the rate of flux of drill fluid into and out of the borehole. If mud is flowing back to the pits more rapidly than it is being pumped into the hole, it is normally indicative of the influx of formation fluids. Unfortunately, accurate gauging of the mud pits during floating drilling operations is precluded by vessel motion except in relatively calm water. Other onshore detection techniques have the disadvantage of relying on observation of pressure fluctuations of the drilling fluid in the standpipe. These pressure changes are also obscured on a floating rig by the pressure surges caused by vessel heave opening and closing the telescoping joint positioned within the drill string to prevent vertical motion of the vessel from overstressing the pipe.

Another onshore technique for detecting entry of gaseous fluid into the wellbore utilizes a downhole tool. This tool is situated in the drill string near the drill bit and includes an expansible sampling chamber which is defined between two telescoping sections of the drill string. A discrete sample of drilling mud is inducted into the chamber from the borehole. The sampling chamber is then expanded, normally by hoisting the drill string, and changes in hook load are interpreted to provide an indication of the presence of gas in the entrapped sample. While this downhole system has the advantage of permitting early detection of kicks, hoisting the drill string is disadvantageous as it requires interrupting drilling operations.

SUMMARY OF THE INVENTION

The method and apparatus of the present invention alleviate the problems outlined above and permit downhole detection of formation fluid influx in the course of drilling operations conducted from a floating vessel. In accordance with the invention, testing may be carried out from a floating vessel on a continuous basis without interrupting the drilling operation.

The method of the invention involves positioning a tubular member provided with a sample chamber in the lower end of the drill string, introducing a sample of drilling fluid into the sample chamber from the annulus between the drill string and the walls of the borehole and isolating the sample within the chamber. The sample is then expanded within the chamber, its pressure-volume behavior is monitored and a surface detectable signal is generated whenever behavior of the expanding sample indicates the presence of gas in the drilling fluid. Following expansion, the fluid sample is expelled, a new sample is introduced and the test cycle is repeated, without any need for surface intervention. The continuous test cycle eliminates any interruption in the drilling operation and at the same time provides an early indication of a positive nature of the presence of gas in the drilling fluid.

The apparatus of the invention includes a tubular member having a hollow chamber in its wall. A piston is slidably disposed within the chamber and defines an expansible sample chamber with the walls thereof. The piston is movable between a first position in which the sample chamber is contracted and a second position in which it is expanded. Valve means are provided for controlling migration of fluid between the exterior of the tubular member and the sample chamber. Means are provided within the tubular member for advancing the piston from the first to the second position which means cooperate with the valve means to admit, isolate and expand a fluid sample within the sample chamber. Means are also provided for generating a remotely detectable signal in response to a pressure condition within the sample chamber indicative of the presence of gas in the sample. In addition, means are provided within the tubular member for moving the piston from the second to the first position which means cooperates with the valve means to compress the sample chamber, expel the sample therefrom and reset the apparatus to repeat the cycle.

The method and apparatus of the invention permit continuous downhole testing of the drilling fluid for the presence of gas. The present system does not employ a telescoping joint and thus permits continuous testing without requiring interruption of drilling operations. It therefore will be seen to have significant advantage over systems existing heretofore.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a cross-sectional schematic elevation view of the downhole testing apparatus of the invention as introduction of fluid into the sample chamber is initiated.

FIG. 2 is a schematic elevation view of the apparatus of FIG. 1 after the fluid sample has been introduced into the sample chamber, isolated from the annulus and is being expanded.

FIG. 3 is a schematic elevation view of the apparatus shown in FIG. 1 wherein expansion of the sample has been completed and the piston is being forced downward to purge the sample from the sample chamber.

FIG. 4 is a schematic elevation view of the apparatus of FIG. 1 wherein the sample has been expelled and the device is ready to repeat the test cycle.

FIG. 5 is a cross-sectional elevation view depicting another embodiment of the apparatus of the invention.

FIG. 6 is an elevation view, partially in section, of a signalling device which can be used with the apparatus of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

Turning to FIG. 1, apparatus is shown comprising a tubular member 11 having an elongated, hollow chamber 13 which is closed at both ends formed within its wall. The tubular member is adapted to be positioned within a drill string with its inner bore 15 in communication with the interiors of adjacent sections of the drill string to permit drilling fluid to flow through the tubular member to a drill bit which is not shown but will be positioned on the lower end of the drill string. The fluid is returned to the earth's surface through the annulus formed between the exterior of the tubular member and the walls of the borehole. Piston 17 is slidably disposed within chamber 13 in the wall of the tubular member and its underside, together with the walls of the chamber, defines an expansible sample chamber 19 therebelow. The piston is movable between a first position depicted in FIG. 1 in which the sample chamber is contracted and a second position, as shown in FIG. 3, in which the sample chamber is expanded.

Means are provided for controlling migration of fluid between the sample chamber and the exterior of the tubular member. This may suitably include a valve such as sample valve 21 situated near the lower end of the tubular member. The position of valve 21, i.e., whether it is open or closed, is preferably controlled by the position occupied by piston 17 within chamber 13. A valve controller, designated by numeral 23 in the drawing, controls the position of the valve and is responsive to piston position. It may, for example, be a mechanically or electrically operated limit device.

Means are also provided within the tubular member for moving the piston between the first and second positions to expand the sample chamber. This means acts in cooperation with valve 21 to admit, isolate and expand a fluid sample within the sample chamber. In the embodiment shown in FIGS. 1-4, this means includes a tension spring identified by numeral 25. The spring is stretched so as to be in tension when the sample chamber 19 is compressed, as shown in FIG. 1, tending to draw piston 17 upwards toward the expanded position.

An exhaust valve 27 is also provided and serves to control migration of fluid from the upper portion of chamber 13, which is separated from the sample chamber by the piston, to the annulus situated to the exterior of the tubular member. Another valve is provided which acts to restore the piston to its initial position and reset the tool. This reset valve, designated by numeral 29, controls the flow of high pressure fluid from the inner bore 15 of the tubular member to the upper portion of chamber 13. Controller 31, which is preferably pressure actuated, is shown positioned near the top of the tubular member and controls the positions of the reset and exhaust valves and, under some circumstances, serves to open sample valve 21. Passages 33 and 35 extend from controller 31 to the lower part of the hollow chamber within the wall of the tubular member and provide pressure communication to permit detection of high and low pressure conditions therein, respectively.

Turning to FIG. 1, which illustrates the position of the various components at the beginning of the test cycle,

sample valve 21 is in the open position to permit fluid to flow from the exterior of the tubular member into the sample chamber. Exhaust valve 27 between the upper part of chamber 13 and the annulus is also open, permitting fluid to be displaced from the upper part of the chamber into the annulus as the spring biased piston moves upward. Valve 29, the reset valve interconnecting the inner bore 15 of the tubular member with the upper part of the chamber, is closed. Piston 17, biased by tension spring 25, travels upward, expanding the sample chamber and causing a sample to be withdrawn from the annulus. The piston continues upwardly and, as shown in FIG. 2, passes limit control 23 which responds by closing sample valve 21. Closing the sample valve isolates the fluid sample contained within the sample chamber from the annulus. The piston, urged by spring 25, continues upward toward the position it occupies in FIG. 2, tending to expand the fluid sample.

Pressure within the sample chamber is monitored by controller 31 which is in pressure communication with the sample chamber through fluid passage 35. This controller acts to open reset valve 29 whenever a predetermined low pressure condition is attained within the sample chamber. Opening the reset valve will in turn permit high pressure fluid within the bore 15 of the tubular member to flow into the upper part of chamber 13. Controller 31 simultaneously overrides limit control 23 to open sample valve 21 and thereby permit expulsion of the sample as the piston is forced downward.

In the event the sample is substantially incompressible, i.e., contains no gas, pressure within the sample chamber will drop sharply after the piston travels a very short distance. If, on the other hand, the sample contains gas, the pressure will decline at a more gradual rate in relation to the distance of piston travel. The predetermined low pressure condition, which causes controller 31 to open the sample and reset valves, is selected such that it will permit the piston to travel a substantial distance, as shown in FIG. 3, if gas is present, and only a very short distance if it is not. In either eventuality, once the low pressure condition is attained, the exhaust, reset and sample valves will be repositioned by controller 31 and the piston will be forced back to its initial position, purging the sample chamber to ready it for another test cycle.

If gas is present, the piston will travel upward a sufficient distance to contact controller 37 before the predetermined low pressure condition is attained within the sample chamber. This limit control, which may be mechanically or electrically actuated, is responsive to piston position and activates a means for emitting a surface detectable signal indicative of the presence of gas in the wellbore. This means may comprise the device for changing apparent bit weight which is discussed below in relation to FIGS. 5 and 6. Alternatively, the signal from the limit control could be employed to cause controller 31 to open both valve 29 and valve 27 for a predetermined time period to route pressurized drill fluid from the bore of the tool to the annulus. Routing fluid from the inner bore to the annulus in this fashion will create a drop in drilling fluid pressure observable at the earth's surface. After the time delay, valve 27 is closed for the purpose of restoring the piston to its initial position and resetting the tool for another test cycle.

Subsequent to the expansion of the sample and the opening of the reset valve, fluid pressure in the tool is again monitored. Controller 31 monitors the pressure of the fluid above the piston through fluid passage 33 so as to sense when a preset high pressure level is attained. This high pressure level will be approximately equal to the pressure of the drilling fluid passing through the inner bore of the tool and will occur once the sample chamber is contracted and the piston has been restored to its initial position. In response to this condition the controller closes reset valve 29 and opens exhaust valve 27. This completes the test cycle and resets the tool to initiate a new test cycle without requiring any intervention from the earth's surface.

Shown in FIGS. 5A and 5B is another embodiment of the apparatus of the present invention. The apparatus shown includes a tubular member designated generally by numeral 51 and provided with a hollow chamber 53 in its wall. A primary piston 55 and a secondary piston 57, which are slidable with respect to one another, and are preferably splined, are slidably disposed within the chamber. The pistons and chamber walls define an expandable sample chamber 58 in the lower end of the chamber. A valve actuating rod 59 is attached to the underside of the primary piston, extends downwardly through packing gland 60 situated at the bottom of the sample chamber and terminates near the lower end of the tubular member. The rod has a cylindrical plug 61 affixed near its lower end. This plug forms in combination with port 63, extending through the wall of the tubular member, a shear seal sample valve. Plug 61 is shown in abutting relation to and thereby blocking valve port 63, preventing flow to the exterior through the sample valve. A vertical passage designated as 91 extends between the sample valve and the lower portion of the sample chamber. This passage permits fluid to flow between the sample chamber and the annulus when the valve is open, i.e., when plug 61 is displaced downwardly beneath valve port 63.

Secondary piston 57, as noted above, is slidable relative to both chamber 53 and primary piston 55. It is connected to the primary piston by a spring 65 which is in tension. This spring extends between the top of the primary piston and the bottom of the secondary piston, tending to draw them together. A second tension spring is designated by numeral 67 in the drawings and extends between the top of the secondary piston and the upper end of chamber 53. This upper tension spring serves to move the primary and secondary pistons in unison and should develop a force substantially in excess of that developed by the spring disposed between the primary and secondary pistons. It may, for example, develop a force on the order of 1000 pounds when the smaller spring develops a force of about 50 pounds. Spring 65 between the two pistons should, however, develop a tensile force greater than the frictional forces generated by the pistons as they slide together within chamber 53 so as to prevent the two pistons from separating until valve body 61 connected by rod 59 to the underside of the primary piston engages facing 62, serving to prevent further upward movement of the primary piston. With the primary piston in its uppermost position, ball detent 69 snaps into place to halt downward piston travel which might be caused by the difference in pressure between the fluid in the annulus and that in the sample chamber. The detent is, however, adapted to release the piston for travel downward in re-

sponse to an increase in pressure differential acting across the piston of the magnitude caused by introduction of pressurized fluid from the inner bore. With the primary piston locked in place, tension spring 67 overcomes spring 65 causing the secondary piston to move upward relative to the primary piston.

Weight release actuator rod 71 is attached to and extends upward from the top of secondary piston 57. It will be noted to extend through seal member 73 situated in the upper end of chamber 53 formed within the tubular member. Vertical displacement of this rod is controlled by movement of the secondary piston. The extent of vertical motion of the latter is, in turn, dictated by whether or not gas is present in the fluid sample. The upper end of the weight release actuator rod interconnects with the weight release assembly depicted in FIG. 6 of the drawings which serves to provide a signal detectable at the earth's surface whenever gas is present in the sample.

A pressure operated tandem valve actuator is shown situated near the top of tubular member 51 and is designated by numeral 75. This device is triggered by variations in sample pressure which are monitored directly through fluid passage 77, extending from the actuator to the lower portion of the sample chamber and providing pressure communication. The tandem valve actuator controls the positions of the reset and exhaust valves, 79 and 81, which are arranged in tandem and connect the upper end of chamber 53 with the inner bore and annulus, respectively. The exhaust valve 79 is connected by means of a circumferential fluid passage 83 to port 85 which extends through the wall of the tubular member to the annulus. The circumferential passage normally occupies only about one-half of the circumference of the tubular member and is positioned so as not to interfere with weight release actuator rod 71 which extends upwardly through this section of the tool. Another circumferential passage designated by numeral 85 extends from the exhaust valve to the upper portion of chamber 53 so that when the valve is open fluid is free to flow between the annulus and the upper part of the chamber by means of circumferential passages 83 and 85. Reset valve 81 is connected to port 89 which extends between chamber 53 and the inner bore of the tubular member. It is also connected to the upper end of the inner chamber. Thus, when the reset valve is open, fluid can flow between the bore of the tool and the purge chamber which forms the upper part of chamber 53.

FIG. 6 of the drawings depicts a device that may be used in the practice of the present invention to create a surface detectable signal whenever gas is detected in the drilling fluid by the downhole tool. Shown in FIG. 6 is a section of drill string designated by numeral 93 in which the apparatus of the present invention is mounted and designated by numeral 51. Situated just above the test tool of the invention is a telescoping joint which is designated by numeral 95. This sub, which may for example be a bumper sub, is shown in an open position and is locked there by pin 97. The pin in turn is operatively connected to weight release actuator rod 71 connected to the secondary piston, not shown, of the embodiment of the invention shown in FIG. 5. The actuator rod is displaced upwardly whenever gas is present in the drilling fluid and acts to dislodge the pin 97 which holds the bumper sub open. Because of the substantial weight of the section of drill string situated

above the pin it will frequently be desirable to increase the mechanical advantage of the lever schematically shown, either mechanically or hydraulically. Closing of the sub creates an abrupt change in the weight of the drill string which can readily be observed at the drilling vessel on the weight indicator.

In operation, the tool depicted in FIG. 5 begins the sampling cycle with the primary and secondary pistons, 55 and 57 respectively, in abutting relation near the lower end of the chamber 53. Connecting rod 59 initially extends downward a sufficient distance such that valve plug 61 is clear of port 63 permitting flow of fluid from the annulus through port 92, passage 91 and into the lower part of sample chamber 58. Tandem valve actuator 75 acts to hold exhaust valve 79 open so as to permit fluid from the purge chamber, i.e., the upper part of chamber 53, to be displaced through circumferential passages 85 and 83 and port 85 into the annulus. Spring 67 is in its fully extended position, and with both the sample valve and the exhaust valve open, acts to draw the primary and secondary pistons upward. The motion of the pistons pushes fluid contained in the upper part of the chamber out through the exhaust valve and draws a new fluid sample from the annulus into the sample chamber. The pistons continue their upward travel until valve body 61 which is connected to the primary piston by connecting rod 59 engages facing 62, preventing further upward movement of the primary piston. Ball detent 69 engages the primary piston and prevents downward movement. At this point of piston travel, plug 61 of the shear seal sample valve also blocks port 63 and port 92, isolating the sample within the sample chamber.

With the primary piston locked in place, by rod 59 and ball detent 69, spring 67 overcomes spring 65 situated between the primary and secondary pistons and draws the secondary piston upwards relative to the primary piston, thereby expanding the fluid sample contained within the sample chamber. Expansion of the sample continues until tandem valve actuator 75 detects a predetermined low pressure condition in the sample chamber through fluid passage 77 which is in pressure communication with the lower end of the sample chamber. Upon sensing this low pressure condition, the actuator closes exhaust valve 79 and opens reset valve 81, setting off a chain of events leading to the initiation of a new sampling cycle.

The distance travelled by the secondary piston prior to the creation of the low pressure condition is indicative of the gas content of the fluid sample. If the sample contains no gas, pressure decline during sample expansion will be very rapid, and the low pressure condition will be attained after a short piston stroke. If, on the other hand, the sample contains gas, pressure decline will be more gradual leading to a relatively long piston stroke. This long stroke drives the weight release actuator rod upwards to the point required to actuate the apparatus of FIG. 6, thereby creating a surface detectable change in weight of the drill string when gas is present in the sample.

The low pressure condition leading to the opening of the reset valve and closing of the exhaust valve permits high pressure fluid from the inner bore of the tool to enter the upper part of the tool through port 89 and reset valve 81. This pressure increase acts to overcome the force of spring 65 and thus to drive the secondary piston back into contact with the primary piston. It fur-

ther creates sufficient differential pressure across the primary piston to force it to overcome ball detent 69. This frees both pistons to move downward together. As the pistons descend, rod 59 is displaced downward, re-opening the sample valve and permitting the fluid sample to be expelled through passage 91 and sample port 63. When the pistons reach the maximum downward stroke a high pressure condition is detected by tandem valve actuator 75. This high pressure condition is created by signal piston 98, which extends downwardly from the base of the primary piston, entering signal cylinder 99 at the base of chamber 53 and thereby compressing the fluid in passage 77 leading to the tandem valve actuator. The high pressure signal causes the actuator to close the reset valve and open the exhaust valve, thereby reinitiating the sampling cycle.

What is claimed is:

1. Apparatus for detecting the presence of gas in a drilling fluid comprising:

- a. a tubular member adapted to be included in a drill string, said tubular member having a hollow chamber formed in the wall thereof;
- b. a piston slidably disposed within said hollow chamber and dividing it into a sample chamber and a purge chamber, said piston movable between a first position in which the sample chamber is contracted and a second position in which it is expanded;
- c. a sample valve situated in the wall of said tubular member and controlling migration of fluid between the exterior of said tubular member and said sample chamber;
- d. an exhaust valve situated in the wall of said tubular member and controlling migration of fluid between said purge chamber and the exterior of said tubular member;
- e. means within said tubular member for moving said piston from said first to said second position to expand said sample chamber and cooperating with said sample valve and said exhaust valve to admit, isolate and expand a fluid sample within said sample chamber;
- f. a reset valve situated in the wall of said tubular member and controlling admission of fluid from the interior of said tubular member into said purge chamber;
- g. means within said tubular member for moving said piston from said second position to said first position and cooperating with said reset valve, said exhaust valve and said sample valve to compress said sampling chamber, purge said fluid sample therefrom and reset the apparatus; and
- h. means for generating a remotely detectable signal in response to pressure expansion behavior of said sample indicative of the presence of gas therein.

2. The apparatus of claim 1 wherein said means for generating a signal includes means for changing the weight of the drill string.

3. Apparatus for detecting the presence of gas in drilling fluid comprising:

- a. a tubular member adapted to be included in a drill string, said tubular member including an annular chamber disposed in the wall thereof;
- b. first and second pistons slidably disposed within said chamber, said pistons being slidable relative to one another within said chamber and forming an expansible sample chamber therein;

- c. a first valve for selectively opening upper exterior and interior ports situated above said pistons and extending through the walls of said annular chamber to the exterior and interior, respectively, of said tubular member;
 - d. a second valve for opening and closing a lower port through the wall of said annular chamber, said lower port extending between the exterior of said tubular member and said sample chamber;
 - e. means for actuating said first valve to open said upper exterior port;
 - f. means responsive to displacement of said first piston for actuating said second valve to open or close said lower exterior port;
 - g. means for displacing said first and second pistons within said annular chamber with said upper and lower exterior ports open to expand said sampling chamber and thereby withdraw a fluid from the exterior of said tubular member through said lower port and into said sample chamber;
 - h. means for displacing said second piston relative to said first piston to further expand said sample chamber after said second valve closes in response to displacement of said first piston to close said lower exterior port and isolate a sample of fluid in said sample chamber;
 - i. means responsive to the pressure within said sample chamber for actuating said first valve to open said upper interior port and close said upper exterior port when said pressure reaches a preset value to permit differential pressure between the interior and exterior of the tool to return the pistons to their original positions and thereby expel the fluid sample from the sample chamber;
 - j. means responsive to the pressure within said annular chamber above said first and second pistons for actuating said first valve to close said upper interior port and open said upper exterior port when said pressure reaches a preset level to permit repetition of the sampling cycle without external intervention; and
 - k. means responsive to the displacement of said second piston for generating a surface detectable signal whenever said displacement attains a level corresponding to the presence of gas within said fluid sample.
4. The apparatus of claim 3 wherein said means for generating a signal includes means for changing the weight of the drill string.
5. Apparatus comprising:
- a. tubular member adapted to be included in a drill string, said member having an inner bore extending therethrough and having an expansible sample chamber disposed in the wall thereof;
 - b. means for introducing a fluid sample from the exterior of said tubular member into said sample chamber;
 - c. means disposed within said tubular member for expanding said sample chamber and means disposed within said tubular member for contracting said sample chamber, at least one of said means being adapted to be actuated by differential pressure be-

- tween the exterior and the bore of the tubular member; and
 - d. means for generating a signal detectable at a remote location in response to pressure volume behavior of said fluid sample within said sample chamber indicative of the presence of gas therein.
6. The apparatus of claim 5 wherein said means for generating a signal includes means for changing the weight of the drill string.
7. Apparatus comprising:
- a. a tubular member adapted to be included in a drill string, said tubular member having an inner bore extending therethrough, having an annular chamber in the wall thereof and having a piston slidably disposed within said chamber to form an expansible sample chamber therein;
 - b. means for introducing a fluid sample from the exterior of said tubular member into said sample chamber and isolating said fluid therewithin;
 - c. means disposed within said tubular member for displacing said piston to expand said sample chamber containing said fluid sample and means situated within said tubular member for returning said piston to its initial position, expelling said fluid from said sampling chamber and actuating said means for introducing fluid, at least one of said means being adapted to be actuated by differential pressure between the exterior and the bore of said tubular member; and
 - d. means for generating a signal detectable at a remote location in response to pressure volume behavior of said expanding sample indicative of the pressure of gas therein.
8. The apparatus of claim 7 wherein said means for generating a signal includes means for changing the weight of the drill string.
9. A method of continuously performing a subsurface test for the presence of gas in drilling fluid during the course of a drilling operation conducted from a floating vessel wherein a drill string extends downwardly from the vessel into a well extending beneath the earth's surface comprising:
- a. positioning a tubular member having an expansible sample chamber in the wall thereof in the drill string and near its lower end;
 - b. circulating drilling fluid through the drill string so as to create a pressure differential between the interior and exterior thereof;
 - c. employing the said differential pressure to expand and contract the sample chamber so as to admit, isolate, expand and discharge a fluid sample therefrom without interrupting the drilling operation;
 - d. monitoring the pressure behavior of the expanding sample and generating a surface detectable signal whenever the pressure volume behavior of the fluid sample is indicative of the presence of gas in the drilling fluid; and
 - e. reinitiating the expansion and contraction cycle and continuing the same without intervention from the earth's surface.

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