Feb. 12, 1946. E. LIPSON 2,394,703

SOIL ANALYSIS BY RADIANT ENERGY

Filed July 6, 1942 2 Sheets-Sheet 1

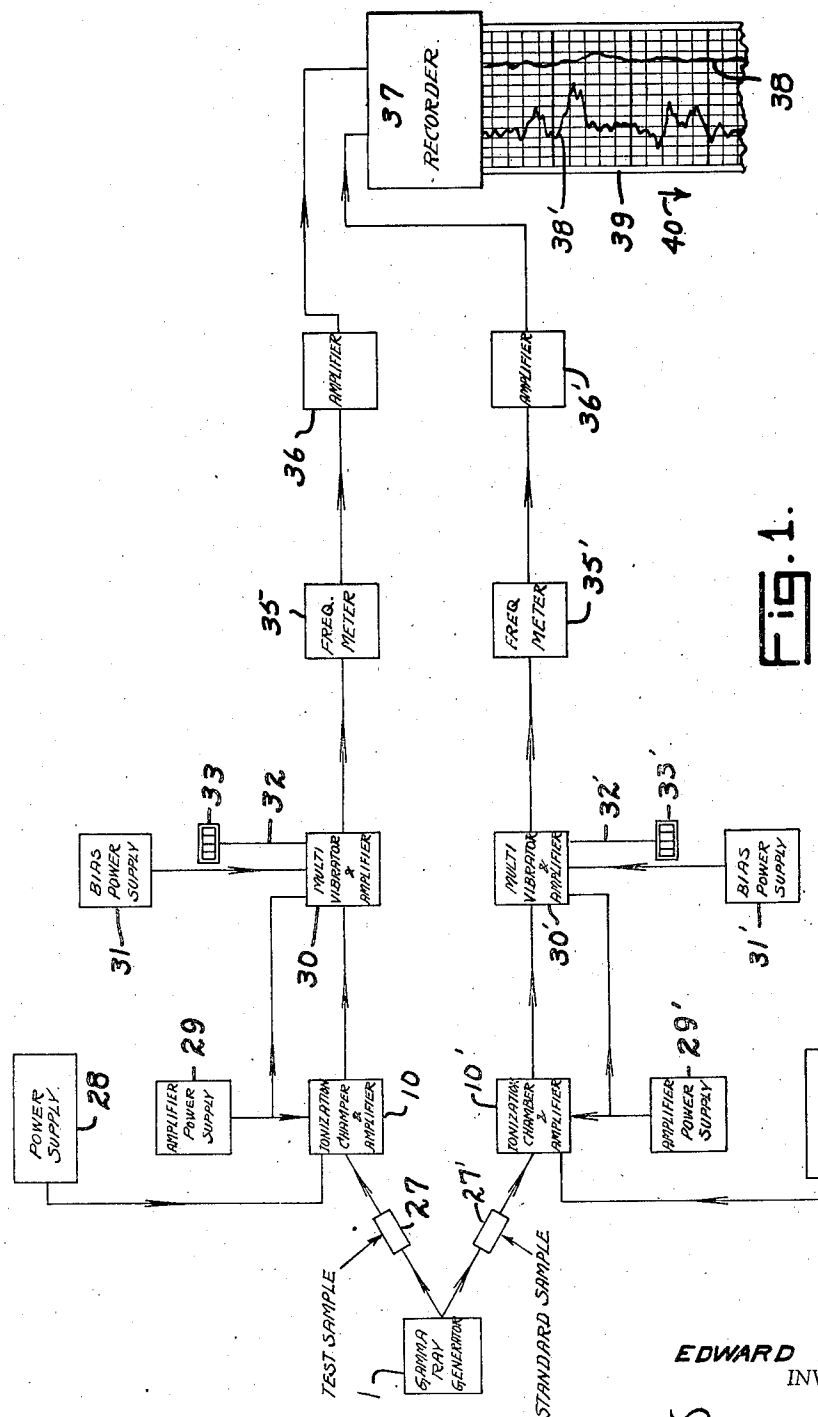


Fig. 1.

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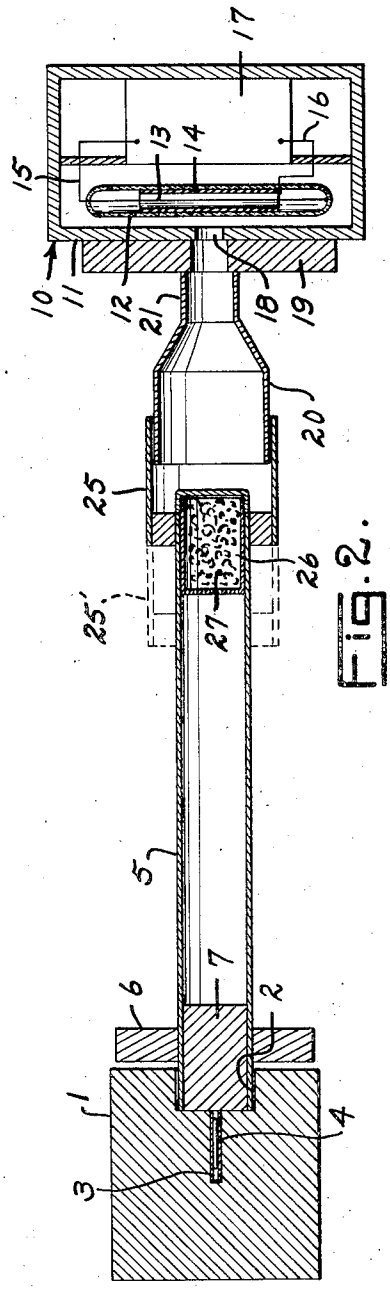


Fig. 2.

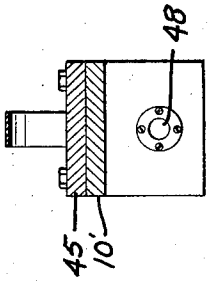


Fig. 5.

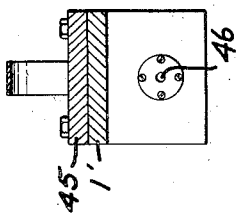


Fig. 4.

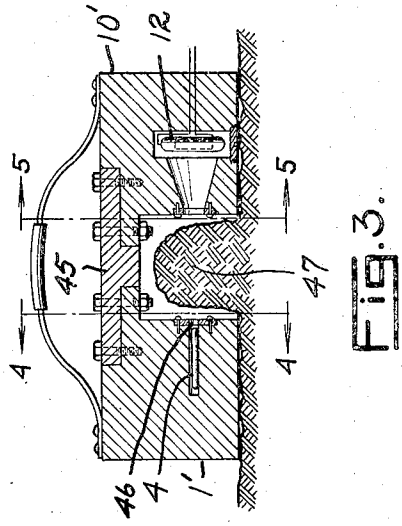


Fig. 3.

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SOIL ANALYSIS BY RADIANT ENERGY

Edward Lipson, Houston, Tex.

Application July 6, 1942, Serial No. 449,922

5 Claims. (Cl. 250—83.6)

This invention relates to method and apparatus for locating hydrocarbon deposits, and more particularly to the analysis of soil samples for information directly indicative of the location, nature and extent of such deposits.

It is well known that gas seeps detectable from odor or by the presence of gas bubbles over a water-covered area are directly indicative of the presence of subsurface buried deposits of oil and gas. Where such seeps are small, as is usually the case, it has been proposed to detect the seeps and determine their areal extent by quantitative analyses which determine the concentration of surface entrapped hydrocarbons or certain solids which result from the mutual presence of hydrocarbons or other chemical constituents of the soil through which the gases pass. A quantitative determination of these seeps is therefore a direct method of detection of the buried deposits of which the presence and location are sought.

The present invention is based upon the discovery that the earth materials, or soil, above or proximate hydrocarbon deposits are in some manner modified by the constituents which migrate through the soil, whereby the opacity or absorption factor of such materials to the transmission of radiant energy is an index or the location, proximity and areal extent of the deposits. It is uncertain as to the exact nature of the modification which takes place in the earth materials and which is utilized in the practice of the invention. A plausible explanation is that the great pressure to which hydrocarbon deposits are subjected in the earth produces a certain amount of disassociation of the highly complicated hydrocarbon compounds and that such disassociation produces heavy natural gases.

As above explained, these heavy gases, and others, migrate upwardly and during their migration dissolve or pick up some of the minerals in the soil. As these products approach the surface the gases gradually diffuse into the atmosphere and leave minerals behind, whereby such minerals produce an increased opacity or absorption factor of the soil to the transmission of radiant energy.

As already pointed out, it is uncertain as to the exact nature of the soil modification which takes place and which is utilized in the practice of the present invention. Ths foregoing is offered merely as a plausible explanation and it is not intended that the scope of the invention shall be in any way limited by the theory which has been advanced.

It is a primary object of the invention to locate valuable subsurface hydrocarbon deposits by the investigation of soil samples proximate or overlying the deposits, whereby the opacity or absorption factor of such soil is an index of the presence of the deposits.

It is also an object of the invention to locate subsurface hydrocarbon deposits by a study of samples of soil systematically obtained from preselected areas at or near the earth's surface.

Still another object is to determine the nature of formations penetrated by well bores by determining the variations in the absorption factor of cuttings or samples which are taken at different depths within the well bore.

Another object is the provision of apparatus for determining the variations in the absorption factor of soil samples by subjecting the samples to radiant energy and measuring the absorption of such energy by the respective samples.

The foregoing objects are primary objects and will, together with other objects, be more fully apparent from reference to the following description taken in connection with the accompanying drawings in which:

Fig. 1 is a schematic diagram of apparatus utilized in the practice of the invention;

Fig. 2 is a sectional view through one form of mechanism for subjecting soil samples to radiant energy so that the absorption factor of such samples may be measured;

Fig. 3 is a sectional view in elevation of a mechanism which may be utilized for measuring the absorption of soil samples in situ;

Fig. 4 is a sectional view taken on the line 4—4 in Fig. 3;

Fig. 5 is a similar sectional view taken on the line 5—5 in Fig. 3.

The method of the invention comprehends the procurement of samples of earth material, or soil, in an area to be investigated. It is to be understood that the samples may be systematically obtained over a relatively large area and that such samples may then be taken to a location for analysis in the manner hereinafter described. Alternately, the invention also comprehends that, if desired, samples may be investigated in situ. The invention is also utilized in providing information as to the location of productive strata penetrated by bore holes, and it is intended that the invention as described and claimed shall include the investigation of samples, such as cuttings or sidewall samples, obtained from different elevations within a bore hole.

Referring first to Fig. 2 of the drawings, one embodiment of apparatus of the invention ca-

pable of carrying out the method comprises a shield member 1 of material having a high atomic weight, such as lead, such member having a counterbore 2 in one end thereof and a smaller inner bore 3 centrally thereof. A quantity of radioactive material 4 is positioned within the bore 3 and serves to provide the desired radiant energy whereby the absorption factor of a soil sample may be determined.

It has been found that one milligram of radium serves satisfactorily as the radioactive substance 4, since such material is a prolific source of gamma rays which are extremely penetrating, and hence rapid observations may be made. It is pointed out, however, that other sources of radiant energy may be utilized, such as other radioactive substances or, with a larger installation, a suitable source of X-rays may be used.

Extending outwardly from within the counterbore 2 is a shielding tube 5, such as lead, and a lead plate 6 surrounds this tube adjacent the mouth of the counterbore 2 to assist in protecting the operator from the radiations from the source 4. A lead plug 7 is also provided within the tube 5 and this plug is of a selected thickness so that the rays passing therethrough are of sufficient intensity that desired observations may be made.

Adjacent the outer end of the tube 5 is a combined ionization chamber and amplifier unit 10 enclosed within the housing 11 which includes a Locher tube 12 which is used as an ionization chamber. The elements 13 and 14 of the Locher tube are connected through conductors 15 and 16 to an amplifier 17 to which reference will further be made in connection with Fig. 1 of the drawings.

The Locher tube 12 is adjacent an opening 18 in the wall of the housing 11 and shield plate 19. A shielded passage is provided between this opening and the end of the tube 5 by the enlarged tubular member 20 having a reduced section 21 adjacent the opening 18.

A slidable shield 25 has one end which fits over the larger end of the member 20 and the other end of this shield fits closely about the outer end of the tube 5. This slidable shield is movable to the position shown in dotted outline at 25' and when in this position, a container 26, such as aluminum, containing a sample of earth material may be positioned within the passage through which energy from the source 4 may pass to the Locher tube 12.

The sample in the container 26 may be in any of various forms. For example, such sample may be solid, comminuted, or may be liquid or semi-liquid in form. The principal requirement is that successive samples be prepared in substantially the same manner so that relative opacity or absorption factors may be obtained with a high degree of accuracy.

In Fig. 1 there is shown a schematic diagram for the use of the apparatus just described. The housing 1 for the source of radiant energy is shown as positioned in a manner that a portion of the radiant energy passes through the test sample 27 and enters the ionization chamber 10 having amplifier 17 therein. The ionization chamber within this unit is supplied with power from the source 28. The amplifier of the unit 10 is provided with power from a separate source 29 which also supplies power for the multi-vibrator and amplifier unit 30.

A bias power supply 31 may be provided for the amplifier for the unit 30 or, if desired, such power supply may be incorporated as a part of the unit.

The quantity of energy from the source which is passed through the test sample 27 produces impulses which constitute the output of the ionization chamber and the amplifier unit 10, and such impulses are transmitted to the unit 30 which is connected by means of a conductor 32 to a mechanical counter 33 whereby the quantity of energy passing through the sample 27 may be determined by the readings of such counter.

In order that additional information may be had as to the quantity of energy passing through the test sample 27, a portion of the output from the amplifier of the unit 30 is utilized as the input to a frequency meter 35 and also as the input to the amplifier 36 of which the output is utilized to actuate the mechanism within the recorder 37 so that there is provided a wave trace 38 as the tape 39 is moved in the direction indicated by the arrow 40. The tape is arranged to be moved because each sample is tested for a period of time and it is necessary to move the tape to obtain the desired recording to detect variations in the radiant energy source or sample.

The operation of apparatus thus far described is believed apparent. By way of summary, it will be assumed that the rate of emanation of energy from the source 1 is known. The counter 33, the frequency meter 35 and the graphical record 38 produced by the recorder 37 indicate the amount of energy that traverses the test sample 27. With this information available, it is possible to determine the opacity or absorption factor of the sample 27.

The absorption factor is obtained in the manner above set forth for a plurality of samples which have been taken in a systematic manner in the area under investigation. Hence, a comparison or composite of the information thus obtained can be utilized for plotting a map of the investigated area. In event such area overlies or is proximate subsurface hydrocarbon deposits, this fact will be revealed by the comparative values of the absorption factors of the various samples.

Inasmuch as the rate of emanation of the quantity of energy from the source 1 varies considerably, it is desirable to provide a separate measuring circuit similar to that already described as comprising elements 10 and 27 to 36, inclusive. This circuit is identified by similar primed reference characters, the only difference being that the standard sample 27' is maintained constant and is preferably of less opacity than the test samples 27. A portion of the radiant energy is directed through each of the samples and the graphical record 38' produced by the energy transmitted through the standard sample enables a determination of the relative transmission of such energy through the standard and test samples. It will be noted that the trace 38' for the standard sample shows larger variations than does the trace 38 for the test sample. This may be explained as caused by the rate of emanation of the radiant energy which varies considerably and the fact that the standard sample may have less opacity than the test sample in which case the larger variations are not masked out like they are in the test sample having the larger opacity. The traces 38 and 38' may represent the readings of several samples one after the other and the length of the trace will depend

upon the length of time that a sample remains under test.

Surveys made in accordance with the foregoing description over various areas having known characteristics have revealed that the present invention is capable of locating subsurface deposits with a high degree of accuracy. This has also been found true where the invention is utilized for determining the relative absorption factor for samples taken from different elevations within a well bore.

The invention is not confined to the making of analyses in the laboratory, but also comprehends the use of equipment whereby observations may be made in the field, the samples being examined in situ in the manner indicated in Figs. 3, 4 and 5 of the drawings. In this form of apparatus the source 4 of radiant energy is positioned within the shield 1' which is attached through a connector member 45 to the housing 10' within which the Locher tube 12 is located. Radiant energy from the source 4 is directed through the opening 46 to and through the mass or sample 47 of earth material about which soil has been removed so that the portable unit may be placed thereover as indicated in Fig. 3.

The energy passing through the sample 47 enters the window 48 in the inner wall of the housing 10' and thence enters the Locher tube 12 and produces ionization therein. This ionization gives rise to electrical impulses within a circuit such as above described and hence enables an examination of the sample 47 without removal of such sample from position at or proximate the surface of the earth.

Broadly, the invention comprehends novel method and apparatus for determining absorption factors of soil samples as an indication of the location, nature and extent of subsurface hydrocarbon deposits.

What is claimed is:

1. In the logging of wells the method comprising the steps of obtaining formation samples at different levels within a well, applying radiant energy such as gamma rays to the samples, and measuring the relative amount of radiant energy transmitted through different ones of said samples as an indication of the hydrocarbon content of such samples due to the original proximity of the samples to formations containing hydrocarbon fluids.

2. In the art of exploration for subsurface deposits from which leakage occurs and produces alteration of opacity of earth materials at points spaced from the deposits, the method of locating the deposits comprising, subjecting samples of earth materials to gamma ray or the like radiant energy, and determining the relative quantity of energy transmitted through said samples due to the proportion of leakage thereinto as an indication of the proximity of the samples to the subsurface deposits.

3. In the art of exploration for subsurface deposits from which leakage occurs and produces alteration of opacity of earth materials at points spaced from the deposits, the method of locating the deposits comprising, subjecting samples of earth materials to gamma ray or the like radiant energy, simultaneously subjecting a standard sample to the radiant energy, measuring for a predetermined time interval the quantity of energy passing through the respective samples, and determining from such measuring step a comparison of the earth with the standard sample to obtain the opacity of the earth sample.

4. Apparatus for determining the location of subsurface hydrocarbon deposits by examination of soil samples which have been modified by emanations passing from the deposits to the formations from which such samples have been obtained comprising, in combination, a source of gamma ray or the like radiant energy, means directing energy from said source to a soil sample, and means responsive to radiant energy passing through the sample whereby the relative opacity of a plurality of the samples is obtained.

5. An apparatus of the character described comprising a metal shield, a source of gamma rays therein, a shield permitting the passage of a predetermined intensity of such rays, a shield tube to receive such last rays, a sample of an earth formation being investigated adapted to be disposed in such tube, a shield to control a flow of gamma rays from said sample, and an ionization chamber to detect such rays as an indication of the radioactive content of such sample.

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