Aug. 6, 1940. G. L. HASSLER 2,210,546

SOIL GAS SAMPLING DEVICE AND METHOD

Original Filed Feb. 14, 1938 2 Sheets-Sheet 1

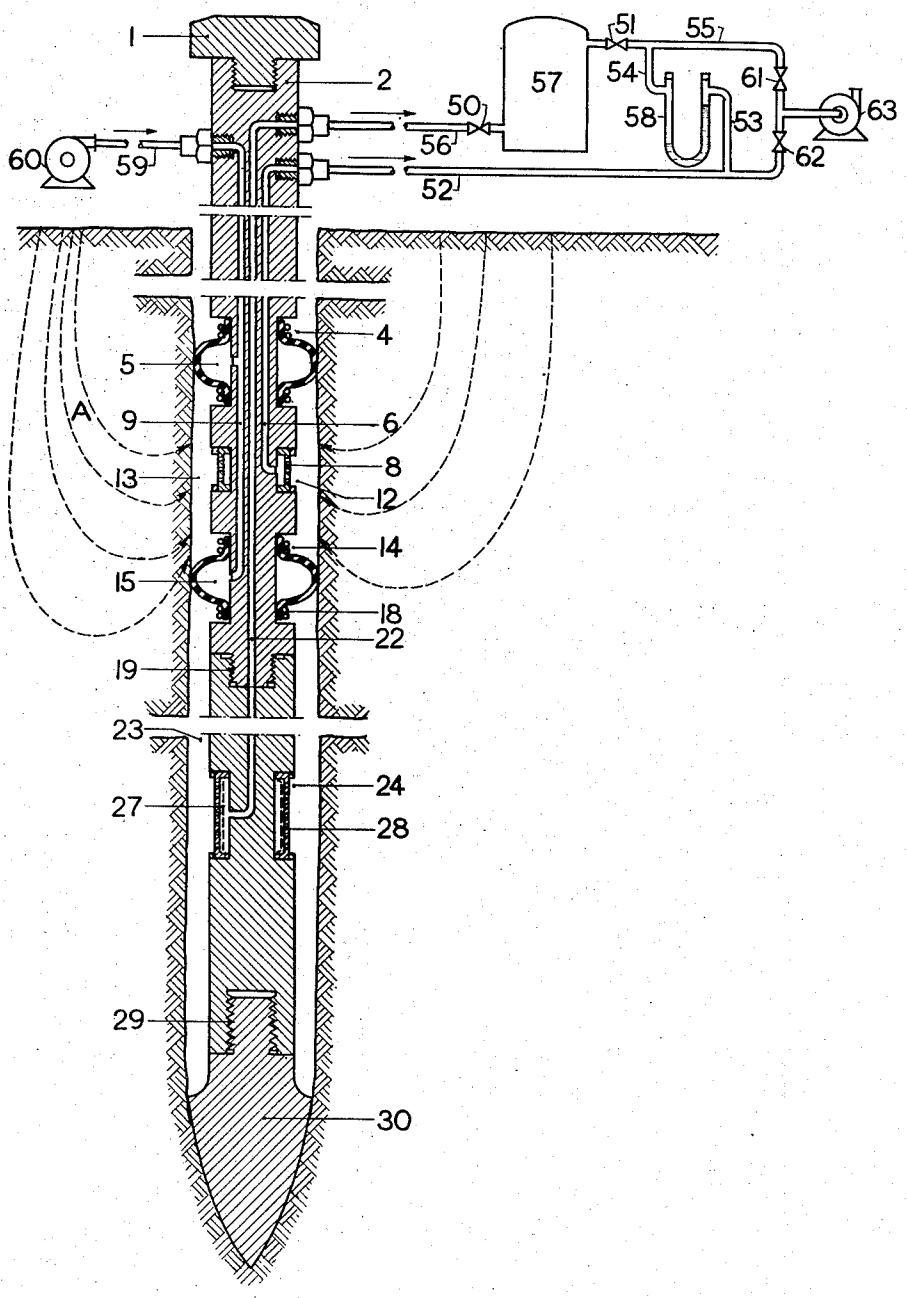


Fig. 1.

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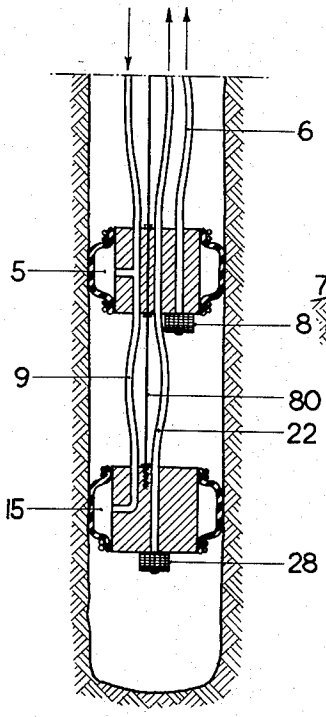


Fig. 2.

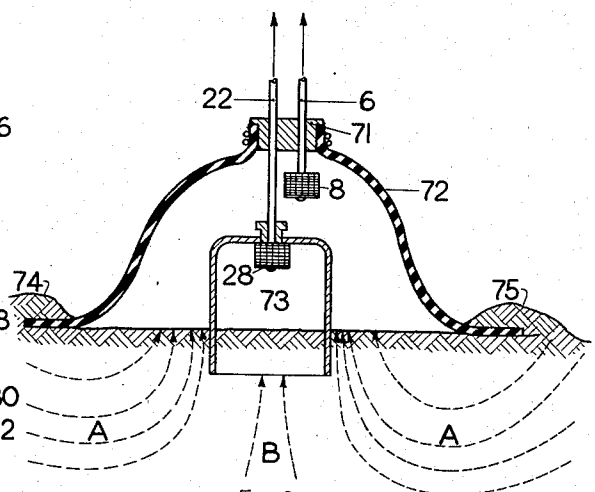


Fig. 3.

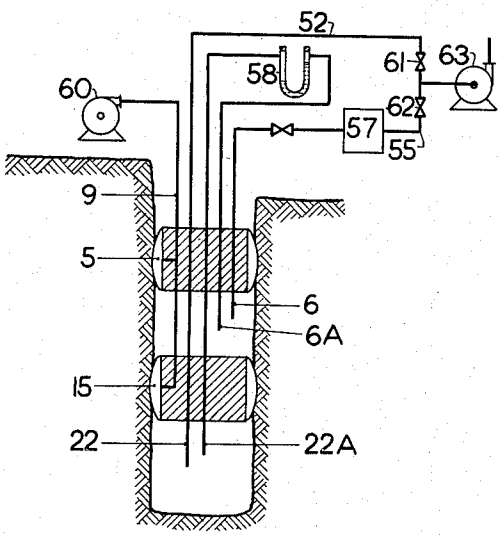


Fig. 4.

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UNITED STATES PATENT OFFICE

2,210,546

SOIL GAS SAMPLING DEVICE AND METHOD

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12 Claims. (Cl. 166—1)

The present invention relates to a method for obtaining samples of gases seeping through the soil, and pertains more particularly to a gas sampler adapted to prevent any contamination of said soil gases by atmospheric air.

The present invention finds a particularly useful application in methods of underground exploration whereby indications of the presence of certain substances, such as oil, in or under a certain formation are derived from the analysis of gases drifting upwards to the surface of the ground by diffusion through the surrounding formations. Thus, it is known that as an oil deposit is approached from any direction, the ratio of ethane or higher hydrocarbons to methane in said soil gases gradually increases owing to the fact that the higher hydrocarbons diffuse through the soil layers at a slower rate than methane. Since, however, the concentration of the hydrocarbons in the samples obtained from the soil is usually exceedingly small, amounting, for example, to about from 10 to 80 parts per million, it is obvious that any contamination of the soil gas samples by atmospheric air will lead to considerable errors and will make the inferences derived from the analysis of said samples entirely worthless.

It is therefore an object of the present invention to provide a method for sampling soil gases, wherein the latter are obtained from a confined sampling zone in contact with the ground, and a second, so-called guard ring zone, is interposed between the atmosphere and the sampling zone, the pressure in said guard ring zone being maintained at a value lower than that of the sampling zone to preclude contamination by atmospheric air seeping through permeable ground.

It is another object of this invention to provide a device of simple and rugged construction whereby soil gas samples may be quickly and efficiently obtained from any desired depth.

Other objects and features of this invention, as well as the construction of a preferred embodiment of the present sampler will be understood from the following description taken with reference to the attached drawings, wherein:

Fig. 1 is a cross-section view of one embodiment of the present device.

Fig. 2 is a diagrammatic cross-section of another embodiment of the present invention.

Fig. 3 is a cross-section view of a form of the present device suitable for taking samples at the surface of the ground.

Fig. 4 is a schematic diagram showing an alternative manometer arrangement for the present device.

The soil gas sampler may comprise a metallic rod 2, consisting of any desired number of sections connected together by means of couplings such as shown at 19, whereby the total length of the sampler may be made to vary from about 10 feet to 40 feet or more. A bit 30 is connected to the lower end of the sampler, and a head 1 to its upper end. The rod 2 is provided with passages or ducts 6, 9 and 22, running longitudinally therethrough. Instead of the solid rod 2 shown in the drawings, a hollow tubular rod may be equally well used, in which case the ducts 6, 9 and 22 are constructed in the form of small diameter tubes made of copper or other suitable material.

The rod 2 is recessed to a smaller diameter at several places, as shown at 4, 12, 14 and 24. Inflatable packers 5 and 15 made of rubber tubing or other suitable material are placed within recesses 4 and 14, respectively, and are securely affixed to the rod 2 by means, for example, of wires or rings such as shown at 18, care being taken to insure a gas-tight fit.

The packers 5 and 15 are in communication on their inner side with the duct 9, connected at the surface with a tube 59 and pump 60, which may be of any desired mechanical or manual type.

An annular filter screen 8 is placed within recess 12, which is located between packers 5 and 15 and is in communication with duct 6 and therethrough with tube 52 and a vacuum pump 63 placed at the surface.

An annular filter screen 28, which may be provided on its inner side with a silk lining 27 to prevent any silt or impurities from getting into the sampling system is placed within the recess 24, which is located below packer 15 and is in communication with duct 22 and therethrough with a tube 56, gas sample reservoir 57, tube 55 and vacuum pump 63, provided with flow-regulating valves 61 and 62.

The packers 5 and 15, when in a deflated condition, and the screens 8 and 28 are placed within the recesses 4, 14, 12 and 24, respectively, in such a manner that they are protected by the overhanging shoulders of the rod 2 from tear or abrasion by contact or friction with the ground when the rod 2 is driven through the ground.

In cases where it is desired to obtain soil-gas samples from a borehole which has been bored or drilled beforehand by means of an ordinary auger or drilling tool, a simplified device schematically shown in Fig. 2 and operating in the

same manner as that of Fig. 1 may be used. This device comprises essentially two packers 5 and 15, which may be lowered and placed within the borehole by any desired means, for example, at the end of tubing strings 6, 9 and 22, made of any suitable material, such as rubber, copper, etc., and corresponding to the similarly numbered ducts of Fig. 1. To keep the packers properly spaced, they may, if desired, be interconnected by a rod 80, of any desired cross-section. The rod 80 may or may not extend to the surface.

In cases where it is desired to obtain gas samples from the surface of the ground, without drilling a borehole, the device shown in Fig. 3 may be used. This device comprises tubes 6 and 22, connected to pump 63, as in Fig. 1. These tubes pass through and support an adapter 71. A hood 72, made of a material such as rubber, impregnated silk, rubberized canvas, etc., and having any suitable shape, such as conical, semispherical, etc. is affixed to the adapter 71, a gas-tight fitting being secured between the tubes, the adapter and the hood. The hood may be provided with a suitable rigid frame or ribs (not shown in the drawings) to prevent it from collapsing when the space thereunder is evacuated. The tube 6 is terminated by an air filter 8 within the hood. The tube 22 is in communication, by means of an air filter 26, with the space within an open-bottom container 73, whose lower edges are adapted to be forced into the ground. The container 73 and the hood 72 may be of any desired size: for example, the container 73 may have a diameter of 1 foot, and the hood 72 a diameter of 12 feet.

In operating the sampling device of Fig. 1, the following procedure may be followed:

After a desired location for obtaining the sample had been selected, the lower section of the sampler, comprising the bit 30 and the screen 28 is driven into the ground, for example, by means of a sledge hammer, by clamp, block and tackle devices, or by applying pressure to the head 1 in any other desired manner. The next rod section is then screwed on top of the first, and the process is continued until the screen 28 has reached a desired depth, such, for example, as from 10 to 50 feet or deeper. The different sections forming the rod 2 are attached to each other in such order that the upper packer 5 is not less than about 5 feet from the surface of the ground, and preferably below the so-called "hard pan", the distance between the packers 5 and 15 being usually about 1 foot. The distance between the lower packer 15 and the screen 28 is preferably about 10 feet.

After the rod 2 has been driven to a desired depth, the connections at the surface are made as shown in the drawing, and the packers 5 and 15 are inflated to any desired pressure within the strength of the material. A pressure of 10 lbs. per square inch will give a good seal between the packers and the formation, while a pressure of 15 lbs. per square inch will support a high vacuum below and atmospheric pressure above either of said packers, if the packers are of "gooch" rubber tubing. Although air is commonly used as the inflating medium, any other fluid, such as an inert gas or a liquid may be used to prevent any possibility of contaminating the samples.

After the packers 5 and 15 have been properly inflated and the portion of the hole below the upper packer has thereby been effectively sealed off from the atmosphere, the space 13 between packers 5 and 15, and the space 23 below packer 15 are exhausted by means of the vacuum pump 63, the gases from space 13 being exhausted to the atmosphere, and the gases from space 23 being drawn through reservoir 57.

The space 13 between packers 5 and 15 is subjected to a higher vacuum than space 23 by properly adjusting valves 61 and 62, and forms a guard ring space around the sampling rod and hole. The purpose of this arrangement is not only to eliminate any possibility of leakage of the atmospheric air past the packers into space 23, wherefrom the gas sample is collected, but also to insure that said sample is not contaminated by any seepage or diffusion of the atmospheric air through a permeable formation along any such paths as shown at A. It will be seen that if the vacuum maintained in space 13 is of a higher order than the vacuum in space 23, no atmospheric air can penetrate within the space 23, since any fluid flow within the formation around and even immediately below the guard ring space will be toward said guard ring and not toward the sampling space. In this manner, the sample obtained from space 23 will be truly representative of the soil gases diffusing through the formation from below only, and the purity of this sample will be made independent of the permeability of the upper soil layers, and of the tightness of the packers.

In order to insure that the vacuum in space 13 is higher than that in space 23, a manometer 58, such for example, as a U-shaped tube, filled with mercury or other suitable liquid is connected between tubes 52 and 55, the difference of the liquid level in the two branches, which may be suitably calibrated, indicating to the operator the existing vacuum differential which may be adjusted by means of valves 61 and 62. In general, this pressure differential should preferably be of the order of 1 centimeter of mercury.

In many cases, it is preferable to use five gaseous conduits or tubes instead of the three shown in Figs. 1 and 2. In such cases, as shown in Fig. 4, besides the tubes 9, 6 and 22, serving the same purposes as in Figs. 1 and 2, the present sampling device is provided with tubes 6A and 22A, opening respectively to the guard ring space 13 and the sampling space 23, the two arms of the manometer 58 being connected to said tubes 6A and 22A. In this manner, the readings of the manometer 58 are truly indicative of the pressure differences in spaces 13 and 23, and are not influenced by effects arising from the viscous flow of gases in tubes 6 and 22.

In operating the device shown in Fig. 3, the lower edges of the container 73 are forced into the ground to a depth of about 4 to 6 inches. The outer edge of the hood 72 is then placed in contact with the ground and is covered with a sufficient amount of loose ground to prevent leakage, as shown at 74 and 75. The spaces within the hood 72 and the container 73 are then evacuated as before, a higher degree of vacuum being maintained under the hood 72 than under the container 73. The atmospheric air seeping through the permeable ground will then be directed towards the low-pressure space under the hood 72, as shown at A and A_1, and only the gases seeping upwards from deep zones will find their way to the space under the container 73, as shown at B.

After operating pump 63 for a time sufficient to insure that all atmospheric air trapped within space 23 by inflating the packers had been removed from the system, the reservoir 57 is flushed with the soil air from the sampling space and is

then filled with non-contaminated soil gases from space 23, whereafter the valves 50 and 51 are closed and sealed, and the sample is ready for analysis.

It is understood that the present invention is not limited to any of the particular embodiments described above, but relates broadly to a method and apparatus for obtaining soil-gas samples, wherein the sampling zone is maintained at a pressure lower than that of the atmosphere, and a guard ring zone is interposed between the sampling zone and the atmosphere, the pressure in said guard ring zone being lower than that of the sampling zone. Thus, any desired amount of packers or seals may be used instead of two for the purpose of establishing the two essential zones described above, and these packers or seals may not necessarily be of the expansible or inflatable type. Any packer, even if it allows a certain amount of leakage between its periphery and the walls of the hole, is operatively satisfactory provided sufficient suction is properly applied to establish the pressure differential required according to the present invention between the sampling zone and the guard ring zone.

I claim as my invention:

1. In a method for obtaining soil gas samples from the ground, confining a sampling zone in contact with the ground, maintaining said zone at a pressure below that of the atmosphere, confining and interposing a second zone between the sampling zone and the atmosphere, and maintaining the pressure in said zone at a value lower than that of the sampling zone.

2. In a method for obtaining soil gas samples from a borehole, confining a sampling zone in contact with the bottom portion of the borehole, maintaining said zone at a pressure below that of the atmosphere, confining a second zone in contact with the walls of the borehole, said second zone being interposed between the sampling zone and the atmosphere, and maintaining said second zone at a pressure lower than that of the sampling zone.

3. In a device for obtaining soil gas samples, two spaced sealing means adapted to be placed above each other within a borehole in contact with the walls thereof, means for reducing the pressure in the space formed by the lower sealing means and the walls of the borehole to a value below that of the atmosphere, and means for reducing the pressure in the space formed by the two sealing means and the walls of the borehole to a value below that of the space formed by the lower sealing means and the walls of the borehole.

4. In a device for obtaining soil gas samples, two spaced expansible packers adapted to be placed above each other within a borehole, means to expand said packers into contact with the walls of the borehole, means for reducing the pressure in the space formed by the lower packer and the walls of the borehole to a value below that of the atmosphere, and means for reducing the pressure in the space formed by the two packers and the walls of the borehole to a value below that of the space formed by the lower packer and the walls of the borehole.

5. In a device for obtaining soil gas samples, two spaced expansible packers adapted to be placed above each other within a borehole, a first gaseous conduit passing through the two packers and opening to the outside below the lower packer, a second gaseous conduit passing through the upper packer and opening to the outside between said two packers, means to expand the packers into contact with the walls of the borehole, means comprising said first gaseous conduit to reduce the pressure in the space formed by the lower packer and the walls of the formation to a value below that of the atmosphere, and means comprising said second gaseous conduit to reduce the pressure in the space formed by the two packers and the walls of the borehole to a value below that of the space formed by the lower packer and the walls of the borehole.

6. In a device for obtaining soil gas samples, two spaced expansible packers adapted to be placed above each other within a borehole, a first gaseous conduit passing through the two packers and opening to the outside below the lower packer, a second gaseous conduit passing through the upper packer and opening to the outside between said two packers, means to expand the packers into contact with the walls of the borehole, manometer means at the surface in gaseous communication with the space formed by the lower packer and the walls of the borehole and with the space formed by the two packers and the walls of the borehole for indicating the pressures in said two spaces, means comprising said first gaseous conduit to reduce the pressure in the space formed by the lower packer and the walls of the formation to a value below that of the atmosphere, and means comprising said second gaseous conduit to reduce the pressure in the space formed by the two packers and the walls of the borehole to a value below that of the space formed by the lower packer and the walls of the borehole.

7. In a device for obtaining soil gas samples, a rod adapted to be placed in a borehole, said rod carrying at least two spaced packers adapted to form a seal with the walls of the borehole, means for maintaining a vacuum in the space confined by the lowermost packer and the walls of the hole, and means for maintaining a vacuum in the space confined by the two packers and the walls of the borehole said second vacuum being higher than said first vacuum.

8. In a device for obtaining soil gas samples, a rod adapted to be placed in a borehole, at least two spaced expansible packers carried by said rod, means to expand said packers into sealing contact with the walls of the hole, means for applying a vacuum to the space confined by the lower packer and the walls of the hole, and means for applying a vacuum to the space confined by the two packers and the walls of the hole, said second vacuum being higher than said first vacuum.

9. In a device for obtaining soil gas samples, a rod, a bit on the lower end of the rod, means for driving said rod into the ground, at least two spaced expansible packers carried by said rod, means to expand said packers into sealing contact with the formation surrounding said rod, means for applying a vacuum to the space confined by the lower packer and the formation, and means for applying a vacuum to the space confined by the two packers and the formation, said second vacuum being higher than said first vacuum.

10. In a device for obtaining soil gas samples, a rod, a bit on the lower end of the rod, means for driving the rod into the ground, at least two spaced annular recesses on said rod, inflatable packers mounted on the rod within said recesses, means to apply fluid pressure to the inner side of said packers, thereby expanding them into sealing contact with the formation surrounding the

rod, means for applying a vacuum to the space confined by the lower packer and the formation, and means for applying a vacuum to the space confined by the two packers and the formation, said second vacuum being higher than said first vacuum.

11. A device for obtaining gas samples from the ground, said device comprising a first sealing means having its peripheral edge in gas-tight contact with the ground, whereby a gas-filled sampling space is defined by said sealing means and the ground, a second sealing means having its perpheral edge in gas-tight contact with the ground, said second sealing means being spaced from said first sealing means, whereby a second gas-filled space is defined by said two sealing means and the ground, said second space being interposed between said first space and the atmosphere, means to apply a vacuum to each of said spaces, and means to regulate the degree of vacuum applied to each of said spaces.

12. In a method for obtaining soil gas samples from the ground, confining a gas-filled sampling zone in contact with the ground, maintaining said zone at a pressure below that of the atmosphere, confining and interposing a second gas-filled zone between the sampling zone and the atmosphere, maintaining said second zone at a pressure below that of the atmosphere, and regulating the ratio of the pressures in said two zones.

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