July 11, 1950 J. E. BLISS ET AL 2,514,690

GAS DETECTION

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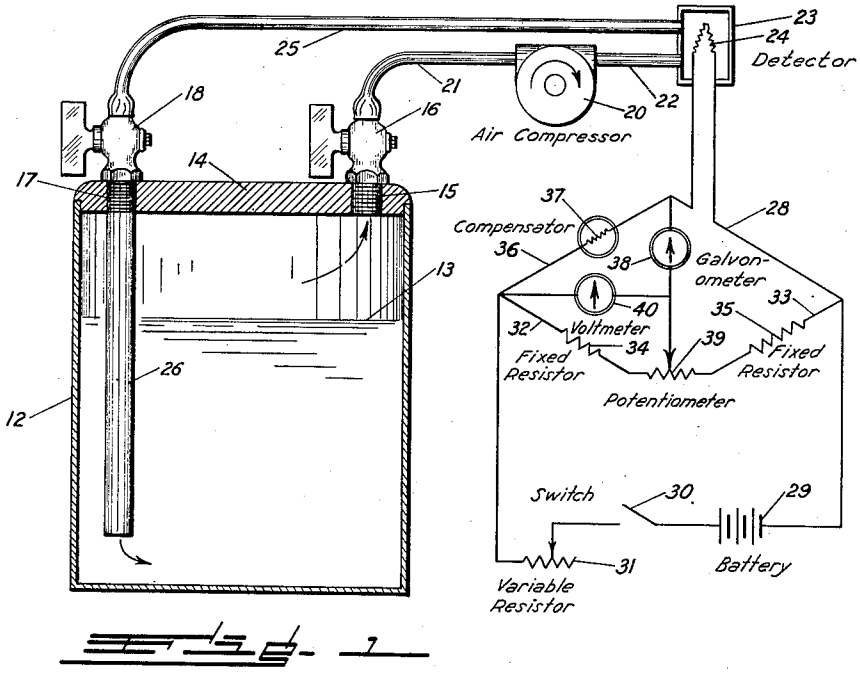


FIG. 1

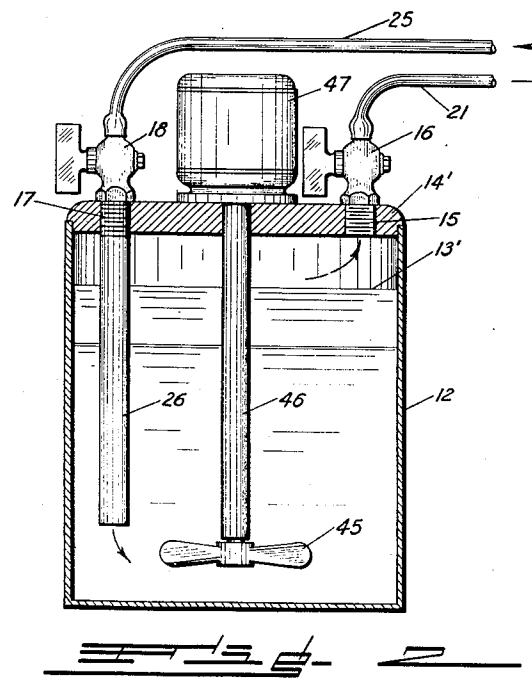


FIG. 2

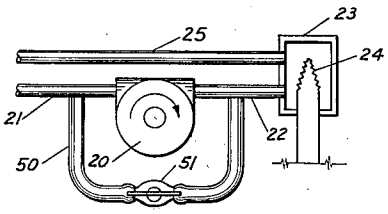


FIG. 3

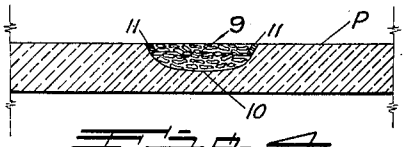


FIG. 4

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GAS DETECTION

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16 Claims. (Cl. 73—26)

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This invention relates to a method of and apparatus for gas detection, as during the drilling of wells and the like.

Previously, it has been difficult to determine with exactitude the presence of oil, and particularly of gas, encountered during the drilling of a well, wherein a drilling bit is normally attached to the lower end of a rotating hollow tube or drill pipe, and the bit drills a hole considerably larger than the drill pipe, so that an annular passage between the outside of the drill pipe and the inside wall of the well is formed. In the usual drilling procedure, quantities of "mud" or drilling fluid are pumped down through the pipe, to be discharged through suitable apertures in the drill bit. This mud carries the removed rock, shale, sand or the like, upwardly in the well through the annular passage, and is recirculated through the well in what may be termed the mud circulating system. "Mud" is normally a suspension of clay or other material in water, with suitable materials added to control the properties of the mud. For instance, bentonite may be utilized to govern viscosity and gel of the mud, barium sulphate may be used to increase the weight of the mud, tannic acid may be used to thin the mud, and caustic soda may be used to raise the pH value. There are, of course, other additives and control agents utilized for other purposes, or in lieu of one or more of the foregoing. Some success has been achieved by testing the outgoing mud for detection of oil or gas, but such operations are nowhere near uniformly successful, for several apparent reasons.

Due to the relatively large quantities of mud utilized, the cuttings, or material removed by the drill, are relatively widely dispersed, and oil or gas, when encountered, may not be present in sufficient amounts to be detected. Thus, when a stratum of oil or gas bearing sand or formation only a few feet thick is drilled through, little oil or gas may escape into the mud, and the amount thereof is usually so dispersed through the mud that detection is difficult. Furthermore, the pressure of the mud is usually maintained considerably above the normal hydraulic pressure at the depth being drilled, and there may be very little escape of oil or gas into the well, and consequently little opportunity for the driller to know of the presence thereof. There is a further possibility that a gas or oil pocket may be sealed by the mud under pressure being forced into the formation with the result again that very little oil or gas may escape into the mud.

In addition, when oil or gas is detected in the

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outgoing mud stream it is often difficult and sometimes impossible to determine the point at which the oil or gas entered the well. The time required for the mud to pass from the top of the hole to the bottom and back upwardly again, even though the inside of the hole may be ragged and uneven, can be measured by placing a suitable indicating material in the mud and allowing it to travel down through the pipe and then back up through the hole. Also, the interior volume of a drill pipe and the pumping rate and pump volume are known, so that the time required for the mud to travel down the drill pipe can be ascertained. By simple subtraction, the time lag between the position of a specified portion of the mud at the bottom of the hole and its appearance at the top can be determined. Also, the length of the drill pipe is known, as is the drilling rate. Thus, the depth at which a specific portion of the outgoing mud passed through the bit can be determined, and the condition of the mud will tend to reflect conditions at the depth being drilled, subject to certain inaccuracies which are of extreme importance. For instance, if there is a gas-bearing formation at, say 2,000 ft., and the well is down to 4,000 ft., gas may continue to bleed into the mud from the formation at 2,000 ft., so that the operator cannot determine whether the gas is coming into the mud from the bottom of the well or somewhere along the side of the well. Oil may bleed into the mud during its travel upward in the well in the same manner. Also, oil and gas are often recirculated several times around the mud circulating system, and this causes false oil or gas indications or "shows" to be logged or recorded. Thus, there may be indications of oil and/or gas in the mud over a considerable drilling depth, but such oil or gas may be coming from only one position, and that position may be considerably removed from the bottom of the well. Also, if short sand beds, for instance, are encountered and these are oil or gas bearing, it is difficult to determine for some time the thickness of the bed, since the subsequent mud may receive oil and/or gas therefrom, long after the bed is passed. Consequently, the methods now in use for determining the presence of gas, for instance, by analysis of the mud, may give an accurate indication of the gas content of each specific portion of the mud, but there is no assurance that the gas was received by the mud at any particular depth, once a gas bearing formation has been encountered somewhere during the drilling of the well.

Among the objects of this invention are to provide an improved method for detecting the presence of gas in substrata encountered during well drilling; to provide such a method which is not affected by dilution of gas in mud; to provide such a method by which the exact location of gas bearing strata can be determined; to provide such a method by which relatively minute quantities of gas can be detected, irrespective of diffusion of gas into the mud, or gas recirculated in the mud stream; to provide such a method which does not interfere with the normal well drilling operation; to provide such a method which is relatively simple in operation and may be carried out relatively rapidly; to provide apparatus particularly adapted to carry out the above method; and to provide such apparatus which is readily portable, easily operated, and involves a minimum of equipment. Other objects and the novel features of this invention will become apparent from the description which follows.

In general, the method of this invention consists in separating the cuttings from the mud, and then testing the cuttings as hereinafter described; to ascertain the possible presence of gas therein. It is advantageous to test the cuttings for oil as well as for gas, so that more complete information about the well will be available. Preferably, in testing for the presence of oil, a selected group of cuttings is subjected to ultra violet radiation or the like, and carbon tetrachloride or other suitable solvent is utilized in obtaining a "residue ring" as described hereinafter in greater detail. Fluorescence of the residue ring indicates the presence of oil, since some of the particles which fluoresce may be mineral and naturally fluorescent particles, but the removal of the oil by the solvent from the particles and subsequent deposition of the oil in a residue ring enables the operator to differentiate between oil and mineral fluorescence of the initial particles.

To ascertain the presence of gas, a predetermined amount of cuttings are collected and placed in a chamber or container, preferably having water therein, and the chamber or container closed, thereby trapping air above the water. The air in the container is removed and circulated around a closed path which initially contains air and leads back to the container, the circulating and recirculating air thereby picking up gas released from the cuttings. During such circulation and recirculation of the air, it is tested for gas, and in addition the water and cuttings are agitated, as by an impeller, or by introducing air from the closed path into the lower end of the container, to cause the air to move or bubble upwardly through the water. Also, a vacuum may be produced initially in the closed path exteriorally of the container, before the container is closed, so that when the container is connected to the closed path, the vacuum in the latter will tend to draw air from the container. While such an initial vacuum may have some effect in causing the release of gas from the cuttings, it is often possible to obtain excellent test results without utilizing an initial vacuum in the container. The removal or release of gas from the cuttings may be due to one of several theoretical reasons, as pointed out hereinafter. For detecting the presence of gas in the recirculation air stream, a "hot arm" detector, as described herein, or any other suitable method such as chemical analysis, may be used.

Apparatus particularly adapted to carry out

the above methods of this invention is illustrated in the accompanying drawing, in which:

Fig. 1 is a side elevation, with certain portions in section and others shown diagrammatically, of apparatus constructed in accordance with this invention;

Fig. 2 is a vertical cross section of a container, forming a portion of the apparatus of Fig. 1, but provided with a mechanical agitator;

Fig. 3 is a fragmentary side elevation, similar to Fig. 1, illustrating a modification thereof; and

Fig. 4 is a fragmentary cross section of a color reaction plate, illustrating the position of the cuttings and the residue ring after the solvent treatments in testing for oil ancillary to this invention.

In carrying out the method of this invention, the cuttings—which are particles of rock or the like, cut by the bit and circulated to the surface of the hole—are separated from the mud by a vibrating or rotating screen or the like. It is necessary, of course, to know the exact depth in the well the cuttings involved came from, and it is convenient for this purpose to provide a clock which is set behind by a predetermined time, i. e. the time lag or time necessary for the cuttings to flow from the bottom up to the top of the well. The time lag may be determined in the manner previously indicated, i. e. by timing the passage of strips of cellophane or brick chips or the like from the top to the bottom and then back to the top, and subtracting the calculated time for passage from the top to the bottom, based on the flow rate of the mud and the known volume of the pipe. A well log is generally kept, and the length of the drill string is always known. Thus, a first clock, set to correct time, is used in charting the well log, while the second clock is set behind the first by the time lag of the cuttings. For instance, the bit may reach 4,000 ft. at 4:00 p. m. by the first clock and at 4:15 p. m. reach 4,002 ft. Now, if the lag time is 30 minutes, the second clock would have indicated 3:30 p. m. when the bit reached 4,000 ft. and 3:45 p. m. when the bit reached 4,002 ft. Thus, when the second clock indicates 4:00 p. m., the cuttings from this 2-foot interval (i. e. between 4,000 ft. and 4,002 ft.) are starting to arrive at the surface. A fine mesh screen or other suitable receptable is then placed in the mud stream to catch the cuttings. When the second clock reaches 4:15 p. m. the cuttings from this 2-foot interval should all have reached the surface and be deposited on the screen or other receptacle.

After separation, a portion of the cuttings may be rinsed in water and subjected to an ultra violet light test for the presence of oil. This may consist in first placing the cuttings in a position in which ultra violet light from a suitable source, such as a lamp or the like, and in a dark room or darkened enclosure, is projected onto the cuttings. The fluorescence which may result may be due either to the presence of oil, or mineral particles, such as limestone, which have the property of fluorescing under ultra violet light. The percentage of the sample which fluoresces may be estimated and recorded, for later use.

A number of the pieces which fluoresce may then be picked out and placed in a color reaction plate, such as plate P of Fig. 4, the set of cuttings 9 being placed in a thumb hole 10. A representative or average set of the cuttings may also be placed in another thumb hole, such set including fluorescing and non-fluorescing pieces in about the same proportion as the sample. Each

set of cuttings is then subjected to an oil solvent, such as ether, acetone, or the like—but preferably carbon tetrachloride. The solvent will tend to dissolve out oil, if present in any of the cuttings, and the reaction plate with its quantity of cuttings is permitted to stand until the solvent evaporates. Sometimes a second application of solvent is applied, particularly if the cuttings are wet and the first application of carbon tetrachloride merely tends to remove moisture. When oil is picked up by the solvent, the oil is deposited as the solvent dries, particularly in the form of a residue ring 11, as in Fig. 4, around the edge of thumb hole 10. The ultra violet light test will disclose the presence of such a ring, which indicates that there was oil in the sample. In the case of the set of cuttings which includes only particles which were fluorescent initially, after the applied solvent evaporates, the presence of a fluorescent ring indicates that at least a portion of the original fluorescence was due to oil. If no ring is left after the solvent evaporates, this is an indication that the original fluorescence was due to minerals. If the fluorescence is due to oil, then the percentage of the sample which showed original fluorescence is recorded and plotted as such, that is, a curve indicating "percentage of sample showing oil fluorescence" is plotted on the log. If the fluorescence is mineral fluorescence alone, such as occurs in the case of most limestone formations, no recording is necessary.

A second oil curve is also plotted on the log. This curve indicates the relative amount of fluorescence of the oil ring deposited, and, in proportion, the relative amount of oil present in the cuttings at the top of the hole. If it appears that the cuttings are about 100 per cent. representative of the formation being drilled (that is, that no material, such as shale, is sloughing in from higher in the hole) the composite or representative sample is used to obtain the second oil curve. If it appears that some of the sample is shale which has sloughed into the hole from above the bit, the selective sample, i. e. that containing only particles initially fluorescent, is used to obtain the second oil curve. In other words, shale or the like sloughing into the hole from above the bit, should be disregarded. It should be understood, of course, that in evaluating the results of testing in accordance with this invention, such results should be correlated with other data, such as the type of strata through which the well passes, previous experience in such strata, the depth and type of bed, and other geological considerations.

After testing for oil in the manner above indicated, or simultaneously therewith, another sample of the cuttings is tested for gas in accordance with this invention. For this test, a suitable container, such as container 12 of Fig. 1, may be filled about half full with clear water, or other suitable liquid, and then sufficient cuttings placed therein to bring the water level up to about approximately the three-quarter mark, such as to the level 13 or 13' of Figs. 1 and 2, respectively. The container 12 may have a convenient capacity, such as about one quart, and after the cuttings are placed therein, the top 14 is attached thereto in a conventional manner. Two connections may be provided in top 14, i. e. an outlet connection 15 having a valve 16 associated therewith, and an inlet connection 17 having a valve 18 associated therewith. From inlet connection 17 a pipe 26 extends nearly to the bottom of container 12 when top 14 is in place. A vacuum may be produced in the interior of container 12, and more particularly air and/or an air-gas mixture circulated through the chamber and through the cuttings by an air compressor 20, which is connected by a suction tube 21 with valve 16. It will be understood, of course, that a vacuum pump, or even an air circulating impeller operating on the blower principle, may be substituted for the air compressor 20. The discharge from compressor 20 passes through a tube 22 to a housing 23 for a detector filament 24, which is the "hot" leg of a gas detection bridge circuit. The air or air-gas mixture is returned to the cuttings through a return tube 25, connecting housing 23 with valve 18, and recirculation pipe 26 extends from connection 17 nearly to the bottom of container 12, for recirculating air and/or an air-gas mixture around the cuttings.

In operation of the gas detection circuit, as in Fig. 1, a voltage of a predetermined amount, such as one volt, is impressed across detector arm 28 of the bridge by a battery 29, a switch 30 being utilized in turning the current on and off, and a variable resistor 31 being used to adjust the voltage. The lower arms 32 and 33 of the bridge circuit are provided with fixed resistors 34 and 35, respectively, while the upper arms comprise the detector arm 28 and a compensator arm 36 in which is installed a compensator filament 37, which is preferably the same size and has the same characteristics as detector filament 24. The detector and compensator filaments may be of the activated platinum type normally used for gas detection purposes in mine safety work. A suitable detector and compensator unit for use in this invention is No. DT–16363, supplied by the Mine Safety Appliance Company, the filaments being installed in a dual housing.

The bridge also includes a galvanometer 38, connected across the upper and lower arms, and to a potentiometer 39 for adjusting the galvanometer to a zero reading when air alone is passed through the detector housing 23, prior to its use for gas detection. A voltmeter 40 may be connected between one end of the bridge and the galvanometer 38, either on the detector side or on the compensator side, as shown. The latter is preferable because when the resistance of detector filament 24 begins to change, due to the presence of combustible gas, the voltage does not always remain constant on the detector side.

To start the test, tubes 21 and 25 are disconnected and air alone passed through detector housing 23, to adjust the bridge into balance. Tubes 21 and 25 are then connected to valves 16 and 18, respectively, and valve 18 may be closed and valve 16 opened, so that a vacuum of a desired degree, such as 4 to 5 in. Hg, may be produced in the container. Valve 18 is then opened, so that the air, or mixture of air and any gas present, passes through housing 23 and recirculates through the chamber formed by container 12. The air, or mixture of air and gas, bubbling from the lower end of pipe 26, passes repeatedly over the cuttings in container 12, thereby causing additional gas to evolve from the cuttings and pass into the air.

The evolution of gas from the cuttings may be enhanced by agitating them before and/or during the passage of air thereover, as illustrated in Fig. 2. Thus, the container 12 of Fig. 2 is identical with the container of Fig. 1, but an agitating impeller 45 is mounted in the lower portion of the container, being suspended at the

lower end of a shaft tube 46 and rotated by a motor 47 mounted on top 14' of the container. If desired, the agitating device may be mounted in the base of the container, in a customary manner. It has been found that the agitation often reduces considerably the time required to obtain a satisfactory reading from gas containing cuttings. The apparatus of Fig. 2 is otherwise identical with that of Fig. 1, the air compressor or circulator and bridge circuit being the same.

As soon as the circulation and recirculation of air through the container, preferably over the cuttings, and then through the detector housing 23 begins, galvanometer readings can be taken. It is sometimes a matter of several minutes before any observable reading is obtained, and it may be necessary to let the cuttings set awhile, as for three or four minutes, and then repeat the test. The circulation and recirculation of the air, or air and gas mixture, is continued until the maximum gas reading is secured by means of detector filament 24, or the operator is certain that there is insufficient gas present to be worth while.

Normally, while the vacuum initially caused evolution of gas, in many instances it has been found that very little or no vacuum is necessary to obtain sufficient gas from gas bearing cuttings to obtain a satisfactory reading. Thus, the passing and bubbling of air over the cuttings and the recirculation of the same air, or gas-air mixture, with consequent increase in the proportion of gas, enables a sufficient proportion of the gas to be extracted from the cuttings. When it is understood that at a depth of, say 6,000 ft., the hydraulic pressure produced by the mud may be on the order of 3,000 lbs. per sq. in., and when the cuttings reach the surface so that the pressure is reduced to atmospheric, a considerable portion of the gas will have escaped, due to such reduction in pressure, the extraction of the gas from the cuttings by the passage of air thereover, and the recirculation of the air, which is maintained at as small a volume as possible, in accordance with the method of this invention, is all the more remarkable. The prior art has considered that the extraction of gas from cuttings (as from a core which is a specially drilled segment of rock removed by special tools from a predetermined depth in the well) is virtually impossible. For instance, it is stated in U. S. Patent No. 2,214,674, at line 46 et seq., column 1, page 3, "The routine for testing for gas generally has been to mix gas with air to provide a combustible mixture which can then be tested for gas by the conventional hot wire filament method. This procedure for detecting gas has not, however, been successfully applied to core analysis, due to the fact that the gas will escape from the core when it reaches the top of the well due to the reduction in pressure." That the gas will escape from cuttings in the same manner as from a core, due to a reduction in pressure, is well recognized by oil operators, and prior to development of the present invention, it was thought impossible to successfully test cuttings for gas. However, such tests can be made in accordance with this invention. A possible explanation therefor is that as the mixture of air and an extremely small amount of gas, for instance, bubbles over the cuttings in the container 12, the small proportion of gas to air means that the partial pressure of the combustible gas is very low, thus producing, in effect, a relatively high vacuum on the cuttings.

Another possible theoretical explanation is that the cuttings have a selective affinity for the air, and when air is circulated about the cuttings, the air tends to permeate the cuttings and displace the gas therefrom. It is known, of course, that silica gel has a selective affinity for moisture or water vapor, whereas finely divided activated carbon has a selective affinity for gas rather than water vapor. Applying the same reasoning in the present instance, it appears possible that gas bearing cuttings, which are normally sandstone or limestone, or sometimes granular sand, have a selective affinity or preferential absorption for air rather than a combustible gas, which causes the gas to be displaced from the cuttings by the air during the continued circulation and recirculation of the air therethrough. Ordinarily, of course, natural gas consists principally of methane, with relatively smaller amounts of ethane and propane, along with still smaller amounts of higher aliphatic hydrocarbons, such as butane, pentanes, hexanes, heptanes, and octanes. Also, the theoretical explanation of the results produced by this invention may be due to phenomenon not now appreciated.

In any event, whatever the theoretical explanation, the fact of the matter is that sufficient gas can be removed in accordance with this invention to provide accurate indications thereof, from cuttings which were heretofore considered to be completely "dead," as it were, with respect to any combustible gas still contained therein.

As further evidence that the extraction of gas from the cuttings, when present therein, is apparently due to the partial pressure of the gas, or selective absorption, or to some other phenomenon, and not so much to the vacuum produced initially, is shown by the variation of Fig. 3. As illustrated therein, a by-pass line 50 provided with a valve 51 is installed around the compressor 20. When pulling the initial vacuum, the by-pass valve 51 is closed, and when the desired vacuum has been produced in container 12, the by-pass valve 51 and valve 18 are opened, so that the circulation and recirculation of the air begins. The by-pass line 50 is useful in increasing the amount of vacuum initially pulled and in reducing the size and amount of air handled by the compressor, but at the same time permits an adequate circulation of the air over and through the cuttings and through the detector filament housing 23. By use of by-pass line 50, an initial vacuum of 20'' Hg has been produced in an installation wherein only 4 to 5'' Hg was previously produced. However, the amount of gas evolved from the same type of cuttings was only slightly increased, and not nearly as great as would be expected from the proportions of the degrees of vacuum involved. It will be understood, of course, despite theoretical considerations, that the initial vacuum is highly desirable because it assists materially in the recirculation of the air and produces a dfferential in pressure which causes more positive recirculation and also causes the recirculating air to pass more vigorously through the cuttings.

The sensitivity of the detection of gas in accordance with this invention is very great. In one installation, a full scale reading of galvanometer 32, actually indicating only one milliamp, was considered to be one hundred for comparison purposes. In one instance, a reading of only two to three on the galvanometer scale was sufficient to indicate a gas productive zone. This indica-

tion was corroborated by the fact that the well was a good gas producer.

Testing of the cuttings for gas, in accordance with this invention, and for oil as ancillary thereto, may be at intervals, when the sub-structure is fairly well known, or, in the case of a wildcat or exploratory well, numerous tests may be made. This invention is particularly applicable to exploratory wells, since no special tools for bringing up cores are needed, and testing does not interfere at all with normal drilling operations.

When either oil or gas, or both, are indicated by testing as described above, and particularly when the geological formation appears to be capable of actually producing the oil or gas present, the well may be tested by what is termed a drill stem test. In this test, the drill string or pipe is pulled and a special test tool placed on the end of the drill pipe. This special tool is lowered to the desired level, and an expanding packer is actuated to seal that portion of the well below the packer from the portion above. Of course, when the drill string is pulled there will be no mud left in the drill string, and the pressure below the packer will be normal atmospheric, for the elevation at that point. Thus, instead of 3,000 lbs. per sq. in. at a depth of 6,000 ft., for instance, the pressure will be only slightly greater than normal atmospheric. Gas or oil in the particular section involved will force mud remaining below the packer up through the pipe and the oil and gas will then enter the pipe and it will soon be known whether or not the well is a producer. Sometimes, in the case of limestone or other formations, which are low in permeability, acidizing or shooting the formation may be necessary before it will produce.

From the foregoing, it will be evident that this invention fulfills to a marked degree the requirements and objects hereinbefore set forth. The apparatus necessary for testing for gas is relatively inexpensive, and easily transported. The operation thereof is fairly simple, and there are substantially no parts which will tend to give trouble. Also, no auxiliary drilling equipment is needed, and there is no interference with normal drilling operations. The test may be repeated as often as desired, as indicated by the type of structure evidenced by the cuttings and any other geological data which may be available.

While the method of this invention has been described as carried out by a particular type of apparatus, it will be understood that various changes, both in the method and apparatus, may be made. Thus, while the electrical detection of gas has been described specifically, it will be understood that the presence of gas may be ascertained in some other manner, as by chemical analysis. It will further be understood that additional embodiments of this invention may exist and that various changes also may be made therein, all without departing from the spirit and scope of this invention.

What is claimed is:

1. A method of gas detection in connection with a well, which comprises separating cuttings from mud and the like; placing a predetermined amount of cuttings in a closed container; introducing air into the lower portion of said container, whereby such air moves upwardly in said container to contact said cuttings; removing said air from the upper portion of said container; recirculating the same air through said container and cuttings, and including gas which is removed from said cuttings; and testing said recirculating air for gas.

2. A method of gas detection in connection with a well, as defined in claim 1, which includes agitating said cuttings.

3. A method of gas detection in connection with a well, which comprises separating cuttings from mud and the like at the upper end of said well; immersing a predetermined amount of cuttings in a predetermined amount of water, in a container adapted to be closed; introducing air into the lower portion of said container, whereby such air moves upwardly in said water to contact said cuttings; removing said air from the upper portion of said container; recirculating the same air through said container and cuttings, and including gas which is removed from said cuttings; and testing said recirculating air for gas.

4. Apparatus for detection of gas in cuttings separated from mud and the like from a well, comprising a closed container for receiving a predetermined amount of said cuttings; means for introducing air into the lower portion of said container, whereby such air contacts said cuttings; means for removing said air from the upper portion of said container; means for recirculating the same air through said container and cuttings, and including gas which is removed from said cuttings; and means for testing said recirculating air for gas.

5. Apparatus for detection of gas in cuttings separated from mud and the like from a well, as defined in claim 4, including means for agitating said cuttings.

6. Apparatus for detection of gas in cuttings separated from mud and the like from a well, comprising a container for immersing a predetermined amount of cuttings in a predetermined amount of water, said container being adapted to be closed; means for producing a pressure lower than atmospheric within said container; means for agitating said cuttings; means for introducing air into the lower portion of said container, whereby such air moves upwardly in said water to contact said cuttings; means for removing said air from the upper portion of said container; means for recirculating the same air through said container and cuttings, and including gas which is removed from said cuttings; and means for passing said recirculating air, including removed gas, to a detector adapted to produce an indication of the presence of a combustible gas in said recirculating air, and back to said container.

7. In apparatus for detecting gas in cuttings removed from a well and separated from mud or the like, a closed container for a portion of such cuttings; an air circulator for removing air and air-gas mixtures from said container; a recirculation line leading from said circulator to said container at a point spaced from the connection point of said circulator; and an impeller for agitating the cuttings in said container.

8. In apparatus for detecting gas in cuttings removed from a well and separated from mud or the like, a closed container for a portion of such cuttings; an air circulator for removing air and air-gas mixtures from said container; a detector adapted to indicate the presence of an air-gas mixture of predetermined concentration; a housing for said detector; an air and air-gas line leading from said air circulator to said housing; a recirculation line leading from said housing to said container; a recirculation tube extending to the lower portion of said container; an impeller for agitating the cuttings in said con-

tainer; and a valved by-pass line extending around said circulator.

9. Apparatus for detecting gas from cuttings removed from a well and separated from mud or the like, comprising a container adapted to receive a portion of such cuttings and liquid in which said cuttings are immersed; an air circulator for removing air and air-gas mixtures from said container; a cap for said container having a valved inlet and a valved outlet, with a recirculation tube extending to the lower portion of said container from said inlet; a suction tube connecting said outlet with the intake of said air circulator; a detector adapted to indicate the presence of an air-gas mixture of predetermined concentration; a housing for said detector; an air and air-gas pipe leading from the exhaust side of said air circulator to said housing; a recirculation tube leading from said housing to said container inlet; an impeller for agitating the cuttings in said container; and a valved by-pass line extending around said circulator.

10. In the detection of gas in cuttings from a well, the steps which comprise separating cuttings from mud and the like at the upper end of said well; placing a predetermined amount of cuttings in an enclosed space; producing a pressure lower than atmospheric within said space; introducing air into the lower portion of said space, whereby such air contacts said cuttings; removing said air from the upper portion of said space; and recirculating the same air through said space and cuttings, including gas which is removed from said cuttings, whereby said recirculating air may be tested for gas.

11. In the detection of gas in cuttings from a well, the steps which comprise separating cuttings from mud and the like at the upper end of said well; immersing a predetermined amount of cuttings in a predetermined amount of water, in an enclosed space; producing a pressure lower than atmospheric within said space; agitating said cuttings; introducing air into the lower portion of said space, whereby such air moves upwardly in said water to contact said cuttings; removing said air from the upper portion of said space; and recirculating the same air through said space and cuttings, and including gas which is removed from said cuttings, whereby said recirculating air, including removed gas, may be tested for the presence of a combustible gas.

12. In apparatus for detecting gas in cuttings removed from a well and separated from mud or the like, a closed container for a portion of such cuttings; an air circulator for removing air and air-gas mixtures from said container; a detector for indicating the presence of a combustible gas; a recirculation line extending between said circulator, said detector and said container; and a recirculation tube connected with said recirculation line and extending to the lower portion of said container.

13. In apparatus for detecting gas in cuttings removed from a well and separated from mud or the like, a closed container for a portion of such cuttings; means for agitating cuttings in said container; an air circulator for removing air and air-gas mixtures from said container; a detector for indicating the presence of a combustible gas; a recirculation line connecting said circulator and said detector with spaced points of said container; and a valved by-pass line extending around said circulator.

14. A method of gas detection in connection with a well, which comprises separating cuttings from mud and the like at the upper end of said well; placing a predetermined amount of cuttings in a container adapted to be closed; producing a pressure lower than atmospheric within said container; introducing air into the lower portion of said container, whereby such air contacts said cuttings; removing said air from the upper portion of said container; recirculating the same air through said container and cuttings, and including gas which is removed from said cuttings; and testing said recirculating air for gas.

15. A method of gas detection in connection with a well, which comprises separating cuttings from mud and the like at the upper end of said well; immersing a predetermined amount of cuttings in a predetermined amount of water, in a container adapted to be closed; producing a pressure lower than atmospheric within said container; agitating said cuttings; introducing air into the lower portion of said container, whereby such air moves upwardly in said water to contact said cuttings; removing said air from the upper portion of said container; recirculating the same air through said container and cuttings, and including gas which is removed from said cuttings; and passing said recirculating air, including removed gas, to a detector adapted to produce an indication of the presence of a combustible gas in said recirculating air.

16. A method of gas detection in connection with a well, which comprises separating cuttings from mud and the like at the upper end of said well; immersing a predetermined amount of cuttings in a predetermined amount of water, in a container adapted to be closed; closing said container, thereby trapping air above the water; agitating said water and said cuttings; removing air from said container and circulating the same around a closed path which initially contains air and leads back to said container, said circulating air thereby picking up gas released from said cuttings; and testing said circulating air for gas.

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