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METHOD OF DETECTING THE PENETRATION OF AN OIL-BEARING HORIZON

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Fig. 1

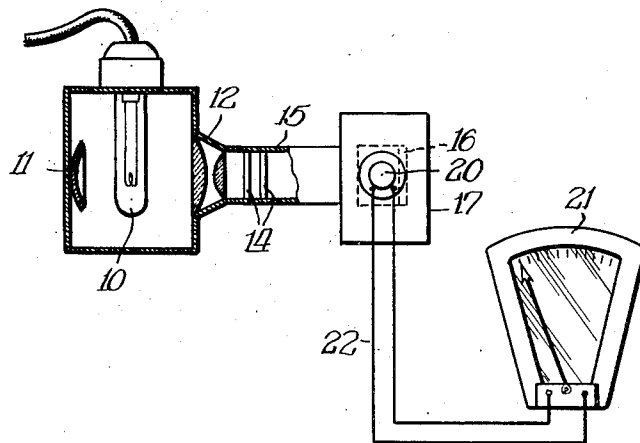
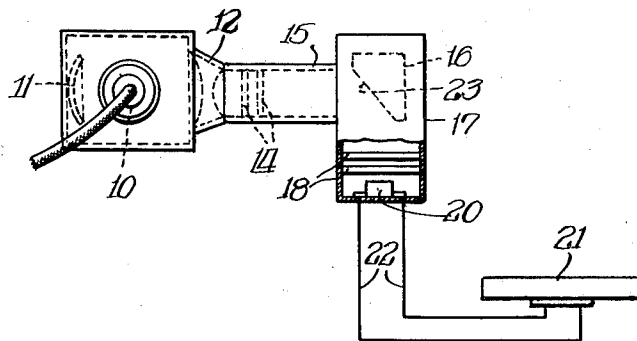


Fig. 2



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METHOD OF DETECTING THE PENETRATION
OF AN OIL-BEARING HORIZONJohn G. Campbell, Houston, Tex., assignor to
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3 Claims. (Cl. 255—1.4)

The invention relates to a method for use in exploring for oil and has more particular reference to an improved method of detecting the penetration of an oil-bearing horizon by the application of ultra-violet light to the drilling fluid entering the well and that leaving the well.

This is a continuation-in-part of my prior Patent No. 2,227,438 granted January 7, 1941, and entitled Method of determining the petroleum oil content of earth samples. In said patent the fact was brought out that in the process of drilling for oil difficulty has been encountered in determining whether an horizon which has been penetrated contains sufficient oil to justify the expense of testing. Due to this uncertainty, productive horizons have occasionally been passed up and the oil which could be produced from these horizons has been lost. This passing up of productive horizons is particularly true of wells drilled by the rotary method, where the sealing action of the mud from the rotary fluids seals off productive horizons.

Until recent years, the detection of productive oil horizons has been dependent upon determining the presence of oil in cores or cuttings and by observing the rainbow on the drilling fluid produced by oil from an horizon. More recently, a system of electrical logging has been used to determine the presence or absence of productive horizons. This system depends upon determining the electrical resistivity of strata encountered in a well. In certain areas, this method has not proved satisfactory and even in the areas where considerable success has been attained some uncertainty exists as to results. This system of electrical logging necessitates the stopping of the drilling operations in order to obtain a resistivity log of a well.

The primary object of the present invention is to provide a method of detecting the penetration of an oil-bearing horizon by comparing the drilling fluid discharged from the well with that entering the well. More specifically, the invention contemplates that the drilling fluids be examined under ultra-violet light and a comparison made between the drilling fluid entering the well and that leaving the well. An increase in the fluorescence of the fluid from the well indicates the penetration of an oil bearing zone. The foregoing is based upon the fact that the drilling fluids will have a fluorescent appearance in ultra-violet light, the intensity of which is in proportion to the oil content. It is therefore possible to obtain a comparison between the oil content of the drilling fluid entering and leaving the well.

In my process of drilling oil wells by the rotary method, a heavy mud, termed "drilling fluid," is pumped through the drill-pipe to the bottom of the hole being drilled. This drilling fluid serves a three-fold purpose: The fluid passes from the drill-pipe through openings in the drilling tool, thereby cooling the tool. After leaving the tool, the drilling fluid ascends to the surface of the ground in the channel between the drill pipe and sides of the hole. The sides of the well become coated with a layer of mud which seals off the surrounding horizons. The ascending flow of drilling fluid carries the cuttings from the bit to the surface of the ground and said cuttings may be analyzed as disclosed and claimed in my patent, herein identified, to determine the oil content thereof. Since the drilling fluid has intimate contact with the horizons penetrated, it follows that if said horizons contain oil then oil will be present in the drilling fluid. However, the amount of oil present in the drilling fluid may not be sufficient to form a rainbow on the fluid in the mud pit because of the sealing action of the mud on the walls of the well. Since all horizons penetrated carry small amounts of oil, the drilling fluid will always contain some oil, but when an horizon carrying a large amount of oil is penetrated there will be a large increase in the oil content of said drilling fluid.

In accordance with the present method, this increase in the oil content of the drilling fluid from the well is determined by comparing under ultra-violet light a sample of the drilling fluid entering the well with a sample discharged from the well and noting the difference in intensity in the fluorescence of the two samples which should contain equal surface areas of liquid for subjection to the ultra-violet light. It is to be understood that each sample under ultra-violet light will fluoresce to an intensity proportionate to the oil content of the same. Accordingly, if the drilling fluid discharged from the well does contain an increase in oil, this increase will be readily detected by the resulting greater intensity in the fluorescence of the sample containing this discharged drilling fluid.

The oil contained in the drilling fluid will comprise the oil dispersed in the liquid and also any particles of oil or globules suspended in the drilling fluid and which are carried along therewith. When samples of the drilling fluids are subjected to ultra-violet light as above described so that the fluorescence may be observed it will be understood that the invention is concerned with the total fluorescent effect of the sur-

face of each sample subjected to ultra-violet light. Said total fluorescence is that produced by the oil dispersed in the liquid and also the fluorescence of any minute particles of oil suspended in the liquid. Drilling fluid containing dispersed oil will glow with a deep violet color when under the influence of ultra-violet light. However, the suspended oil particles or globules will appear as individual bright specks. Therefore the oil content of the drilling fluid samples can be determined by measuring the total fluorescence under ultra-violet light since said fluorescence is proportional to the amount of oil.

With these and various other objects in view, the invention may consist of certain novel features of construction and operation, as will be more fully described and particularly pointed out in the specification, drawing and claims appended hereto.

In the drawing which illustrates an embodiment of the invention and wherein like reference characters are used to designate like parts—

Figure 1 is a side elevational view illustrating an instrument for subjecting the drilling fluid samples to ultra-violet light and measuring the fluorescent effect produced; and

Figure 2 is a top plan view of the instrument shown in Figure 1.

It is essential that the samples be subjected to ultra-violet light in a room free of visible light and for precise work it is likewise essential that all visible light as far as practicable be filtered out from the source of ultra-violet rays. Violet ray equipment which has been found satisfactory for purposes of the present invention is standard equipment such as shown in the drawing for measuring the fluorescence of liquids and solids. The exciting light source 10 may consist of a mercury capillary arc. Behind the lamp is a reflector 11 and in front a condensing lens system 12. The filters 14 permit passage of ultra-violet light but filter out significant visible rays. The metal tube 15 allows passage of the exciting light to the cuvette 16 in the housing 17, one side of which can be removed for the introduction or withdrawal of the cuvette. The fluorescent light from the drilling fluid sample within the cuvette passes through the special filters 18 to the photo-electric cell 20 connecting in circuit with the galvanometer 21 either directly by the wires 22, as shown in the drawing, or indirectly through a switch control panel not shown. The fluorescent light striking the photo-electric cell allows a current to flow to the galvanometer proportional to the intensity of the fluorescent effect. The reading on the galvanometer can be converted into terms of oil by comparing the fluorescence produced by known amounts of crude petroleum dispersed in an equal quantity of drilling fluid. In this connection, it is only necessary to calibrate the instrument by testing the standard drilling fluids wherein the petroleum oil concentration is known and following such calibration the amount of oil in a drilling fluid sample taken from a well can be readily determined.

The instrument above described is similar in construction and operation to that shown in my copending application Serial No. 334,341 entitled Analysis of soil samples for determining oil content and filed May 10, 1940.

Before subjecting samples of the drilling fluids to ultra-violet light it is desirable to separate the cuttings contained in the drilling fluids from the fluid. This action of centrifugal force on the

liquid causes the cuttings to settle to the bottom of the container. The invention contemplates the separation of the cuttings in order that the sample of drilling fluid subjected to ultra-violet light will be relatively free of coarse particles obtained from the drilling operation. The removal of the large particles of cuttings results in obtaining a sample more nearly representative of the horizon being penetrated because of the time lag of the heavy particles reaching the surface.

When the drilling fluid is contained within the cuvette 16 the portion of the sample in contact with the diagonal wall 23 will be subjected to ultra-violet light. Also to obtain a comparison of the fluorescence of the drilling fluid leaving the well with the fluorescence of the drilling fluid entering the well the respective samples may be contained in separate cuvettes conveniently positioned side by side in the instrument and both subjected to the action of ultra-violet rays in a manner as described. Any difference in the intensity of the fluorescence of the two samples may then be observed by the operator in any convenient manner.

It has been found that the action of centrifugal force on the drilling fluid during the process of separating the large particles also results in increasing the concentration of the oil at the surface. This increased concentration assists in detecting the oil within the samples. However, the intensity of the fluorescence produced by subjecting the samples to ultra-violet light can be enhanced by the addition of an oil solvent, such as ethyl ether or benzol, especially if a thin layer of the solvent is produced on the surface of the sample, since the same will dissolve the oil in the surface layer of the sample. The addition of ethyl ether or benzol to the sample sufficient to form a relatively thin layer, approximately one-eighth of an inch to one-sixteenth of an inch in thickness, is satisfactory for purposes of the invention, it being understood that this thin layer does not act to extract the oil from the main body of the sample but merely concentrates the surface oil within the solvent layer so that the fluorescent effect may be observed to better advantage. It is contemplated that the fluorescent effect produced in this surface layer of solvent by ultra-violet light can be viewed to best advantage on a horizontal plane looking through the thickest section of the solvent layer. Since the concentration of the oil in the solvent is dependent upon the surface area of the sample and the volume of the solvent, the invention requires that equivalent amounts of solvent per unit of surface area of the sample be used. The solvent used for the surface layer, as above described, should produce none or only a small amount of fluorescent light when exposed to ultra-violet rays. The material in such solvents which will produce fluorescent light can be removed by treatment with activated carbon such as Nuchar. When such solvents are treated with activated carbons care should be taken that none of the carbon remains in the solvent because any such solvent will interfere with obtaining a proper measurement of the intensity of the fluorescent effect.

In the preferable practice of the invention, the samples taken of the drilling fluid entering and leaving the well represent approximately the same fluid. In order that the sample taken of the drilling fluid leaving the well will correspond to the fluid entering, a certain time factor must be considered, based on the approximate depth

of the well, the size of the hole and the speed of pumping. These factors determine the flow of the fluid into the well and back to the surface again. Therefore the sample of the discharge fluid is taken following a lapse of time, based on the above given factors, so that the two samples eventually compared under ultra-violet light will represent approximately the same drilling fluid. It is possible by the present method to obtain comparisons of the drilling fluid samples at the well and while the drilling operation continues.

The invention as hereinabove set forth may be variously embodied within the scope of the following claims.

What is claimed is:

1. The method of determining the penetration of an oil-bearing horizon in the drilling of a well, which consists in obtaining a sample of the drilling fluid entering the well and an independent sample of approximately the same drilling fluid leaving said well, adding equal amounts of an oil solvent per unit surface area to the surface of each sample to form a relatively thin layer of said solvent over the surface, subjecting the said samples to the action of ultra-violet light in order to cause the oil content thereof to fluoresce, the intensity of the fluorescence of said samples being in direct proportion to the oil content thereof, and measuring any increase in the fluorescence of the discharged drilling fluid sample as compared to the fluorescence of the sample of drilling fluid entering the well, to thereby detect the penetration of an oil-bearing horizon, said thin layer of oil solvent on the surface of each sample facilitating the observation of the fluorescent effect.

2. The method of determining the penetration of an oil-bearing horizon in the drilling of a well, which consists in obtaining samples of the drilling fluid entering and approximately the same drilling fluid leaving the well, respectively, add-

ing equal amounts of an oil solvent per unit surface area to the surface of each sample to form a relatively thin layer of solvent over the surface to thereby extract a quantity of the oil from the surface layer of the sample, subjecting the solvent layer on the surface of each sample of drilling fluid to the action of ultra-violet light to cause the oil content thereof to fluoresce, the intensity of the fluorescence of said oil solvent layers being in direct proportion to the oil content thereof, observing the fluorescence of said oil solvent layers, and noting any increase in the fluorescence of the solvent layer over the surface of the discharged drilling fluid as compared to the fluorescence of the solvent layer over the surface of the drilling fluid entering the well, to thereby detect the presence of an oil-bearing horizon.

3. The method of determining the penetration of an oil-bearing horizon in the drilling of a well, which consists in obtaining samples of the drilling fluid entering and approximately the same drilling fluid leaving the well, respectively, adding equal amounts of ethyl ether per unit surface area to the surface of each sample to form a relatively thin layer over the surface to thereby extract a quantity of the oil from the surface layer of the sample, subjecting the ethyl ether layer on the surface of each sample of the drilling fluid to the action of ultra-violet light to cause the oil content thereof to fluoresce, the intensity of the fluorescence of said layers being in direct proportion to the oil content thereof, observing the fluorescence of said ethyl ether layers, and noting any increase in the fluorescence of the said layer over the surface of the discharged drilling fluid as compared to the fluorescence of the ethyl ether layer over the surface of the drilling fluid entering the well, to thereby detect the presence of an oil-bearing horizon.

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