

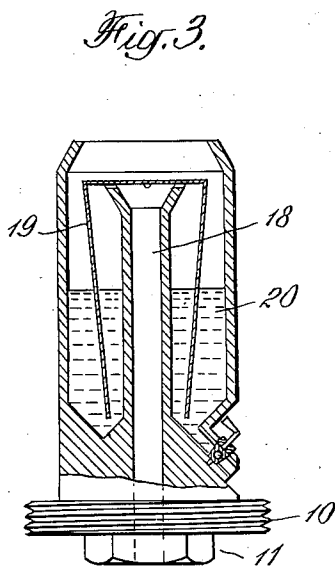
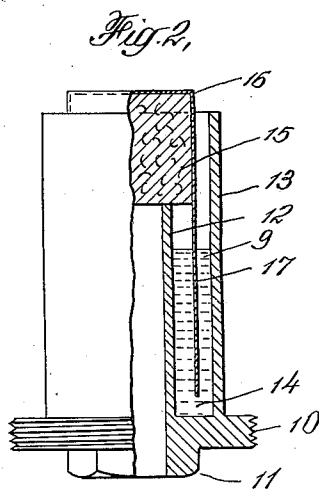
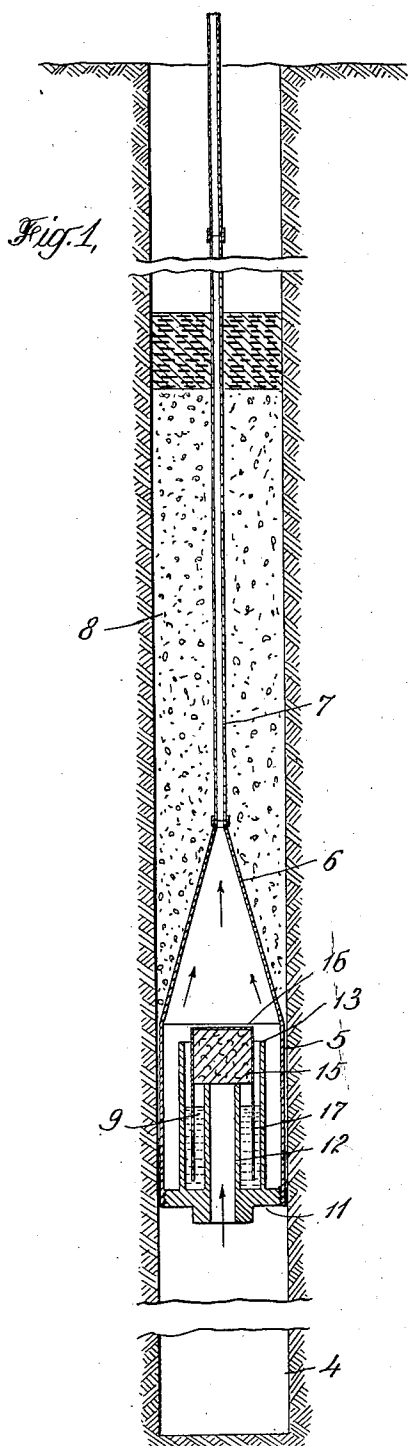
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GEOPHYSICAL PROSPECTING METHOD

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GEOPHYSICAL PROSPECTING METHOD

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This invention relates to methods of prospecting for oil, gas, or similar buried deposits which give rise to gaseous emanations of a nature which may be identified and related to the source. It is particularly directed to prospecting for buried hydrocarbon deposits, such as natural gas or petroleum oil, the hydrocarbon gas emanations from which may be related to the position of the underground deposit.

It has been recognized that anomalous variations in the amount of gaseous materials, related to hydrocarbons, such as hydrogen, hydrocarbons, and oxides of carbon, occur in the vicinity of petroliferous deposits and that such anomalies may be correlated with known petroliferous deposits or that they may be used alone, or in correlation with other geological or geophysical methods, for the locating of prospective petroliferous deposits.

However, such methods as are already being used in commercial exploration and which have to do with the sampling of soil and the removal of gas from that soil sample or which rely on the analysis of gas samples collected and removed from the soil-in-place under high vacuum conditions have several drawbacks.

In connection with the first method referred to, the analytical data cannot be readily interpreted in terms of the soil-air hydrocarbons which they should represent for two closely related reasons: (1) difference in soil sorptive abilities; (2) difference in conditions of sorption. With methods known at present, neither of these can be properly measured, evaluated or corrected for. The problem of correction for these factors is a complicated one.

The other and earlier known method of soil gas analysis offers more promise but also suffers from a lack of properly developed technique. Sampling gas in a borehole under high vacuum creates unnecessary complications.

Our experimental work leads us to believe that the two methods just discussed have at least one serious drawback in common; namely, that of sampling at too shallow depths. We have found that sampling depth may affect gas composition appreciably.

It is an object of this invention to provide a novel method for geophysical prospecting by observation of gaseous emanations from soil in the area being prospected.

A further object is the observation of anomalies in rate of emanation of gaseous material from oil over an area to be prospected and the relation of those anomalies to the possible presence

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of petroliferous deposits below that surface area.

A further object is the observation of anomalies of rates of emanation of various constituents of gaseous emanates over an area to be prospected and the relation of those anomalies to the possible presence of petroliferous deposits below the area examined.

A further object is the provision of a low cost method of obtaining additional information correlated with and supplementary to other methods of geophysical prospecting.

This invention is based upon the discovery that anomalous variations in the rates of flow of gases from the soil occur in various portions of an area under examination, and that these variations may be related to the presence of buried petroliferous deposits.

This invention is based particularly upon the surprising discovery that sufficiently large rates of flow are observed, and sufficiently large variations are found therein, to greatly increase the ease of interpretation of the data. The rate of flow method based upon this discovery does away with the uncertainties inherent in methods which involve taking from relatively very shallow depths within the "breathing zone," small samples of gas or small samples of soil from which gas is extracted, and submitting these gas samples to analysis.

For example, in one case, at a point where a soil sample analysis showed only 1 to 2 parts of ethane per billion, examination of a test hole drilled to a depth of ninety feet showed a rate of evolution of gases of 3 cubic feet of gas per hour, of which gas about 85 percent was hydrocarbons. From this, it is obvious that in many cases the method herein disclosed is less open to errors of technique and in many instances may be of vastly increased sensitivity.

In its barest essentials the method consists of sinking a bore hole into the earth to a depth below the water table or to a depth below which "breathing" of the soil due to temperature and other variations is a significant factor and observing the rate of evolution of gas from the surrounding soil into the bottom of that hole after suitable sealing means have been provided to isolate the bottom of the hole from communication with the atmosphere.

It is of importance in this method that the hole be bottomed below the level at which movement of air and gases within the soil initiated by surface temperature and pressure changes would vitiate the results. Such movement of air and gases is herein denoted "breathing." Ordinarily

this method could quite conveniently be carried out in "shot holes" drilled for use with seismograph surveys, before the shots are placed and fired.

Many methods of measuring the amount of gas evolved during a given period of time may be made use of. In some areas, flows would be sufficient so that known metering devices, or means for determining gas volume by means of pressure differentials may be used. In others, probably in most cases, more delicate methods may be required. For example, the gases may be caused to pass through and be absorbed in a suitable absorptive liquid, placed either at the bottom of the hole or in communication therewith and the gas amount measured or estimated either by changes in the properties of the absorptive liquid or by desorption of the gas therefrom and subsequent volumetric measuring and analysis. The use of an absorption method for determining the rate of flow is specifically claimed in copending application Serial No. 508,917 filed November 4, 1943. As a further example, particularly when records of gas evolution over a period of time are desirable, use may be made of the familiar hot-wire gas flowmeter, wherein a hot-wire, heated by a constant energy input, exposed to the flowing gas, records by its change in temperature and/or resistance, after suitable calibration, the amount of gas flowing past it. The latter method is particularly applicable to a survey wherein simultaneous observation of a number of points is desired.

As an example of one method whereby the rate of evolution of gas may be measured, reference is made to the drawing made a part of this specification, Figure 1 of which shows a simplified vertical cross section of a bore hole under test and Figures 2 and 3 of which show detailed sections of a particular portion of the apparatus.

In Figure 1, 4 denotes the chamber at the bottom of the bore hole, into which there has been suspended a sampler 5, the cylindrical body of which is tapered to 6 to connect with a smaller pipe 7 which extends to the surface. Surface water, etc., are excluded by packing 8. Within sampler 5 there is mounted a trap 9, shown in more detail in Figure 2. This consists of a threaded base 10 with nut 11 from which there extends upwardly two cylinders 12 and 13, as shown, forming an annular well 14 which may be filled with a sealing liquid, preferably non absorptive to soil gases, such as mercury. Resting upon cylinder 12 we find a porous absorptive material block 15, such as filtros, housed in container 16 which has a depending skirt 17 which dips into the sealing liquid in space 14. The porous absorptive material block is saturated with a liquid, such as ethyl alcohol, kerosene, a light oil fraction or the like, capable of dissolving the soil gas, or at least an indicative portion thereof. After remaining within the bore-hole for a specified time, the apparatus may be removed, the material removed from the porous block, and examined to determine the amount of gas constituents absorbed.

In Figure 3, a liquid absorption system of different type is used, wherein soil gas passing up through central passage 18 will be forced by baffle 19 to pass through absorptive liquid 20 of the type described above.

It will of course be necessary in many cases to so manage operations at the bottom of the hole, in holes where water flows in from the formation being examined, as to prevent submergence of

the gas analyzer by incoming water, and to effectively separate gas from fluid at this point.

In the foregoing, it is pointed out that what is herein considered of prime importance is the rate of evolution of gas into the bore hole. It is of course to be understood that such standardization of conditions as are applicable, for example, corrections for bottom-hole pressure variations between several holes in a series of tests, corrections for atmospheric pressure between tests upon a series of days, uniformity of amount of hole-wall surface from which evolution occurs, and other comparative standardization will be applied.

It will also be understood that anomalies in the rate of flow of the individual, constituent gases entering the bore hole, as well as in total rate, are of use in this method. For example, in areas without marked anomalies in total rate of evolution from point to point, anomalies in the rate of evolution of individual constituents of the gaseous mixture may occur and are of indicative value.

The term "soil" as used herein denotes not merely the surface portion of the earth in the area to be prospected, but is utilized in the broad sense to denote the whole of the vertical column which may be explored by this method of prospecting. In this sense, it will be seen not to include merely the surface layer of material suitable for cultivation, but also the subsoil, and even to extend into the relatively undecomposed underlying strata. The term soil-gas is herein used in an equally broad sense as covering that gas present in, or evolved from, or capable of being evolved from the earth at any level within the scope of the method herein disclosed.

I claim:

1. The method of geophysical prospecting which comprises sinking bore holes at points distributed over the area to be prospected to depths below the limit of atmospheric "breathing" of the soil, selecting a zone in each of said bore holes of substantially uniform hole-wall surface area at a depth below the limit of said atmospheric "breathing," isolating said zone from access thereto of gases from other levels in said bore hole, determining the natural rate of evolution of gases from the surrounding soil into said zone, and correlating variations in the rate of said evolution in the individual holes throughout the area examined whereby information useful in locating petroliferous deposits may be obtained.

2. In the prospecting for petroliferous deposits the method which comprises sinking bore holes at spaced points in the surface of the earth over an area to be prospected, sealing off a section of each bore hole from contamination from above while maintaining provision for passage of gas through the seal, whereby gas emanating from the strata surrounding the said sections will collect in the sealed off sections and pass therethrough at a rate equal to that of its natural emanation from the surrounding strata into the sealed off sections of the bore holes without acceleration or retardation of the natural emanation of the gas, determining the rates at which the gas traverses the sealed off sections per unit area of strata exposed in said sections, and correlating variations in said rates among the various holes whereby information useful in locating petroliferous deposits may be obtained.

3. The process of claim 2 wherein the bore hole is sunk to a depth below the limit of at-

mospheric "breathing" and the sealed off section located therein below the limit of atmospheric "breathing."

4. The method of geophysical prospecting which comprises sinking bore holes at points distributed over the area to be prospected, selecting a zone in each of said bore holes of known hole-wall surface area, isolating said zone from access thereto of gases from other levels in said bore hole, determining the natural rate of evolution of gas from the surrounding soil into said zone per unit area of soil wall exposed in said zones, and correlating variations in the rate of evolution in the individual holes throughout the area examined whereby information useful in locating petroliferous deposits may be obtained.

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