April 21, 1942. J. T. HAYWARD 2,280,075

DETECTION OF GAS IN DRILLING FLUIDS

Filed Feb. 23, 1938 2 Sheets-Sheet 1

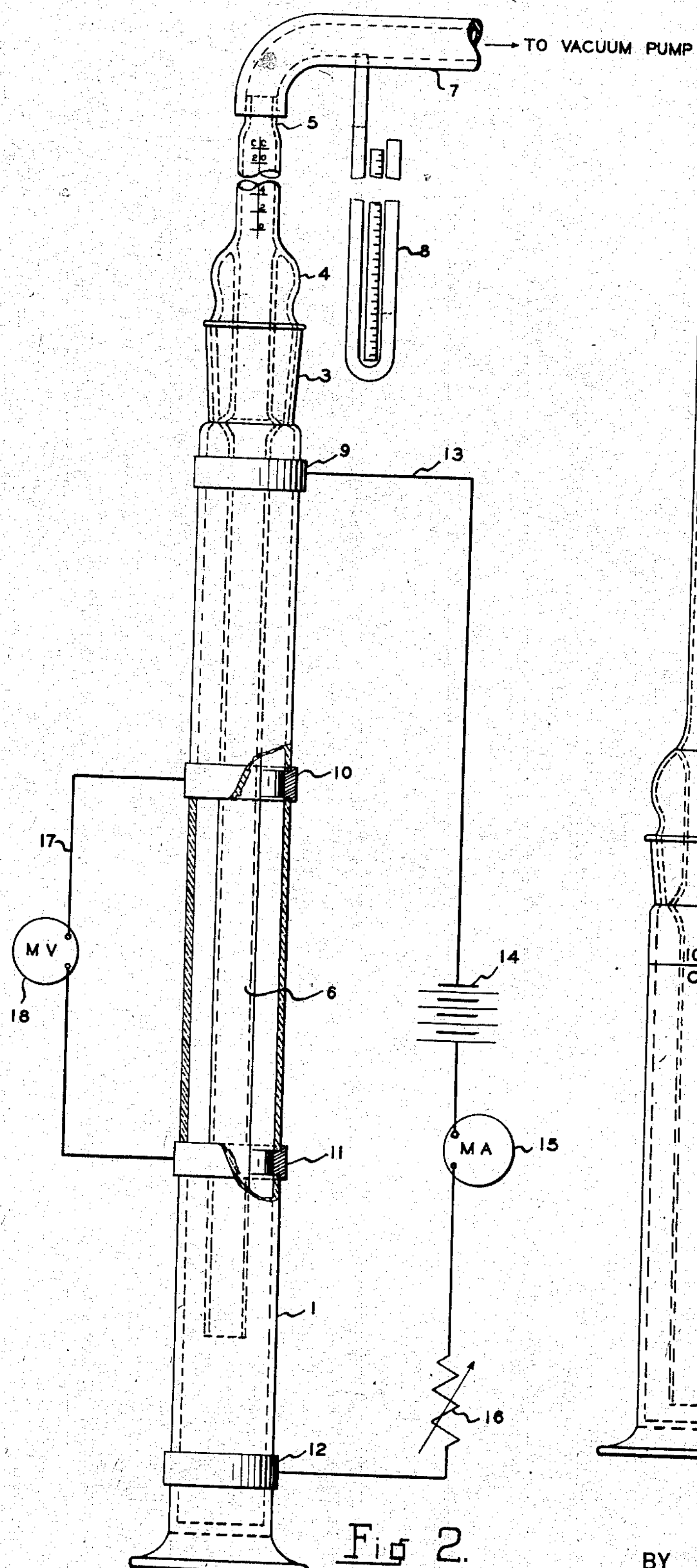


Fig 2.

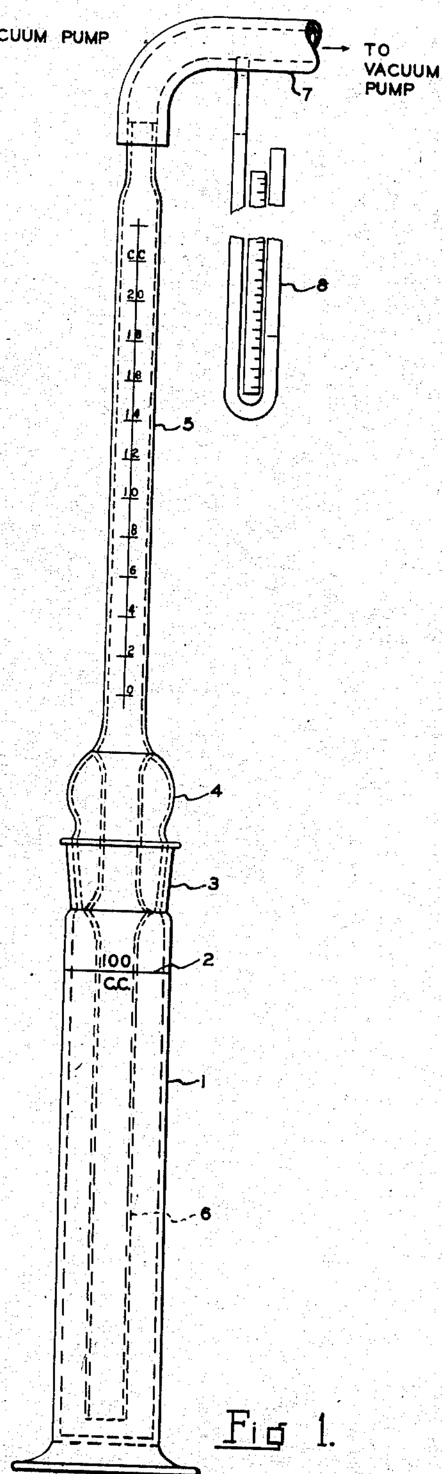


Fig 1.

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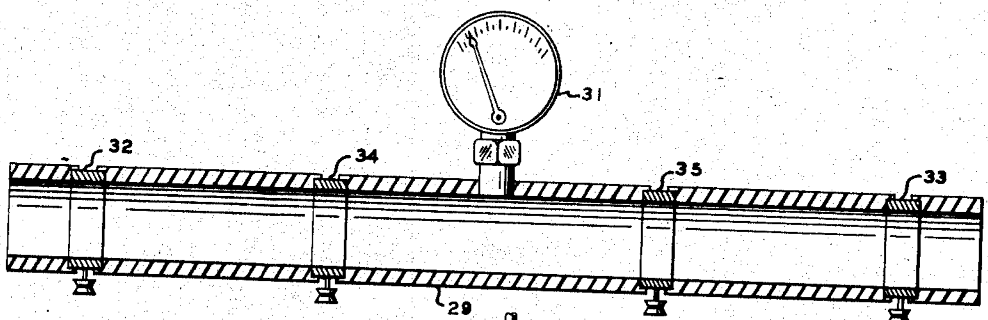


Fig 4.

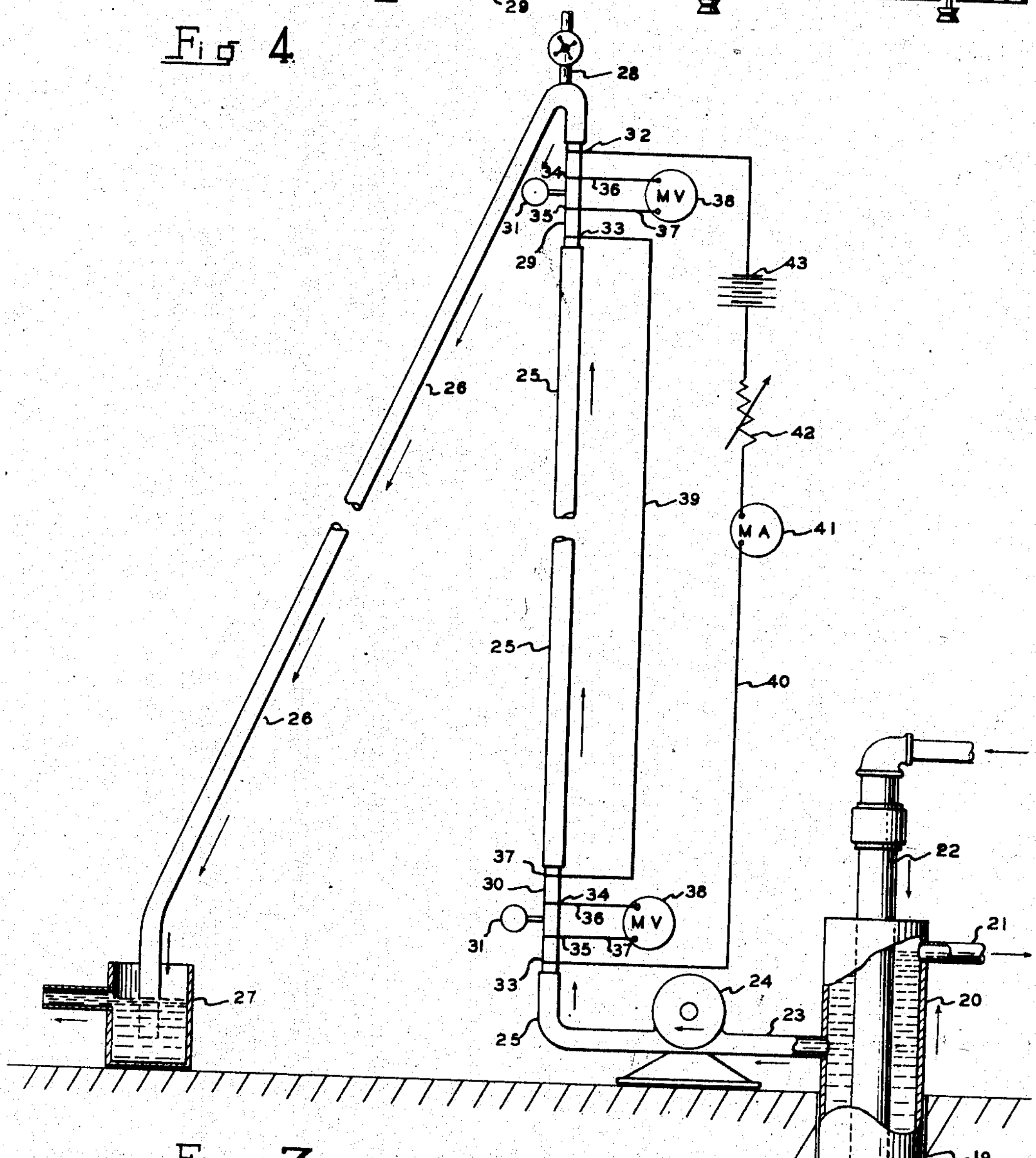


Fig 3.

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2,280,075

# UNITED STATES PATENT OFFICE

2,280,075

## DETECTION OF GAS IN DRILLING FLUIDS

John T. Hayward, Tulsa, Okla.

Application February 23, 1938, Serial No. 191,895

5 Claims. (Cl. 73—51)

This invention relates to a method of detecting and measuring the gas content of hydraulic fluids, and particularly of mud fluids such as are used in connection with the drilling of oil or gas wells.

In the drilling of oil or gas wells, wherein a hydraulic fluid, such as a suspension of clay or earthy materials in water, is circulated through the well during the drilling thereof, by conventional practice, the specific gravity of the circulating fluid is controlled, ordinarily, so that the head of fluid in the well is greater than the pressure of oil or gas which it is expected will be encountered at points in the well. This procedure is followed in order to prevent the pressure of a gas formation, which may be encountered, from exceeding that of the fluid head pressure and causing "blow-outs," whereby the fluid is blown from the well with disastrous consequences, which, in some cases, may result in complete destruction of the well and endanger lives and property in the vicinity of the well.

While this procedure is advantageous for protecting the well during drilling, it is disadvantageous in that the excess pressure of the hydraulic fluid prevents the entrance into the well of gas from an encountered gas-containing formation, with the result that such formation may entirely escape detection of the drill operators and become "mudded-off" or sealed by the circulating mud fluid, and erroneously cause the well to become abandoned as a non-producer. Also, as oil is very often found in immediate or adjacent association with gas, failure to detect the presence of gas substantially immediately after penetration by the drill into the gas formation, may cause the driller to continue entirely through the oil-containing formation and also mud-off that formation. This is particularly true where, as is often the case, the oil-containing formation is quite thin, that is, only a few feet thick. The danger is heightened greatly by the fact that oil and gas formations are usually sandy formations, which are relatively soft and will be very quickly traversed by the drill unless comparatively exact knowledge of the location of such formations is known beforehand and the approach of the drill thereto very carefully controlled.

Since as noted, the pressure of the fluid column in the well is ordinarily controlled to exceed that of any gas formation which may be encountered, only that relatively small quantity of gas, which is contained in the relatively small cylinder of formation cut out by the drill traversing the formation, will escape into the fluid, and recognition of the gas formation must rely wholly upon the prompt detection of this small quantity of gas in the fluid. The following example will serve to illustrate the relatively minute quantities of gas which will be present in the mud fluid under a normal set of drilling conditions: A well is being drilled at a depth of 6000 feet where a gas-containing formation is encountered. The formation pressure is approximately 3000 pounds per square inch. The mud fluid in the well has a specific gravity of 1.38 producing a fluid column pressure at the bottom of the well of approximately 3600 pounds per square inch or approximately 600 pounds per square inch greater than that of the gas formation. Obviously under these conditions, substantially no gas will escape into the well from the gas formation and the only gas entering the circulating fluid will be that relatively small amount of gas present in the cuttings comprising the cylinder of the formation being cut out by the drill bit. Assume the diameter of the bore of the well is nine inches, a conventional size. The volume of each lineal foot of the cylinder of gas formation drilled will be approximately 735 cubic inches. If we assume a porosity of 25 per cent, that is, the pore space in the formation in which the gas is held constitutes 25 percent of the volume of the formation, then it is evident that the total volume of gas in one lineal foot of the cylinder of formation will be approximately 184 cubic inches at a pressure of 3000 pounds per square inch. When the fluid containing this quantity of gas reaches the surface of the ground, the pressure will be reduced to substantially atmospheric pressure, and disregarding the factor of temperature, the gas will expand roughly 200 volumes, or to a volume of 36,800 cubic inches. However, as the mud fluid is ordinarily circulated through the well at a rate of approximately 100 barrels per lineal foot drilled, the 36,800 cubic inches of gas will be distributed through 100 barrels of mud fluid, and upon calculation, it will be found that the mud fluid, when it reaches the top of the well, will contain only about 3.8% by volume of gas. Such a small quantity of gas is practically impossible to detect by ordinary inspection methods, due to the fact that the mud fluids ordinarily used in drilling are generally very viscous and have gel-like properties which cause the minute globules of gas to be strongly occluded in the fluid to an extent, in many cases, that substantially none of the gas will escape from the fluid, even when the fluid is allowed to stand for hours in the open air. As a result of such conditions, the drill may completely traverse the gas formation without detection of the gas formation by the drill operator.

To provide a ready and accurate method for detecting the presence of gas in liquids, such as well muds, this invention contemplates generally the detection and/or measurement of gas contained in such liquids by measuring the change in volume of a sample of the liquid, under different pressures, the difference in volumes at the different pressures indicating the presence of gas in the sample and providing a measure of the amount of gas contained in the liquid.

It has been discovered that when gases are suspended or occluded within liquids, the liquids will expand or contract under changes in pressure applied thereto, in substantially direct relation to the amount of gas contained within the liquid. Thus, if a liquid containing 2 percent of gas occupies a volume of 100 cubic centimeters, at one atmosphere pressure, at one-half atmosphere, the liquid will occupy a volume of 102 cubic centimeters, that is, the gas occluded within the liquid will expand to twice its volume, namely 4 cubic centimeters, and in expanding, will displace an equal amount of liquid, thereby increasing the apparent volume of the liquid by the amount of the increase in volume of the gas contained therein. By measuring the volume of the gas-containing liquid at normal atmospheric pressure and again at one-half atmosphere pressure, then starting with an initial volume of 100 cubic centimeters of the liquid, the increase in volume read in cubic centimeters will give directly the approximate percentage of gas in the sample.

The change in volume of a gas-containing liquid under changes in pressure, may be measured directly, as above described, or may be measured indirectly by electrical methods by measuring the electrical specific resistivity of a sample of the gas-containing liquid at different pressures. It has been found that the electrical resistivity of an incompressible conductor liquid, such as well mud, containing a compressible non-conducting gas, such as petroleum gases, is approximately proportional to the volume of such gas in the liquid. By reducing the pressure on a column of gas-containing liquid of unit length and cross-sectional area, the gas will expand in accordance with the decrease in pressure and displace a proportional amount of liquid from the column, thereby proportionally reducing the conducting cross-sectional area of the liquid and increasing the electrical resistance approximately in direct proportion to the decrease in this cross-sectional area. By utilization of suitable electrical apparatus, as will be more fully described hereinafter, the electrical resistance of the fluid under different pressures may be measured, and the measurements so obtained utilized to determine the percentage of gas in the fluid.

The method of this invention may be utilized for merely detecting the presence of gas in liquids, without measuring the volume of gas, or it may be used for measuring quantitatively the volume of gas contained within the fluid. Where the original fluid may contain gas, the method of this invention may be utilized to measure the gas content of the original fluid and the gas content after contact with gaseous fluids and to determine by difference, the increase in gas content. The latter procedure may be particularly valuable in connection with well drilling where, due to the viscous nature of the well fluid, gas, which may have been previously introduced into the fluid, remains occluded in the fluid, even after the same is removed from the well, and is settled, agitated or treated. Under these conditions, the detection or measurement of the gas content of the fluid leaving the well must be referred to or compared with that of the fluid entering the well in order to determine whether or not the gas content has increased during passage through the well. Such a comparison method is referred to in my co-pending application Serial Number 187,619, filed January 29, 1938, which became Patent No. 2,214,674 September 10, 1940, in connection with the detection and logging of gas formations and to the extent of such common subject matter, this application is a continuation-in-part of my co-pending application.

It is, therefore, a principal object of this invention to provide a method for detecting the presence of gas occluded in liquids.

Another object is to provide a method for measuring the quantity of gas occluded in hydraulic liquids.

Still another object is to provide a method for measuring the quantity of gas contained in a hydraulic fluid, by measuring the volumetric changes in the fluid at different pressures.

A further object is to provide a method for measuring the quantity of gas contained in a hydraulic fluid by measuring the electrical specific resistivity of the fluid under different pressures.

Another and more specific object is to provide a method for detecting and measuring the gas contained in a mud fluid circulated in a well during the drilling thereof.

Additional and important objects and advantages of this invention will become apparent from the following detailed description, when read in conjunction with the accompanying drawings, which illustrate forms of apparatus which may be utilized for successfully practicing the new invention.

In the drawings:

Fig. 1 illustrates a form of measuring bottle for indicating the presence of, or for measuring directly the volume of gas in a gas-containing fluid, or both.

Fig. 2 illustrates a form of electrical apparatus for indicating the presence of, or for measuring indirectly the volume of gas in gas-containing fluids.

Fig. 3 illustrates an assembly of apparatus for continuously indicating and measuring gas in well drilling muds.

Fig. 4 is a detail of one of the resistance measurement tubes utilized in the apparatus of Fig. 3.

Fig. 1 illustrates a simple form of measuring apparatus for measuring the change in volume of a gas-containing liquid under different pressures. The apparatus comprises a glass bottle 1 adapted to contain somewhat more than 100 cubic centimeters of the fluid to be tested. Bottles of other volumetric capacities may be used, the 100 c. c. size being preferred for simplifying calculations. The bottle is marked with a ring mark 2 to denote the level to which the bottle is to be filled. Bottle 1 is provided with a wide mouth neck 3 into which is inserted a stopper 4 in which is mounted an upwardly extending hollow measuring tube 5 provided with a downward extension 6, which extends into bottle 1 to a point near the bottom thereof. The adjacent surfaces of neck 3 and stopper 4 are ground to form an air-tight seal. Measuring tube 5 is calibrated preferably in cubic centimeters and has connected to its open upper end an exhaust pipe 7 which may be made of heavy rubber tubing, generally designated as vacuum tubing, which leads to a vacuum pump, not shown, of any form suitable for producing a low pressure in bottle 1. A pressure-vacuum gage, such as a manometer 8, is connected into pipe 7 to indicate the pressure in the apparatus.

This apparatus is utilized in the following manner: A sample of the liquid to be examined is poured into bottle 1, through neck 3, until the level of fluid is at ring mark 2, which, as noted, preferably indicates 100 cubic centimeters. The bottle is then filled to the neck with distilled water or other non-expansible liquid to displace air or gas from the space above the sample, and stopper 4 is inserted with extension 6 extending through the liquid in the bottle to a point near the bottom thereof. If necessary some additional water is dropped into the open top of measuring tube 5 until the level of liquid stands at the zero mark in the measuring tube. Pipe 7 is then connected to the top of measuring tube 5 and suction applied, until a subatmospheric pressure of the desired degree, indicated on manometer 8, is attained in the apparatus. If gas is present in the sample in bottle 1, the level of liquid will rise in measuring tube 5. The mere fact of an increase in volume will immediately indicate the presence of gas in the liquid sample. The point to which the level will rise will be dependent upon the volume of gas in the sample and the vacuum applied thereto, in accordance with the well known principles of Boyle's Law. For example, assume that suction is applied to reduce the pressure on the sample to one-fifth of an atmosphere, and the volume increases 8 cubic centimeters as shown by the level in measuring tube 5. The percentage by volume of gas in the original sample will be found by simple calculation to be 2 percent.

Thus, by this simple method and apparatus, both a qualitative and a quantitative measurement of the gas occluded in a liquid may be quickly determined.

By applying this method to a well fluid such as a mud fluid used in well drilling, the presence and the amount of gas occluded in the fluid can be readily and easily determined. By measuring the quantity of gas in the well mud leaving a well, and comparing it with the quantity of gas, measured in the same manner, contained in the mud entering the well, any increase in gas content of the exiting mud over that of the entering mud will be due to gas introduced into the mud during its passage through the well. Of course, if the entering mud is known to be free of gas, then the gas content of the exiting mud will be solely that picked up by the mud in passage through the well. By correlating specific entering and exiting increments of the mud and by relating them to the depth of the bottom of the well, as explained in my co-pending application, referred to above, the sub-surface formation, which was responsible for the increased gas content of the mud, may be readily logged.

Fig. 2 shows another modification of apparatus for detecting and measuring, by electrical means, the gas content of liquids containing occluded gas.

The apparatus is in many respects quite similar to the apparatus of Fig. 1. In this modification, bottle 1 is elongated sufficiently to properly accommodate four vertically spaced band electrodes, 9, 10, 11 and 12, respectively, reading from the top down. The electrodes are separated and insulated from one another by the glass walls of the bottle. Insulating material other than glass may be used. The other portions of the apparatus are substantially the same as those utilized in the measuring bottle of Fig. 1. Namely, a ground glass stopper 4 fitting in a ground neck 3, a measuring tube 5, an extension 6, a suction pipe 7 and a manometer 8.

The four electrodes 9, 10, 11 and 12 comprise the electrodes for a more or less conventional apparatus used for measuring electrical resistivity of materials. The outermost electrodes 9 and 12 are placed in circuit through a lead 13 with a suitable direct current source, such as battery 14, and a milli-ammeter 15 and a variable resistance 16 connected into the circuit. The two intermediate electrodes 10 and 11 are connected together in circuit by means of a lead 17, into which is connected a millivoltmeter 18. With this arrangement of apparatus, a suitable current is applied to the fluid in bottle 1 through electrodes 9 and 12 and the resulting potential differences in the fluid between electrodes 10 and 11 read on millivoltmeter 18.

This apparatus is utilized in the following manner: A sample of liquid to be tested is poured into bottle 1 until the bottle is completely filled to neck 3 to displace any air or gas therein. Stopper 4 is inserted as before and the liquid caused to rise in measuring tube 5 by displacement by extension 6. In this instance, no water or other fluid is added in order not to alter the electrical resistivity of the sample. It is unnecessary to measure the changes in volume directly in this modification, since the gas content of the liquid will be determined by the electrical measurements to be described, and, therefore, no specific volume of sample need be used. However, for purposes of comparison, the measuring tube in this modification may be calibrated to measure directly the change in volume while the change is also being measured indirectly by electrical means, and in such a case a sample of known initial volume is placed in the bottle.

With the sample of liquid in place in bottle 1, and while under atmospheric pressure, a current of suitable amount, generally small, such as 10 milliamperes, is applied to the sample through electrodes 9 and 12. Variable resistance 16 is utilized to regulate the amount of current applied, which will be determined to a great extent by the nature of the liquid to be tested. In the event the liquid is an electrolyte, the amount of current will preferably be quite small to avoid polarization, or alternating instead of direct current may be used. When the current has been applied, as described, the potential drop between electrodes 10 and 11 is read on milli-voltmeter 18.

Pipe 7 is now connected to the top of measuring tube 5 and suction applied to the sample to reduce the pressure thereon to the desired degree of sub-atmospheric pressure. The pressure is noted and the same amount of current again applied to electrodes 9 and 12 and the resulting potential drop between electrodes 10 and 11 read.

Since changes in pressure will have no effect upon the resistivity of the sample unless gas is actually present in the liquid, the mere fact that the resistivity of the liquid changes upon change in pressure will immediately indicate the presence of gas in the liquid and will be sufficient for purposes of detecting the presence of gas occluded in the liquids.

As noted above, it is found that the change in resistance of a mixture of liquid and occluded gas at different pressures is approximately directly proportional to the change in the proportional volume of the gas in the mixture at the different pressures.

From this relation, it is possible to set up a simple equation for expressing the percentage of gas in the fluid mixture in terms of change in resistance of the mixture at change in pressure, and by substituting the measured values of resistance of the fluid at the different measured pressures, the percentage by volume of gas in the fluid may be readily calculated within a reasonable degree of accuracy.

One equation suitable for such calculations is as follows:

$$\frac{V_G}{V_L}\times 100=\left(\frac{R_2-R_1}{R_2}\right)\times\left(\frac{P_2}{P_1-P_2}\right)\times 100 \text{ approximately.}$$

Where:

$P_1$ and $P_2$=different, absolute pressures at which the sample was tested, and $P_2$ is less than $P_1$

$R_1$=resistance (voltage) at $P_1$

$R_2$=resistance (voltage) at $P_2$

$V_G$=volume of gas in the sample measured at $P_1$, and

$V_L$=volume of the liquid in the sample.

Since the relationship between potential drop and resistances is a direct one, volts may be substituted in place of ohms in the above formula without altering the final proportion of volume of gas to volume of liquid in the fluid.

The following is an example of the way in which the equation is used in calculating the percentage volume of gas in a gas-containing liquid:

The reading of milli-voltmeter 18 at a pressure of 760 mm. of mercury was 525 millivolts, and at a pressure of 190 mm. was 625 millivolts. Substituting in the above formula,

$$\frac{V_G}{V_L}\times 100=\left(\frac{625-525}{625}\right)\left(\frac{190}{760-190}\right)100$$

$$=\frac{100}{625}\times\frac{190}{570}\times 100$$

$$=5.35\%$$

The fluid mixture contained 5.35% of gas.

As will be noted, the result of the above equation gives directly the percentage, by volume, of the gas in the fluid sample. The size of the sample is, therefore, largely immaterial except as it may be regulated for convenience in handling and in keeping the measuring apparatus within reasonable limits of size. Practically speaking, the resistivity of the liquid portion of the fluid need not be known, as it does not enter directly into the above equation.

Figure 3 illustrates an arrangement of apparatus for continuously measuring the volume of gas in well drilling muds by the electrical method described above in connection with Fig. 2. In this figure, the numeral 19 indicates the upper end of a well bore in which is inserted the usual surface casing 20 having a mud overflow pipe 21. Numeral 22 indicates the conventional hollow drill pipe which extends through the casing to the bottom of the well and has the usual drill bit, not shown, attached to the bottom end thereof. The well drilling mud is circulated in the usual manner through drill pipe 22 to the bottom of the well into contact with the formations being drilled and picks up the cuttings of the formation and carries them back to the surface through casing 20, from which the mud and cuttings are discharged through overflow pipe 21, the mud then being returned to the drill pipe after being subjected to such usual settling, screening and treating operations, as may be required to maintain the mud at the desirable consistency for drilling purposes.

A pipe 23, which communicates with the casing 20 at a point below the level at which the mud fluid overflows from pipe 21, is connected to a pump 24, which continuously withdraws a small stream of the mud fluid as it returns to the surface from the bottom of the well, and discharges the withdrawn mud through a riser conduit 25, which extends substantially vertically to a suitable height above the surface of the ground, thence through a down-comer conduit 26 into a liquid-seal trap 27. The pump 24 is utilized primarily to start a siphonic flow of the mud fluid from the casing through riser conduit 25 and down-comer conduit 26, and once the siphon flow is established, the pump need not be used. Instead of the pump, a vacuum jet, not shown, may be connected to a valved nipple 28, which is connected to the top of riser conduit 25, to draw the mud fluid to the top of the riser and so initiate the siphon flow.

The siphonic flow of the mud fluid through riser 25 and down-comer 26 creates a vacuum in riser 25 and the pressure in the upper portion of the riser will therefore be lower than that in the lower portion thereof, the difference in pressure being proportional, in general, to the height of the riser and the weight of the volume of mud fluid therein.

Resistance measuring tubes 29 and 30, of the four electrode type described above in connection with Fig. 2, (see Fig. 4), are inserted in riser 25, closely adjacent to its extreme upper and lower ends, respectively. A pressure-vacuum gage 31 is connected into the mid-point of each of the tubes 29 and 30 to record the respective pressures in these tubes. The outer electrodes of each tube are numbered 32 and 33, while the intermediate electrodes are numbered 34 and 35. The body of the tubes is constructed preferably of Bakelite or similar insulating materials having sufficient structural strength to withstand the required pressures.

Intermediate electrodes 34 and 35 of each of the resistance tubes are connected by suitable leads 36 and 37 to individual voltmeters 38—38, while the outer electrodes 32 and 33 are connected in series in a circuit consisting of a lead 39 connecting electrode 33 of one resistance tube to electrode 32 of the other, and a second lead 40 connecting the remaining electrodes. An ammeter 41, variable resistance 42 and current source 43 are connected into lead 40. By connecting the outer electrodes of both resistance tubes in series, the same amount of current can be passed through both tubes and the resulting voltage readings of voltmeters 38 and 38a will not require correction for proper correlation.

The apparatus is utilized as follows: A siphonic flow of mud fluid from casing 20 is initiated through riser 25 and downcomer 26 by means of pump 24 or by vacuum jet, not shown, connected to nipple 28. When the flow of mud fluid is well established, current of suitable density is applied to the measuring tubes and the potential drops in each resistance tube read from its respective voltmeter. The pressure in each tube is read from the corresponding gage. By substituting these measured values of pressure and voltage in the above, or an equivalent formula, the percentage, by volume, of gas in the mud fluid can be quickly calculated.

To reduce any error in the readings, the height of riser **25** and the distances between the resistance tubes is proportioned in accordance with the specific gravity of the fluid to produce a substantial decrease in pressure in tube **29** over that in tube **30**. For example, with a mud fluid of approximately 1.4 specific gravity, a distance of about 15 feet between the resistance tubes will produce a pressure of about one fourth of an atmosphere, absolute, in tube **29** and approximately one atmosphere in tube **30**.

When the well fluid entering the well is known to be gas-free, a difference in the readings between voltmeters **38**—**38** will immediately indicate the presence of gas in the outgoing fluid and will thus immediately apprise the well operator that a gas formation has been penetrated by the drill. Ordinarily this is all that is desired for proper inspection of the drilling operation. If the entering well fluid contains gas, apparatus similar to that last described may be connected to the pipe supplying mud fluid to the well, and the percent of gas in the entering mud determined thereby. By then measuring the gas content of the mud leaving the well after the elapse of a period of time required for the mud to reach the bottom of the well and return to the top, and comparing the two measurements, the increase in gas content, if any, can be readily determined.

From the foregoing, it will be seen that this invention provides a simple and novel method for detecting and measuring gas occluded in liquids and one which is particularly valuable for detecting and measuring relatively small percentages of gas which is occluded in very viscous fluids, such as well drilling muds. It will also be seen that the invention consists broadly in measuring the volumetric change of a gas-containing liquid at different pressures; that the volumetric change may be measured directly or the volumetric change may be measured indirectly by measuring the electrical specific resistivity of the gas-containing liquids at different pressures.

It will be understood that while in the above description the measurements are obtained at two pressures one of which is preferably atmospheric or super-atmospheric, while the other is subatmospheric, both pressures may be super-atmospheric or both may be sub-atmospheric.

This invention may be advantageously employed in connection with well drilling for estimating the gas reserves, that is the gas content, of a sub-surface formation. Since the volume of well drilling mud circulated per foot of well drilled may be readily measured or calculated, by measuring the percentage of gas contained in the mud leaving the well, the volume of gas per cubic foot of the sub-surface formation can be calculated, and from this, knowing the thickness of the formation and its area, the gas content of the formation may be estimated within reasonable limits of accuracy.

What I claim and desire to secure by Letters Patent is:

1. The method of detecting gas in well drilling mud containing gas introduced therein solely from the drill cuttings which comprises, subjecting said well drilling mud to a change in pressure from substantially atmospheric to sub-atmospheric, and observing the resulting change in volume thereof.

2. The method of testing well drilling mud for the presence of small amounts of gas introduced therein solely from the drill cuttings which comprises, placing a measured quantity of mud in a vessel, subjecting the mud to two different pressures, one of which is sub-atmospheric, observing the resulting increase in volume of said mud, and computing the percentage of compressible fluid in said mud in accordance with the known laws of the behavior of gaseous fluids, to thereby obtain an indication of the presence of gas in the mud and an indication of the amount of gas therein.

3. In the drilling of wells wherein a mud fluid is circulated through a well under hydrostatic pressure greatly in excess of the pressures of gas-containing formations encountered by the drill and wherein only the relatively minute amounts of gas contained in the drill cuttings become occluded in said mud fluid, the method of testing said mud fluid for the presence of said relatively minute amounts of gas occluded therein which comprises placing a measured quantity of said mud fluid in a vessel, subjecting the mud fluid to two different pressures one of which is sub-atmospheric, observing the resulting increase in volume of said mud fluid, and computing the percentage of compressible fluid in the mud fluid in accordance with the known laws of the behavior of gaseous fluids, to thereby obtain an indication of the presence of gas in the mud fluid and an indication of the amount of gas therein.

4. Apparatus for detecting gas in well drilling mud comprising, a container having an opening therein, and adapted to receive a measured volume of mud, an air-tight closure for said opening, an elongated hollow tube extending through said closure to a point adjacent the bottom of said container and in open communication therewith, and having an extension above said container, means connected to said extension to apply a vacuum through said tube to the mud within said container, gage means for measuring the pressure in said container, and means cooperating with said extension to indicate changes in volume of said mud responsive to the change in pressure in said container.

5. An apparatus according to claim 4 wherein said extension is provided with a transparent sight portion having a calibrated scale thereon, whereby a visual indication is provided of the change in level of said mud in said extension in response to the change in pressure.

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