Patented May 23, 1944 2,349,472

# UNITED STATES PATENT OFFICE

2,349,472

## OIL PROSPECTING METHOD

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No Drawing. Application June 7, 1939, Serial No. 277,891

10 Claims. (Cl. 23—230)

The present invention is directed to a method for prospecting for oil.

Some years ago the theory was advanced that hydrocarbon gases diffuse upwardly from petroleum deposits and can be detected in soil gas. This led to the development of the soil gas analysis method of prospecting for petroleum. According to this method soil gas samples are collected and are analyzed by one of several methods for the presence of hydrocarbons heavier than methane. Since the content of such hydrocarbons in the soil gas, even over a deposit of petroleum, is quite low, percentages as low as ten parts per million being significant, it is apparent that the method involves much painstaking laboratory work.

More recently it has been discovered that these soil gases diffusing upwardly from petroleum deposits have an effect on the surface soil, it having been established with a considerable degree of certainty that these hydrocarbon gases feed certain bacteria in the soil, whereby the existence of a petroleum deposit can be recognized by either a high content of such bacteria in the soil or the presence in the soil of products resulting from the feeding of said bacteria upon the hydrocarbon content of the soil, such products being fairly heavy organic compounds. The primary test adopted in the practice of this method was a color test. As is known, great care must be exercised in the practice of any method, the results of which depend upon color tests, both in the preparation of the sample to be tested and in the observation of the color. The latter step could be made largely free from error by the use of photoelectric colorimeters, but the results were still subject to error on the part of the operator preparing the samples for color determination.

According to the present invention, the human element is largely eliminated from a method of the general type last described by subjecting the soil samples to the action of gases containing air and hydrocarbons, preferably heavier than methane, and observing the rate or degree of consumption of the hydrocarbons by the soil, this rate or degree depending upon the bacterial content of the soil which, in turn, depends upon the previous history of the soil and particularly upon its relation to petroleum deposits. The practice of the method simply involves the placing of a soil sample in a suitably sealed chamber, preferably transparent, filling the chamber with air and hydrocarbons, and observing the drop in pressure over a selected period of time, the greater the drop, the greater the bacterial content of the soil sample.

Collection of soil samples for the practice of the present invention is in general the same as that for the soil analysis method previously referred to. In general, these samples should be collected from undisturbed surfaces; that is, from surfaces which have not been recently plowed or worked over. The preferred procedure includes scraping off the vegetation from the top of the soil and then taking a sample to a depth not exceeding six inches, including, of course, the surface itself. No special precaution need be observed about sealing the sample or holding adsorbed or absorbed gases in it, because the results of the present invention are not predicated upon the existence of such constituents. To insure uniformity, however, and to avoid accidental exposure to hydrocarbon atmospheres prior to testing, it is desirable to pack the samples in cardboard cartons, fruit jars, or the like, for transportation to the scene of the test. Of course, the present invention contemplates the testing of soil samples directly on location, since the apparatus involved is simple and can easily be carried on a truck, there being so sensitive parts of the apparatus which might suffer from jolting in transit.

In order that the results may be properly recorded, each sample is given a number and its location on a map of the area under investigation is noted. Samples may be collected at any desired intervals. Experience has demonstrated that ten samples to a mile is a satisfactory spacing, although closer or wider spacing may be followed. The samples, for ease of location on a map, are preferably collected along straight lines, intersecting each other over the area to be investigated in such a way as to give a comprehensive picture of the area.

Referring specifically to the testing method, each sample is placed in a sealed chamber which is preferably transparent. A gas mixture containing a hydrocarbon, preferably ethane, propane or butane, in admixture with air or oxygen, is fed into the chamber. The gas mixture may contain from five to fifty percent, or more, of hydrocarbon, it being required only that sufficient air be present for the propagation of the bacteria which are aerobic. The chamber is originally at atmospheric pressure and is provided with a manometer. If desired, the chamber may be originally at a pressure above atmospheric and provided with pressure gauge.

The sample is allowed to stand in the hydro-

carbon atmosphere for any selected period of time, usually in excess of about two hours and preferably for from five to fifteen hours, and the manometer is read periodically. A small drop in pressure is to be expected in any case due to adsorption of hydrocarbon by the soil sample. When the soil sample contains substantial amounts of hydrocarbon consuming bacteria, however, a very substantial drop in pressure is observed, so much so that if the atmosphere contains sufficient hydrocarbon, the mercury in the manometer will be sucked into the chamber in due course.

For uniform results it is of course necessary that all samples be subjected to the same atmosphere for the same length of time. The drops in pressure observed with the various samples are then recorded, and the highs are noted on the map of the area under investigation. By drawing lines through locations of samples giving the same pressure drop it is possible to draw a contour map somewhat similar to that which is ordinarily drawn for gravity surveys.

It will be understood that the general principle involved in the present invention can be utilized without following the specific procedure outlined above. For example, the amount of hydrocarbons absorbed or taken up by the soil sample can be determined by analyzing residual gas in the sealed chamber as well as by observing the drop in pressure. Another refinement is to divide each sample into portions and subject one portion to the action of methane, while another portion is subjected to the action of heavier hydrocarbons under the same conditions, the same concentration of hydrocarbons being used in each case. This procedure serves to eliminate errors which might arise by reason of the fact that the soil may contain bacteria which have a preferential action on methane. By comparing the results obtained by the action of the respective gases one can determine with certainty the amount of bacteria contained in the soil sample which is propagated by heavier hydrocarbons.

The nature and objects of the present invention having been thus described, what is claimed as new and useful and is desired to be secured by Letters Patent is:

1. A method for prospecting for petroleum deposits which comprises subjecting samples of the surface soil from spaced points in the area under investigation to the action of hydrocarbon gas in a sealed zone and determining the amount of the hydrocarbon gas taken up by the individual soil samples.

2. A method for prospecting according to claim 1 in which the gas employed is heavier than methane.

3. A method for prospecting for petroleum deposits which comprises collecting spaced samples of surface soil over an area under investigation, placing each sample in a sealed zone, filling the zone to a selected pressure with a mixture of air and hydrocarbon gas, and observing the decrease in pressure in said zone with time.

4. A method according to claim 3 in which the gas is a hydrocarbon heavier than methane.

5. A method for prospecting for petroleum deposits which comprises collecting a plurality of samples of surface soil at each of a plurality of points over an area under investigation, subjecting at least one sample from each point to the action of an atmosphere containing air and methane, subjecting at least one other sample from the same point to the action of an atmosphere of air and a hydrocarbon gas heavier than methane, and comparing the amounts of the hydrocarbon gases taken up by the samples from different points.

6. In a method of exploration for deposits of hydrocarbon matter, the steps of collecting spaced samples of soil, confining each of said samples in an atmosphere comprising gaseous hydrocarbons, and determining the presence in said sample of hydrocarbon-consuming bacteria by observing the change in the pressure of the confined atmosphere surrounding said sample.

7. In a method of exploration for deposits of hydrocarbon matter, the steps of collecting spaced samples of soil, confining each of said samples in an atmosphere comprising a gaseous hydrocarbon component, and determining the presence in said sample of hydrocarbon-consuming bacteria by observing the loss of the hydrocarbon component from said atmosphere.

8. In a method of exploration for deposits of hydrocarbon matter, the steps of collecting spaced samples of soil, confining each of said samples in an atmosphere containing hydrocarbons other than methane, and determining the presence in said sample of hydrocarbon-consuming bacteria by observing the loss from said atmosphere of hydrocarbons other than methane.

9. In a method of exploration for deposits of hydrocarbon matter, the steps of collecting samples of soil at different points throughout a region, confining each of said samples in an atmosphere comprising gaseous hydrocarbons, and determining the relative population density of hydrocarbon-consuming bacteria in said samples by observing the rate of change of the pressure of the confined atmosphere surrounding each sample.

10. A method for prospecting for petroleum deposits which comprises collecting samples of surface soil at spaced points over an area under investigation, placing each sample in a sealed zone, filling the zone with a mixture of air and hydrocarbon gas containing a selected amount of hydrocarbon gas which will be the same for each soil sample, permitting this system to stand for a selected period which is the same for each soil sample, and then determining the amount of hydrocarbons left in the atmosphere in the sealed zone.

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